Electricity Supply Corporation of Malawi Limited (ESCOM)
Ministry of Energy (MOE)
The Republic of Malawi

PREPARATORY SURVEY REPORT ON THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC OF MALAWI

NOVEMBER 2020

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

YACHIYO ENGINEERING CO., LTD.
WEST JAPAN ENGINEERING CONSULTANTS, INC.

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to the Consortium consist of Yachiyo Engineering Co., Ltd. and West Japan Engineering Consultants, Inc.

The survey team held a series of discussions with the officials concerned of the Government of Malawi, and conducted field investigations. As a result of further studies in Japan, 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.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Malawi for their close cooperation extended to the survey team.

November, 2020

Amada Kiyoshi

Director General,

Infrastructure Management Department

Japan International Cooperation Agency

SUMMARY

① Overview of the Country

The Republic of Malawi (hereinafter referred to as "Malawi") is a landlocked country located in the southeastern part of the African continent at latitudes 9 ° -17 ° S and longitude 33 ° -36 ° east. The land is long and narrow with 855 km from north to south, and the national land area is 118,000 km^2, of which Lake Malawi occupies about one-fifth. Most of the western region to the border with Lilongwe and Zambia and the southeast to the border with Mozambique are plateaus at an altitude of 1,100 to 1,400 m, with gently undulating flat terrain.

The Government of Malawi has formulated the "Integrated Resource Plan for Malawi (IRP)" a strategic roadmap for the energy sector. The electricity demand forecast was reviewed from a long-term perspective for the next 20 years (2017-2037), and high-priority power development plan, grid development plan, and minimum cost investment plan were formulated. In particular, the total population of the capital city of Lilongwe, where major industries are concentrated, is about 2.6 million including urban and rural areas, which is about 15 % of the national total. It is expected that the substation facilities will be renovated and strengthened in order to improve the infrastructure for industrial development in the city and promote further economic development. On the other hand, the supply capacity of many substations in the country has already reached its limit, and it is expected that it will not be able to cope with the future increase in power supply due to its severe deterioration.

② Background of the Project

In order to overcome this situation, the Government of Malawi has formulated the "National Energy Policy 2018 (NEP 2018)". It states that "government will intensify the expansion and rehabilitation of the transmission system in line with the IRP and in a socially and environmentally responsible manner, with a view to catalysing industrialisation, rural transformation, sustainable economic development, inclusive growth and creation of wealth".

However, many substations have serious problems such as lack of transformers capacity suitable for rapid increasing power demand and future power supply, and chronic rolling blackouts due to aging.

Based on the background, the Government of Malawi has requested the Government of Japan on the Project for Improvement of Substations in Lilongwe City.

③ Outline of the study findings and Project contents

In response to the request, JICA dispatched the Survey Team to Malawi from January 19 to February 17, 2019 (first field survey) and from January 19 to January 27, 2020 (second field survey) in order to reconfirm the contents of the request and discuss the contents for implementation with related agencies on the Malawi side (the Executing Agency: ESCOM, the line ministry of the Executing Agency: Ministry of Infrastructure (MOE)), and survey the Project sites and gather related materials and data.

On returning to Japan, the Survey Team examined the necessity, social and economic impacts and

validity of the Project based on the field survey materials and compiled the findings into the draft preparatory survey report. Also, JICA and the Survey Team had Web conference with Malawi side from September 30 to October 2, 2020 in order to explain and discuss the draft preparatory survey report (outline explanations) and reach a basic agreement with the Malawi side.

The Project plan compiled based on the survey findings targets the procurement and installation for the improvement of substation facilities, and the construction of new substations and related facilities. The Outline of the Basic Plan is as follows;

Outline of the Project Components

Category		Major Components	Quantity
Procurement/Installation	1	**Expansion and Rehabilitation of Kanengo Substation (Lilongwe-B) (132/66/33/11 kV)**	
		- 50MVA 132/66 kV Auto transformer with OLTC	2 units
		- 25 MVA 66/33 kV Power transformer with OLTC	1 unit
		- 25 MVA 66/11 kV Power transformer with OLTC	1 unit
		- 132 kV Switchgear facilities	1 lot
		- 66kV Switchgear facilities	1 lot
		- 33kV Switchgear facilities	1 lot
		- 11kV Switchgears (Indoor type metal clad type)	1 lot
		- Control and protection panels & Substation control system (IEC61850 based)	1 lot
		- Station transformer	1 unit
		- AC/DC LV power facilities	1 lot
		- Earthing System	1 lot
	2	**Renewal of Old Town Substation (Lilongwe-A) (66/33/11 kV)**	
		- 25 MVA 66/33 kV Power transformer with OLTC	1 unit
		- 25/31.5 MVA (ONAN/ONAF) 66 /11 kV Power transformer with OLTC	1 unit
		- 66kV Switchgear facilities	1 lot
		- 33kV Switchgears (Indoor type metal clad type)	1 lot
		- 11kV Switchgears (Indoor type metal clad type)	1 lot
		- Control and protection panels & Substation control system (IEC61850 based)	1 lot
		- Station transformer	1 unit
		- AC/DC LV power facilities	1 lot
		- Earthing System	1 lot
Procurement	3	**Maintenance Tool for the Equipment of the Project**	1 lot
	4	**Spare Parts and Consumables for the Equipment of the Project**	1 lot
Construction Work	5	**Foundation for the Equipment of the Project (Transformers, Gantry Towers, etc.)**	1 lot
	6	**Control Building for Kanengo Substation**	1 building
	7	**Control Building for Old Town Substation**	1 building

④ Project implementation schedule and cost estimation

In the case where the Project is implemented under the Government of Japan's Grant Aid scheme, the total cost of the Project will be (*confidential*). The costs to be borne by the Malawi side will be 2,124,832 US$. The contents and costs to be borne by the Malawi side are as given below:

1) Before the Bid (Relocation of all existing underground cables, etc): 747,102 US$
2) Before the Project Implementation Removal of existing equipment, etc): 79,557 US$
3) During the Project Implementation (Rerouting of 66 kV existing transmission line to gantry with support structure, etc): 867,930 US$
4) After the Project (Allocation of maintenance cost, etc): 430,243 US$

The implementation schedule for the Project (after the Contract with Successful Bidder) will be approximately 25 months.

⑤ Project Evaluation

(1) Relevance

The relevance for this Project is considered to be high as it helps to achieve Malawi socioeconomic development policy as well as Japan's official development assistance (ODA) policy.

(2) Efficiency

The impacts expected from the implementation of the Project are as follows:

1） Quantitative impacts

Outcome Indicator	Base Value (2019 Current Value)	Target Value (2026) (3 years after the completion of the Project)	
		Without the Project	With the Project
1. Installed capacity in Kanengo Substation *1(MVA)	83.0 *2	83.0 *2	158.0 *2
2. Installed capacity in Old Town Substation *3 (MVA)	37.5	37.5	50.0
3. Capacity utilization ratio of Kanengo Substation *4 (%)	101.7	134.1	70.4
4. Capacity utilization ratio of Old Town Substation *4 (%)	65.4	80.1	60.4

*1 Indicate the installed capacity of 132kV System Voltage in Kanengo Substation
*2 Indicate the installed capacity when using Oil Natural Air Forced(ONAF)
*3 Indicate the installed capacity of 66kV System Voltage in Old Town Substation
*4 Ratio of power demand to installed capacity. Forecasted Demand in 2026 at Kanengo Substation is 111.3 MVA (132 kV) and at Old Town Substation is 30.2 MVA (66 kV)

2） Qualitative impacts (Project)

Present Status and Problems	Project Countermeasures (Grant Aid Project)	Extent of Project Effects and Improvement
In Malawi, the demand for electric power is increasing rapidly. On the other hand, the unstable electric supply due to the insufficient of transformer capacity and aging of substation facilities, causing frequent power outages including chronic rolling blackouts, cause the following problems. 1. It cause reduction of the quality of lives of residents. 2. It cause trouble the operation of public facilities, especially medical facilities and airport facilities. 3. It slows down industrial and economic development.	Rehabilitation of Kanengo Substation and renewal of Old Town Substation	After implementation of the Project, installation capacity of substation will be increased and supply capacity be recovered to the Lilongwe City, which contribute to economic activities, public services and the lives of residents.

To sum up, since Project implementation can be expected to have major effects, it is confirmed to be relevant for implementation under the Grant Aid scheme of the Government of Japan. Moreover, the Malawi side is deemed to possess adequate personnel and budget for implementing the Project and conducting operation and maintenance after implementation.

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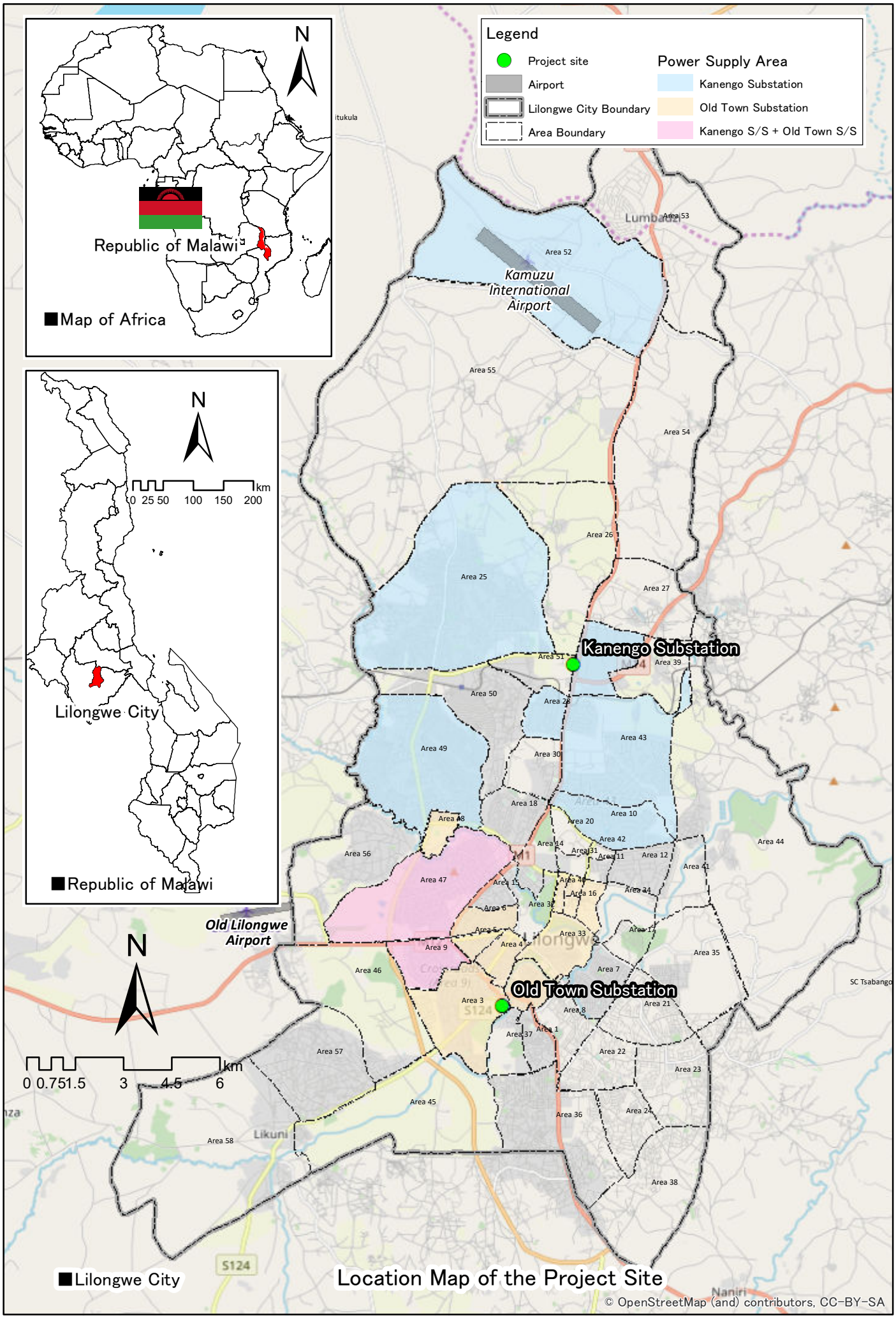
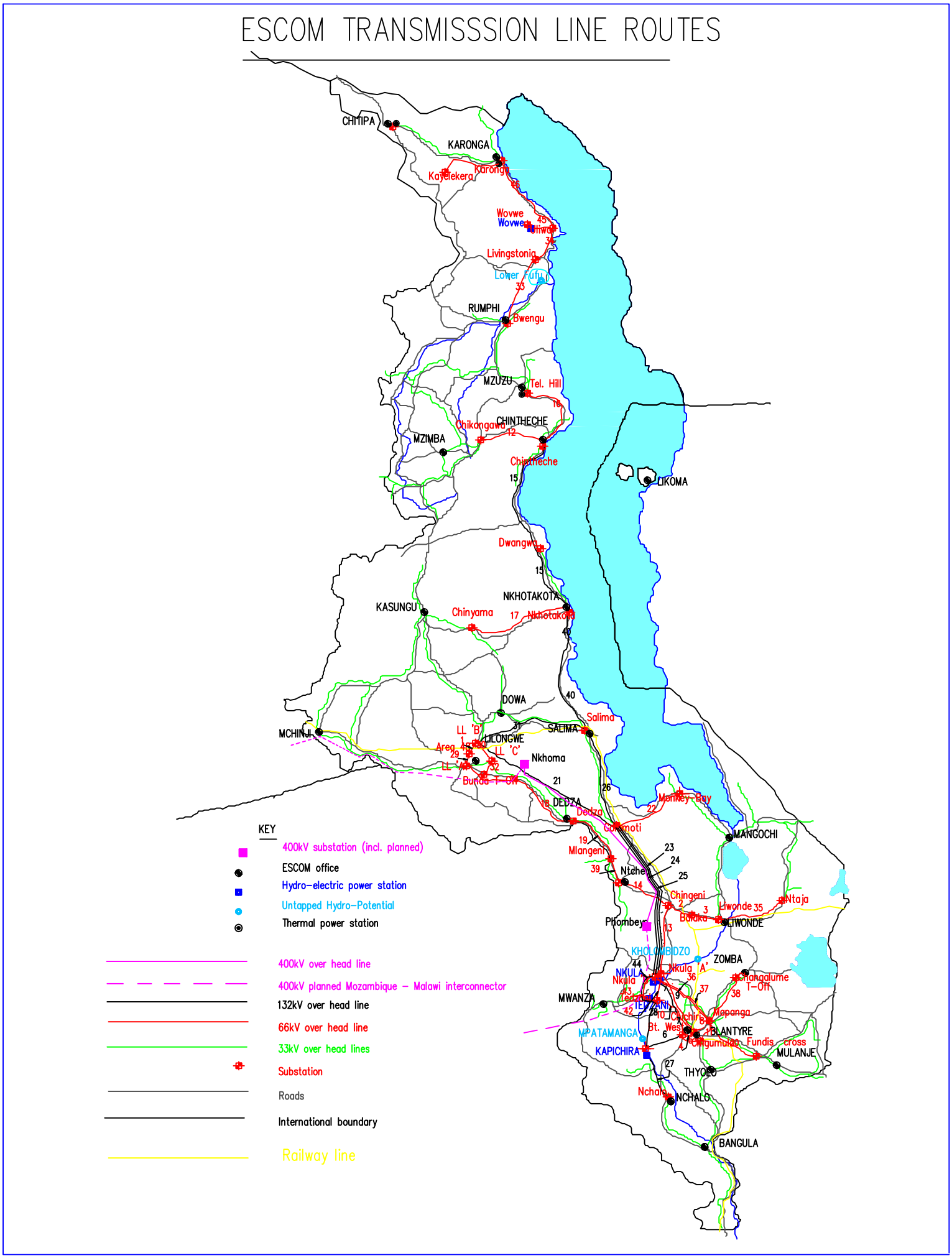

Legend
Project site
Airport
Lilongwe City Boundary
Area Boundary
Power Supply Area
Kanengo Substation
Old Town Substation
Kanengo S/S + Old Town S/S
N
Republic of Malawi
Map of Africa
Lilongwe City
Republic of Malawi
0 25 50 100 150 200 km
Kamuzu International Airport
Old Lilongwe Airport
Kanengo Substation
Old Town Substation
0 0.751.5 3 4.5 6 km
Lilongwe City
Location Map of the Project Site
© OpenStreetMap (and) contributors, CC-BY-SA

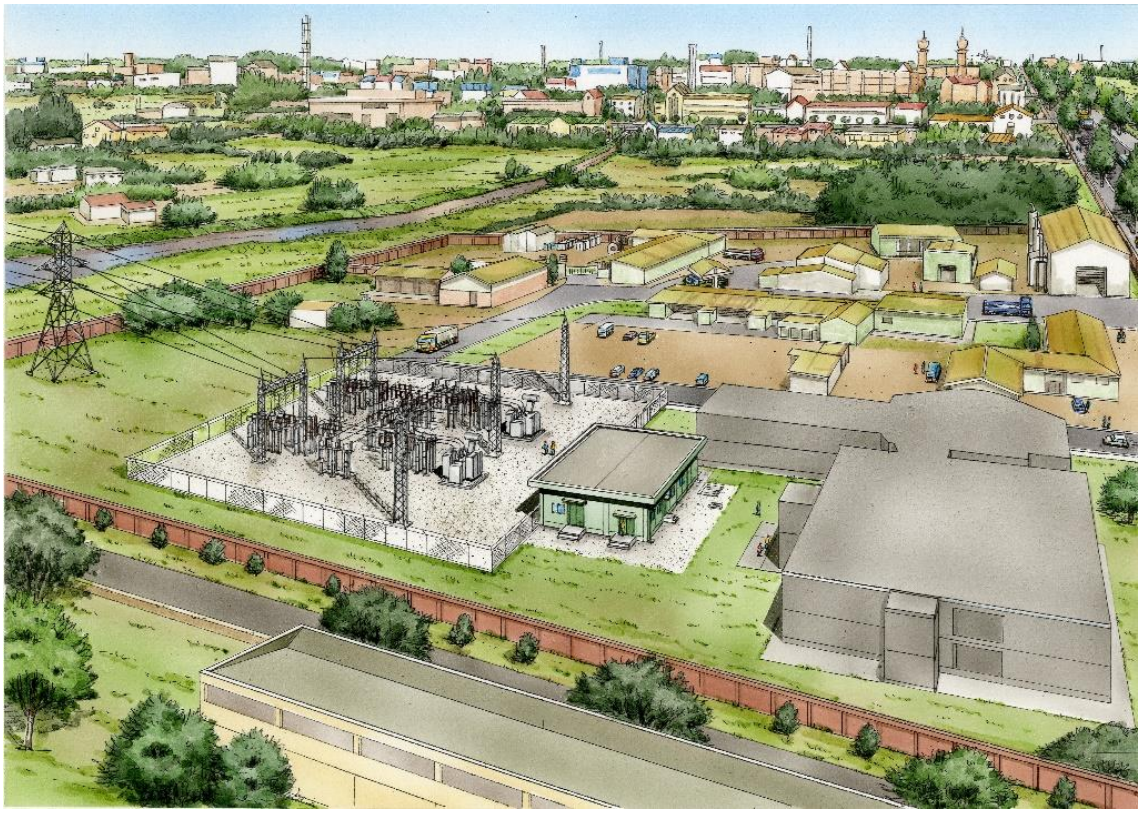


Source: ESCOM

ESCOM Transmission Network Diagram in Malawi

(1) Kanengo Substation

(2) Old Town Substation



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Abbreviations

ASEAN	Association of South - East Asian Nations
AfDB	African Development Bank
BCU	Bay Control Units
BS	British standard
DAC	Development Assistance Committee
DC	Direct Current
DIN	Deutsches Institut für Normung
EAPP	Eastern African Power Pool
EIA	Environmental Impact Assess
E/N	Exchange of Notes
ESCOM	Electricity Supply Corporation of Malawi Limited
EGENCO	Electricity Generation Company (Malawi) Limited
EU	European Union
FS	Fusibility Study
G/A	Grant Agreement
GDP	Gross Domestic Product
GNI	Gross National Income
GIS	Gas Insulated Switchgear
IDA	International Development Association
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IMF	International Monetary Fund
IRP	Integrated Resource Plan for Malawi
IPP	Independent Power Producer
JEC	Japanese Electrotechnical Committee
JEM	Japan Electrical Manufacturers' Association
JICA	Japan International Cooperation Agency
JIS	Japan Industrial Standards
KV	Kilo Volt
LAN	Local Area Network
M/D	Minutes of Discussions
MCCB	Molded Case Circuit Breaker
MCC	Millennium Challenge Corporation
MEAP	Malawi Electricity Access Project
MFNR	Ministry of Forestry and Natural Resources
MGDS	Malawi Growth and Development Strategy
MOE	Ministry of Energy
MOF	Ministry of Finance
MDGs	Millennium Development Goals

MFEPD	Ministry of Finance, Economic Planning and Development
MNREM	Ministry of Natural Resources, Energy and Mining
MRA	Malawi Revenue Authority
MVA	Mega Volt-Ampere
MW	Mega Watt
NCC	National Control Center
NCIC	National Construction Industry Council
NEP	National Energy Policy
OJT	On the Job Training
ONAF	Oil Natural Air Forced
ONAN	Oil Natural Air Natural
O&M	Operation and Maintenance
QS	Quantity Surveyor
PCB	Poly Chlorinated Biphenyl
ROD	Record of Discussion
RTU	Remote Terminal Unit
SABS	South African Bureau of Standard
SAPP	Southern African Power Pool
SAS	Substation Automation System
SCADA	Supervisory Control and Data Acquisition System
SCP	Substation Control Panel
SI	International System of Units
SMO	System and Market Operator
TOR	Term of Reference
TICAD	Tokyo International Conference on African Development
TPIN	Tax Payer Identification Number
UPS	Uninterruptible Power Supply
WB	World Bank
WDI	World Development Indicators

CHAPTER 1 BACKGROUND OF THE PROJECT

Chapter 1 Background of the Project

1-1 Background of the Project

The Republic of Malawi (hereinafter referred to as "Malawi") is a landlocked country located in the southeastern part of the African continent with a population of around 17.56 million[1]. Surrounded by mineral resource-rich countries such as Zambia and Mozambique, the country has been attracting attention in recent years on its potential for mineral resource development, such as rare earths.

Malawi's installed capacity of power generation in 2018 is about 403 MW. On the other hand, Malawi's peak electricity demand in 2018 was 526 MW, and it is expected that electricity demand will reach 1,155 MW in 2025[2], due to increasing industrial development and an average annual population increase of 2.6 %[3]. Approximately 91 % of the country's main power sources depend on hydroelectric power generation, and the decline in the utilization rate of power plants nationwide due to the effects of water shortages in recent years has spurred the normal power shortage. Therefore, it is necessary to secure the power supply capacity to meet the future economic growth and increase in power demand expected due to the recent increase in domestic industries and population growth. Under these circumstances, the Malawi government is prioritizing the enhancement of power generation capacity as an urgent issue, aiming to increase the power supply to 1,254 MW by 2025 with the support of other donors. Furthermore, the national electrification rate is as low as about 14.6 %, urban areas about 62.5 %, and rural areas about 5.1 %[4], and the government has set a target of 30% by 2020 and 40% by 2050[5].

On the other hand, the supply capacity of many substations in the country[6] has already reached its limit, and it is expected that it will not be able to cope with the future increase in power supply due to its severe deterioration. In particular, the total population of the capital city of Lilongwe, where major industries are concentrated, is about 2.6 million including urban and rural areas, which is about 15 % of the national total. It is expected that the substation facilities will be renovated and strengthened in order to improve the infrastructure for industrial development in the city and promote further economic development.

The Electricity Supply Corporation of Malawi Limited (ESCOM), which is responsible for power transmission, transformation, and distribution, faces the biggest issue of power supply limitations. The main causes of the limitations are explained below.

(1) Insufficient substation capacity

Since it is difficult to raise funds, it has not been possible to expand, upgrade, or install new

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[1] Census 2018, National Statistical Office of Malawi
[2] Integrated Resource Plan 2017
[3] World Bank WDI data, Sep. 8, 2020 version, URL: https://data.worldbank.org/country/malawi?display=default
[4] World Economic Outlook 2019, IEA
[5] National Energy Policy 2018
[6] As of 2011, the capacity of the transformer for power transmission is about 988 MVA and the capacity of the transformer for distribution is 868 MVA. Integrated Resource Plan 2017.

facilities to increase the capacity to satisfy the growth in electricity demand from secondary industries (manufacturing, mining, construction, etc.) or tertiary industries (service industries). This has resulted in chronic rolling blackouts.

(2) Supply limitation due to aging substation equipment

A number of inevitable incidents are believed to have been caused by aging facilities, causing even more power outages.

1-2 Natural Condition

1-2-1 Location of planned site

The target sites of the natural condition survey in this project are as follows:

- New substation will be constructed inside the existing Old Town Substation (about 20,000 m^2)
- The old transformer inside the existing Kanengo Substation will be replaced (about 20,000 m^2)

Topographic survey of these sites were commissioned to a local surveying company in this project. A survey map was created that represents latitude, longitude and orientation of the existing structures, obstacles, trees, infrastructure, and leveling was conducted at 5 m grid and contour lines at 0.5 m pitch. Report of executed topographic survey is attached in Appendix-9.

(1) Construction site inside Old Town Substation

The construction site is an open space located in the center of the northern side of the Old Town Substation, but it is necessary to survey for understanding interference with existing substation facilities, roads within the premises, and buried objects. The site has an elevation of 1,040 m on the west side and 1,037 m on the east side.

The construction site of the new control building is almost flat, but the location of the new substation equipment has a height difference of about 3 m, so a construction with cut and fill works is necessary. Although levelling of the ground is important, placing the foundation of the target equipment such as transformers on a stable ground is more important. Therefore, a proper construction plan has to be formulated based on the survey result.

(2) Construction site of Kanengo Substation

The construction site in the Kanengo Substation covers the entire substation site, so all the sites in the substation were investigated.

1-2-2 Geological condition

(1) Old Town Substation site

The soil investigation revealed that the soil type of the Project site is mainly composed of red clay layers, weathered rocks, bedrock, etc. The soil is in a good condition and generally strong enough to support the substation foundation. Therefore, only the humus soil on the surface is removed and

spread footing foundation is adopted.

(2) Kanengo Substation site

The sites for the construction of new substation facilities, rehabilitation and expansion facilities are all located in the substation premises. The result of the soil investigation shows that the soil type of all of the Project site is generally solid like that of the Old Town Substation and the soil is also in a good condition to provide support for the substation foundation. Therefore, only the humus soil on the surface is removed and spread footing foundation is adopted.

1-2-3 History of earthquakes and floods

Earthquakes occur due to the activities of the Great Rift Valley in Malawi. In recent years, M6.0 earthquake was recorded once on the shores of Lake Malawi in 1989, but no other earthquake with similar magnitude was recorded in the past 100 years. The central region, where this project site is located, does not have a history of damages caused by a large earthquake. For this reason, in this project, structural analysis based on seismic horizontal force is performed with seismic layer shear coefficient Cb of 0.10.

There is no history of large-scale damage caused by floods, lightning or storms, according to testimonies from the target site and its surroundings. However, several natural disasters have occurred in Malawi since 2000. In the Old Town Substation, there is a concern that the east side of the Project site could be flooded by the Lilongwe River. Therefore, it is necessary to carefully design the ground height of the new transformation facility.

1-2-4 Weather conditions

The weather conditions are shown in Table 1-2-4.1. Lilongwe City has an altitude of 1,000 to 1,100 m, and belongs to the savanna climate. The maximum temperature is 32.5 °C and the minimum temperature is 8.4°C. The maximum monthly rainfall is 426 mm.

Table 1-2-4.1 Weather conditions

Item		dimension
Height		1,000-1,100 m
Outside air temperature	Maximum	32.5 °C
	Minimum	8.4 °C
	Average	21.1 °C
High humidity		87 %
Maximum wind speed		30 m/s
Rainfall (largest monthly)		426 mm
Earthquake load		Horizontal force 0.10 G
Ground capacity	Control building in Kanengo Substation	200 kN/m^2
	Control Building In Old Town Substation	300 kN/m^2
	Equipment Foundation	100 kN/m^2

Source: Malawi Meteorological Ministry

1-3 Environmental and Social Considerations

Since there is no need to acquire new land or expand the existing substations beyond their borders, it is assumed that obtaining an Environmental Impact Assessment (EIA) license will not be necessary in this project. That being said, even if it is determined that an EIA is unnecessary, a Certificate of Exemption of EIA may still be required. ESCOM must submit a project brief (Field Report) to the Environmental Affairs Department (EAD) of Ministry of Forestry and Natural Resources (MFNR) to determine whether an EIA is required. After that, ESCOM will acquire either an EIA license if the assessment is required, or a Certificate of Exemption if it is not required.

The procedural flow for obtaining an EIA license or EIA exemption certificate, as confirmed in a previous survey, is as follows.

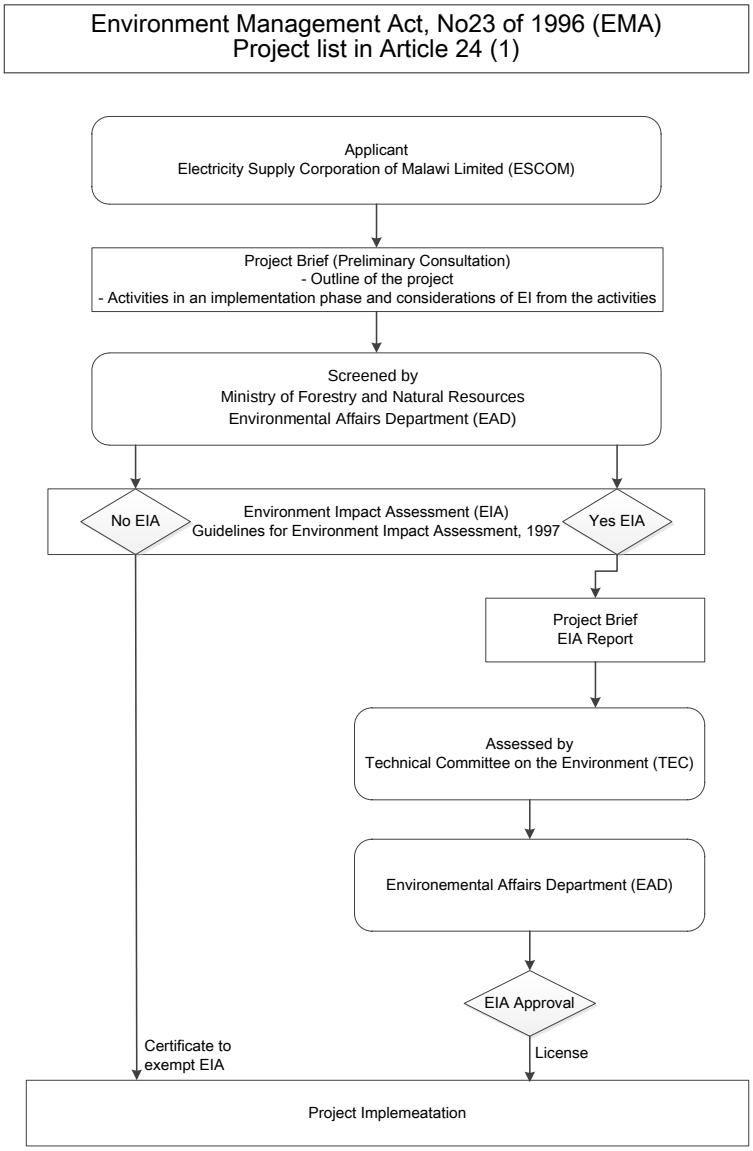


Figure 1-3.1 Flow chart and procedure of EIA

CHAPTER 2 CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

This project objective is to enhance the power supply capacity by rehabilitation of Kanengo Substation and renewal of the Old Town Substation in Lilongwe City, and improve the serious economic damage in the area caused by the insufficient power supply capacity of transmission/distribution facilities and aging facilities. Table 2-1.1 gives an outline of the Project.

Table 2-1.1 Outline of the Project Components

Category		Major Components	Quantity
Procurement/Installation	1	**Expansion and Rehabilitation of Kanengo Substation (Lilongwe-B) (132/66/33/11 kV)**	
		- 50MVA 132/66 kV Auto transformer with OLTC	2 units
		- 25 MVA 66/33 kV Power transformer with OLTC	1 unit
		- 25 MVA 66/11 kV Power transformer with OLTC	1 unit
		- 132 kV Switchgear facilities	1 lot
		- 66kV Switchgear facilities	1 lot
		- 33kV Switchgear facilities	1 lot
		- 11kV Switchgears (Indoor type metal clad type)	1 lot
		- Control and protection panels & Substation control system (IEC61850 based)	1 lot
		- Station transformer	1 unit
		- AC/DC LV power facilities	1 lot
		- Earthing System	1 lot
	2	**Renewal of Old Town Substation (Lilongwe-A) (66/33/11 kV)**	
		- 25 MVA 66/33 kV Power transformer with OLTC	1 unit
		- 25/31.5 MVA (ONAN/ONAF) 66 /11 kV Power transformer with OLTC	1 unit
		- 66kV Switchgear facilities	1 lot
		- 33kV Switchgears (Indoor type metal clad type)	1 lot
		- 11kV Switchgears (Indoor type metal clad type)	1 lot
		- Control and protection panels & Substation control system (IEC61850 based)	1 lot
		- Station transformer	1 unit
		- AC/DC LV power facilities	1 lot
		- Earthing System	1 lot
Procurement	3	**Maintenance Tool for the Equipment of the Project**	1 lot
	4	**Spare Parts and Consumables for the Equipment of the Project**	1 lot
Construction Work	5	**Foundation for the Equipment of the Project (Transformers, Gantry Towers, etc.)**	1 lot
	6	**Control Building for Kanengo Substation**	1 building
	7	**Control Building for Old Town Substation**	1 building

Source: Preparatory Survey Team

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

By rehabilitation of Kanengo Substation and renewal of Old Town Substation, this project aims

- to enhance the power supply capacity to the industrial area and the center of Lilongwe City, which drive the economic growth of Malawi,
- to improve economic growth and citizens' quality of lives.

Although this project is an urgent grant aid project, in light of the above point, it must avoid the replacement of the equipment before it reaches its service life. Thus, the target years for the Project evaluation and facility planning are to be set carefully as mentioned in "2-2-2-1 (2) Target year of the Project".

2-2-1-2 Plan for Natural Conditions

(1) Temperature and Humidity

Malawi's climate is mostly tropical with rainy season from November to April, and the dry season from May to October.

Lilongwe City has a high altitude of 1,000 to 1,100 m, a maximum annual temperature of 32.5°C, a minimum annual temperature of 8.4°C, an average annual temperature of 21.1°C, and a maximum humidity of 87%.

The substation equipment to be adopted in this project will take into consideration the temperature, humidity and altitude mentioned above; moreover, it is necessary to confirm that the equipment operates normally against ambient temperatures and transient temperature increases due to direct sunlight as well as high humidity in the hot and wet rainy seasons to avoid operation disruptions.

(2) Rainfall

Malawi has a savanna climate, in which the rainy season and dry season are clearly separated. It is quite different from equatorial rain belt, where heavy rain falls throughout the year.

The monthly average rainfall of Lilongwe City is about 138 mm in the rainy season and around 2 mm in the dry season. But there are squalls depending on places, and there are almost no flat areas; therefore, it is necessary to take measures against inundation, such as raising the floor level of the control room and foundation of the transformer area by around 20 to 30 cm from the ground level, and installation of gutters to drain the rain water.

(3) Earthquake

Since the probability of occurrence of an earthquake with magnetite 6.0 or more is small in the Project area, the structure shall be designed seismic layer shear coefficient Cb of 0.10.

2-2-1-3 Plan for Socioeconomic Conditions

This project involves power outage work in the substation installation work along with reconnecting work among substation – transmission line, substation – distribution line and busbars. Therefore, it is necessary to schedule the construction in a way that minimizes the power outage time to minimize the impact on customers. During construction, maximum care should be taken to not obstruct the surrounding residents, traffic, existing structures and underground utilities. Regarding the conductor line work, careful consideration should be given in order to keep the lines at a safe distance from surrounding houses and shops along the road boundary line.

2-2-1-4 Plan for Construction / Procurement Conditions

(1) Basic policy

The Project site is located near Lilongwe City, the capital of Malawi. Nowadays, there are many construction companies including electric construction companies as well as multiple suppliers who can carry out the construction of ultra-high voltage substation equipment or power transmission equipment. Currently, the construction of various public facilities, commercial facilities, houses, etc. is ongoing. Therefore, the construction works of this project can be carried out by local companies.

Steel is not produced in Malawi at the moment. Therefore, the steel frame is expensive and there are no cases of using steel for general building construction in the Project area. It is a normal practice to build public facilities, and middle class (3 to 6 floor) buildings with reinforced concrete. Therefore, the current target facilities, such as control building, the equipment foundation frame can be done with reinforced concrete. Concrete production is basically at a kneading site, and it is also assumed that a batcher plant will be installed to produce concrete on-site depending on the construction scale and construction area.

(2) Building standards, related laws and regulations

1) Building standards

Malawi does not have its own original design standard, and the building standards generally used are those of the British Standard (BS) or South African Bureau of Standards (SABS). In this project, design will be conducted according to either BS, SABS, or Japanese standards on a case-by-case basis.

2) Construction permission

Any construction, public or private, in the urban area is required to apply for construction permission. The permission is issued by the construction section of each city office. The applicants for the construction permits must be architects or structural designers with public qualifications, and since ESCOM has qualified persons, it will perform the application work for this project. At the stage of tender document approval, the consultant submits the drawing to ESCOM, and

ESCOM submits it to the construction section of the city office. The drawings necessary for the application are site plan drawings, layout drawings, general drawings (plan, elevation and sectional views), and the submission of the structural drawings is required only if there are large span frameworks. The maximum number of days required for the construction permit review is 60 days, and the city office checks whether it conforms to the Town and Country Planning Standard and Guidelines for Development.

The disaster prevention equipment selection is based on the Fire Service Law or discussion with fire department having jurisdiction over each area. This project plans to install the minimum required disaster prevention equipment, since the works will be carried out within the existing Substation.

2-2-1-5 Plan for Using Local Contractors and Materials

(1) Plan for using local contractors

1) Local contractors

As the construction work in this project has only reinforced concrete single-story control building and transformer foundation, it is expected that even middle-class contractor who can receive orders without limit can carry out the work as a subcontractor of a Japanese contractor.

2) Local suppliers

There are medium-sized material suppliers in Lilongwe and Blantyre, Malawi's commercial center; however, suppliers of other cities are limited to small scale building materials. Therefore, many construction companies commonly procure materials from other third world countries such as South Africa after receiving construction orders, and the procurement from supplier is limited mainly to make up for shortages. The Japanese contractor will also use local suppliers in the same way.

3) Local consultants

The consultants registered with NCIC are 10 construction companies, 26 engineering companies, and 11 Quantity Surveyor (QS) companies. The architects, engineers and QS qualifications are managed by the Malawi Architects Association, Board of Engineers and QS Association, respectively. The policy of this project is to utilize local consultant engineers as required in the implementation stage for the construction supervision.

(2) Plan for using local materials

It is possible to procure domestically supplied materials for the construction, including imported products, but the main materials produced in Malawi are cement, aggregate, secondary concrete products such as blocks, timber and plywood. Most of the other materials are imported from South Africa. This project plans to use locally-produced products and imported materials, as long as they have no workability, maintenance and economic issues.

2-2-1-6 Plan for O&M Capacity of Implementing Agency

ESCOM manages the engineering and maintenance of the substations at the head office in Blantyre. The central regional control center in the Old Town Substation operates substations targeted by this project with monitoring and commanding of each piece of equipment of substations.

As the Project consists of installation or replacement of substation equipment and the required skills do not significantly vary from those required to manage the existing equipment, ESCOM will be able to operate and maintain the equipment after the project.

2-2-1-7 Setting Grades for Facilities and Equipment

As ESCOM has not had design standards for substations of its own, the team interviewed about the applicable standards. According to the interview, the standards of the latest equipment constructed with the support of U.S.A, Europe and China, etc. are applicable to the Project.

Consequently, as a rule, it should be designed that specifications of Old Town Substation are referred to that of Kapichira and Bunda Substations, specifications of 132 kV and 66 kV equipment in Kanengo Substation are referred to that of the existing transformer IBT2 in Kanengo Substation, and specifications of 33 kV and 11 kV equipment in Kanengo substation are referred to that of the existing equipment.

2-2-1-8 Plan for Construction and Procurement Methods and Work Period

As this project will be performed based on the Japan's Grant Aid Scheme, installation must be completed within the time limits given in the Exchange of Notes (E/N) and Grant Agreement (G/A). In order to complete the work within the specified construction period and achieve the results expected from substation construction, the implementation plan must effectively coordinate the Japanese and Malawi work schedules to streamline importing and other various procedures.

With simultaneous construction of Kanengo Substation and Old Town Substation, care must be taken to keep the scheduling efficient. Work teams need to be formed appropriately, the construction methods used need to be well known to local contractors and engineers, and the implementation system must be structured so that work progresses safely and swiftly.

2-2-2 Basic Plan

2-2-2-1 Pre-condition of the Plan

(1) Purpose of power demand forecast for the Project

The main project components are expansion and rehabilitation of Kanengo Substation (Lilongwe-B) (132/66/33/11 kV) and renewal of Old Town Substation (Lilngwe-A) (66/33/11 kV).

The power demand forecast by substation unit aims to clarify the pre-conditions of this project. The forecast will serve as base data for power system analysis, optimal power supply plan, and

component assessment.

(2) Target year of the Project

Relevance and effectiveness of the Project as a grant aid project, including its urgency and benefit, will be confirmed through the preparatory study. Still, in the absence of medium- to long-term system plans, there are concerns that operation of lower level power facilities and even supply stability may also be impacted as the Project targets Lilongwe City where Malawi's major industries are concentrated and significant population growth is observed.

The target year of the facility planning will be ten years after the commencement of service. This project must avoid the replacement of the equipment before its service life, and the ten year figure is consistent with other similar grant aid projects. Meanwhile, as this project is an urgent grant aid project, the target year for evaluating the Project and its benefits will be three years after commencement of service.

Target year for project evaluation:	2026 (three years from start of service)
Target year for facility plan:	2033 (ten years from start of service)

2-2-2-2 Power Demand Forecast

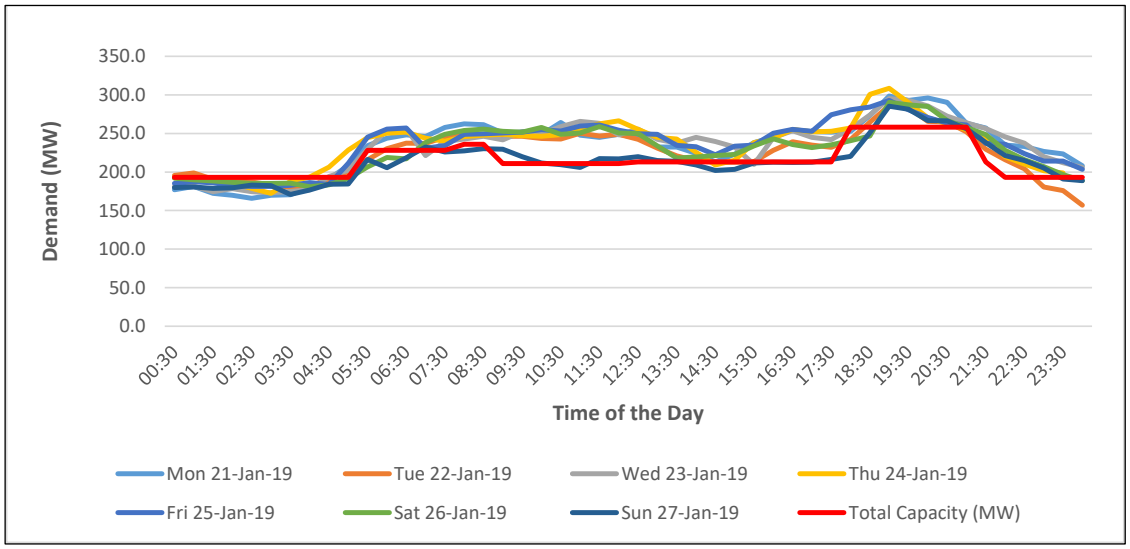
(1) Condition of demand and supply of electricity and demand forecast

According to "National Energy Policy 2018 (NEP 2018), Ministry of Natural Resources, Energy and Mining : MNREM[1]", energy policy plays an important role in achieving Malawi's target of Vision 2020, but the number of concrete plans of the energy policy is limited, and this may hinder the achievement of Vision 2020. In 2016, 250,000 consumers were supplied with electricity, which accounts for just 10% of Malawi's population. The 2003 energy policy, "National Energy Policy 2003, MNREM", planned to increase the electrification rate to 10% by 2010, 30% by 2020 and 40% by 2050. Malawi's peak power demand in 2018 was 526 MW and is expected to reach 1,155 MW in 2025. On the other hand, Malawi's installed capacity of power generation in 2018 is about 403 MW. Thus, electrification is still facing major challenges including limited power supply, and supply limitation due to aging facilities.

ESCOM's electrical tariff has 4 categories: domestic (including commercial), general, industrial, and essential service. In addition, it is divided by payment system (pre-paid or post-paid), phase (single-phase supply or three-phase supply), and by voltage class. The tariff is listed on ESCOM's homepage.

Currently, ESCOM is carrying out load shedding, and it forecasts demand of every week based on the power supply record of the preceding week, to publish the load shedding schedule based on the forecast on its website. Load shedding is implemented for domestic customers every day and for industrial customers once a week, with the exception of essential service.

[1] Ministry of Energy (MOE) at present



Source: ESCOM

Figure 2-2-2-2.1 ESCOM's Demand Forecast of the Whole Country for a Coming Week

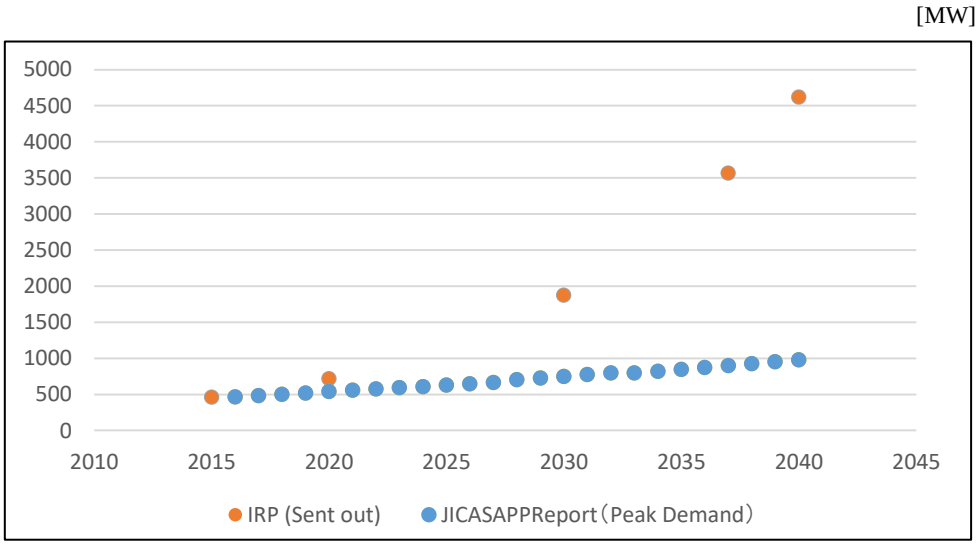
In order to overcome this situation, NEP 2018 outlines a power supply sector strategy, including reviewing the Integrated Resource Plan (IRP) every 5 years, making the investment in power generation more attractive for the private sector.

According to an interview with ESCOM, the development plan of the power supply sector is based on IRP. However, IRP assumes 10% annual increase in demand for power supply without clear evidence. In addition, the World Bank (WB) is implementing Malawi Electricity Access Project (MEAP), but according to its consultant, the Project is at the initial stage and details of the implementation are under consideration.

Under such circumstances, the consultant reviewed, in addition to IRP, the demand forecast of Malawi referring to "Data collection survey on southern African power pool, JICA June 2017" (hereinafter referred to as the "JICA SAPP Report") to estimate the future demand for Kanengo Substation and Old Town Substation, which are the targets of the Project.

(2) Demand forecast for the whole country

Figure 2-2-2-2.2 shows demand forecast by IRP and JICA SAPP Report.



Source: JICA Survey Team with the data from IRP and JICA SAPP Report

Figure 2-2-2-2.2 Demand forecast in IRP and JICA SAPP Report

The IRP demand forecast consists of record of power sent out. The increase rate is very high even though the transmission loss is about 18%.

The increase rate of 3% described in JICA SAPP Report deemed appropriate judging from the fact that increase rate in demand from 2010 to 2014 in Malawi was 4%[2]. The lack of enough power supply is making the increase rate low, and the countermeasure policies, especially the master plan for empowerment of substation facilities, are unclear.

On the other hand, the substations for which the demand is forecast under the Project are the existing ones and they have limitations, such as limited land availability and regulated maximum capacity of transformers. The demand forecast was conducted with increase rate of 3% for reference, considering the enhancement plan of each substation.

(3) Demand forecast for Kanengo Substation and Old Town Substation

According to the interview with ESCOM, when IRP was created, demand forecasts by each substation were not accumulated and there is no demand forecast for the existing substations. Moreover, the existing demand records are limited. Under these circumstances, the demand for Kanengo Substation and Old Town Substation were forecast up to 2033 based on the policy described below.

1) Common

- Initial value: Recent data of demand record after review

[2] JICA SAPP Report

- Reference increase rate applied to forecast the demand
  - Very high case : 10% as Malawi's demand forecast in IRP
  - High case : 5% the highest increase rate in JICA SAPP Report except for that for Tanzania, which seems to be special
  - Base case : 3% as Malawi's demand forecast in JICA SAPP Report

2) Kanengo Substation

Kanengo Substation has electronic record. Initial value of the substation was calculated based on the record of each feeders in 2018-2019. If the operational status is always constant, the initial value shall be the value of each feeder of the day when the total demand indicates the peak value. However, the peak time has "0" as the demand of a part of feeder because of the operation circumstances of the day. So, the initial value was calculated as the total of the peak demand of each feeder at different times, considering a concurrent usage ratio of 0.7.

In Kanengo Substation, where the rate of industry load is comparatively high, both the demand forecast for the whole country and specific plan for the substation loads shall be considered. As the step loads, only 8MVA in 2019 and 5MVA in 2020 are considered by ESCOM for future connection at the moment. However, 2MVA is taken into account after 2021 as the step load every year because there are 1 to 2 applications for connection in each year and the trend is assumed to remain the same.

The feeders are roughly separated into industry feeders and others. The demand forecast was estimated as the total of (i) the sum of rated increase and step loads for industrial feeders and (ii) rated increase for other feeders.

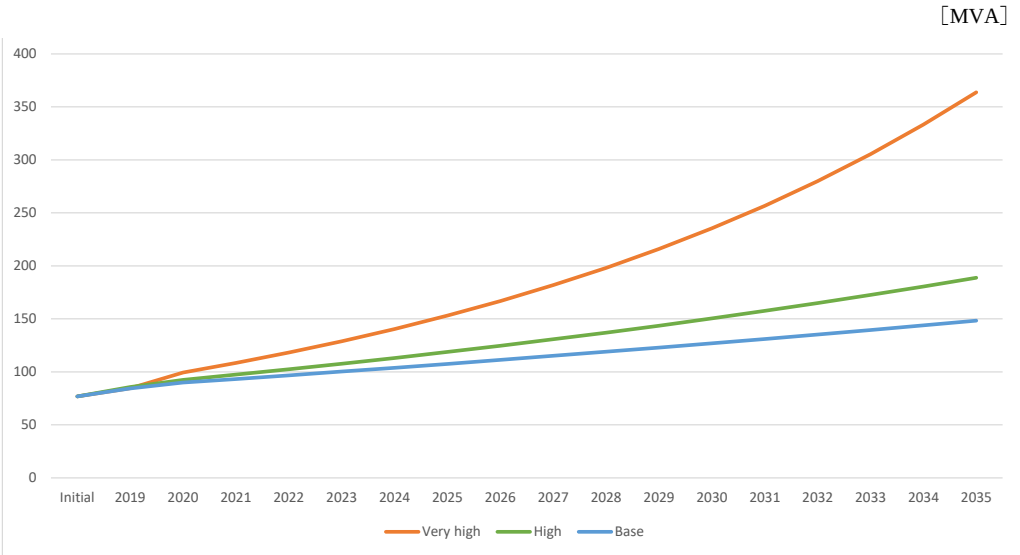
Table 2-2-2-2.1 and Figure 2-2-2-2.3 below show the demand forecast in the very high case, high case and base case.

Table 2-2-2-2.1 Demand Forecast for Kanengo Substation

[MVA]

	Initial	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Very high	76.9	88.8	99.3	108.4	118.2	128.9	140.5	153.1	166.8	181.8	198.1	216.0	235.4	256.7	279.9	305.4	333.2	363.7
High	76.9	85.7	92.5	97.4	102.5	107.7	113.2	118.8	124.6	130.7	137.0	143.6	150.4	157.5	164.9	172.5	180.5	188.8
Base	76.9	84.4	89.9	93.3	96.8	100.3	103.9	107.6	111.3	115.1	119.0	122.9	127.0	131.1	135.3	139.5	143.9	148.4

Source: JICA Survey Team



Source: JICA Survey Team

Figure 2-2-2-2.3 Demand forecast for Kanengo Substation

3) Old Town Substation

Old Town Substation has some paper based records. However data of 33 kV feeder has not been recorded. So the initial value was set based on the load record of each 33 kV and 11 kV transformer.

According to ESCOM, peak demand is normally found in June and July. The data on the demand in July 2015 and in July 2016 were found from the record, and the 2015 peak value, which is higher, was taken as the initial value.

There are no industrial customers connected and no future connection is assumed to the feeders from Old Town Substation. Thus, the demand forecast was estimated based on the initial value and the general increase rates of the very high case, high case, and base case.

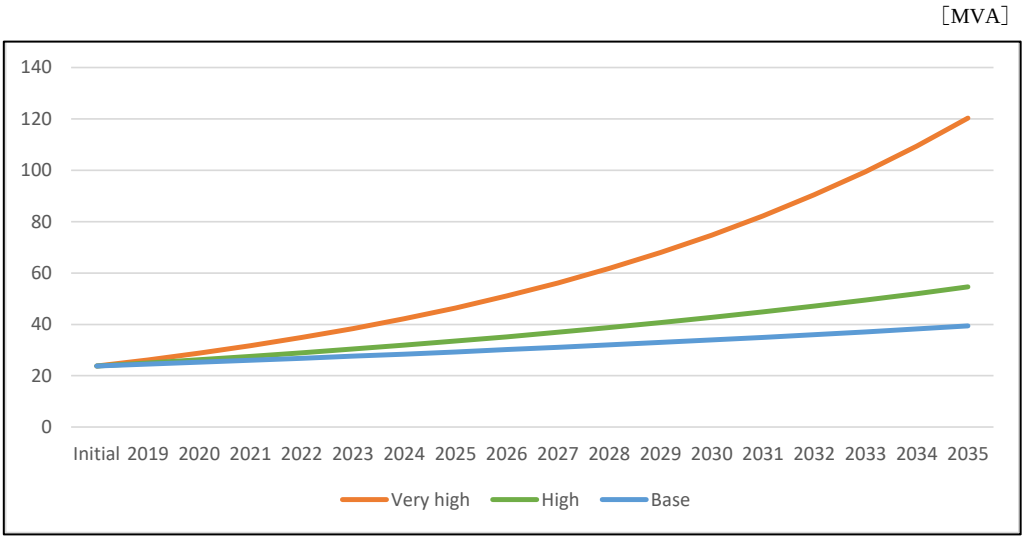
Table 2-2-2-2.2 and Figure 2-2-2-2.4 below show the demand forecast in the very high case, high case, and base case.

Table 2-2-2-2.2 Demand Forecast for Old Town Substation

[MVA]

	Initial	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Very high	23.8	26.2	28.8	31.7	34.9	38.4	42.2	46.4	51.0	56.2	61.8	67.9	74.7	82.2	90.4	99.5	109.4	120.4
High	23.8	25.0	26.3	27.6	28.9	30.4	31.9	33.5	35.2	36.9	38.8	40.7	42.8	44.9	47.2	49.5	52.0	54.6
Base	23.8	24.5	25.3	26.0	26.8	27.6	28.4	29.3	30.2	31.1	32.0	33.0	34.0	35.0	36.0	37.1	38.2	39.4

Source: JICA Survey Team



Source: JICA Survey Team

Figure 2-2-2-2.4 Demand forecast for Old Town Substation

(4) Recommendation for Operation and Maintenance

As described above, the Project substations exist but with some limitations. If the increasing rate of consumers of both substations conform to that of the demand forecast in the base case (rated increase of 3%), the substations will operate without over load until 2023.

All the facilities except the Project components will be aging, and it is recommended to renew them as written below to keep them in N-1 condition.

1) Kanengo Substation

132/66 kV transformer (25 MVA) shall be replaced by the end of 2029.

66/11 kV transformer (12.5 MVA) shall be replaced by the end of 2028.

Other transformers shall be installed according to the demand.

2) Old Town Substation

66/11 kV transformer (25 MVA) shall be added by the end of 2028 so as not to rely on ONAF mode.

Other transformers shall be installed according to the demand.

The implementation year could be moved forward depending on the increase rate.

The details for the demand forecast are shown in Table 2.6-3 and Table 2.6-4 below.

In any event, it is important not only to observe the demand of each substation but also to have a master plan by comprehending the change in the demand properly and by considering how to build and/or expand substations (renewal plan for facilities).

As a reference, demand forecasts for each feeder at Kanengo Substation and Old Town Substation in the very high case, high case and base case are described in Attachment 7.

2-2-2-3 Power System Analysis

(1) Provision of the Power Flow Analysis

Based on the values shown in Table 2-2-2-3.1, which have been provided by Malawi Grid Code, the results of the power flow analyses are evaluated.

Voltage Range: Voltages on power grids and distribution lines should be maintained within nominal voltage of ± 10 %.

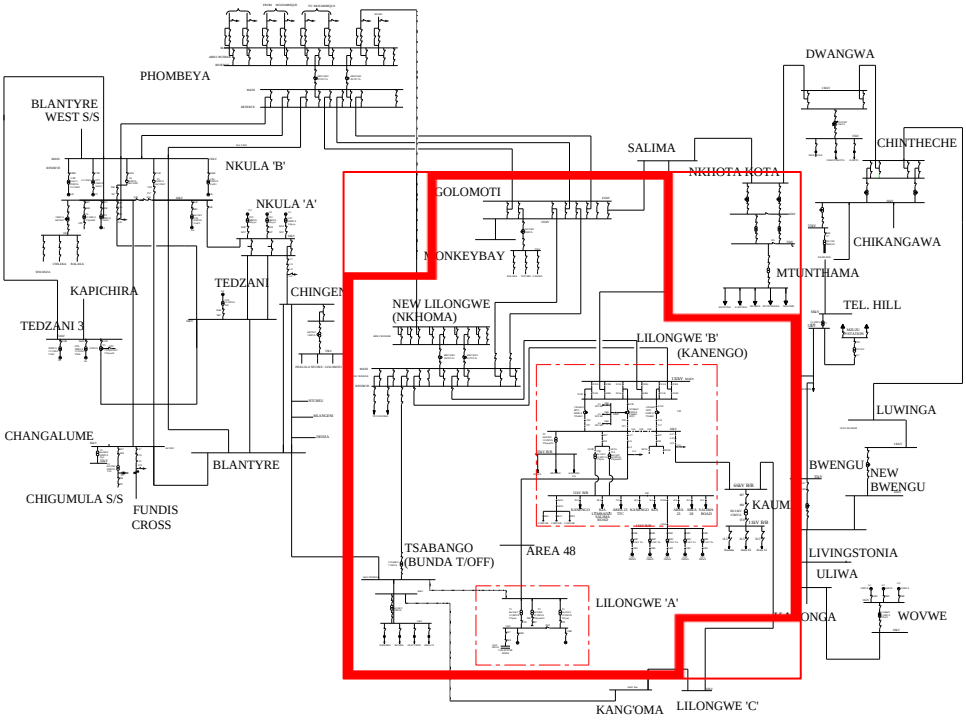
Table 2-2-2-3.1 shows the standard voltage level of the Grid Code.

Table 2-2-2-3.1 Standard Voltage Level

Nominal Voltage Vn [kV]	Maximum Continuous Voltage Vm [kV]	(Vm - Vn)/Vn %
765	800	4.58
400	420	5
330	346.5	5
275	300	9.09
220	245	11.36
132	145	9.85
66	72.5	9.85
33	36	9.09
11	12	9.09

Source: Malawi Grid Code May 2018

Figure 2-2-2-3.1 shows the power flow analysis area. The power flow shall be maintained to keep the standard voltage level shown in Table 2-2-2-3.1 and to avoid overloading of the transformer capacity under this power flow analysis.



Source: ESCOM (edited by JICA Study Team)

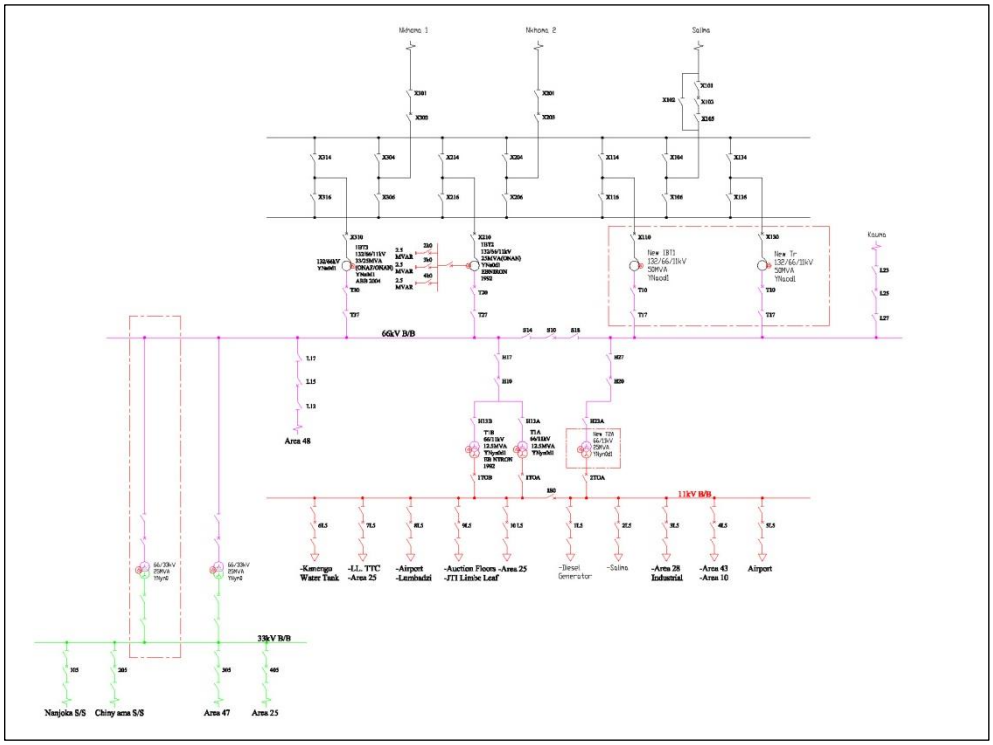
Figure 2-2-2-3.1 Range of the Power Flow Analysis

(2) Result of the Power Flow Analysis

The power flow analysis has been conducted considering the following main equipment in each substation.

The main equipment under rehabilitation in Kanengo Substation considered is as follows:

- Replacement of the existing 132/66 kV 25 MVA Transformer (IBT1) with new 50 MVA Transformer,
- Installation of 1 set of new 132/66 kV 50 MVA Transformer,
- Installation of 1 set of new 66/33 kV 25 MVA Transformer,
- Installation of 1 set of new 66/11 kV 25MVA Transformer.

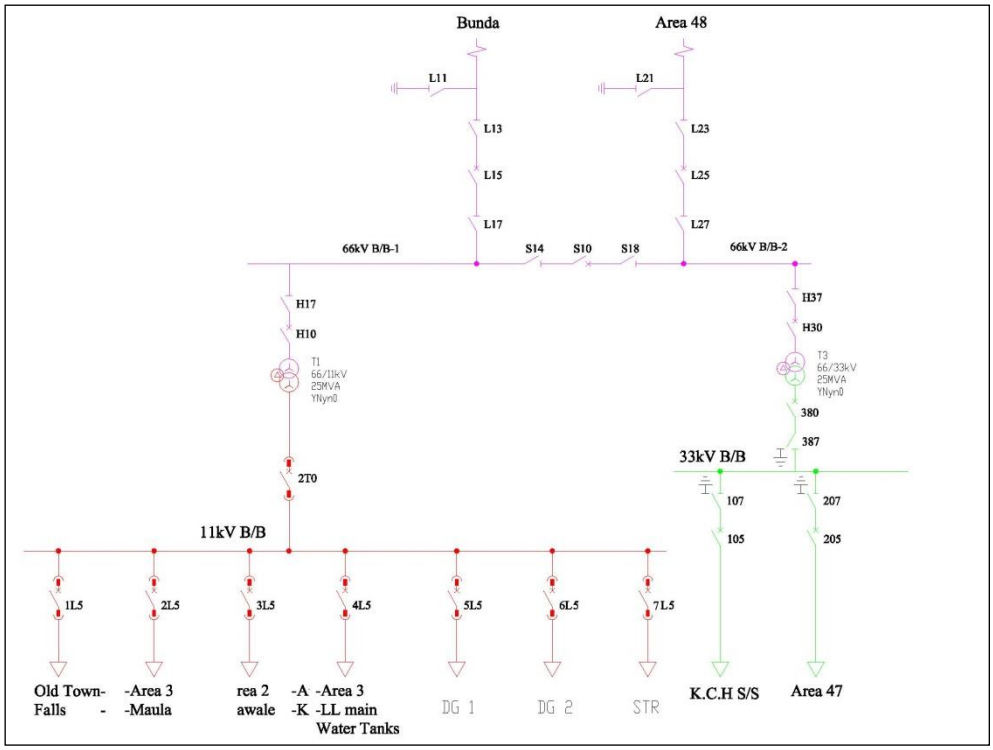


Source: JICA Study Team

Figure 2-2-2-3.2 Kanengo Substation Rehabilitation Plan

The main equipment under rehabilitation plan of Old Town Substation considered is as follows:

- Installation of 1 set of new 66/33 kV 25 MVA Transformer,
- Installation of 1 set of new 66/11 kV 25/31.5 MVA (ONAN/ONAF) Transformer.



Source: JICA Study Team

Figure 2-2-2-3.3 Old Town Substation Replacement Plan

Table 2-2-2-3.2 shows transformers' load conditions under base case situation in cases where the Project is conducted (w/Rehab) and not conducted (w/o Rehab).

Table 2-2-2-3.2 Transitions Transformers' Loads at Kanengo Substation and Old Town Substation (Base Case between 2018 and 2032)

			2018	2020	2021	2022		2023		2024		2025		2026		2027		2028		2032	
			w/o Rehab	w/o Rehab	w/o Rehab	w/o Rehab	W/ Rehab	w/o Rehab	W/ Rehab	w/o Rehab	W/ Rehab	w/o Rehab	W/ Rehab	w/o Rehab	W/ Rehab	w/o Rehab	W/ Rehab	w/o Rehab	W/ Rehab	w/o Rehab	W/ Rehab
Kanengo Substation																					
132/66kV Transformer																					
	IBT1	25MVA	20.7	23.8	24.95	26.1	-	26.4	-	27.2	-	28.2	-	29.1	-	30.1	-	21.1	-	36.1	-
	IBT2	25MVA	17.5	20.6	21.75	22.9	15.7	23.5	15.7	24.5	16	25.6	16.3	26.5	16.4	27.9	16.8	29.2	17.2	35.4	19.4
	IBT3	30/33MVA	27.3	31.5	33	34.5	19.5	34.8	20.3	36	20.9	37.2	21.7	38.5	22.3	39.7	23	41.1	23.7	47.7	27.1
	New IBT1	50MVA	-	-		-	29.5	-	30.7	-	31.7	-	32.8	-	33.7	-	34.8	-	35.9	-	41.1
	New 66 Tr 2	50MVA	-	-		-	29.5	-	30.7	-	31.7	-	32.8	-	33.7	-	34.8	-	35.9	-	41.1
66/33kV Transformer																					
	T3	25MVA	16.7	28.2	28.75	29.3	15.7	30	16	30.6	16.4	31.2	16.8	31.9	17.2	32.5	17.6	33.2	18	36.9	19.9
	New 66 Tr	25MVA	-	-	-	-	16.5	-	16.9	-	17.3	-	17.7	-	18.1	-	18.6	-	19	-	21
66/11kV Transformer																					
	T1A	12.5MVA	9.42	9.62	10.46	11.3	9.91	12	10.3	12.7	9.8	13.5	10.6	14.2	9.94	15	10.2	15.7	10.3	18.5	12.2
	T1B	12.5MVA	9.42	9.62	10.46	11.3	9.91	12	10.3	12.7	9.8	13.5	10.6	14.2	9.94	15	10.2	15.7	10.3	18.5	12.2
	New T2A	25MVA	-	-		-	9.24	-	8.38	-	8.36	-	8.97	-	10.1	-	11.1	-	12.2	-	14.5
Old Town Substation																					
66/33kV Transformer																					
	T3	12.5MVA	6.04	6.42	6.525	6.63	-	7.01	-	7.22	-	7.44	-	7.66	-	7.89	-	8.13	-	9.21	-
	New T3	25MVA	-	-	-	-	6.48	-	6.91	-	7.12	-	7.35	-	7.58	-	7.82	-	8.08	-	9.16
66/11kV Transformer																					
	T1	12.5MVA	9.38	9.99	10.295	10.6	-	10.9	-	11.2	-	11.5	-	11.8	-	12.2	-	12.5	-	13.9	-
	T2	12.5MVA	9.38	9.99	10.295	10.6	-	10.9	-	11.2	-	11.5	-	11.8	-	12.2	-	12.5	-	13.9	-
	New T1	25MVA	-	-	-	-	21.2	-	21.9	-	22.6	-	23.3	-	24.1	-	24.8	-	25.5	-	28.8

The result of the power flow analysis under base case shows that the 66/33 kV 25 MVA transformer (T3) of Kanengo Substation will be overloaded in 2020. Also the 132/66 kV 30/33 MVA transformer (IBT3) will be in 100% load condition in 2021.

132/66 kV 25MVA transformers (IBT1 and IBT2) will be overloaded in 2022. Since all transformers in Kanengo Substation will be overloaded by the year 2024, 132/66 kV 50 MVA transformer (IBT4) should be installed at Kanengo Substation under this project.

Existing IBT1, which was installed in Kanengo Substation in 1988, has already passed 30 years after commissioning. JICA Study Team has discussed with ESCOM and decided to replace with a new transformer under this project. Since increase of transitions transformers' loads is about 1-2MVA per year, it can be operated without overload for a few years after 2033.

Since 66/11 kV transformers' load will reach 25.5 MVA and 28.8 MVA in the years 2028 and 2032, respectively, ESCOM standard transformer capacity of 25 MVA with double ratings such as ONAN/ONAF type will be installed to prevent transformers' overload over 10 years after completion the project. Table 2-2-2-3.3 shows the results of the power flow analysis under the high case.

Table 2-2-2-3.3 Transitions Transformers' Loads at Kanengo Substation and Old Town Substation (High Case between 2018 and 2032)

			2018	2020	2021	2022		2023		2024		2025	2026	2027	2028	2029	2030	2031	2032
			w/o Rehab	w/o Rehab	w/o Rehab	w/o Rehab	W/ Rehab	w/o Rehab	W/ Rehab	w/o Rehab	W/ Rehab	W/ Rehab	W/ Rehab	W/ Rehab	W/ Rehab	W/ Rehab	W/ Rehab	W/ Rehab	W/ Rehab
Kanengo Substation																			
132/66kV Transformer																			
	IBT1	25MVA	21.7	24.8	25.75	26.7	-	28.9	-	30.4	-	-	-	-	-	-	-	-	-
	IBT2	25MVA	17.7	21.4	22.45	23.5	16.2	26	16.6	27.6	17	17.6	18.1	18.9	20.3	20.7	21.6	22.6	24
	IBT3	30/33MVA	28.6	32.8	34	35.2	21.4	38.2	22.3	40.1	23.2	24.3	25.5	26.7	28.6	29.7	30.8	32.3	34.1
	New IBT1	50MVA	-	-		-	32.4	-	33.7	-	35.2	36.8	38.6	40.4	43.3	45.1	46.7	48.9	51.7
	New 66 Tr 2	50MVA	-	-		-	32.4	-	33.7	-	35.2	36.8	38.6	40.4	43.3	45.1	46.7	48.9	51.7
66/33kV Transformer																			
	T3	25MVA	16.8	28.7	29.9	31.1	17.4	32.4	18.1	33.5	18.8	19.6	20.4	21.3	22.2	23.2	24.2	25.2	26.5
	New 66 Tr	25MVA	-	-	-	-	16.7	-	17.4	-	18.1	18.8	19.6	20.4	21.3	22.2	23.2	24.2	25.4
66/11kV Transformer																			
	T1A	12.5MVA	9.42	9.84	10.77	11.7	10.6	12.6	10.7	13.4	11.2	12	11.9	11.4	12.7	12.2	12.2	12.7	13.2
	T1B	12.5MVA	9.42	9.84	10.77	11.7	10.6	12.6	10.7	13.4	11.2	12	11.9	11.4	12.7	12.2	12.2	12.7	13.2
	New T2A	25MVA	-	-		-	10.2	-	8.75	-	9.29	10.1	10.2	11.2	13.7	14.4	15.6	15.6	16.2
Old Town Substation																			
66/33kV Transformer																			
	T3	12.5MVA	6.04	6.69	7.055	7.42	-	7.81	-	8.21	-	-	-	-	-	-	-	-	-
	New T3	25MVA	-	-	-	-	7.25	-	7.63	-	8.04	8.47	8.92	9.41	9.92	10.6	11	11.5	12.2
66/11kV Transformer																			
	T1	12.5MVA	9.37	10.4	16.5	22.6	-	12.5	-	12.7	-	-	-	-	-	-	-	-	-
	T2	12.5MVA	9.37	10.4	16.5	22.6	-	12.5	-	12.7	-	-	-	-	-	-	-	-	-
	New T1	25MVA	-	-	-	-	23.2	-	24.4	-	25.7	27.1	28.5	29.9	31.4	33	34.6	36.3	38.4

As Table 2-2-2-3.3 above for the high case scenario shows, no overloaded transformers will be observed in Kanengo Substation until the year 2030 and Old Town Substation until the year 2028 if this project is conducted and 25 MVA/31.5 MVA (ONAN/ONAF) transformer is installed at Old Town Substation.

(3) Fault Current Calculation

Table 2-2-2-3.4 and Table 2-2-2-3.5 show expected fault currents at Kanengo Substation and Old Town Substation in the base case scenario in 2032.

Table 2-2-2-3.4 Fault Current at Kanengo Substation in 2032

	Bus Voltage	Fault Current
1	132 kV	3.7 kA
2	66 kV	7.8 kA
3	33 kV	7.6 kA
4	11 kV	32.7 kA

Table 2-2-2-3.5 Fault Current at Old Town Substation in 2032

	Bus Voltage	Fault Current
1	66 kV	5.3 kA
2	33 kV	3.9 kA
3	11 kV	18.1 kA

Table 2-2-2-3.6 and Table 2-2-2-3.7 show expected fault currents at Kanengo Substation and Old Town substation in the high case scenario in 2032.

Table 2-2-2-3.6 Fault Current at Kanengo Substation in year 2032

	Bus Voltage	Fault Current
1	132 kV	3.9 kA
2	66 kV	8.6 kA
3	33 kV	9.4 kA
4	11 kV	37.3 kA

Table 2-2-2-3.7 Fault Current at Old Town Substation in 2032

	Bus Voltage	Fault Current
1	66 kV	5.7 kA
2	33 kV	4.1 kA
3	11 kV	20.4 kA

The design will reflect this fault current calculation results.

2-2-2-4 Designing of Transformer Capacity

(1) Existing Transformer Capacities at substations around Lilongwe City

Table 2-2-2-4.1 shows the existing transformer capacities at substations around Lilongwe City.

Table 2-2-2-4.1 Existing Transformer Capacities at substations around Lilongwe City

	Name of Substation	Transformer Capacity
1	Bunda Substation	132/66 kV 50 MVA x 1 66/11 kV 15 MVA x 1
2	Kangoma Substation	66/11 kV 7.5 MVA x 1
3	Lilongwe C Substation	66/33 kV 15 MVA x 1 66/11 kV 7.5 MVA x 1
4	Kauma Substation	66/11 kV 15 MVA x 1
5	Chinyama Substation	66/33 kV 20 MVA x 1
6	Kasungu Substation	33/11 kV 7.5 MVA x 1
7	Mtunthama Substation	33/11 kV 0.5 MVA x 2
8	Nkhota-Kota Substation	66/33 kV 5 MVA x 2 33/11 kV 5 MVA x 1
9	Illovo Substation	33/11 kV 7.5 MVA x 1
10	Dwangwa Substation	132/33 kV 25 MVA x 1
11	Area 48 Substation	66/11 kV 12.5 MVA x 2
12	Nanjoka Substation	132/33 kV 15 MVA x 1 33/11 kV 3 MVA x 1 33/11 kV 7.5 MVA x 1
13	Chitipa Substation	33/11 kV 7.5 MVA x 1
14	Area 47 Substation	33/11 kV 7.5 MVA x 1
15	K.C.H Substation	33/11 kV 7.5 MVA x 1
16	Lilongwe City Center Substation	33/11 kV 10 MVA x 1
17	Area 25 Substation	33/11 kV 10 MVA x 1

(2) Substation Expansion Plan

Lilongwe C, Kangoma, Bunda, Lilongwe City Center and Area 25 substations shown in Table 2-2-2-4.1 were newly constructed or expanded by the Millennium Challenge Corporation. Also Dwangwa and Kauma substations were newly constructed by the World Bank.

ESCOM had only a plan of Kanengo Substation 33 kV feeder expansion for Industrial Park (Chinese investment project; 8 MVA in year 2019, and 5 MVA in year 2020, thus 13 MVA in total) as of February 2019.

(3) Verifying Transformer Capacities

Since there was no consolidated demand data of each substation and no national plan of demand forecast in Malawi, JICA Study Team has prepared electricity demand forecast only for Area 25 Substation and Area 48 Substation under the power flow analysis. The result of the power flow analysis shows that transformers located in Area 25 Substation and Area 48 Substation have enough capacity to meet the forecast demand until the year 2032.

2-2-2-5 Monitoring, Controlling and Protection

(1) Substation with Micro SCADA system

Micro SCADA system should be built in the substation to monitor and control the substation equipment. Only the new equipment of Kanengo Substation and Old Town Substation is the target of this system, and the facilities to be coordinated with National Control Center (NCC) or existing equipment is maintained by ESCOM.

Main components of Micro SCADA system are as follows:

- Network Gateway: All data of the equipment inside the substation will be transmitted to Substation Control Panel (SCP) through Bay Control Unit (BCU), Ethernet switch, etc., utilizing various I/O data in a substation, such as status of switchgears, protection relays, local control facilities and other power facilities.
- Micro SCADA system: Micro SCADA system will be built by using control and monitoring software utilizing the information of SCP via local area network (LAN).
- Work Station for supervision and control: Work Station consisting of display, keyboard, mouse, etc. will control each measurement (voltage, active power, reactive power, etc. of all bays), supervise (condition and fault of all circuits) and operate all circuit condition in the substation. And an uninterruptible power supply (UPS) will feed power to the Work Station to maintain proper operation during power outages.
- Local Area Network (LAN): LAN will consist of BCU, Ethernet switch, etc. of each circuit, and communicate with I/O data through optical fiber cable or LAN cable in the substation.

(2) Protection of the substation

Protection relays should be installed in the substation to protect the substation equipment. Proper

type of protection relays should be applied: current differential relay (main protection) and overcurrent relay (backup protection) for transformers, and distance relay (main protection) and overcurrent relay (backup protection) for transmission lines.

Only the equipment of Kanengo Substation is the target of the protection.

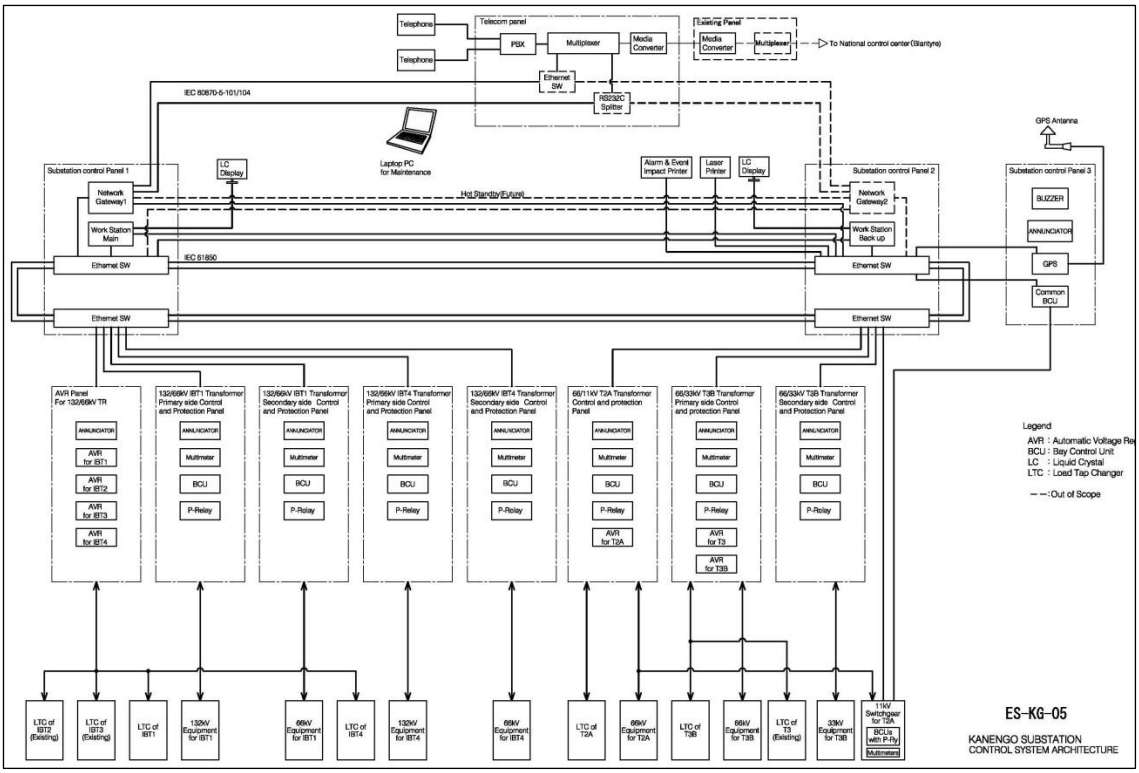
(3) Monitoring and operation of the substation from NCC

Communication equipment between the substation and NCC through optical fiber network should be installed to enable the monitoring and operation of the substation from NCC.

Only the new equipment of Kanengo Substation and Old Town Substation is the target of this system, and the facilities to be coordinated with NCC or existing equipment is maintained by ESCOM.

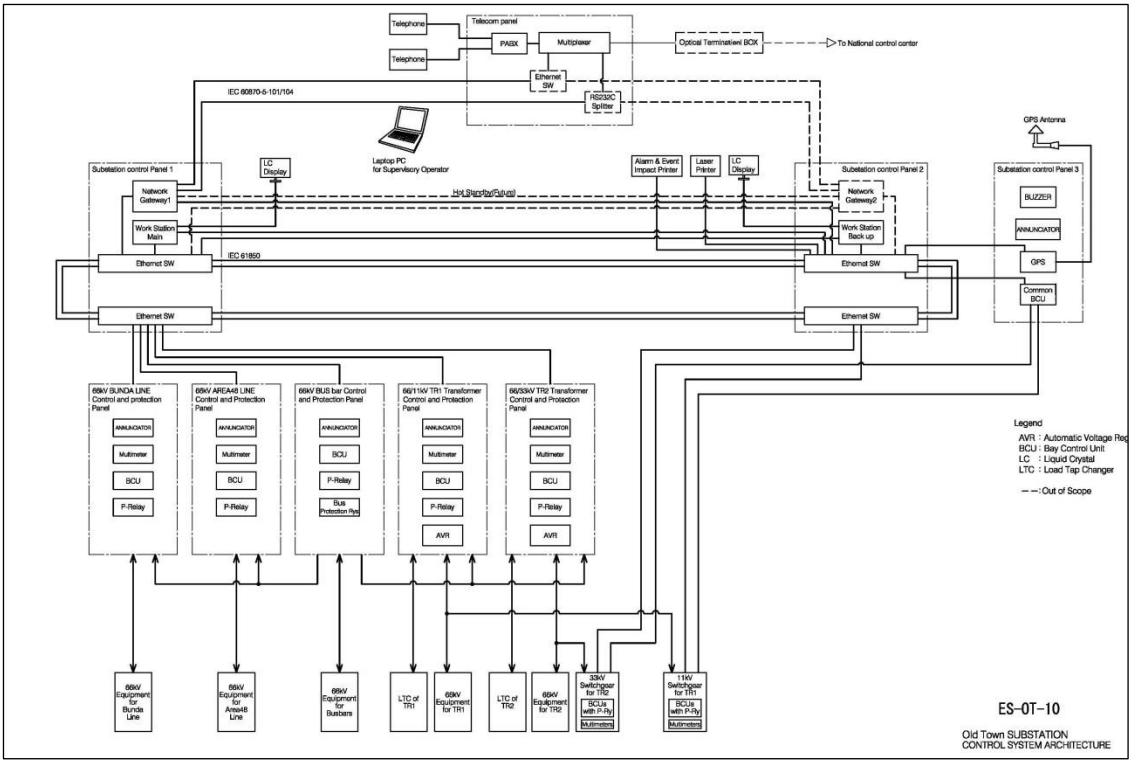
(4) SCADA system architecture

The preliminary SCADA system architecture of Kanengo Substation and Old Town Substation is, respectively, shown in Figure 2-2-2-5.1 and Figure 2-2-2-5.2.



Source: Prepared by JICA survey team

Figure 2-2-2-5.1 Architecture of SCADA System of Kanengo Substation



Source: Prepared by JICA survey team

Figure 2-2-2-5.2 Architecture of SCADA System of Old Town Substation

2-2-2-6 Arrangement Plan

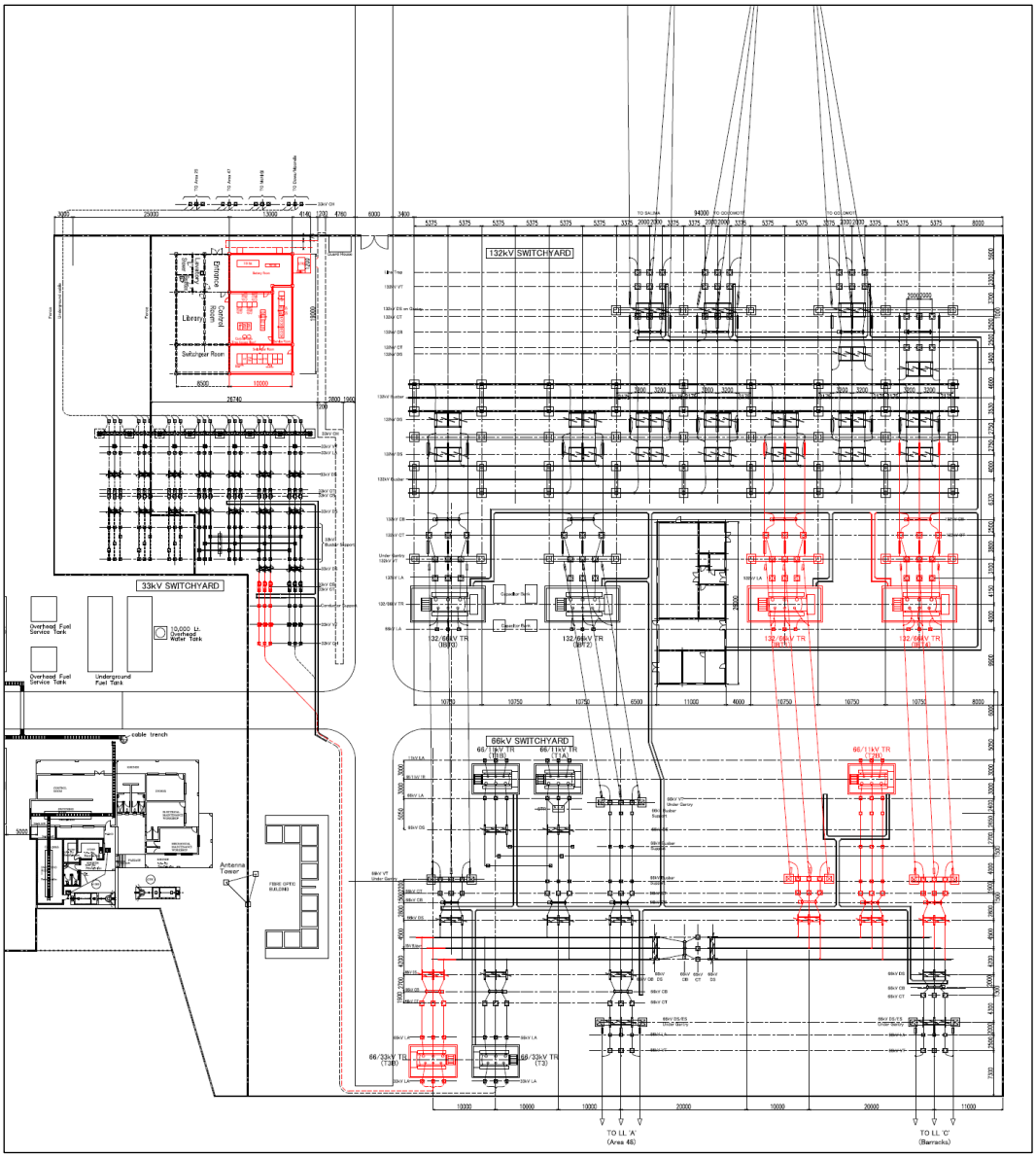
(1) Condition of Substation Site and Arrangement Plan

The preliminary arrangement plans of Kanengo Substation and Old Town Substation are shown in Figure 2-2-2-6.1 and Figure 2-2-2-6.2, respectively. Expansion of the existing sites of both substations is not required for this project.

Regarding Old Town Substation, the equipment of the substation should be installed at an elevation similar to that of the existing equipment taking of adjacent river into consideration while retaining the land for the Control Complex Building planned by ESCOM.

The design ground level will be 1,037m above sea level, which is the same height as the existing Old Town Substation. From discussions with ESCOM, it has become clear that this sea level has not been damaged by floods in the past, and it is clear planned water level is much higher when referenced from "the Preparatory Survey Report for the Project for the Improvement of Major Roads in the City of Lilongwe, June 2019 " (1,032.76 m above sea level).

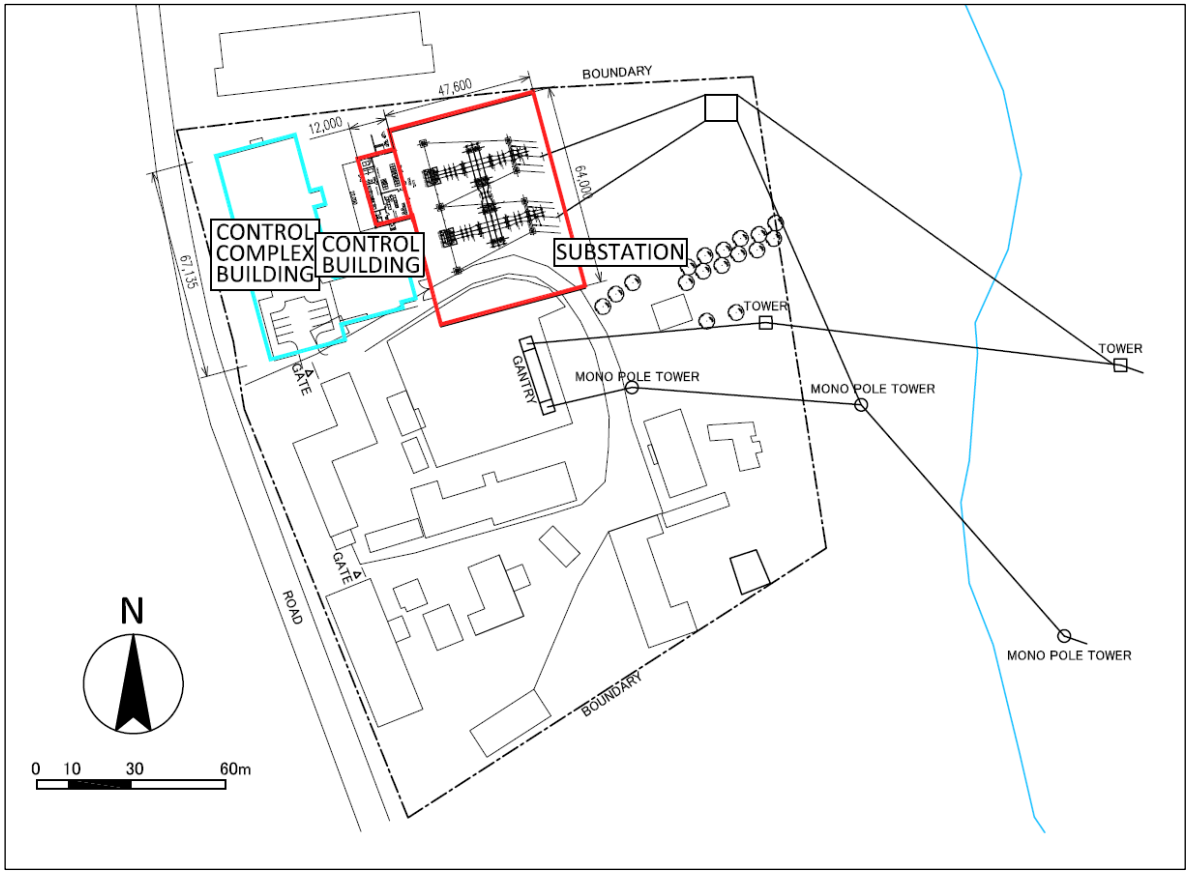
1) Kanengo Substation



Source: Prepared by JICA survey team based on ESCOM information

Figure 2-2-2-6.1 Site Layout Plan of Kanengo Substation

2) Old Town Substation



Source: Prepared by JICA survey team based on ESCOM information

Figure 2-2-2-6.2 Site Plan of Old Town Substation

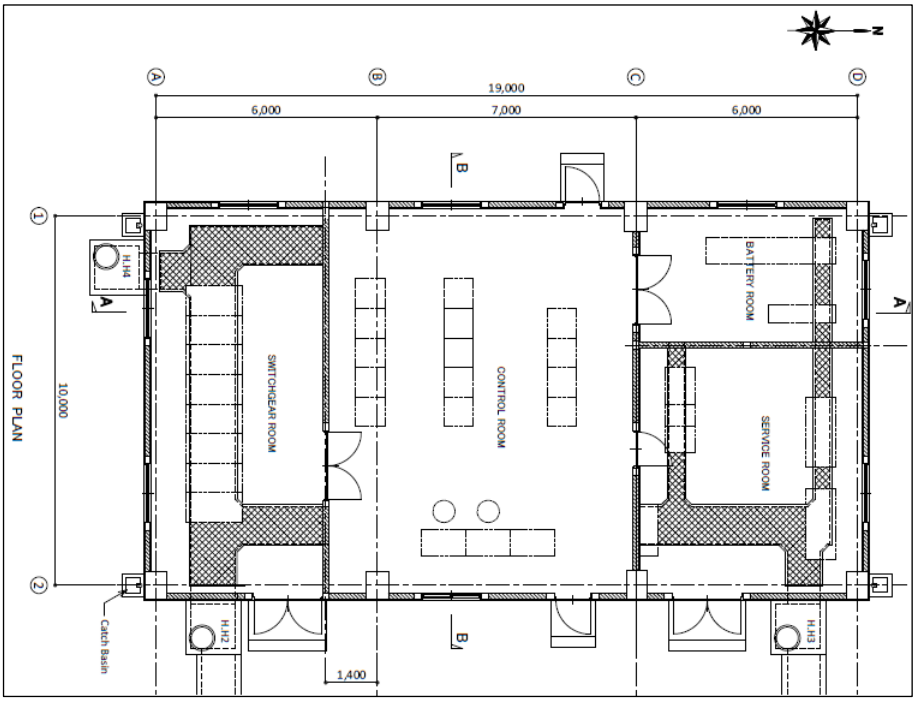
(2) Plan for Control Building

1) Kanengo Substation

The control building is a building in which substation equipment necessary for operation and management of substation facilities to be installed. The Kanengo Substation control building is a one-story building made of reinforced concrete structure with a length of 19 m and width of 10 m. The building is planned considering the minimum required area. Offices and meeting rooms necessary for the management are located in the existing facilities. No special finishing materials are planned for the interior and exterior parts, and locally sourced materials are to be used. The open space on the west side will be used for the future expansion. The building will have expansion joints.

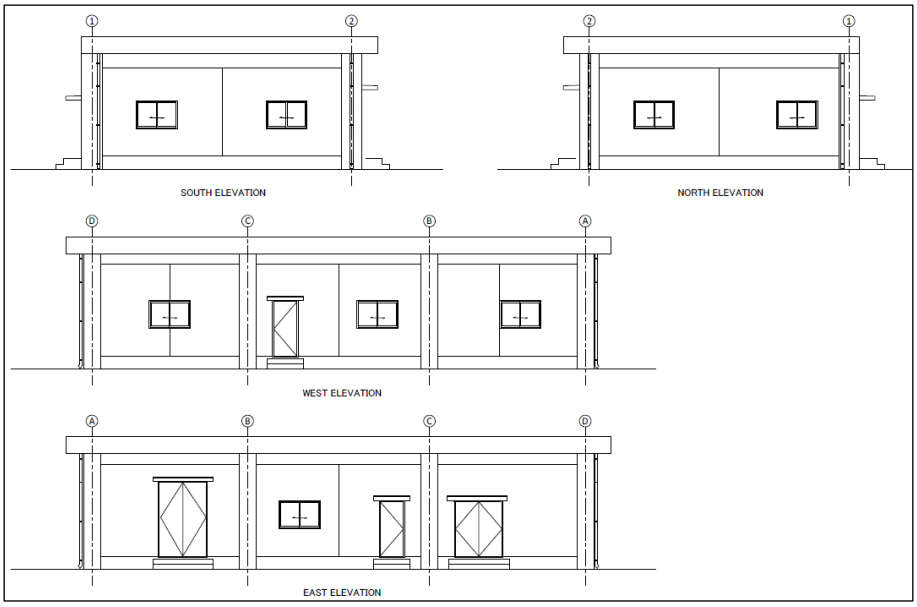
The air conditioning equipment should be selected considering the proper temperature that should be maintained in the room in which the substation equipment will be installed.

The Malawian side is responsible for all external constructions including the access route, because it is a building within the existing substation.



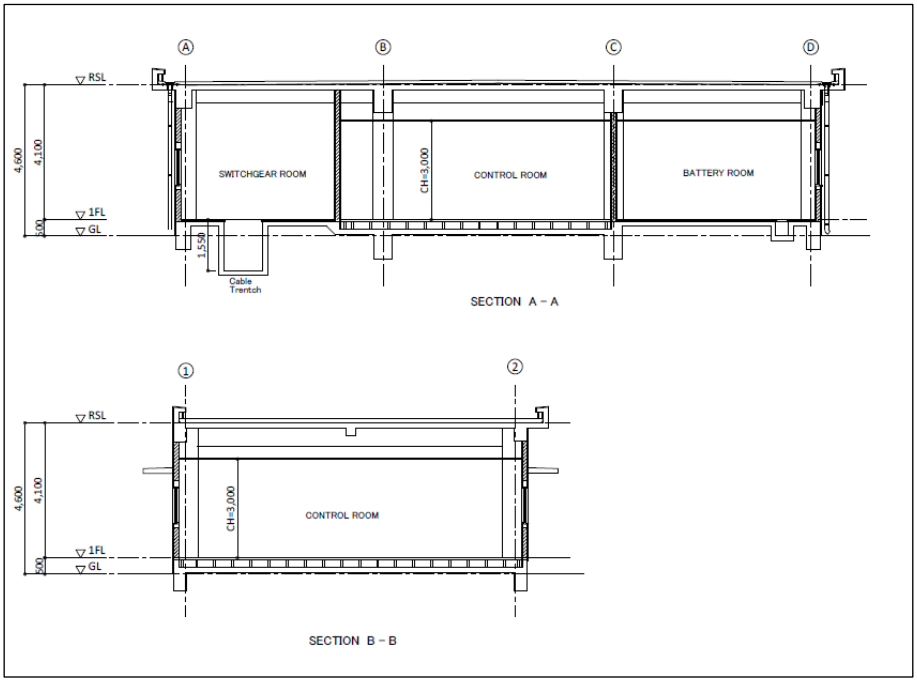
Source: JICA Survey Team

Figure 2-2-2-6.3 Plan



Source JICA Survey Team

Figure 2-2-2-6.4 Elevation



Source: JICA Survey Team

Figure 2-2-2-6.5 Section

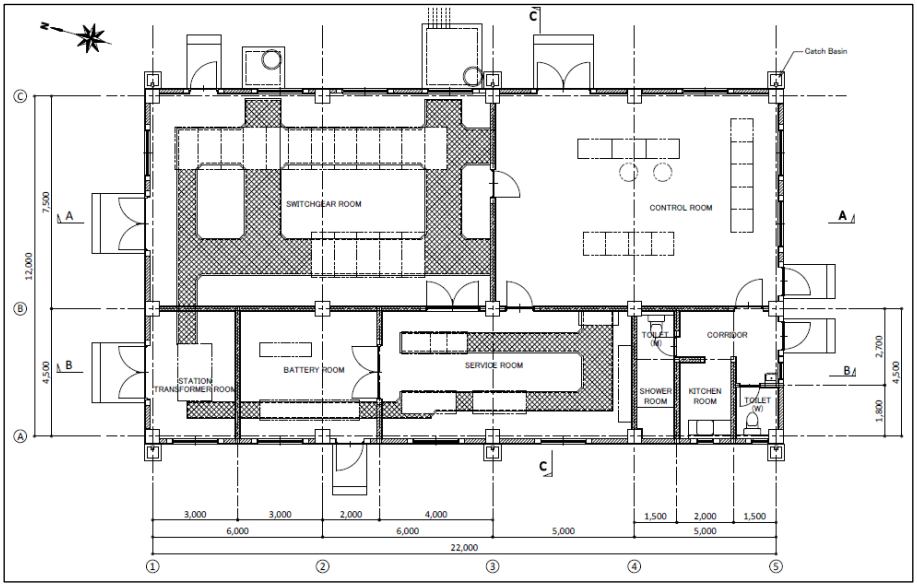
2) Old Town substation

The control building is a building in which the equipment necessary for operation and management of substation facilities is to be installed. The Old Town Substation control building is a one-story building made of reinforced concrete structure with a length of 22 m and width of 12 m. The building is planned considering the minimum required area such as the toilet and shower room. Offices and meeting rooms necessary for the management are located in the existing facilities. No special finishing materials are planned for interior and exterior parts, and locally sourced materials are to be used.

As the building will be built in an existing facility in the city area, domestic water will be supplied by the city. As water shortage often occurs, a storage tank is planned. In addition, since there is no public sewage pipe, the toilet sewage will be treated on-site by a soak pit connected to a purifying septic tank made of concrete.

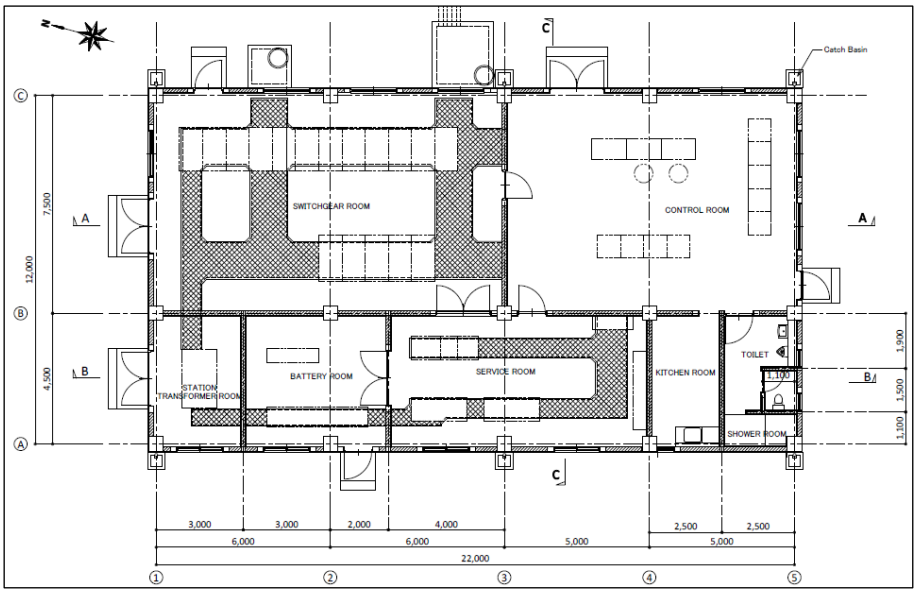
The air conditioning equipment section should consider ensuring the proper temperature environment in the room in which the substation equipment will be installed.

The Malawian side is responsible for the external constructions such as substation yard boundary wall, fence and gate, and the Japanese side can reasonably handle the gravel work in the yard.



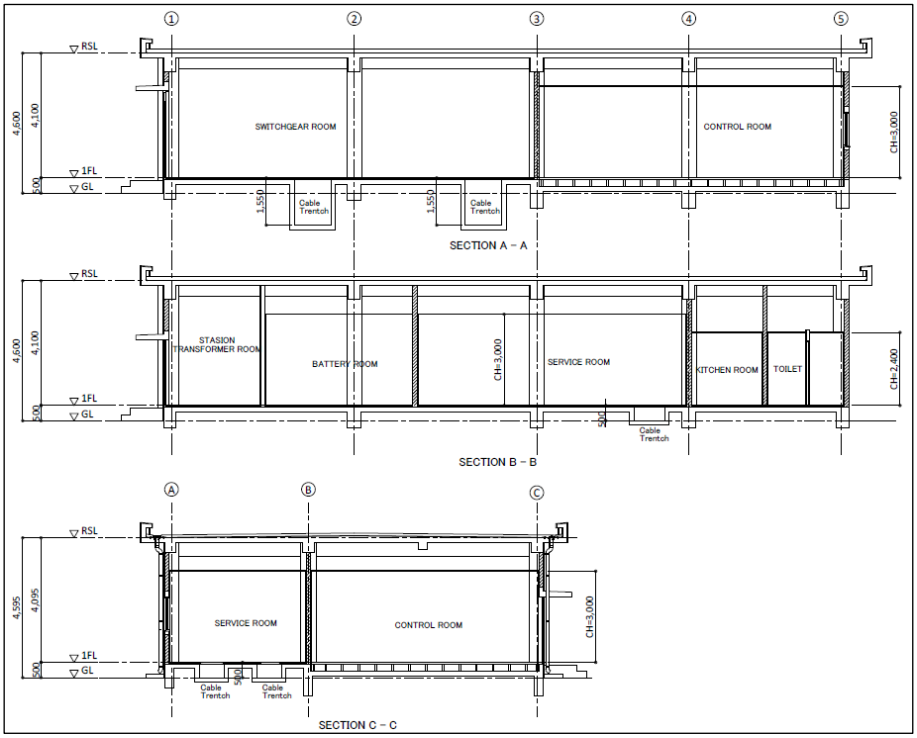
Source: JICA Survey Team

Figure 2-2-2-6.6 Plan



Source: JICA Survey Team

Figure 2-2-2-6.7 Elevation



Source: JICA Survey Team

Figure 2-2-2-6.8 Section

2-2-2-7 Overall Plan

(1) Design Conditions

Project design conditions are as follows.

1) Natural conditions

Basic natural conditions that may be considered in the design of substation facilities, building facilities, and foundations are shown in Table 2-2-2-7.1.

Table 2-2-2-7.1 Basic Natural Conditions for the Facility Design of the Project

Items		Values
Altitude		1,000-1,100 m
Ambient Temperature	Maximum	32.5 Degrees Centigrade
	Minimum	8.4 Degrees Centigrade
	Mean	21.1 Degrees Centigrade
Maximum Humidity		87%
Maximum Wind Velocity		30 m/s
Annual Rain Fall (Maximum)		426 mm/month
Seismic Force		Horizontal 0.10 G
Soil Bearing Capacity		100-200 kN/m^2 Depending on the soil survey result

2) System voltage

- 132 kV : 132 kV ± 10% (118.8 - 132 - 145.2 kV)
- 66 kV : 66 kV ± 10% (59.4 - 66 - 72.6 kV)
- 33 kV : 33 kV ± 10% (29.7 - 33 - 36.3 kV)
- 11 kV : 11 kV ± 10% (9.9 - 11 - 12.1 kV)

3) System frequency

50 Hz ± 0.5 Hz (49.5 - 50 - 50.5 Hz)

4) System short circuit current

According to our approximate system analysis, the following short circuit current is considered:

- 132 kV : 25 kA
- 66 kV : 25 kA
- 33 kV : 25 kA
- 11 kV : 40 kA (Kanengo), 25 kA (Old Town)

5) System earthing

- 132 kV : Solid grounding
- 66 kV : Solid grounding
- 33 kV : Solid grounding
- 11 kV : Solid grounding

6) Insulation Level

Light (IEC-60815)

7) Applicable Codes and Standards

As a rule, the substation system equipment shall be designed in accordance with IEC, or equivalent entities such as JEC, or higher standards, and international system of units (SI units) shall be used.

2-2-2-8 Outline of the Basic Plan

(1) Basic Plan for Kanengo Substation

1) Basic Concept

- Transformers should be newly installed and replaced in the existing Kanengo Substation. These transformers to be procured for this project should consist of two units of 132/66/11 kV 50 MVA transformer (one for replacement, another to be newly installed), one unit of 66/33 kV 25 MVA transformer (to be newly installed), and one unit of 66/11 kV 25 MVA transformer (to be newly installed). The mounting provisions for fans on the radiators should be specified for ONAF (oil-immersed, air-forced cooled) cooling to be modified easily in the future.
- The equipment to be newly installed such as 11kV switchgears, control and protection panels, and communication panel should be installed in the control building to be newly constructed.
- The control building should be designed considering its future expansion.

- The power capacity of the auxiliary electrical equipment in the control building should be designed considering the additional power demand for air conditioning and lighting after the future expansion.
- SCADA system should be built for equipment to be newly installed for monitoring and controlling, and connected to the existing SCADA system via a cable such as optical fiber.
- Installation of transformers should be installed in stages to meet demand, and the completed transformers should start operation one by one.
- Unit test of protection and control panels, and communication panel should be conducted by the beginning of an integrated test between control system and equipment.
- Power outage in some limited area of the substation will be needed during connection works, such as connecting the existing busbars and changeover of feeders.
- Temporary power source will be needed for the construction work.

The following preliminary drawings show the details of the Kanengo Substation:

- KG-ES-01: Kanengo Substation Single Line Diagram
- KG-ES-02: Kanengo Substation Existing Site Layout
- KG-ES-03: Kanengo Substation Site Layout Plan
- KG-ES-04: Kanengo Substation Control Building Layout Plan
- KG-ES-05: Kanengo Substation SCADA System Architecture
- KG-ES-06: Kanengo Substation Scope of the Project

2) Technical Specification

No.	Equipment	Specifications	Unit
KG-1	132/66/11 kV Transformer		2 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	Outdoor use, Oil-immersed, Autotransformer with On-load tap changer (OLTC)	
	➢ Rated primary/secondary capacity	50 MVA	
	➢ Rated tertiary capacity	Approximately 32% of the rated primary/secondary capacity (similarly to the existing transformers)	
	➢ Rated primary voltage	132 kV	
	➢ Rated secondary voltage	66 kV	
	➢ Rated tertiary voltage	11 kV	
	➢ Cooling	ONAN (Refer to particular conditions)	
	➢ Number of phase	3-phase	
	➢ Rated frequency	50 Hz	
	➢ Tap voltage	132 kV +3/- 11*1.43%	
	➢ Number of taps	15 Taps	
	➢ Step voltage	1.43%	
	➢ Winding connections		
	- Primary & Secondary	Star with solidly grounded	
	- Tertiary	Delta	
	- Vector group	YNa0d1	
	➢ % of Impedance	To consider parallel operation with existing transformers	
	➢ Rated lightning impulse withstand voltage	Primary: 650 kV or higher Secondary: 325 kV or higher	

No.	Equipment	Specifications	Unit
	➢ Rated power frequency withstand voltage (1 min.)	Tertiary: 95 kV or higher Primary: 275 kV or higher Secondary: 140 kV or higher Primary & Secondary neutral: 95 kV or higher Tertiary: 28 kV or higher	
	➢ Connections	Primary: Overhead conductors Secondary: Overhead conductors Tertiary: Cables	
	➢ Bushing CT	Class: 5P20 or more Secondary: 800/1 A (one-phase) Primary neutral: 400/1 A Tertiary: 800/1 A	
	➢ Control voltage	DC 110 V, AC 230/400V	
	➢ Oil preservation system	Conservator type	
	➢ Loss	No-load loss: 25kW or lower, Load loss at rated output: 270kW or lower	
	➢ Paint color	RAL 7044 or similar colors	
	➢ Accessories	Insulating oil, OLTC motor operating device, Hand lamp, Control switch (raising and lowering), Changeover switch (remote and local), Cable duct of tertiary side, Buchholz relay with alarm contact, LTC oil flow relay, Oil level gauge with alarm contact, Oil temperature indicator with alarm contact, Oil and Winding temperature elements for remote indication, Pressure relief device with alarm contact, Dehydrating breathers, Ladder for maintenance, Handle for LTC operation, Earth terminal, Terminal box, Oil drain valve, Radiator, Conservator, and All necessary fittings for installation	
	➢ Particular conditions - Parallel operation	Parallel operation with the existing transformers shall be provided. Specifications of the existing transformer (IBT3) Rating capacity: 33 MVA, Ratio of transformation: 132/66 kV, Tap: 132 kV+3/-11*1.43%, No-load loss: 2.6kW, Vector group: YNa0d1, % of Impedance (self-capacity base) : Tap 1/4/15 : 8.1/8.0/8.4%	
	- Provisions for ONAF	The mounting provisions for fans shall be provided on the radiators for 65 MVA ONAF (oil-immersed, air-forced cooled) cooling in order to meet power demand in the future.	
	- Control circuits of cooling fans	Fan control circuits and associated power supply circuits for ONAF cooling shall be provided in a local control panel from the beginning.	
	- Oil pit	An oil pit with storage capacity of 120% of the total insulating oil volume of the transformer shall be provided under each transformer.	

No.	Equipment	Specifications	Unit
KG-2	132 kV Circuit breaker		2 Sets
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	3-Phase, Live tank type, Outdoor use, Spring-operated GCB	
	➢ Rated voltage	145 kV	
	➢ Rated current	1,250 A or higher	
	➢ Rated short-circuit breaking current	25 kA or higher	
	➢ Rated operating sequence	O-0.3 sec.-CO-3 min.-CO	
	➢ Rated short-time withstand current & Rated duration of short-circuit & Rated duration of short-circuit	25 kA-2 sec. or higher	
	➢ Rated lightning impulse withstand voltage	650 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	275 kV or higher	
	➢ Control voltage	DC 110 V	
	➢ Heater voltage	AC 230 V	
	➢ Auxiliary switch contact	12 normally open, 12 normally closed (except self-use)	
	➢ Accessories	Local control box, Changeover switch (remote and local), Switching operation counter, Charging handle of tripping/closing spring, Support structure, All necessary fittings for installation	
	➢ Paint color (local control box)	RAL 7044 or similar colors	
KG-3	132 kV Current transformer		-
1-1	132 kV Current transformer		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	Outdoor use, Single-phase, Porcelain insulator type	
	➢ Rated voltage	145 kV	
	➢ Rated primary current	400 A	
	➢ Rated secondary current	1/1/1/1 A	
	➢ Accuracy class		
	- for Instrument	Class 0.5 or more	
	- for Protection x 2	Class 5P20 or more	
	- for Busbar protection (future)	Class PX	
	➢ Rated burden	Each 30 VA or higher	
	➢ Rated short-time withstand current & Rated duration of short-circuit	25 kA-2 sec. or higher	
	➢ Rated lightning impulse withstand voltage	650 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	275 kV or higher	
	➢ Accessories	All necessary fittings for installation	
1-2	Support structure of 132 kV current transformer		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Material	Steel materials	
	➢ Rustproofing treatment	Hot-dip galvanizing	
	➢ Accessories	All necessary fittings for installation	

No.	Equipment	Specifications	Unit
KG-4	132 kV Lightning arrester		-
1-1	132 kV Lightning arrester		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	Outdoor use, Metal-oxide gapless, Single-phase type	
	➢ Rated voltage	120 kV	
	➢ Nominal discharge current	10 kA	
	➢ Line discharge class	Class 3	
	➢ Accessories	Surge counter (each phase) , All necessary fittings for installation	
1-2	Support structure of 132 kV Lightning arrester		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Material	Steel materials	
	➢ Rustproofing treatment	Hot-dip galvanizing	
	➢ Accessories	All necessary fittings for installation	
KG-5	132 kV Voltage transformer		-
1-1	132 kV Voltage transformer		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	Outdoor use, Single-phase, Porcelain insulator, Capacitor voltage type	
	➢ Rated primary voltage	132 kV/√3 V	
	➢ Rated secondary voltage	110/√3 V	
	➢ Highest Voltage	145 kV	
	➢ Accuracy class		
	- for Instrument	Class 0.5 or more	
	- for Protection	Class 3P or more	
	➢ Rated burden	Each 50 VA or higher	
	➢ Rated lightning impulse withstand voltage	650 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	275 kV or higher	
	➢ Accessories	All necessary fittings for installation	
1-2	Support structure of 132 kV Voltage transformer		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Material	Steel materials	
	➢ Rustproofing treatment	Hot-dip galvanizing	
	➢ Accessories	All necessary fittings for installation	
KG-6	66/33 kV Transformer		1 Unit
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	Outdoor use, Oil-immersed, Transformer with On-load tap changer (OLTC)	
	➢ Rated capacity	25 MVA	
	➢ Rated primary voltage	66 kV	
	➢ Rated secondary voltage	33 kV	
	➢ Cooling	ONAN (Refer to particular conditions)	
	➢ Number of phase	3-Phase	
	➢ Rated frequency	50 Hz	
	➢ Tap voltage	+4/- 12*1.25%	

No.	Equipment	Specifications	Unit
	➢ Number of taps	17 taps	
	➢ Step voltage	1.25%	
	➢ Winding connections		
	- Primary	Star with solidly grounded	
	- Secondary	Star with solidly grounded	
	- Tertiary	Delta (Stabilizing winding)	
	- Vector group	YNyn0+d1	
	➢ % of Impedance	Parallel operation with the existing transformers shall be provided.	
	➢ Rated lightning impulse withstand voltage	Uniform insulation Primary: 325 kV or higher Secondary: 170 kV or higher Tertiary: 75 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	Uniform insulation Primary: 140 kV or higher Secondary: 70 kV or higher Tertiary: 28 kV or higher	
	➢ Connections	Primary: Overhead conductors Secondary: Cables (inside of the cable duct)	
	➢ Bushing CT	Class: 5P20 or more Secondary: 800/1 A (one-phase) Secondary neutral: 800/1 A	
	➢ Lightning arrester of secondary side	Metal-oxide gapless type, 30 kV, 10 kA, Line discharge class 2	
	➢ Control voltage	DC 110 V, AC 230/400V	
	➢ Oil preservation system	Conservator type	
	➢ Loss	No-load loss: 25kW or lower, Load loss at rated output: 150kW or lower	
	➢ Paint color	RAL 7044 or similar colors	
	➢ Accessories	Insulating oil, OLTC motor operating device, Hand lamp, Control switch (raising and lowering), Changeover switch (remote and local), Cable duct of secondary side, Buchholz relay with alarm contact, LTC oil flow relay, Oil level gauge with alarm contact, Oil temperature indicator with alarm contact, Oil and Winding temperature elements for remote indication, Pressure relief device with alarm contact, Dehydrating breathers, Ladder for maintenance, Handle for LTC operation, Earth terminal, Terminal box, Oil drain valve, Radiator, Conservator, and All necessary fittings for installation	
	➢ Particular conditions		
	- Parallel operation	Parallel operation with the existing transformer shall be provided. Specifications of the existing transformer (T3) Rating capacity: 25 MVA, Ratio of transformation: 66/33 kV, Tap: 66+4/-12*1.25%, Load loss: 119.65kW, Vector group: YNyn0+d1, % of Impedance (self-capacity base) : 69.3 kV/10.53%, 66 kV/10.22%, 56.1 kV/9.88%	
	- Provisions for ONAF	The mounting provisions for fans shall be provided on the radiators for 31.5 MVA ONAF (oil-immersed, air-forced cooled) cooling in order to	
	- Control circuits of cooling fans		

No.	Equipment	Specifications	Unit
	- Oil pit	meet power demand in the future. Fan control circuits and associated power supply circuits for ONAF cooling shall be provided in a local control panel from the beginning. An oil pit with storage capacity of 120% of the total insulating oil volume of the transformer shall be provided under each transformer.	
KG-7	66/11 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated capacity ➢ Rated primary voltage ➢ Rated secondary voltage ➢ Cooling ➢ Number of phase ➢ Rated frequency ➢ Tap voltage ➢ Number of taps ➢ Step voltage ➢ Winding connections - Primary - Secondary - Tertiary - Vector group ➢ % of Impedance ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Connections ➢ Bushing CT ➢ Lightning arrester of secondary side ➢ Control voltage ➢ Oil preservation system ➢ Loss ➢ Paint color ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Oil-immersed, Transformer with On-load tap changer (OLTC) 25 MVA 66 kV 11 kV ONAN (Refer to particular conditions) 3-Phase 50 Hz +3/- 11*1.42% 15 taps 1.42% Star with solidly grounded Star with solidly grounded Delta (Stabilizing winding) YNyn0+d1 10.22% (Same as the existing 66/33 kV transformer) Uniform insulation Primary: 325 kV or higher Secondary: 75 kV or higher Tertiary: 40 kV or higher Uniform insulation Primary: 140 kV or higher Secondary: 28 kV or higher Tertiary: 10 kV or higher Primary: Overhead conductors Secondary: Cables (inside of the cable duct) Class: 5P20 or more Secondary: 2,500/1 A (one-phase) Secondary neutral: 2,500/1 A Metal-oxide gapless type, 12 kV, 10 kA, Line discharge class 2 DC 110 V, AC 230/400V Conservator type No-load loss: 25kW or lower, Load loss at rated output: 150kW or lower RAL 7044 or similar colors Insulating oil, OLTC motor operating device, Hand lamp, Control switch (raising and lowering), Changeover switch (remote and local), Cable duct of secondary side, Buchholz relay with alarm contact, LTC oil flow relay, Oil level gauge with alarm contact, Oil temperature indicator with alarm contact, Oil and Winding temperature elements for remote indication,	1 Unit

No.	Equipment	Specifications	Unit
	➢ Particular conditions - Parallel operation - Provisions for ONAF - Control circuits of cooling fans - Oil pit	Pressure relief device with alarm contact, Dehydrating breathers, Ladder for maintenance, Handle for LTC operation, Earth terminal, Terminal box, Oil drain valve, Radiator, Conservator, and All necessary fittings for installation Design shall be done taking the parallel operation with other transformers in the future into consideration. The mounting provisions for fans shall be provided on the radiators for 31.5 MVA ONAF (oil-immersed, air-forced cooled) cooling in order to meet power demand in the future. Fan control circuits and associated power supply circuits for ONAF cooling shall be provided in a local control panel from the beginning. An oil pit with storage capacity of 120% of the total insulating oil volume of the transformer shall be provided under each transformer.	
KG-8	66 kV Circuit breaker		-
1-1	66 kV Circuit breaker (3-phase) of 132/66/11 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated operating sequence ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories ➢ Paint color (local control box)	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-Phase, Live tank type, Outdoor use, Spring-operated GCB 72.5 kV 1,250 A or higher 25 kA or higher O-0.3 sec.-CO-3 min.-CO 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher DC 110 V AC 230 V 12 normally open, 12 normally closed (except self-use) Local control box, Changeover switch (remote and local), Switching operation counter, Charging handle of tripping/closing spring, Support structure, All necessary fittings for installation RAL 7044 or similar colors	2 Units
2-1	66 kV Circuit breaker (3-phase) of 66/33 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-Phase, Live tank type, Outdoor use, Spring-operated GCB 72.5 kV 1,250 A or higher 25 kA or higher	1 Unit

No.	Equipment	Specifications	Unit
	➢ Rated operating sequence ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories ➢ Paint color (local control box)	O-0.3 sec.-CO-3 min.-CO 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher DC 110 V AC 230 V 12 normally open, 12 normally closed (except self-use) Local control box, Changeover switch (remote and local), Switching operation counter, Charging handle of tripping/closing spring, Support structure, All necessary fittings for installation RAL 7044 or similar colors	
3-1	66 kV Circuit breaker (3-phase) of 66/11 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated operating sequence ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories ➢ Paint color (local control box)	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-Phase, Live tank type, Outdoor use, Spring-operated GCB 72.5 kV 1,250 A or higher 25 kA or higher O-0.3 sec.-CO-3 min.-CO 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher DC 110 V AC 230 V 12 normally open, 12 normally closed (except self-use) Local control box, Changeover switch (remote and local), Switching operation counter, Charging handle of tripping/closing spring, Support structure, All necessary fittings for installation RAL 7044 or similar colors	1 Unit
KG-9 1-1	66 kV Disconnecting switch 66 kV Disconnecting switch (3-phase) for 132/66/11 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-phase, Outdoor use, Horizontal double-break rotary motion, Porcelain insulator type 72.5 kV 1,250 A or higher 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher	- 2 Units

No.	Equipment	Specifications	Unit
	withstand voltage (1 min.) ➢ Operation ➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories ➢ Paint color (local control box) ➢ Particular conditions - Electrical interlocking	 Motor operation DC 110 V AC 230 V 10 normally open, 10 normally closed (except self-use) Local control box, Changeover switch (remote and local), Manual handle for opening/closing, All necessary fittings for installation RAL 7044 or similar colors Electrical interlocking between the associated circuit breaker and the disconnecting switch shall be provided.	
1-2	Support structure of 66 kV Disconnecting switch (for 132/66/11 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	2 Units
2-1	66 kV Disconnecting switch (3-phase) of 66/33 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Operation ➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories ➢ Paint color (local control box) ➢ Particular conditions - Electrical interlocking	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-phase, Outdoor use, Horizontal double-break rotary motion, Porcelain insulator type 72.5 kV 1,250 A or higher 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher Motor operation DC 110 V AC 230 V 10 normally open, 10 normally closed (except self-use) Local control box, Changeover switch (remote and local), Manual handle for opening/closing, All necessary fittings for installation RAL 7044 or similar colors Electrical interlocking between the associated circuit breaker and the disconnecting switch shall be provided.	1 Unit
2-2	Support structure of 66 kV Disconnecting switch (for 66/33 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	1 Unit

No.	Equipment	Specifications	Unit
3-1	66 kV Disconnecting switch (3-phase) of 66/11 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Operation ➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories ➢ Paint color (local control box) ➢ Particular conditions - Electrical interlocking	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-phase, Outdoor use, Horizontal double-break rotary motion, Porcelain insulator type 72.5 kV 1,250 A or higher 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher Motor operation DC 110 V AC 230 V 10 normally open, 10 normally closed (except self-use) Local control box, Changeover switch (remote and local), Manual handle for opening/closing, All necessary fittings for installation RAL 7044 or similar colors Electrical interlocking between the associated circuit breaker and the disconnecting switch shall be provided.	1 Unit
3-2	Support structure of 66 kV Disconnecting switch (for 66/11 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	1 Unit
KG-10	66 kV Current transformer		-
1-1	66 kV Current transformer (3-phase) of 132/66/11 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated primary current ➢ Rated secondary current ➢ Accuracy class - for Instrument - for Protection x 2 - for Busbar protection (future) ➢ Rated burden ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Single-phase, Porcelain insulator type 72.5 kV 800 A 1/1/1/1 A Class 0.5 or more Class 5P20 or more Class PX Each 30 VA or higher 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher All necessary fittings for installation	6 Units

No.	Equipment	Specifications	Unit
1-2	Support structure of 66 kV current transformer (for 132/66/11 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	6 Units
2-1	66 kV Current transformer (3-phase) of 66/33 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated primary current ➢ Rated secondary current ➢ Accuracy class - for Instrument - for Protection x 2 - for Busbar protection (future) ➢ Rated burden ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Single-phase, Porcelain insulator type 72.5 kV 500 A 1/1/1/1 A Class 0.5 or more Class 5P20 or more Class PX Each 30 VA or higher 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher All necessary fittings for installation	3 Units
2-2	Support structure of 66 kV Current transformer (for 66/33 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units
3-1	66 kV Current transformer (3-phase) of 66/11 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated primary current ➢ Rated secondary current ➢ Accuracy class - for Instrument - for Protection x 2 - for Busbar protection (future) ➢ Rated burden ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Single-phase, Porcelain insulator type 72.5 kV 500 A 1/1/1/1 A Class 0.5 or more Class 5P20 or more Class PX Each 30 VA or higher 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher	3 Units

No.	Equipment	Specifications	Unit
	withstand voltage (1 min.) ➢ Accessories	 All necessary fittings for installation	
3-2	Support structure of 66 kV Current transformer (for 66/11 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units
KG-11 1-1	66 kV Lightning arrester 66 kV Lightning arrester (3-phase) of 132/66/11 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Nominal discharge current ➢ Line discharge class ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Metal-oxide gapless, Single-phase type 60 kV 10 kA Class 3 Surge counter (each phase) , All necessary fittings for installation	- 6 Units
1-2	Support structure of 66 kV Lightning arrester (for 132/66/11 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	6 Units
2-1	66 kV Lightning arrester (3-phase) of 66/33 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Nominal discharge current ➢ Line discharge class ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Metal-oxide gapless, Single-phase type 60 kV 10 kA Class 3 Surge counter (each phase) , All necessary fittings for installation	3 Units
2-2	Support structure of 66 kV Lightning arrester (for 66/33 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units
3-1	66 kV Lightning arrester (3-phase) of 66/11 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Metal-oxide gapless, Single-phase type 60 kV	3 Units

No.	Equipment	Specifications	Unit
	➢ Nominal discharge current ➢ Line discharge class ➢ Accessories	10 kA Class 3 Surge counter (each phase) , All necessary fittings for installation	
3-2	Support structure of 66 kV Lightning arrester (for 66/11 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units
KG-12 1-1	66 kV Voltage transformer 66 kV Voltage transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated primary voltage ➢ Rated secondary voltage ➢ Highest Voltage ➢ Accuracy class - for Instrument - for Protection ➢ Rated burden ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Single-phase, Capacitor voltage type 66 kV/√3 V 110/√3 V 72.5 kV Class 0.5 or more Class 3P or more Each 50 VA or higher 325 kV or higher 140 kV or higher All necessary fittings for installation	- 6 Units
1-2	Support structure of 66 kV Voltage transformer ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	6 Units
KG-13 1-1	66 kV Busbars (including support structure) 66 kV Busbars (extension part) ➢ Applicable standards ➢ Conductor material ➢ Dimensions	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Aluminum pipe or equivalent Equivalent to the existing busbars	- 1 Lot
2-1	Support structure of 66 kV busbars insulator ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units
3-1	66 kV Busbars insulator ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Material ➢ Rated lightning impulse withstand	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Station post insulator Porcelain 325 kV or higher	1 Lot

No.	Equipment	Specifications	Unit
	voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.)	140 kV or higher	
KG-14	33 kV Circuit breaker ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated operating sequence ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories ➢ Paint color (local control box)	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-Phase, Live tank type, Outdoor use, Spring-operated GCB 36 kV 800 A or higher 25 kA or higher O-0.3 sec.-CO-3 min.-CO 25 kA-2 sec. or higher 170 kV or higher 70 kV or higher DC 110 V AC 230 V 12 normally open, 12 normally closed (except self-use) Local control box, Changeover switch (remote and local), Switching operation counter, Charging handle of tripping/closing spring, Support structure, All necessary fittings for installation RAL 7044 or similar colors	1 Unit
KG-15 1-1	33 kV Disconnecting switch 33 kV Disconnecting switch ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Operation ➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories ➢ Paint color (local control box) ➢ Particular conditions - Electrical interlocking	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-phase, Outdoor use, Horizontal single or double-break rotary motion, Porcelain insulator type 36 kV 800 A or higher 25 kA-2 sec. or higher 170 kV or higher 70 kV or higher Motor operation DC 110 V AC 230 V 10 normally open, 10 normally closed (except self-use) Local control box, Changeover switch (remote and local), Manual handle for opening/closing, All necessary fittings for installation RAL 7044 or similar colors Electrical interlocking between the associated circuit breaker and the disconnecting switch shall be provided.	- 1 Unit

No.	Equipment	Specifications	Unit
1-2	Support structure of 33 kV Disconnecting switch ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	1 Unit
KG-16 1-1	33 kV Current transformer 33 kV Current transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated primary current ➢ Rated secondary current ➢ Accuracy class - for Instrument - for Protection x 2 ➢ Rated burden ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use 36 kV 800 A 1/1/1 A Class 0.5 or more Class 5P20 or more Each 30 VA or higher 25 kA-2 sec. or higher 170 kV or higher 70 kV or higher All necessary fittings for installation	- 3 Units
1-2	Support structure of 33 kV Current transformer ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units
KG-17 1-1	33 kV Lightning arrester 33 kV Lightning arrester ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Nominal discharge current ➢ Line discharge class ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Metal-oxide gapless, Single-phase type 30 kV 10 kA Class 2 Surge counter (each phase) , All necessary fittings for installation	- 3 Units
1-2	Support structure of 33 kV Lightning arrester ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units
KG-18 1-1	33 kV Voltage transformer 33 kV Voltage transformer ➢ Applicable standards ➢ Creepage distance of insulator	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher	- 3 Units

No.	Equipment	Specifications	Unit
	➢ Type ➢ Rated primary voltage ➢ Rated secondary voltage ➢ Highest Voltage ➢ Accuracy class - for Instrument - for Protection ➢ Rated burden ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Accessories	Outdoor use, Single-phase type 33 kV/√3 V 110/√3 V 36 kV Class 0.5 or more Class 3P or more Each 50 VA or higher 170 kV or higher 70 kV or higher All necessary fittings for installation	
1-2	Support structure of 33 kV Voltage transformer ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units
KG-19 1-1	11 kV Switchgear 11 kV Switchgear of Incomer (66/11 kV Transformer) ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Panel equipped with: ➢ Earthing switch ➢ Voltage transformer - Rated voltage - Accuracy class - Rated burden ➢ Paint color ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Metal-enclosed switchgear (Partition class PM) 12 kV 2,000 A or higher 40 kA or higher 40 kA-2 sec. or higher 75 kV or higher 28 kV or higher DC 110 V Bay control unit (BCU) with display, Protection relay, Measuring meter, Current transformer (CT), Voltage detection device, etc. Manual operation type 11 kV/√3 V / 110/√3 V for Instrument Class: 0.5 or more, for Protection Class: 3P or more Each 50 VA or higher RAL 7035 or similar colors All necessary fittings for installation	- 1 Panel
2-1	11 kV Switchgear of 11 kV Feeder ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated short-time withstand current &	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Metal-enclosed switchgear (Partition class PM) 12 kV 630 A or higher 40 kA or higher 40 kA-2 sec. or higher	4 Panels

No.	Equipment	Specifications	Unit
	Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Panel equipped with: ➢ Earthing switch ➢ Voltage transformer (VT) - Rated voltage - Accuracy class ➢ - Rated burden ➢ Paint color ➢ Accessories ➢ Particular conditions - Panel configuration	 75 kV or higher 28 kV or higher DC 110 V BCU with display, Protection relay, Measuring meter, CT, Voltage detection device, etc. Manual operation type (Just one panel equipped with the VT) 11 kV/√3 V / 110/√3 V for Instrument Class: 0.5 or more, for Protection Class: 3P or more Each 50 VA or higher RAL 7035 or similar colors All necessary fittings for installation If the VT could not be fitted into a feeder panel, it is allowable to add another panel.	
3-1	11 kV Switchgear of Diesel generator ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Panel equipped with: ➢ Earthing switch ➢ Paint color ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Metal-enclosed switchgear (Partition class PM) 12 kV 630 A or higher 40 kA or higher 40 kA-2 sec. or higher 75 kV or higher 28 kV or higher DC 110 V BCU with display, Protection relay, Measuring meter, CT, Voltage detection device, synchronizing relay, Voltage Transformer, etc. (Manual synchronizing for a generator) Manual operation type RAL 7035 or similar colors All necessary fittings for installation	1 Panel
4-1	11 kV Switchgear for Station transformer ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Panel equipped with:	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Metal-enclosed switchgear (Partition class PM) 12 kV 630 A or higher 40 kA or higher 40 kA-2 sec. or higher 75 kV or higher 28 kV or higher DC 110 V BCU with display, Protection relay, Measuring	1 Panel

No.	Equipment	Specifications	Unit
		meter, CT, Voltage detection device, etc.	
	➢ Earthing switch	Manual operation type	
	➢ Paint color	RAL 7035 or similar colors	
	➢ Accessories	All necessary fittings for installation	
KG-20	Control and protection panel		-
1-1	Control and protection panel of 132/66/11 kV Transformer (Primary)		2 Panels
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Type	Indoor use, Free standing enclosure type	
	➢ Types of protection relays	1) Digital protection relay	
	➢ Communication standard	2) Relays: differential, overcurrent, etc.	
	➢ Purpose	IEC 61850	
	➢ Panel equipped with:	132/66/11 kV Transformer (2units)	
	➢ Accessories	BCU with display, Protection relay, Measuring meter, CT, Annunciator, etc. Lighting, 230 VAC Outlet for maintenance (Common use of KG-20)	
	➢ Paint color	RAL 7035 or similar colors	
	➢ Accessories	All necessary fittings for installation	
	➢ Particular conditions - Terminal block for cables	Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	
1-2	Control and protection panel of 132/66/11 kV Transformer (Secondary)		2 Panels
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Type	Indoor use, Free standing enclosure type	
	➢ Types of protection relays	1) Digital protection relay	
	➢ Communication standard	2) Relays: differential, overcurrent, etc.	
	➢ Purpose	IEC 61850	
	➢ Panel equipped with:	132/66/11 kV Transformer (2units)	
	➢ Accessories	BCU with display, Protection relay, Measuring meter, CT, Annunciator, etc. Lighting, 230 VAC Outlet for maintenance (Common use of KG-20)	
	➢ Paint color	RAL 7035 or similar colors	
	➢ Accessories	All necessary fittings for installation	
	➢ Particular conditions - Terminal block for cables	Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	
2-1	Control and protection panel of 66/33 kV Transformer (Primary)		1 Panels
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Type	Indoor use, Free standing enclosure type	
	➢ Types of protection relays	1) Digital protection relay 2) Relays: differential, overcurrent, etc.	
	➢ Communication standard	IEC 61850	
	➢ Purpose	66/33 kV Transformer	
	➢ Panel equipped with:	BCU with display, Protection relay, Measuring meter, Annunciator, Automatic voltage regulator (AVR), etc.	
	➢ Accessories	Lighting	
	➢ Paint color	RAL 7035 or similar colors	
	➢ Accessories	All necessary fittings for installation	
	➢ Particular conditions		

No.	Equipment	Specifications	Unit
	- Parallel operation - Terminal block for cables	Parallel operation with the existing transformer shall be provided. Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	
2-2	Control and protection panel of 66/33 kV Transformer (Secondary) ➢ Applicable standards ➢ Type ➢ Types of protection relays ➢ Communication standard ➢ Purpose ➢ Panel equipped with: ➢ Accessories ➢ Paint color ➢ Accessories ➢ Particular conditions - Parallel operation - Terminal block for cables	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type 1) Digital protection relay 2) Relays: differential, overcurrent, etc. IEC 61850 66/33 kV Transformer BCU with display, Protection relay, Measuring meter, Annunciator, Automatic voltage regulator (AVR), etc. Lighting RAL 7035 or similar colors All necessary fittings for installation Parallel operation with the existing transformer shall be provided. Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	1 Panels
3-1	Control and protection panel of 66/11 kV Transformer ➢ Applicable standards ➢ Type ➢ Types of protection relays ➢ Communication standard ➢ Purpose ➢ Panel equipped with: ➢ Accessories ➢ Paint color ➢ Accessories ➢ Particular conditions - Parallel operation - Terminal block for cables	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type 1) Digital protection relay 2) Relays: differential, overcurrent, etc. IEC 61850 66/11 kV Transformer BCU with display, Protection relay, Measuring meter, AVR, etc. Lighting RAL 7035 or similar colors All necessary fittings for installation Design shall be done taking the parallel operation with other transformers in the future into consideration. Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	1 Panel
4-1	Control and protection panel for Regulation of the secondary voltage of the transformer ➢ Applicable standards ➢ Type ➢ Voltage regulation type ➢ Communication standard ➢ Target for voltage regulation ➢ Panel equipped with: ➢ Accessories ➢ Paint color ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type Digital type AVR IEC 61850 132/66/11 kV Transformers including the existing (IBT1, IBT2, IBT3, and IBT4) Annunciator, AVR, etc. Lighting RAL 7035 or similar colors All necessary fittings for installation	1 Panel

No.	Equipment	Specifications	Unit
	➢ Particular conditions - Parallel operation - Terminal block for cables	 Parallel operation shall be provided between the existing (IBT2, IBT3) and the new installation (new IBT1, IBT4). Parallel operation shall be provided between the existing (T3) and the new installation (T3B). Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	
KG-21	11/0.4 kV Station transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated capacity ➢ Rated primary voltage ➢ Rated secondary voltage ➢ Cooling ➢ Number of phase ➢ Rated frequency ➢ Tap voltage ➢ Number of taps ➢ Step voltage ➢ Winding connections - Primary - Secondary - Vector group ➢ % of Impedance ➢ Connections ➢ Paint color ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Oil-immersed, Transformer with Off-load tap changer 300 kVA 11 kV 400 - 230 V (3-phase, 4-wire) ONAN 3-Phase 50 Hz 11 kV +/-5.0% 5 Taps 2.5% Delta Star with solidly grounded Dyn11 Approximately 5% Primary & Secondary: Cables (inside of the cable duct) RAL 7044 or similar colors Cable duct of primary and secondary sides, Oil temperature indicator, All necessary fittings for installation	1 Unit
KG-22	Auxiliary AC distribution panel ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Distribution system ➢ Panel equipped with: ➢ Paint color ➢ Accessories ➢ Particular conditions - Spares of MCCB - Terminal block for cables	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type AC 400 - 230 V 3-phase, 4-wire Protection relay (50N/51N), Voltmeter, Ammeter, Change-over switch (VS, AS), Watt-hour meter, Fuse, CT, MCCB, etc. RAL 7035 or similar colors All necessary fittings for installation At least 2 spares of MCCB of feeder shall be mounted in the panel. Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	1 Panel
KG-23	Auxiliary DC distribution panel ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Panel equipped with: ➢ Paint color	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type 110 V DC MCCB, etc. RAL 7035 or similar colors	1 Panel

No.	Equipment	Specifications	Unit
	➢ Accessories ➢ Particular conditions - Spares of MCCB - Terminal block for cables	All necessary fittings for installation At least 2 spares of MCCB of feeder shall be mounted in the panel. Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	
KG-24 1-1	DC Charger panel 110 V DC Charger panel ➢ Applicable standards ➢ Type ➢ Input voltage ➢ DC output voltage ➢ Panel equipped with: ➢ Paint color ➢ Accessories ➢ Particular conditions - Spares of MCCB - Terminal block for cables	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Thyristor controlled rectifier, Indoor use, Free standing enclosure type 400 V AC or 230 V AC 110 V DC (+/-3 V), 120 A Output voltage shall be regulated by load voltage compensator such as silicon dropper. Input isolation transformer, Rectifier, Load voltage compensator, Voltmeter, Ammeter, Change-over switch, Shunt resistor, MCCB, etc. RAL 7035 or similar colors All necessary fittings for installation At least 1 spare of MCCB of feeder shall be mounted in the panel. Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	- 1 Set
2-1	48 V DC Charger panel ➢ Applicable standards ➢ Type ➢ Input voltage ➢ DC output voltage ➢ Panel equipped with: ➢ Paint color ➢ Accessories ➢ Particular conditions - Spares of MCCB - Terminal block for cables	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Thyristor controlled rectifier, Indoor use, Free standing enclosure type 400 V AC or 230 V AC 48 V DC (+/-3 V) , 50 A Output voltage shall be regulated by load voltage compensator such as silicon dropper. Input isolation transformer, Rectifier, Load voltage compensator, Voltmeter, Ammeter, Change-over switch, Shunt resistor, MCCB, etc. RAL 7035 or similar colors All necessary fittings for installation At least 1 spare of MCCB of feeder shall be mounted in the panel. Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	1 Set
3-1	Inverter panel ➢ Applicable standards ➢ Type ➢ Input ➢ Output ➢ Feeding type ➢ Operation type ➢ Panel equipped with:	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type 400/230 V AC, 110 V DC (substation batteries) AC 230 V (Single phase) +/- 5%, 50 A On-line type or equivalent Uninterruptible changeover type (25 m sec. +/- 1% or lower) Inverter, Output transformer, AC transfer switch, Protection relay, Voltmeter, Ammeter, Change-over switch, Shunt resistor, MCCB, etc.	1 Set

No.	Equipment	Specifications	Unit
	➢ Bypass circuit ➢ Paint color ➢ Accessories ➢ Particular conditions - Spares of MCCB	Maintenance bypass switch RAL 7035 or similar colors All necessary fittings for installation At least 1 spare of MCCB of feeder shall be mounted in the panel.	
KG-25 1-1	Battery for Substation 110 V Battery ➢ Applicable standards ➢ Type ➢ Capacity ➢ Quantity ➢ Installation type ➢ Accessories ➢ Particular conditions - Capacity	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Valve-regulated lead-acid battery or equivalent 700 Ah/10 Hr. 54 cells Open rack All necessary fittings for installation Batteries shall have adequate capacity so that after power outage occurs, control system including gateways, HMIs and BCUs can work over 6 hours, and next, operation of receiving power can be done.	- 1 Set
2-1	48 V Battery ➢ Applicable standards ➢ Type ➢ Capacity ➢ Quantity ➢ Installation type ➢ Accessories ➢ Particular conditions - Capacity	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Valve-regulated lead-acid battery or equivalent 300 Ah/10 Hr. 24 cells Open rack All necessary fittings for installation Batteries shall have adequate capacity so that after power outage occurs, communication system including a multiplexer and telephones can work over 6 hours, and next, communication for operation of receiving power can be done.	1 Set
KG-26 1-1	Gantry tower (dead-end structure) Gantry tower of 132/66/11 kV Transformer bay of 132kV side ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Dimensions ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing Equivalent to the existing gantry tower All necessary fittings for installation	- 2 Sets
2-1	Gantry tower of 132/66/11 kV Transformer bay of 66kV side ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Dimensions ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing Equivalent to the existing gantry tower All necessary fittings for installation	2 Sets
KG-27 1-1	Overhead line Overhead line and others ➢ 132 kV Overhead lines and conductors between equipment (2 bays)		- 1 Lot

No.	Equipment	Specifications	Unit
	- Applicable standards - Conductor ➢ 66 kV Overhead lines and conductors between equipment (2 bays) - Applicable standards - Conductor ➢ Ground wires - Applicable standards - Conductors ➢ Insulators - Applicable standards - Creepage distance of insulator - Suspension insulator	IEC or equivalent standards (JEC, JEM, JIS, etc.) Stranded hard-drawn aluminum conductors (AAC 185 mm^2) or equivalent IEC or equivalent standards (JEC, JEM, JIS, etc.) Stranded hard-drawn aluminum conductors (AAC 400 mm^2) or equivalent IEC or equivalent standards (JEC, JEM, JIS, etc.) Galvanized steel strand wires (55 mm^2) or equivalent IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Clevis type or ball and socket type	
2-1	Hardware of conductor ➢ Applicable standards ➢ Hardware of conductor	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Attachment of bare conductors, all necessary fittings	1 Lot
KG-28 1-1	Insulators (including support poles) Insulators of 66 and 33 kV conductors ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Material ➢ Purpose ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.)	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Station post insulator Porcelain Support of conductor of 66/33 kV Transformer bay of 33kV side and 66/11 kV Transformer bay of 66kV side For 66kV side: 325 kV or higher, for 33kV side: 170 kV or higher For 66kV side: 140 kV or higher, for 33kV side: 70 kV or higher	- 1 Lot
2-1	Support poles of insulators of 66 and 33 kV conductors ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories ➢ Purpose	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation Support of insulator of 66/33 kV Transformer bay of 33kV side and 66/11 kV Transformer bay of 66kV side	1 Lot
KG-29 1-1	Underground cables 33 kV Underground cables (including termination) ➢ Applicable standards ➢ Type ➢ Conductor ➢ Size ➢ Use ➢ Others	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 33 kV power cable with XLPE insulation, PVC sheath and wire shield Copper 400 mm^2 x 1 length per phase From 66/33 kV Transformer to 33 kV busbars (including 33 kV temporary cable) Materials for termination	- 1 Lot

No.	Equipment	Specifications	Unit
2-1	11 kV Underground cables (including termination) ➢ Applicable standards ➢ Type ➢ Conductor ➢ Size ➢ Use ➢ Others	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 11 kV power cable with XLPE insulation, PVC sheath and wire shield Copper 400 mm^2 x 4 lengths per phase From 66/11 kV Transformer to 11 kV Switchgears (including 11 kV temporary cable) Materials for termination	1 Lot
3-1	Support structure of underground cables ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	1 Lot
4-1	Materials of cabling for Underground cables ➢ Applicable standards ➢ Materials of cabling	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Conduit, cable rack, all necessary fittings and accessories	1 Lot
KG-30 1-1	Low-voltage power cables Low-voltage power cables ➢ Applicable standards ➢ Power cables ➢ Others	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 600 V power cable with XLPE insulation and PVC sheath, or 600 V power cable with XLPE insulation and PVC sheath including metallic armoured, or equivalent All necessary fittings and accessories for connecting cables	- 1 Lot
2-1	Materials of cabling for Low-voltage power cables ➢ Applicable standards ➢ Conduit ➢ Cable rack/tray ➢ Others	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Rigid steel conduit, Pliable plastics conduit, Corrugated hard synthetic resin pipe (for underground), or equivalent Metallic ladder type cable rack/tray with Hot-dip galvanizing, or equivalent Materials of support for cable tray on cable duct in the control building, cable hangers on outdoor cable duct, all necessary fittings and accessories	1 Lot
KG-31 1-1	Cables for protection, control and communication Cables for protection and control ➢ Applicable standards ➢ Cables for protection and control ➢ Others	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Shielded cable with PVC insulation and PVC sheath for control, or equivalent All necessary fittings and accessories for connecting cables	- 1 Lot
2-1	Cables for communication ➢ Applicable standards	 IEC or equivalent standards (JEC, JEM, JIS, etc.)	1 Lot

No.	Equipment	Specifications	Unit
	➢ Cables for communication ➢ Others	Ethernet cable (LAN cable), optical fiber cable All necessary fittings and accessories for connecting cables	
3-1	Materials of cabling for protection, control and communication ➢ Applicable standards ➢ Conduit ➢ Cable rack/tray ➢ Others	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Rigid steel conduit, Pliable plastics conduit, Corrugated hard synthetic resin pipe (for underground), or equivalent Metallic ladder type cable rack/tray with Hot-dip galvanizing, or equivalent Materials of support for cable tray on cable duct in the control building, cable hangers on outdoor cable duct, all necessary fittings and accessories	1 Lot
KG-32 1-1	Earthing equipment Earthing conductors ➢ Applicable standards ➢ Earthing type ➢ Earthing connection ➢ Required resistance of the earthing system ➢ Materials - Buried earthing conductors - Earthing conductors - Others	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Earthing grid Earthing system shall be bonded with the existing earthing conductors at several points. When fault current occurs, the earthing system shall not harm human bodies and damage equipment.(the resistance must be 1 ohm or lower) Annealed copper stranded conductors, or equivalent Control building area: 250 mm^2 or higher, Transformers and switchgears area: 150 mm^2 or higher PVC insulated wires (150 mm^2 or higher), or equivalent Rod electrodes and plate electrodes shall be used as necessary.	- 1 Lot
2-1	Connecting materials ➢ Applicable standards ➢ Bonding materials ➢ Other materials	 IEC or equivalent standards (JEC, JEM, JIS, etc.) C-grid tap connectors (compression type) for earthing conductors, or equivalent Bonding materials to the existing earthing conductors	1 Lot
KG-33	Local SCADA System for the Project equipment ➢ Applicable standards ➢ Components ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) - Substation Control System Panel (GPS clock:1 Unit, Network gateway: 1 Unit, Work station (Server): 2 Units, Annunciator: 1 Set, Ethernet switch: 4 Units, etc.): 3 Panels - Human Machine Interface devices (Keyboard, LC Display, Printer): 2 Units - Telecom panel (Multiplexer, PBX): 1 Panel - Telephone: 2 Units - Laptop computer with pre-installed software for maintenance of protection relays: 1 Unit Lighting, 230 VAC Outlet for maintenance	1 Lot

No.	Equipment	Specifications	Unit
		(Common use of KG-33)	
	➢ Communication standard	IEC 61850 and IEC 60870-5-101/104	
	➢ Control voltage	110 V DC, 48 V DC, 230 V AC (including UPS)	
	➢ Necessary transmission data at least	Data (Current, Voltage, Active Power, Reactive power, Frequency, Power factor) with floating points and time tags	
	➢ Accessories	All necessary fittings for installation	
	➢ Particular conditions		
	- Future extension	Design shall be done taking a network gateway, Ethernet switch and RS232C splitter in the future extension into consideration.	
	- The existing multiplexer	Specifications of the existing multiplexer which connects to a communication device: @ STM 4, FOX 615 of ABB	
	- Terminal block for cables	Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	

(2) Basic Plan for Old Town Substation

1) Basic Concept

- The whole equipment of the substation should be newly installed on vacant ground in the existing Old Town substation. Transformers to be procured for the Project consist of one unit of 66/33 kV 25 MVA transformer, and one unit of 66/11 kV 25 MVA transformer (newly installed). The mounting provisions for fans on the radiators should be specified for ONAF (oil-immersed, air-forced cooled) cooling to be modified easily in the future.
- The equipment to be newly installed such as 33/11 kV switchgears, control and protection panels, and communication panel should be installed in the control building to be newly constructed.
- The equipment of the substation and control building to be newly constructed should be arranged taking the Control Complex Building to be also constructed by ESCOM in the future into consideration.
- SCADA system should be built for monitoring and controlling, and connected to the existing SCADA system.
- Unit test of protection and control panels, and communication panel should be conducted by the beginning of an integrated test between control system and equipment.
- Power outage will be needed during changeover of the transmission line.
- Temporary power source will be needed for the construction work.
- Entire earthing system in the substation should be considered.

The following preliminary drawings show the details of Old Town Substation:

- OT-ES-01: Old Town Substation Single Line Diagram
- OT-ES-02: Old Town Substation Site Plan
- OT-ES-03: Old Town Substation Site Layout Plan
- OT-ES-04: Old Town Substation Control Building Layout Plan
- OT-ES-05: Old Town Substation SCADA System Architecture
- OT-ES-06: Old Town Substation Scope of the Project

2) Technical Specification

No.	Item	Specification	Unit
OT-1	66/33 kV Transformer		1 Unit
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	Outdoor use, Oil-immersed, Transformer with On-load tap changer (OLTC)	
	➢ Rated capacity	25 MVA	
	➢ Rated primary voltage	66 kV	
	➢ Rated secondary voltage	33 kV	
	➢ Cooling	ONAN (Refer to particular conditions)	
	➢ Number of phase	3-Phase	
	➢ Rated frequency	50 Hz	
	➢ Tap voltage	+4/- 12*1.25%	
	➢ Number of taps	17 taps	
	➢ Step voltage	1.25%	
	➢ Winding connections:		
	- Primary	Star with solidly grounded	
	- Secondary	Star with solidly grounded	
	- Tertiary	Delta (Stabilizing winding)	
	- Vector group	YNyn0+d1	
	➢ % of Impedance	10.22% (Same as the existing 66/33 kV transformer in Kanengo substation)	
	➢ Rated lightning impulse withstand voltage	Uniform insulation Primary: 325 kV or higher Secondary: 170 kV or higher Tertiary: 75 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	Uniform insulation Primary: 140 kV or higher Secondary: 70 kV or higher Tertiary: 28 kV or higher	
	➢ Connections	Primary: Overhead conductors Secondary: Cables (inside of the cable duct)	
	➢ Bushing CT	Class: 5P20 or more Secondary: 800/1 A (one-phase) Primary neutral: 500/1 A Secondary neutral: 800/1 A	
	➢ Lightning arrester of secondary side	Metal-oxide gapless type, 30 kV, 10 kA, Line discharge class 2	
	➢ Control voltage	DC 110 V, AC 230/400V	
	➢ Oil preservation system	Conservator type	
	➢ Loss	No-load loss: 25kW or lower, Load loss at rated output: 150kW or lower	
	➢ Paint color	RAL 7044 or similar colors	
	➢ Accessories	Insulating oil, OLTC motor operating device, Hand lamp, Control switch (raising and lowering), Changeover switch (remote and local), Cable duct of secondary side, Buchholz relay with alarm contact, LTC oil flow relay, Oil level gauge with alarm contact, Oil temperature indicator with alarm contact, Oil and Winding temperature elements for remote indication, Pressure relief device with alarm contact, Dehydrating breathers, Ladder for maintenance, Handle for LTC operation, Earth terminal, Terminal box, Oil drain valve, Radiator, Conservator, and All necessary fittings for	

No.	Item	Specification	Unit
		installation	
	➢ Particular conditions		
	- Parallel operation	Design shall be done taking the parallel operation with other transformers in the future into consideration.	
	- Provisions for ONAF	The mounting provisions for fans shall be provided on the radiators for 31.5 MVA ONAF (oil-immersed, air-forced cooled) cooling in order to meet power demand in the future.	
	- Control circuits of cooling fans	Fan control circuits and associated power supply circuits for ONAF cooling shall be provided in a local control panel from the beginning.	
	- Oil pit	An oil pit with storage capacity of 120% of the total insulating oil volume of the transformer shall be provided under each transformer.	
	- Waste water treatment	An oil pit to separate oil from oil-contaminated water, and drainage pump shall be provided as oil spill prevention.	
OT-2	66/11 kV Transformer		1 Unit
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	Outdoor use, Oil-immersed, Transformer with On-load tap changer (OLTC)	
	➢ Rated capacity	25 MVA	
	➢ Rated primary voltage	66 kV	
	➢ Rated secondary voltage	11 kV	
	➢ Cooling	ONAN (Refer to particular conditions)	
	➢ Number of phase	3-Phase	
	➢ Rated frequency	50 Hz	
	➢ Tap voltage	+3/- 11*1.42%	
	➢ Number of taps	15 taps	
	➢ Step voltage	1.42%	
	➢ Winding connections		
	- Primary	Star with solidly grounded	
	- Secondary	Star with solidly grounded	
	- Tertiary	Delta (Stabilizing winding)	
	- Vector group	YNyn0+d1	
	➢ % of Impedance	10.22% (Same as the existing 66/33 kV transformer in Kanengo substation)	
	➢ Rated lightning impulse withstand voltage	Uniform insulation Primary: 325 kV or higher Secondary: 75 kV or higher Tertiary: 40 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	Uniform insulation Primary: 140 kV or higher Secondary: 28 kV or higher Tertiary: 10 kV or higher	
	➢ Connections	Primary: Overhead conductors Secondary: Cables (inside of the cable duct)	
	➢ Bushing CT	Class: 5P20 or more Secondary: 2,500/1 A (one-phase) Primary neutral: 500/1 A Secondary neutral: 2,500/1 A	
	➢ Lightning arrester of secondary side	Metal-oxide gapless type, 30 kV, 10 kA, Line discharge class 2	
	➢ Control voltage	DC 110 V, AC 230/400V	

No.	Item	Specification	Unit
	➢ Oil preservation system ➢ Loss ➢ Paint color ➢ Accessories ➢ Particular conditions - Parallel operation - Provisions for ONAF - Control circuits of cooling fans - Oil pit - Waste water treatment	Conservator type No-load loss: 25kW or lower, Load loss at rated output: 150kW or lower RAL 7044 or similar colors Insulating oil, OLTC motor operating device, Hand lamp, Control switch (raising and lowering), Changeover switch (remote and local), Cable duct of secondary side, Buchholz relay with alarm contact, LTC oil flow relay, Oil level gauge with alarm contact, Oil temperature indicator with alarm contact, Oil and Winding temperature elements for remote indication, Pressure relief device with alarm contact, Dehydrating breathers, Ladder for maintenance, Handle for LTC operation, Earth terminal, Terminal box, Oil drain valve, Radiator, Conservator, and All necessary fittings for installation Design shall be done taking the parallel operation with other transformers in the future into consideration. The mounting provisions for fans shall be provided on the radiators for 31.5 MVA ONAF (oil-immersed, air-forced cooled) cooling in order to meet power demand in the future. Fan control circuits and associated power supply circuits for ONAF cooling shall be provided in a local control panel from the beginning. An oil pit with storage capacity of 120% of the total insulating oil volume of the transformer shall be provided under each transformer. An oil pit to separate oil from oil-contaminated water, and drainage pump shall be provided as oil spill prevention.	
OT-3 1-1	66 kV Circuit breaker 66 kV Circuit breaker (3-phase) of 66 kV Transmission line ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated operating sequence ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-Phase, Live tank type, Outdoor use, Spring-operated GCB 72.5 kV 1,250 A or higher 25 kA or higher O-0.3 sec.-CO-3 min.-CO 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher DC 110 V AC 230 V 12 normally open, 12 normally closed (except self-use) Local control box, Changeover switch (remote and	- 2 Units

No.	Item	Specification	Unit
		local), Switching operation counter, Charging handle of tripping/closing spring, Support structure, All necessary fittings for installation	
	➢ Paint color (local control box)	RAL 7044 or similar colors	
2-1	66 kV Circuit breaker (3-phase) of 66/33 kV Transformer		1 Unit
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	3-Phase, Live tank type, Outdoor use, Spring-operated GCB	
	➢ Rated voltage	72.5 kV	
	➢ Rated current	1,250 A or higher	
	➢ Rated short-circuit breaking current	25 kA or higher	
	➢ Rated operating sequence	O-0.3 sec.-CO-3 min.-CO	
	➢ Rated short-time withstand current & Rated duration of short-circuit	25 kA-2 sec. or higher	
	➢ Rated lightning impulse withstand voltage	325 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	140 kV or higher	
	➢ Control voltage	DC 110 V	
	➢ Heater voltage	AC 230 V	
	➢ Auxiliary switch contact	12 normally open, 12 normally closed (except self-use)	
	➢ Accessories	Local control box, Changeover switch (remote and local), Switching operation counter, Charging handle of tripping/closing spring, Support structure, All necessary fittings for installation	
	➢ Paint color (local control box)	RAL 7044 or similar colors	
3-1	66 kV Circuit breaker (3-phase) of 66/11 kV Transformer		1 Unit
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	3-Phase, Live tank type, Outdoor use, Spring-operated GCB	
	➢ Rated voltage	72.5 kV	
	➢ Rated current	1,250 A or higher	
	➢ Rated short-circuit breaking current	25 kA or higher	
	➢ Rated operating sequence	O-0.3 sec.-CO-3 min.-CO	
	➢ Rated short-time withstand current & Rated duration of short-circuit	25 kA-2 sec. or higher	
	➢ Rated lightning impulse withstand voltage	325 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	140 kV or higher	
	➢ Control voltage	DC 110 V	
	➢ Heater voltage	AC 230 V	
	➢ Auxiliary switch contact	12 normally open, 12 normally closed (except self-use)	
	➢ Accessories	Local control box, Changeover switch (remote and local), Switching operation counter, Charging handle of tripping/closing spring, Support structure, All necessary fittings for installation	
	➢ Paint color (local control box)	RAL 7044 or similar colors	

No.	Item	Specification	Unit
4-1	66 kV Circuit breaker (3-phase) of 66 kV Busbars		1 Unit
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	3-Phase, Live tank type, Outdoor use, Spring-operated GCB	
	➢ Rated voltage	72.5 kV	
	➢ Rated current	2,000 A or higher	
	➢ Rated short-circuit breaking current	25 kA or higher	
	➢ Rated operating sequence	O-0.3 sec.-CO-3 min.-CO	
	➢ Rated short-time withstand current & Rated duration of short-circuit	25 kA-2 sec. or higher	
	➢ Rated lightning impulse withstand voltage	325 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	140 kV or higher	
	➢ Control voltage	DC 110 V	
	➢ Heater voltage	AC 230 V	
	➢ Auxiliary switch contact	12 normally open, 12 normally closed (except self-use)	
	➢ Accessories	Local control box, Changeover switch (remote and local), Switching operation counter, Charging handle of tripping/closing spring, Support structure, All necessary fittings for installation	
	➢ Paint color (local control box)	RAL 7044 or similar colors	
OT-4	66 kV Disconnecting switch		-
1-1	66 kV Disconnecting switch (3-phase) of 66 kV Transmission line		4 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	3-phase, Outdoor use, Horizontal double-break rotary motion, Porcelain insulator type	
	➢ Rated voltage	72.5 kV	
	➢ Rated current	1,250 A or higher	
	➢ Rated short-time withstand current & Rated duration of short-circuit	25 kA-2 sec. or higher	
	➢ Rated lightning impulse withstand voltage	325 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	140 kV or higher	
	➢ Operation	Motor operation	
	➢ Control voltage	DC 110 V	
	➢ Heater voltage	AC 230 V	
	➢ Auxiliary switch contact	10 normally open, 10 normally closed (except self-use)	
	➢ Earthing switch (Only side of the transmission line)	Manual operation with mechanical interlocking between the disconnecting switch and the earthing switch	
	➢ Accessories	Local control box, Changeover switch (remote and local), Manual handle for opening/closing, All necessary fittings for installation	
	➢ Paint color (local control box)	RAL 7044 or similar colors	
	➢ Particular conditions		
	- Electrical interlocking	Electrical interlocking between the associated circuit breaker, the disconnecting switch, and the earthing switch shall be provided.	

No.	Item	Specification	Unit
1-2	Support structure of 66 kV Disconnecting switch (for 66 kV Transmission line) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	4 Units
2-1	66 kV Disconnecting switch (3-phase) of 66/33 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Operation ➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories ➢ Paint color (local control box) ➢ Particular conditions - Electrical interlocking	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-phase, Outdoor use, Horizontal double-break rotary motion, Porcelain insulator type 72.5 kV 1,250 A or higher 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher Motor operation DC 110 V AC 230 V 10 normally open, 10 normally closed (except self-use) Local control box, Changeover switch (remote and local), Manual handle for opening/closing, All necessary fittings for installation RAL 7044 or similar colors Electrical interlocking between the associated circuit breaker and the disconnecting switch shall be provided.	1 Unit
2-2	Support structure of 66 kV Disconnecting switch (for 66/33 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	1 Unit
3-1	66 kV Disconnecting switch (3-phase) of 66/33 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Operation	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-phase, Outdoor use, Horizontal double-break rotary motion, Porcelain insulator type 72.5 kV 1,250 A or higher 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher Motor operation	1 Unit

No.	Item	Specification	Unit
	➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories ➢ Paint color (local control box) ➢ Particular conditions - Electrical interlocking	DC 110 V AC 230 V 10 normally open, 10 normally closed (except self-use) Local control box, Changeover switch (remote and local), Manual handle for opening/closing, All necessary fittings for installation RAL 7044 or similar colors Electrical interlocking between the associated circuit breaker and the disconnecting switch shall be provided.	
3-2	Support structure of 66 kV Disconnecting switch (for 66/11 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	1 Unit
4-1	66 kV Disconnecting switch (3-phase) of 66 kV Busbars ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Operation ➢ Control voltage ➢ Heater voltage ➢ Auxiliary switch contact ➢ Accessories ➢ Paint color (local control box) ➢ Particular conditions - Electrical interlocking	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher 3-phase, Outdoor use, Horizontal double-break rotary motion, Porcelain insulator type 72.5 kV 2,000 A or higher 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher Motor operation DC 110 V AC 230 V 10 normally open, 10 normally closed (except self-use) Local control box, Changeover switch (remote and local), Manual handle for opening/closing, All necessary fittings for installation RAL 7044 or similar colors Electrical interlocking between the associated circuit breaker and the disconnecting switch shall be provided.	2 Units
4-2	Support structure of 66 kV Disconnecting switch (for 66 kV Busbars) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	2 Units

No.	Item	Specification	Unit
OT-5	66 kV Current transformer		-
1-1	66 kV Current transformer (3-phase) of 66 kV Transmission line		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	Outdoor use, Single-phase, Porcelain insulator, Capacitor voltage type	
	➢ Rated voltage	72.5 kV	
	➢ Rated primary current	500-1,000 A	
	➢ Rated secondary current	1/1/1/1 A	
	➢ Accuracy class		
	- for Instrument	Class 0.5 or more	
	- for Protection x 2	Class 5P20 or more	
	- for Busbar Protection	Class PX	
	➢ Rated burden	Each 30 VA or higher	
	➢ Rated short-time withstand current & Rated duration of short-circuit	25 kA-2 sec. or higher	
	➢ Rated lightning impulse withstand voltage	325 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	140 kV or higher	
	➢ Accessories	All necessary fittings for installation	
1-2	Support structure of 66 kV Current transformer (for 66 kV Transmission line)		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Material	Steel materials	
	➢ Rustproofing treatment	Hot-dip galvanizing	
	➢ Accessories	All necessary fittings for installation	
2-1	66 kV Current transformer (3-phase) of 66/33 kV Transformer		3 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	Outdoor use, Single-phase, Porcelain insulator, Capacitor voltage type	
	➢ Rated voltage	72.5 kV	
	➢ Rated primary current	500 A	
	➢ Rated secondary current	1/1/1/1 A	
	➢ Accuracy class		
	- for Instrument	Class 0.5 or more	
	- for Protection x 2	Class 5P20 or more	
	- for Busbar Protection	Class PX	
	➢ Rated burden	Each 30 VA or higher	
	➢ Rated short-time withstand current & Rated duration of short-circuit	25 kA-2 sec. or higher	
	➢ Rated lightning impulse withstand voltage	325 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	140 kV or higher	
	➢ Accessories	All necessary fittings for installation	
2-2	Support structure of 66 kV Current transformer (for 66/33 kV Transformer)		3 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Material	Steel materials	
	➢ Rustproofing treatment	Hot-dip galvanizing	
	➢ Accessories	All necessary fittings for installation	

No.	Item	Specification	Unit
3-1	66 kV Current transformer (3-phase) of 66/11 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated primary current ➢ Rated secondary current ➢ Accuracy class - for Instrument - for Protection x 2 - for Busbar Protection ➢ Rated burden ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Single-phase, Porcelain insulator type 72.5 kV 500 A 1/1/1/1 A Class 0.5 or more Class 5P20 or more Class PX Each 30 VA or higher 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher All necessary fittings for installation	3 Units
3-2	Support structure of 66 kV Current transformer (for 66/11 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units
4-1	66 kV Current transformer (3-phase) of 66 kV Busbars ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Rated primary current ➢ Rated secondary current ➢ Accuracy class - for Protection - for Busbar Protection ➢ Rated burden ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Single-phase, Porcelain insulator type 72.5 kV 500-1,000 A 1/1 A Class 5P20 or more Class PX 30 VA or higher 25 kA-2 sec. or higher 325 kV or higher 140 kV or higher All necessary fittings for installation	3 Units
4-2	Support structure of 66 kV Current transformer (for 66 kV Busbars) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units

No.	Item	Specification	Unit
OT-6	66 kV Lightning arrester		-
1-1	66 kV Lightning arrester (3-phase) of 66 kV Transmission line ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Nominal discharge current ➢ Line discharge class ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Metal-oxide gapless, Single-phase type 60 kV 10 kA Class 3 Surge counter (each phase), All necessary fittings for installation	6 Units
1-2	Support structure of 66 kV Lightning arrester (for 66 kV Transmission line) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	6 Units
2-1	66 kV Lightning arrester (3-phase) of 66/33 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Nominal discharge current ➢ Line discharge class ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Metal-oxide gapless, Single-phase type 60 kV 10 kA Class 3 Surge counter (each phase), All necessary fittings for installation	3 Units
2-2	Support structure of 66 kV Lightning arrester (for 66/33 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units
3-1	66 kV Lightning arrester (3-phase) of 66/11 kV Transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated voltage ➢ Nominal discharge current ➢ Line discharge class ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Metal-oxide gapless, Single-phase type 60 kV 10 kA Class 3 Surge counter (each phase), All necessary fittings for installation	3 Units
3-2	Support structure of 66 kV Lightning arrester (for 66/11 kV Transformer) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	3 Units

No.	Item	Specification	Unit
OT-7	66 kV Voltage transformer		-
1-1	66 kV Voltage transformer (3-phase) of 66 kV Transmission line		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	Outdoor use, Single-phase, Capacitor voltage type	
	➢ Rated primary voltage	66 kV/√3 V	
	➢ Rated secondary voltage	110/√3 V	
	➢ Highest Voltage	72.5 kV	
	➢ Accuracy class		
	- for Instrument	Class 0.5 or more	
	- for Protection	Class 3P or more	
	➢ Rated burden	Each 50 VA or higher	
	➢ Rated lightning impulse withstand voltage	325 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	140 kV or higher	
	➢ Accessories	All necessary fittings for installation	
1-2	Support structure of 66 kV Voltage transformer (for 66 kV Transmission line)		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Material	Steel materials	
	➢ Rustproofing treatment	Hot-dip galvanizing	
	➢ Accessories	All necessary fittings for installation	
2-1	66 kV Voltage transformer (3-phase) of 66 kV Busbars		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Creepage distance of insulator	27.8 kV/mm or higher	
	➢ Type	Outdoor use, Single-phase, Capacitor voltage type	
	➢ Rated primary voltage	66 kV/√3 V	
	➢ Rated secondary voltage	110/√3 V	
	➢ Highest Voltage	72.5 kV	
	➢ Accuracy class		
	- for Instrument	Class 0.5 or more	
	- for Protection	Class 3P or more	
	➢ Rated burden	Each 100 VA or higher	
	➢ Rated lightning impulse withstand voltage	325 kV or higher	
	➢ Rated short-duration power-frequency withstand voltage (1 min.)	140 kV or higher	
	➢ Accessories	All necessary fittings for installation	
2-2	Support structure of 66 kV Voltage transformer (for 66 kV Busbars)		6 Units
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Material	Steel materials	
	➢ Rustproofing treatment	Hot-dip galvanizing	
	➢ Accessories	All necessary fittings for installation	
OT-8	66 kV Busbars (including support structure)		-
1-1	66 kV Busbars		1 Lot
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Conductor material	Aluminum pipe or equivalent	
	➢ Dimensions	Outer diameter: 100 mm or higher, Thickness: 6mm or higher	
	➢ Allowable current	2000 A or higher	

No.	Item	Specification	Unit
2-1	Support structure of 66 kV Busbars insulator ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	1 Lot
3-1	66 kV Busbars insulator ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Material ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.)	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 mm/kV or higher Station post insulator Porcelain 325 kV or higher 140 kV or higher	1 Lot
OT-9 1-1	33 kV Switchgear 33 kV Switchgear of Incomer (66/33 kV Transformer) ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Panel equipped with: ➢ Earthing switch ➢ Voltage transformer - Rated voltage - Accuracy class - Rated burden ➢ Paint color ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Metal-enclosed switchgear (Partition class PM) 36 kV 800 A or higher 25 kA or higher 25 kA-2 sec. or higher 170 kV or higher 70 kV or higher DC 110 V Bay control unit (BCU) with display, Protection relay, Measuring meter, Current transformer (CT), Voltage detection device, etc. Manual operation type 33 kV/√3 V / 110/√3 V for Instrument Class: 0.5 or more, for Protection Class: 3P or more Each 50 VA or higher RAL 7035 or similar colors All necessary fittings for installation	4 Panels 1 Panel
2-1	33 kV Switchgear of 33 kV Feeder ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Metal-enclosed switchgear (Partition class PM) 36 kV 630 A 以上 25 kA 以上 25 kA-2 sec. 以上 170 kV 以上 70 kV 以上	3 Panels

No.	Item	Specification	Unit
	withstand voltage (1 min.) ➢ Control voltage ➢ Panel equipped with: ➢ ➢ Earthing switch ➢ Lightning arrester (3-phase) - for busbars ➢ Voltage transformer - Rated voltage - Accuracy class - Rated burden ➢ Paint color ➢ Accessories ➢ Particular conditions - Panel configuration	 DC 110 V BCU with display, Protection relay, Measuring meter, CT, Voltage detection device, etc. Manual operation type (Just one panel equipped with the VT) Metal-oxide gapless type, 30 kV, 10 kA, Line discharge class 2 (Just one panel equipped with the VT) 33 kV/√3 V / 110/√3 V for Instrument Class: 0.5 or more, for Protection Class: 3P or more Each 50 VA or higher RAL 7035 or similar colors All necessary fittings for installation If the VT could not be fitted into a feeder panel, it is allowable to add another panel.	
OT-10 1-1	11 kV Switchgear 11 kV Switchgear of Incomer (66/11 kV Transformer) ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Panel equipped with: ➢ Earthing switch ➢ Voltage transformer - Rated voltage - Accuracy class - Rated burden ➢ Paint color ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Metal-enclosed switchgear (Partition class PM) 12 kV 2,000 A or higher 25 kA or higher 25 kA-2 sec. or higher 75 kV or higher 28 kV or higher DC 110 V Bay control unit (BCU) with display, Protection relay, Measuring meter, Current transformer (CT), Voltage detection device, etc. Manual operation type 11 kV/√3 V / 110/√3 V for Instrument Class: 0.5 or more, for Protection Class: 3P or more Each 50 VA or higher RAL 7035 or similar colors All necessary fittings for installation	- 1 Panel
2-1	11 kV Switchgear of 11 kV Feeder ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Metal-enclosed switchgear (Partition	6 Panels

No.	Item	Specification	Unit
	voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Panel equipped with: ➢ Earthing switch ➢ Voltage transformer (VT) - Rated voltage - Accuracy class ➢ - Rated burden ➢ Paint color ➢ Accessories ➢ Particular conditions - Panel configuration	class PM) 12 kV 630 A or higher 25 kA or higher 25 kA-2 sec. or higher 75 kV or higher 28 kV or higher DC 110 V BCU with display, Protection relay, Measuring meter, CT, Voltage detection device, etc. Manual operation type (Just one panel equipped with the VT) 11 kV/√3 V / 110/√3 V for Instrument Class: 0.5 or more, for Protection Class: 3P or more Each 50 VA or higher RAL 7035 or similar colors All necessary fittings for installation If the VT could not be fitted into a feeder panel, it is allowable to add another panel.	
3-1	11 kV Switchgear for Diesel generator ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Panel equipped with: ➢ Earthing switch ➢ Paint color ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Metal-enclosed switchgear (Partition class PM) 12 kV 630 A or higher 25 kA or higher 25 kA-2 sec. or higher 75 kV or higher 28 kV or higher DC 110 V BCU with display, Protection relay, Measuring meter, CT, Voltage detection device, synchronizing relay, Voltage Transformer, etc. (Manual synchronizing for a generator) Manual operation type RAL 7035 or similar colors All necessary fittings for installation	2 Panels
4-1	11 kV Switchgear for Station transformer ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Rated current ➢ Rated short-circuit breaking current ➢ Rated short-time withstand current & Rated duration of short-circuit ➢ Rated lightning impulse withstand	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Metal-enclosed switchgear (Partition class PM) 12 kV 630 A or higher 25 kA or higher 25 kA-2 sec. or higher 75 kV or higher	1 Panel

No.	Item	Specification	Unit
	voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.) ➢ Control voltage ➢ Panel equipped with: ➢ Earthing switch ➢ Paint color ➢ Accessories	28 kV or higher DC 110 V BCU with display, Protection relay, Measuring meter, CT, Voltage detection device, etc. Manual operation type RAL 7035 or similar colors All necessary fittings for installation	
OT-11 1-1	Control and protection panel Control and protection panel of 66 kV Transmission line ➢ Applicable standards ➢ Type ➢ Types of protection relays ➢ Communication standard ➢ Purpose ➢ Panel equipped with: ➢ Accessories ➢ Paint color ➢ Accessories ➢ Particular conditions - Terminal block for cables	IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type 1) Digital protection relay 2) Main Protection relays: Distance, Instantaneous overcurrent, Ground instantaneous overcurrent, Overvoltage, Undervoltage, etc. 3) Backup Protection relays: Time overcurrent, Ground time overcurrent, etc. 4) Others: Auto reclose, Synchronism-check IEC 61850 66 kV Transmission line BCU with display, Protection relay, Measuring meter, CT, Annunciator, etc. Lighting RAL 7035 or similar colors All necessary fittings for installation Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	- 2 Panels
2-1	Control and protection panel of 66 kV Busbars ➢ Applicable standards ➢ Type ➢ Types of protection relays ➢ Communication standard ➢ Purpose ➢ Panel equipped with: ➢ Accessories ➢ Paint color ➢ Accessories ➢ Particular conditions - Terminal block for cables	IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type 1) Digital protection relay 2) Protection relays: Current differential, Overcurrent, Ground overcurrent, etc. IEC 61850 66 kV Busbars BCU with display, Protection relay, Measuring meter, CT, Annunciator, etc. Lighting RAL 7035 or similar colors All necessary fittings for installation Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	1 Panel
3-1	Control and protection panel of 66/33 kV	IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type 1) Digital protection relay 2) Main Protection relays: Current differential,	1 Panel

No.	Item	Specification	Unit
	Transformer ➢ Applicable standards ➢ Type ➢ Types of protection relays ➢ Communication standard ➢ Purpose ➢ Panel equipped with: ➢ Accessories ➢ Paint color ➢ Accessories ➢ Particular conditions - - Terminal block for cables	Instantaneous overcurrent, Ground instantaneous overcurrent, etc. 3) Backup Protection relays: Time overcurrent, Ground time overcurrent, etc. IEC 61850 66/33 kV Transformer BCU with display, Protection relay, Measuring meter, Annunciator, Automatic voltage regulator (AVR), etc. Lighting RAL 7035 or similar colors All necessary fittings for installation Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	
4-1	Control and protection panel of 66/11 kV Transformer ➢ Applicable standards ➢ Type ➢ Types of protection relays ➢ Communication standard ➢ Purpose ➢ Panel equipped with: ➢ Accessories ➢ Paint color ➢ Accessories ➢ Particular conditions - Terminal block for cables	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type 1) Digital protection relay 2) Main Protection relays: Current differential, Instantaneous overcurrent, Ground instantaneous overcurrent, etc. 3) Backup Protection relays: Time overcurrent, Ground time overcurrent, etc. IEC 61850 66/33 kV Transformer BCU with display, Protection relay, Measuring meter, AVR, etc. Lighting RAL 7035 or similar colors All necessary fittings for installation Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	1 Panel
OT-12	11/0.4 kV Station transformer ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Rated capacity ➢ Rated primary voltage ➢ Rated secondary voltage ➢ Cooling ➢ Number of phase ➢ Rated frequency ➢ Tap voltage ➢ Number of taps ➢ Step voltage ➢ Winding connections	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Outdoor use, Oil-immersed, Transformer with Off-load tap changer 300 kVA 11 kV 400 - 230 V (3-phase, 4-wire) ONAN 3-Phase 50 Hz 11 kV +/-5.0% 5 Taps 2.5%	1 Unit

No.	Item	Specification	Unit
	- Primary - Secondary - Vector group ➢ % of Impedance ➢ Connections ➢ Paint color ➢ Accessories	Delta Star with solidly grounded Dyn11 Approximately 5% Primary & Secondary: Cables (inside of the cable duct) RAL 7044 or similar colors Cable duct of primary and secondary sides, Oil temperature indicator, All necessary fittings for installation	
OT-13	Auxiliary AC distribution panel ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Distribution system ➢ Panel equipped with: ➢ Paint color ➢ Accessories ➢ Particular conditions - Spares of MCCB - Terminal block for cables	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type AC 400 - 230 V 3-phase, 4-wire Protection relay (50N/51N), Voltmeter, Ammeter, Change-over switch (VS, AS), Watt-hour meter, Fuse, CT, MCCB, etc. RAL 7035 or similar colors All necessary fittings for installation At least 2 spares of MCCB of feeder shall be mounted in the panel. Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	1 Panel
OT-14	Auxiliary DC distribution panel ➢ Applicable standards ➢ Type ➢ Rated voltage ➢ Panel equipped with: ➢ Paint color ➢ Accessories ➢ Particular conditions - Spares of MCCB - Terminal block for cables	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type 110 V DC, 48 V DC MCCB, etc. RAL 7035 or similar colors All necessary fittings for installation At least 2 spares of MCCB of feeder shall be mounted in the panel. Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	1 Panel
OT-15 1-1	DC Charger panel 110 V DC Charger panel ➢ Applicable standards ➢ Type ➢ Input voltage ➢ DC output voltage ➢ Panel equipped with: ➢ Paint color ➢ Accessories ➢ Particular conditions - Spares of MCCB	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Thyristor controlled rectifier, Indoor use, Free standing enclosure type 400 V AC or 230 V AC 110 V DC (+/-3 V), 120 A Output voltage shall be regulated by load voltage compensator such as silicon dropper. Input isolation transformer, Rectifier, Load voltage compensator, Voltmeter, Ammeter, Change-over switch, Shunt resistor, MCCB, etc. RAL 7035 or similar colors All necessary fittings for installation At least 1 spare of MCCB of feeder shall be mounted in the panel.	- 1 Set

No.	Item	Specification	Unit
	- Terminal block for cables	Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	
2-1	48 V DC Charger panel ➢ Applicable standards ➢ Type ➢ Input voltage ➢ DC output voltage ➢ Panel equipped with: ➢ Paint color ➢ Accessories ➢ Particular conditions - Spares of MCCB - Terminal block for cables	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Thyristor controlled rectifier, Indoor use, Free standing enclosure type 400 V AC or 230 V AC 48 V DC (+/-3 V) , 50 A Output voltage shall be regulated by load voltage compensator such as silicon dropper. Input isolation transformer, Rectifier, Load voltage compensator, Voltmeter, Ammeter, Change-over switch, Shunt resistor, MCCB, etc. RAL 7035 or similar colors All necessary fittings for installation At least 1 spare of MCCB of feeder shall be mounted in the panel. Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	1 Set
3-1	Inverter panel ➢ Applicable standards ➢ Type ➢ Input ➢ Output ➢ Feeding type ➢ Operation type ➢ Panel equipped with: ➢ Bypass circuit ➢ Paint color ➢ Accessories ➢ Particular conditions - Spares of MCCB	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Indoor use, Free standing enclosure type 400/230 V AC, 110 V DC (substation batteries) AC 230 V (Single phase) +/- 5%, 50 A On-line type or equivalent Uninterruptible changeover type (25 m sec. +/- 1% or lower) Inverter, Output transformer, AC transfer switch, Protection relay, Voltmeter, Ammeter, Change-over switch, Shunt resistor, MCCB, etc. Maintenance bypass switch RAL 7035 or similar colors All necessary fittings for installation At least 1 spare of MCCB of feeder shall be mounted in the panel.	1 Set
OT-16 1-1	Battery for Substation 110 V Battery ➢ Applicable standards ➢ Type ➢ Capacity ➢ Quantity ➢ Installation type ➢ Accessories ➢ Particular conditions - - Capacity	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Valve-regulated lead-acid battery or equivalent 700 Ah/10 Hr. 54 cells Open rack All necessary fittings for installation Batteries shall have adequate capacity so that after power outage occurs, control system including gateways, HMIs and BCUs can work over 6 hours, and next, operation of receiving power can be done.	- 1 Set

No.	Item	Specification	Unit
2-1	48 V Battery ➢ Applicable standards ➢ Type ➢ Capacity ➢ Quantity ➢ Installation type ➢ Accessories ➢ Particular conditions - Capacity	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Valve-regulated lead-acid battery or equivalent 300 Ah/10 Hr. 24 cells Open rack All necessary fittings for installation Batteries shall have adequate capacity so that after power outage occurs, communication system including a multiplexer and telephones can work over 6 hours, and next, communication for operation of receiving power can be done.	1 Set
OT-17	Gantry tower (dead-end structure) ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Dimensions ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing Equivalent to the existing gantry tower All necessary fittings for installation	1 Sets
OT-18 1-1	Overhead line Overhead line ➢ Applicable standards ➢ 66 kV Overhead conductors between equipment (2 bays) ➢ Ground wires ➢ Particular conditions - Scope	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Stranded hard-drawn aluminum conductors (AAC 400 mm^2) or equivalent Galvanized steel strand wires (55 mm^2) or equivalent It is out of scope of overhead conductors, ground wires and insulators of incoming transmission line to the gantry tower.	- 1 Lot
2-1	Hardware of conductor ➢ Applicable standards ➢ Hardware of conductor ➢ Particular conditions - Scope	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Attachment for bare conductors, all necessary fittings It is out of scope of hardware of conductor of incoming transmission line to the gantry tower.	1 Lot
OT-19 1-1	Insulators (including support poles) Insulators of 66 kV conductors ➢ Applicable standards ➢ Creepage distance of insulator ➢ Type ➢ Material ➢ Rated lightning impulse withstand voltage ➢ Rated short-duration power-frequency withstand voltage (1 min.)	 IEC or equivalent standards (JEC, JEM, JIS, etc.) 27.8 kV/mm or higher Station post insulator Porcelain 325 kV or higher 140 kV or higher	- 1 Lot
2-1	Support poles of insulators of 66 kV conductors ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing All necessary fittings for installation	1 Lot

No.	Item	Specification	Unit
OT-20	Underground cables		-
1-1	33 kV Underground cables (including termination)		1 Lot
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Type	33 kV power cable with XLPE insulation, PVC sheath and wire shield	
	➢ Conductor	Copper	
	➢ Size	400 mm^2 x 1 length per phase	
	➢ Use	From 66/33 kV Transformer to 33 kV Switchgear (including 33 kV temporary cable)	
	➢ Others	Materials for termination	
2-1	11 kV Underground cables (including termination)		1 Lot
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Type	11 kV power cable with XLPE insulation, PVC sheath and wire shield	
	➢		
	➢ Conductor	Copper	
	➢ Size	400 mm^2 x 4 lengths per phase	
	➢ Use	From 66/11 kV Transformer to 11 kV Switchgears (including 11 kV temporary cable)	
	➢ Others	Materials for termination	
3-1	Materials of cabling for Underground cables		1 Lot
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Materials of cabling	Conduit, cable rack, all necessary fittings and accessories	
OT-21	Low-voltage power cables		-
1-1	Low-voltage power cables		1 Lot
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Power cables	600 V power cable with XLPE insulation and PVC sheath, or 600 V power cable with XLPE insulation and PVC sheath including metallic armoured, or equivalent	
	➢ Others	All necessary fittings and accessories for connecting cables	
2-1	Materials of cabling for Low-voltage power cables		1 Lot
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Conduit	Rigid steel conduit, Pliable plastics conduit, Corrugated hard synthetic resin pipe (for underground), or equivalent	
	➢ Cable rack/tray	Metallic ladder type cable rack/tray with Hot-dip galvanizing, or equivalent	
	➢ Others	Materials of support for cable tray on cable duct in the control building, cable hangers on outdoor cable duct, all necessary fittings and accessories	
OT-22	Cables for protection, control and communication		-
1-1	Cables for protection and control		1 Lot
	➢ Applicable standards	IEC or equivalent standards (JEC, JEM, JIS, etc.)	
	➢ Cables for protection and control	Shielded cable with PVC insulation and PVC sheath for control, or equivalent	
	➢ Others	All necessary fittings and accessories for connecting cables	

No.	Item	Specification	Unit
2-1	Cables for communication ➢ Applicable standards ➢ Cables for communication ➢ Others	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Ethernet cable (LAN cable), optical fiber cable All necessary fittings and accessories for connecting cables	1 Lot
3-1	Materials of cabling for protection, control and communication ➢ Applicable standards ➢ Conduit ➢ Cable rack/tray ➢ ➢ Others	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Rigid steel conduit, Pliable plastics conduit, Corrugated hard synthetic resin pipe (for underground), or equivalent Metallic ladder type cable rack/tray with Hot-dip galvanizing, or equivalent Materials of support for cable tray on cable duct in the control building, cable hangers on outdoor cable duct, all necessary fittings and accessories	1 Lot
OT-23 1-1	Earthing equipment Earthing conductors ➢ Applicable standards ➢ Earthing type ➢ Earthing connection ➢ Required resistance of the earthing system ➢ Materials - Buried earthing conductors - Earthing conductors - Others	 IEC or equivalent standards (JEC, JEM, JIS, etc.), IEEE Std 80 Earthing grid Earthing system shall be bonded with the existing earthing conductors at several points. When fault current occurs, the earthing system shall not harm human bodies and damage equipment.(the resistance must be 1 ohm or lower) Annealed copper stranded conductors (150 mm^2 or higher), or equivalent PVC insulated wires (150 mm^2 or higher), or equivalent Rod electrodes and plate electrodes shall be used as necessary.	- 1 Lot
2-1	Connecting materials ➢ Applicable standards ➢ Bonding materials ➢ Other materials	 IEC or equivalent standards (JEC, JEM, JIS, etc.) C-grid tap connectors (compression type) for earthing conductors, or equivalent Bonding materials to the existing earthing conductors	1 Lot
OT-24	Lightning equipment ➢ Applicable standards ➢ Material ➢ Rustproofing treatment ➢ Height ➢ Accessories	 IEC or equivalent standards (JEC, JEM, JIS, etc.) Steel materials Hot-dip galvanizing Equivalent to the Gantry tower (dead-end structure) All necessary fittings for installation	1 Lot
OT-25	Local SCADA System for the Project	 IEC or equivalent standards (JEC, JEM, JIS, etc.) - Substation Control System Panel (GPS clock:1 Unit, Network gateway: 1 Unit, Work station (Server): 2 Units, Annunciator: 1 Set, Ethernet	1 Lot

No.	Item	Specification	Unit
	equipment ➢ Applicable standards ➢ Components ➢ Accessories ➢ Communication standard ➢ Control voltage ➢ Necessary transmission data at least ➢ Accessories ➢ Particular conditions - Future extension - Terminal block for cables	switch: 4 Units, etc.): 3 Panels - Human Machine Interface devices (Keyboard, LC Display, Printer): 2 Units - Telecom panel (Multiplexer, PBX): 1 Panel - Telephone: 2 Units - Laptop computer with pre-installed software for maintenance of protection relays: 1 Unit Lighting, 230 VAC Outlet for maintenance (Common use of OT-25) IEC 61850 and IEC 60870-5-101/104 110 V DC, 48 V DC, 230 V AC (including UPS) Data (Current, Voltage, Active Power, Reactive power, Frequency, Power factor) with floating points and time tags All necessary fittings for installation Design shall be done taking a network gateway, Ethernet switch and RS232C splitter in the future extension into consideration. Spares of at least 10% of amount of terminals shall be provided on the terminal blocks for cables.	

(3) Control Building Plan

1) Plan for Control Building in Kanengo Substation

It is planned to build a control building (one-story building) to install the control equipment of the main equipment in the existing Kanengo Substation site on the north side (next to the gate). The outline of the facility is as follows:

Control Building: one-story building of reinforced concrete frame structure
Building area: about 190 m^2; Floor area: about 190 m^2

The major functions and architectural plans, exterior finishing and interior finishing are shown in Table 2-2-2-8.1, Table 2-2-2-8.2 and Table 2-2-2-8.3.

Table 2-2-2-8.1 Control Building

Floor	Room	Area	Equipment / Specifications
GF	Control room		Lighting outlet, ventilation system, air conditioning system, Free Access Floor H = 300
	Switchgear room		Lighting outlet, ventilation equipment, air conditioning equipment, wiring pit
	Service room		Lighting outlet, ventilation equipment, air conditioning equipment, wiring pit
	Battery room		Lighting outlet, ventilation equipment, air conditioning

Floor	Room	Area	Equipment / Specifications
			equipment, wiring pit
	total	190 m^2	

The main materials for exterior finishing are as follows.

Table 2-2-2-8.2 Exterior Finishing

Function	Part	Specifications
Control building	roof(1)	Asphalt waterproof 3 layers, Holding concrete t = 800 to 140 Expansion joint @ 2000 inside and outside
	outer wall	Upper exterior paint of mortal finish
	Window	Aluminum sash ready product
	Entrance	Steel door
	Loading door	Steel door
	Downspout	Hard vinyl tube 100φ
	Roof drain	Made of cast iron

The main materials for interior finishing are as follows.

Table 2-2-2-8.3 Interior Finishing

Floor	room	Flooring	wall	Ceiling
GF	control room	300 square tiled	Mortal finish, EP paint	Lightweight steel base, PB12mm EP paint
	Switchgear room	300 square tiled	Mortal finish, EP paint	Lightweight steel base, PB12mm EP paint
	Service room	300 square tiled	Mortal finish, EP paint	Lightweight steel base, PB12mm EP paint
	Battery room	300 square tiled	Mortal finish, EP paint	Lightweight steel base, PB12mm EP paint

2) Plan for control building in Old Town Substation

It is planned to build a control building (one-story building) to install the control equipment of the main equipment in the existing Old Town Substation site on the northwest side. The outline of the facility is as follows:

Control Building: one-story building, Reinforced concrete frame structure
Building area: about 260m^2, Floor area: about 260 m^2

The major functions and architectural plans, exterior finishing and interior finishing are shown in Table 2-2-2-8.4, Table 2-2-2-8.5 and Table 2-2-2-8.6.

Table 2-2-2-8.4 Control Building

Floor	Room	Area	Equipment / Specifications
GF	Control room		Lighting outlet, ventilation system, air conditioning system, Free Access Floor H = 300
	Switchgear		Lighting outlet, ventilation equipment, air conditioning

Floor	Room	Area	Equipment / Specifications
	room		equipment, wiring pit
	Service room		Lighting outlet, ventilation equipment, air conditioning equipment, wiring pit
	Battery room		Lighting outlet, ventilation equipment, air conditioning equipment, wiring pit
	Toilet		Lighting outlet, toilet bowl, toilet
	Shower room		Lighting outlet, shower
	Water supply room		Lighting outlet, kitchen sink, electric stove
	Total	260 m^2	

Table 2-2-2-8.5 Exterior Finishing

Function	Part	Specifications
Control building	roof(1)	Asphalt waterproof 3 layers, Holding concrete t = 800 to 140 Expansion joint @ 2000 inside and outside
	outer wall	Upper exterior paint of mortal finish
	Window	Aluminum sash ready product
	Entrance	Steel door
	Loading door	Steel door
	Downspout	Hard vinyl tube 100φ
	Roof drain	Made of cast iron

Table 2-2-2-8.6 Interior Finishing

Floor	room	Flooring	wall	Ceiling
GF	Control room	300 square tiled	Mortal finish, EP paint	Lightweight steel base, PB12mm EP paint
	Switchgear room	300 square tiled	Mortal finish, EP paint	Lightweight steel base, PB12mm EP paint
	Service room	300 square tiled	Mortal finish, EP paint	Lightweight steel base, PB12mm EP paint
	Battery room	300 square tiled	Mortal finish, EP paint	Lightweight steel base, PB12mm EP paint
	Toilet	300 square tiled	Mortal finish, EP paint	Lightweight steel base, PB12mm EP paint
	Shower room	300 square tiled	Mortal finish, EP paint	Lightweight steel base, PB12mm EP paint
	Water supply room	300 square tiled	200 square tiled	Lightweight steel base, PB12mm EP paint

2-2-3 Outline Design Drawing

The Project outline design drawings are given in Appendix-6.

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The Project will be implemented in line with Japan's general Grant Aid Scheme The implementation of the Project will be initiated after the Japanese government approves the implementation, followed by the conclusion of the Exchange of Notes (E/N) between the governments of Japan and Malawi and the Grant Agreement (G/A) between JICA and Malawi government. Basic implementation plan shall be as discussed in the following sections.

(1) Executing Agency

The executing agency of this project will be ESCOM. The line ministry of the Executing Agency, which will supervise the overall implementation of this project, will be MOE.

Under the supervision of MOE, ESCOM will make close communication with the Consultant and the Supplier of this project during the implementation for the smooth implementation of this project.

The Planning and Development Department of ESCOM will be in charge of executing this project. This directorate will be the direct counterpart of the Japanese side to manage the Project progress by carrying out the following tasks but not limited to: tax exemption procedure, tax refund, coordination with stakeholders of Malawi side, and coordination with the Consultant and the Supplier by monthly meetings.

(2) Consultant

Japanese consultants will sign a design and supervision agreement with ESCOM to procure and install equipment for the Project, prepare detailed design, and supervise the construction work related to the Project. Along with drafting bidding documents, the consultants will handle the bidding process on behalf of ESCOM, the Project implementing body.

(3) Supplier

In accordance with Japan grant aid framework, independent Japanese contractors selected by open bidding will procure and install equipment for the Project (and provide operational guidance).

The Supplier will need to continue supplying spare parts, providing support for failures, and other services after the Project is completed, and as such must give due consideration to a post-delivery communication and coordination.

(4) Need for Dispatching Engineers

This project includes renovation of existing transformers and bays within the existing substation. To minimize power outage, the construction will be planned in a way that keeps adjacent transformer bays live. Therefore, it is necessary to coordinate among ESCOM, the Supplier, and the Consultant and give a priority to the safety control. As the majority of the works will be done

concurrently, it is essential to dispatch foremen familiar with the Japanese grant aid system from Japan to keep management and site guidance for the whole works consistent in terms of scheduling, quality, finished forms and safety management.

2-2-4-2 Implementation Conditions

(1) Malawian Construction Conditions and Technology Transfers

As explained in Section 2-2-1-5 above, there are several general construction companies and electric construction companies in Lilongwe City, which can accept orders for laborers, transportation of construction vehicles and equipment/materials within Malawi, as well as building work, civil engineering work and electrical work. However, dispatching Japanese engineers is essential in terms of schedule management, quality control and safety management.

(2) Using Local Equipment and Materials

Materials such as cement, aggregate and wood are produced locally, while rebar and other materials are imported from South Africa. Cement, aggregate, rebar and other materials for the building work and foundation work can be procured locally, but they must be managed for quality and timely delivery. Thus, in the interest of developing local industries, it may be planned to procure the materials for the control building and foundation from the local market to the extent possible. However, the equipment such as the substation facilities and power transmission equipment needed for the Project will be procured in Japan or another country, since Malawi relies on imported one.

(3) Safety Measures

Malawi has relatively few safety problems, and since the Project is located in an urban area it is easy to access and monitor it. Still, work after sunset is to be avoided, and sufficient care must be taken to prevent equipment theft and ensure the safety of construction staff. The temporary storage area of the Project materials and equipment will be located within these substation yards. As the storage area is likely to be far from the control building, security guards will be staffed around the clock to protect it.

(4) Tax Exemption

The Malawian tax exemption procedure (including VAT) for equipment and materials to be procured for the Project is as follows: (1) the Supplier requests ESCOM to ensure the tax exemption, (2) ESCOM requests the Ministry of Finance to issue a tax exemption letter via MOE, (3) the Ministry of Finance issues the tax exemption letter to customs, with a copy issued to MOE and the Supplier. When procured equipment and materials arrive at ports in Tanzania, Mozambique or other country, the Supplier is required to attach the above copy of the tax exemption letter with the given shipping documents to be submitted to customs for the tax exemption. Care must be taken so that tax exemption delays do not impact the Project progress.

2-2-4-3 Scope of Works

The Japanese side will be responsible for the procurement, installation, test and adjustment works for Kanengo Substation an Old Town Substation as well as the related civil engineering and building construction works for the Project. Malawi side will be responsible for the relocation of 33 kV and 11 kV distribution line, removal of existing substation facilities, reconnecting works (substation transmission lines and busbars, substation distribution line and circuit breaker) etc.

Detailed scopes of the works of the Japanese and Malawi sides are given in the section 2-3.

2-2-4-4 Consultant Supervision

According to Japan's grant aid system, consultants are to form a project team consistent with the final design and construction supervision based on the spirit of the basic design and smoothly complete the work. This project requires installation of equipment in the substation in operation, and monitoring based on on-site coordination with ESCOM. As such, the consultant is to station at least one engineer at the site to handle the overall schedule management, quality control, progress control and safety control during the construction supervision stage. Other engineers will also be dispatched to monitor the progress of the works including equipment installation, commissioning and adjustments, delivery testing and other works by the contractor. As necessary, a domestic expert is to witness factory inspections and pre-shipment inspections of equipment and the mobile substation manufactured domestically, and also supervise to prevent problems after unloading the equipment at the site.

(1) Basic Policy for Construction Management

As a basic policy, consultants are to supervise the progress so that the work is completed within the given construction period. Along with ensuring on time delivery of the equipment with the quality and finished forms stipulated in the agreement, consultants will supervise and advise contractors so that they can perform the work safely at the site. The following are the main points to be kept in mind during construction supervision.

(2) Schedule Management

Consultant management staff will compare actual progress against the work schedule planned at the time of contract on monthly and weekly basis so that contractors will keep the delivery schedule given in the contract. If the work gets behind schedule, the staff will warn contractors and request them to submit and implement plans to get back to the original schedule, and guide contractors so that they can complete the work and deliver equipment within the contract construction period. The actual progress of the following items will be compared against the schedule:

- Equipment and material transported to site (equipment and materials for substation, power transmission equipment, civil engineering and construction)
- Temporary works and readiness of construction machinery
- Work progress of site installation work including building and foundation construction work
- Productivity and actual numbers of engineers, skilled workers, laborers and other workers.

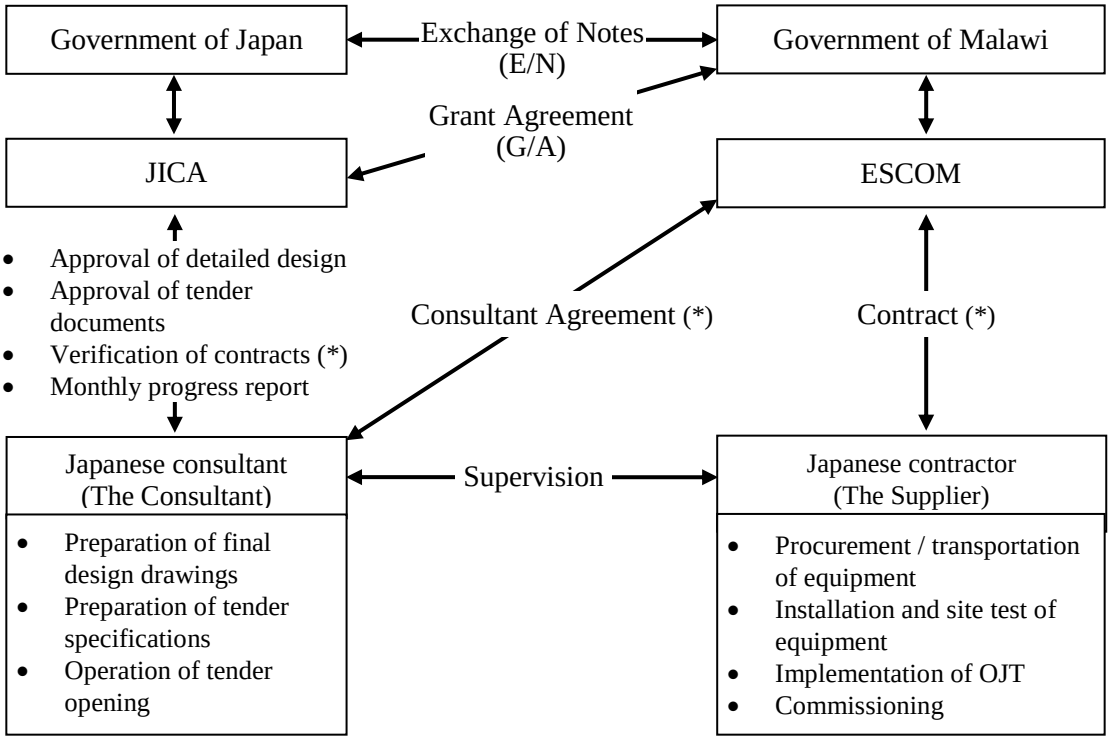
(3) Safety Control

Since installation work will be conducted within the existing substation in operation, it is necessary to consider construction safety carefully, for example, securing enough distance from live conductor and scheduling outage works at night. The consultant's supervisory staff will consult and work together with the contractor's representative, and manage the work safety to prevent any occupational accidents on the site during the construction period or accidents involving third parties. The following actions are to be taken in terms of site safety management:

- Establish safety management regulations and assign a safety manager
- Prevent disasters through regular inspection of construction machinery
- Decide a service route for transporting machinery and other work vehicles, and ensure safe driving
- Strictly push workers to take advantage of worker benefits and take leave.
- Thorough education for new workers/visitors

(4) Overall Relationships concerning Project Implementation

The concerned bodies of the Project including their roles and their relationship are shown in Figure 2-2-4-4.1.



Note: *JICA's verification is required for Consultant Agreement and Contract.
Source: Preparatory Survey Team

Figure 2-2-4-4.1 Project Implementation Diagram

(5) Construction Managers

The Supplier will procure and install substation equipment in the existing substation, and construct buildings and foundation. Furthermore, it will subcontract the works to local Malawian contractors. Accordingly, the contractor is required to ensure that subcontractors fully comply with the work schedule, quality, finished form and safety measures given in the work contract. To accomplish this, the Supplier will deploy engineers with experience in similar overseas works to guide and advise local contractors.

2-2-4-5 Quality Control Plan

The consultant's construction supervisory staff is to supervise and verify that the Suppliers are maintaining the quality, construction and installation forms given in the contract documents, including technical specifications and detailed design drawings. The staff will request the Suppliers to correct, change or revise the work if quality or finished form is compromised.

The Consultant will carry out the following tasks:

1) Verify fabrication drawings and specifications for equipment
2) Witness factory inspections for equipment or verify inspections
3) Verify packaging, transportation and temporary stockyards on site
4) Verify working drawings and installation manual procedures for equipment
5) Verify equipment commissioning, adjustment, testing and inspection reports
6) Supervise site installation of equipment and witness commissioning, adjustments, tests and inspections
7) Verify equipment working drawings, fabrication drawings, and finished forms
8) Verify construction drawings, fabrication drawings, and on-site progress.

2-2-4-6 Procurement Plan

As the equipment and materials for the substation facilities to be procured and installed in the Project are not manufactured in Malawi, the substation, the substation facilities, including switchboard and other power distribution will be procured from Japan or Europe.

ESCOM, which will handle the O&M after the Project facilities start service, holds Japanese products in particularly high regard. ESCOM has also come to rely on the benefits of the high quality and follow-up services of Japanese manufacturers throughout the O&M process. Thus, ESCOM, the implementing body, is strongly interested in using Japanese products for the key project equipment.

Given the above points, the suppliers of the equipment and materials used in this project are specified as follows.

(1) Equipment and Materials Procured in Malawi

Construction materials, such as cement, sand, concrete aggregates, concrete roadblocks, rebar, wood, gasoline, diesel, construction vehicles, cranes, trailers and other temporary work equipment/materials, etc.

(2) Equipment and Materials Procured in Japan

132/66 kV transformers, 66/33 kV transformers, 66/11 kV transformers, Materials for installation of equipment（mounting structures, porcelain Insulator, low-voltage power cables）, etc.

(3) Equipment and materials to be procured from Japan or other DAC or ASEAN countries

132 kV switchgears (Outdoor), 66 kV switchgears (Outdoor), 33 kV switchgears (Outdoor), 33 kV switchgears (Indoor type metal clad type), 11 kV switchgears (Indoor type metal clad type), control and protection panel, Local SCADA System for the Project equipment, 33 kV cables, 11 kV cables, etc.

2-2-4-7 Operational Guidance Plan

As a basic policy, a trainer from the manufacturer will give guidance on initial operation and O&M methods for the equipment procured in the Project as on-the-job training before the work is completed and in accordance with the O&M manuals.

For the smooth implementation of this guidance plan, ESCOM must delegate a full-time engineer to attend the guidance and keep close contact with the Japanese consultants and contractors. Also, specialist manufacturer engineers with moderate skill level are needed for substation facility operations as well as adjustments and testing of transmission line equipment. The engineers must be sent from Japan to carry out these tasks and handle the quality control, technical guidance, and schedule management.

2-2-4-8 Implementation Schedule

Based on the Japan’s Grant Aid Scheme, the Project implementation schedule is given in Figure 2-2-4-8.1.

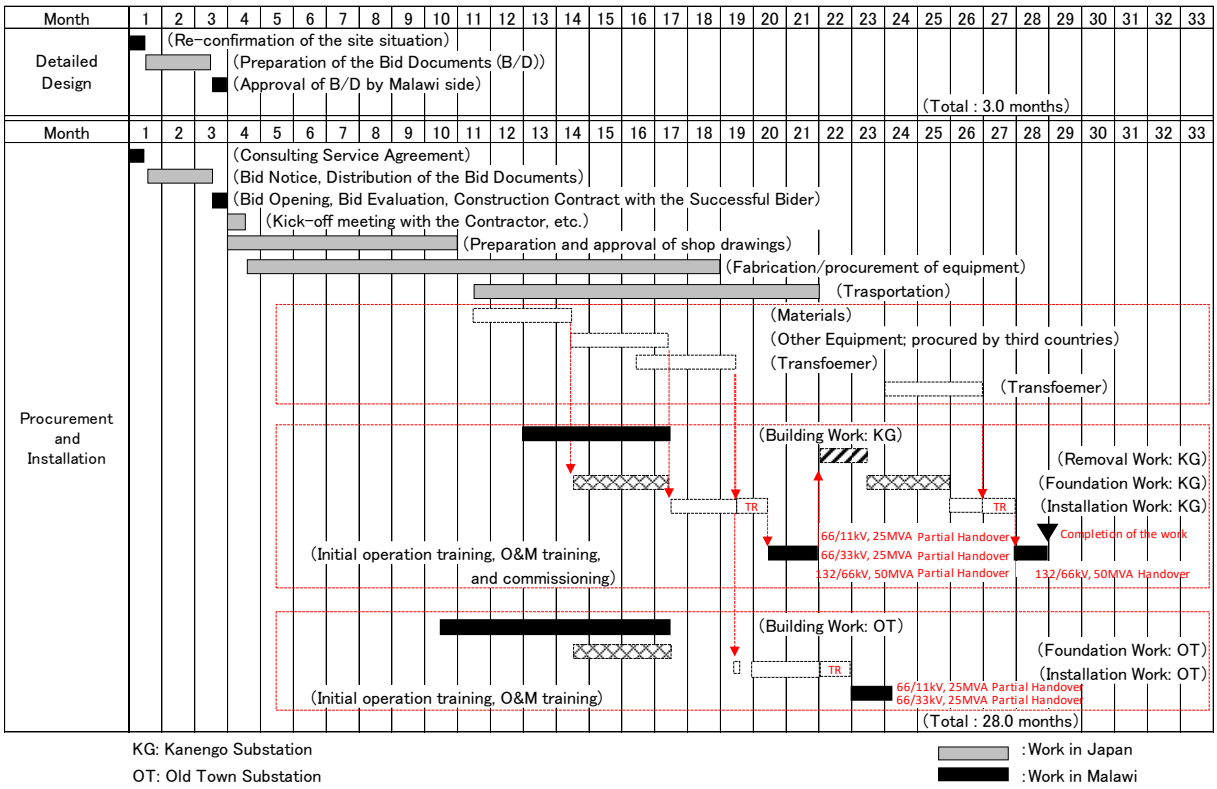


Figure 2-2-4-8.1 Project Implementation Schedule

2-3 Obligations of Recipient Country

The detailed scopes of the works for the Japanese and Malawian sides, from the technical point of view, in addition to the prior burdens identified in Annex 5 of the Minutes of Discussions are as shown in Table 2-3.1. The ESCOM department responsible for each work item is also given in the rightmost column.

Table 2-3.1 Major Undertakings to be covered by Japan and Malawi

No.	Work Items	Japanese side		Malawian side		
		Procurement	Installation	Procurement	Installation	Responsibility
1. Before the Bid						
1	【Common】To open bank account (B/A)	-	-	●	●	MOE/ MOF
2	【Common】To issue A/P to a bank in Japan (the Agent Bank) for the payment to the consultant	-	-	●	●	MOE/ MOF
3	【Common】To secure necessary budget for the removal and demolition of existing equipment and facilities	-	-	●	●	MOE/ ESCOM
4	【Common】To submit Project Monitoring Report (with the result of Detail Design)	-	-	●	●	DOPD
5	【Common】Secure and clear the project sites (Kanengo Substation and Old Town Substation)	-	-	●	●	TL
6	【Kanengo Substation】 Replacement of existing overhead conductor with underground cable Relocation of all existing underground cables and 33 kV VT	-	-	●	●	DL
7	【Old Town Substation】 Relocation 5x11kV UGCs and 2x33kV OHL/UGCs			●	●	DL
8	【Common】Construction of access road to the project sites	-	-	●	●	Admin
9	【Common】Approval of construction work from City council	-	-	●	●	Admin
2. Before the Project Implementation						
1	【Common】Clearance of the project site (the existing obstacle, materials and trees)	-	-	●	●	TL
2	【Common】Preparation of stockyard for the project (during the implementation period)	-	-	●	●	DOPD
3	【Kanengo Substation】 Removal of existing 132/11kV 20MVA transformer (T4T) and related bay equipment and its foundation	-	-	●	●	TL
4	【Kanengo Substation】 Removal of existing 66/11kV 12.5MVA transformer (currently out of service) and related bay equipment and its foundation	-	-	●	●	TL
3. During the Project Implementation						
1	【Common】To issue A/P to a bank in Japan (the Agent Bank) for the payment to the Supplier(s)	-	-	●	●	MOF
2	【Common】To bear the following commissions to a bank in Japan for the banking services based upon the B/A 1) Advising commission of A/P 2) Payment commission for A/P	-	-	●	●	MOF
3	【Common】To ensure prompt unloading and customs clearance at ports of disembarkation in recipient country and to assist the Supplier(s) with internal transportation therein	-	-	●	●	MOE/ MOF
4	【Common】To accord Japanese nationals and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work	-	-	●	●	MOE/ ESCOM
5	【Common】To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the products and/or the services be exempted	-	-	●	●	MOE/ MOF

No.	Work Items	Japanese side		Malawian side		
		Procurement	Installation	Procurement	Installation	Responsibility
6	【Common】To bear all the expenses, such as necessary registration fee to the related agency, other than those covered by the Grant, necessary for the implementation of the Project	-	-	●	●	MOE/ ESCOM
7	【Common】To ensure that all conditions under the jurisdiction of National Construction Industry Council, registration fees for consultants and contractor, one(1) percent of the total contract amount and the requirement of achieving a minimum work proportion of thirty(30) percent for Malawian construction firms, are exempt in this project.			●	●	MOF
8	【Common】To submit Project Monitoring Report 1) after each work under the contract(s) such as shipping, hand over, installation and operational training 2) final	-	-	●	●	DOPD
9	【Common】To submit a report concerning completion of the Project	-	-	●	●	DOPD
10	【Common】To take necessary measure for safety construction	-	-	●	●	DOPD
11	【Common】Leveling of the project sites	●	●	-	-	-
12	【Common】Road and parking lot in the site	●	●	-	-	-
13	【Common】Construction of control building (However, Furniture such as desk, chair, reception set, electric appliances and others shall be procured by Malawi side)	●	●	-	-	-
14	【Common】Substation equipment replacement, and project construction works（procurement, installation, testing and adjustment, foundation work）	●	●	-	-	-
15	【Common】Spare parts and consumables	●	-	-	-	-
16	【Common】Maintenance tools	●	-	-	-	-
17	【Common】On-the-job training (OJT) for the Equipment	-	●	-	-	-
18	【Common】Installation, testing and adjustment of the control system inside the substation (local SCADA system)	●	●	-	-	-
19	【Common】Modification, relocation, re-connection, testing and adjustment of SCADA system in the National Control Center or other substation	-	-	●	●	TL
20	【Common】Submission of necessary interface information to connect to local SCADA system, and witnessing testing as requested.	-	-	●	●	TL
21	【Common】Temporary power outage management during the work	-	-	●	●	SMO
22	【Kanengo Substation】 Electrical isolation work including cables for existing equipment before removal work	-	-	●	●	TL
23	【Kanengo Substation】 Removal of existing 132/66kV 25MVA transformer (IBT1) and related bay equipment and its foundation	●	●	-	-	TL
24	【Kanengo Substation】 Removal of existing 66/33kV 7.5MVA transformer and related bay equipment	●	●	-	-	TL
25	【Kanengo Substation】 Removal of foundation for 66/33kV 25MVA transformer	●	●	-	-	-
26	【Kanengo Substation】Disposal of removed equipment -Removed existing 132/11kV 20MVA transformer (T4T), -Removed existing 66/11kV 12.5MVA transformer (currently out of service), -Removed existing 132/66kV 25MVA transformer (IBT1),	-	-	●	●	TL / DL

No.	Work Items	Japanese side		Malawian side		
		Procurement	Installation	Procurement	Installation	Responsibility
	-Removed existing 66/33kV 7.5MVA transformer, -related bay equipment and those foundation, and -Removed foundation for 66/33kV 25MVA transformer					
27	【Kanengo Substation】 Installation of disconnecting switch for new 132/66kV transformer including connection work to the 132kV busbars	-	-	●	●	TL
28	【Kanengo Substation】 Switching over of outgoing feeder of 11kV switchgear from existing control building to new one	-	-	●	●	DL
29	【Old Town Substation】 Switching over of outgoing feeder of 33kV and 11kV switchgear from existing control building to new one	-	-	●	●	DL
30	【Old Town Substation】 Rerouting of 66 kV existing transmission line to gantry with support structure, if necessary	-	-	●	●	TL
31	【Common】Gate and fence for substations	-	-	●	●	Admin
32	【Common】FAT ESCOM participation	-	-	-	●	DOPD
4. After the Project						
1	【Common】To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid 1) Allocation of maintenance cost 2) Operation and maintenance structure 3) Routine check/Periodic inspection	-	-	●	●	DOPD
2	【Kanengo Substation】 Expansion of the control building	-	-	●	●	Admin
3	【Kanengo Substation】 Relocation and switching over of all of the existing equipment from existing control building to expanded one	-	-	●	●	TL / DL
4	【Old Town Substation】 Removal and disposal of existing substation equipment	-	-	●	●	TL / DL
5	【Common】Storage the testing equipment, spare parts and consumables	-	-	●	●	DOPD

Note: DOPD: Directorate of Planning and Development
TL: Transmission
DL: Distribution
SMO: System and Market Operator
Admin: Administrator

2-4 Project Operation Plan

2-4-1 Basic Plan

Proper O&M for the substation facilities, as well as preservation of their surrounding environments, are essential for improving consumer trust in power supply in the Project area and stable power supply management. As such, appropriate preventative maintenance is recommended to reduce the rate of facility accidents and improve trust, safety and efficiency levels. The basic concepts for substation facility maintenance are shown in Figure 2-4-1.1. Prevention must be the focus of the maintenance of the equipment and facilities procured, installed and built for the Project.

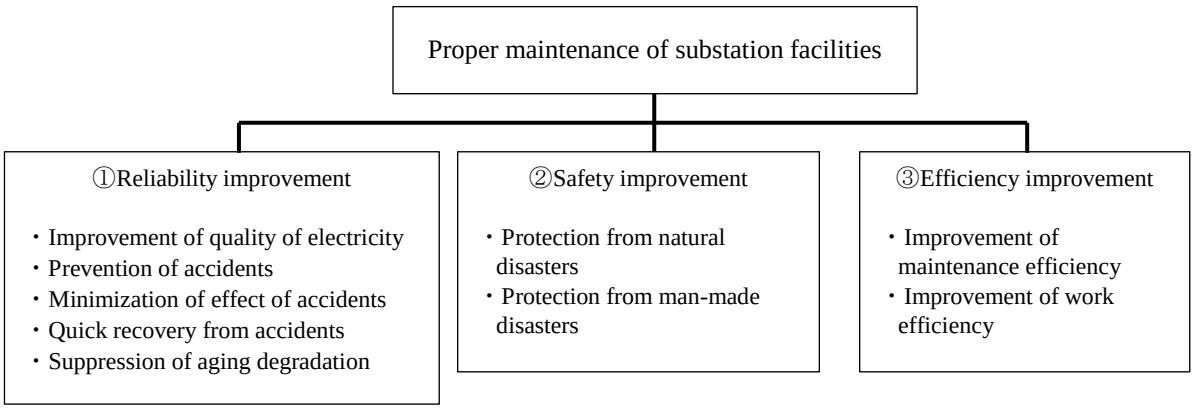


Figure 2-4-1.1 Basic Concepts for Substation Facility Maintenance

In the Project, engineers dispatched by the Japanese contractor are planned to train local engineers in O&M of the substation facilities during installation and the testing and adjustment periods. The fruits of this OJT can be fully reaped by also having the Japanese side furnish the necessary spare parts, tools for testing and maintenance, and O&M manuals, and establishing an O&M system after commissioning.

2-4-2 Regular Inspection and Periodical Inspection Items

The standard regular inspection items for the substation facilities to be procured and installed in the Project are given in Table 2-4-2.1. As given in the table, inspections for the above facilities are classified as follows:

1) Daily inspections, which involve a sensory check to detect abnormal heat, sounds and smells from the equipment,
2) Regular inspections, which check equipment for loose bolts, surface dirt or damage on insulation and other energized parts not checked on daily basis, and
3) Detailed inspections, which include functional checks of interlock mechanisms between devices, and precision maintenance of instrumentation.

In general, regular inspections are conducted once every one to two years, and detailed inspections are conducted once every four years. Switchboard internal fuses, metering, relays and other components with deteriorating performance, reduced insulation, contact wear or characteristic changes, should be replaced as appropriate during regular and detailed inspections upon confirming component qualities and frequency of use.

Table 2-4-2.1 Inspection Items for Standard Facility Equipment

Inspection Items	Details of Inspection (Method)	Daily	Regular	Detailed
Visual Appearance	State of switch indicators and display lights	○	○	
	Abnormal noise and/or smells	○	○	
	Overheat and discoloration of terminal	○	○	
	Cracking, damage or staining of bushings and porcelain	○	○	
	Rust on mounting cases, frame, etc.	○	○	
	Abnormal heat (temperature gauge)	○	○	

Inspection Items	Details of Inspection (Method)	Daily	Regular	Detailed
	Clamping of bushing terminal (mechanically checked)	○	○	
Operating Devices and Control Panel	Display conditions on measuring instruments	○	○	○
	Indication on operation counters		○	○
	Dampness, rust or staining on operation box or panel		○	○
	Refilling oil, cleaning		○	○
	Clamping of distributing terminals	○	○	○
	Confirmation of switching display status		○	○
	Air or oil leaks		○	○
	Confirmation of pressures (air, etc.) before/after operation		○	○
	Confirmation of operation meter		○	○
	Rust, deformation and/or damage on springs (maintenance)	○	○	○
	Abnormalities of tightening pins		○	○
	Inspection of auxiliary switches and relays (maintenance)		○	○
	Inspection of DC control power source	○		
Measurement and Test	Measurement of insulating resistance		○	○
	Measurement of contact resistance			○
	Breakage of heater wires		○	○
	Operation test of relay		○	○

2-4-3 Spare parts procurement Plan

2-4-3-1 Spare Parts for Equipment

Spare parts should be selected on the basis of parts which wear and deteriorate with daily operations and must be replaced regularly. The following spare parts, fulfilling quantities needed for one year, will be procured for the Project:

1) Transformers
2) 132 kV Switchgears
3) 66 kV Switchgears
4) 33 kV Switchgears
5) 11 kV switchgears
6) Control and protection equipment
7) Station power supply equipment
8) Communication equipment.

2-4-3-2 Spare parts procurement Plan

The Japanese side plans to procure the minimum required standard spare parts for one year for the Project. These items are given in Table 2-4-3-2.1 and Table 2-4-3-2.2. ESCOM will be responsible for preparing a budget for purchasing necessary replacement parts after one year of the completion of the Project.

Table 2-4-3-2.1 Lists of Spare Parts

Legend: N.A. (Not applicable)

No.	Spare Part	Unit	Quantity	
			Kanengo	Old Town
1.	132/66/11 kV Transformer			
(1)	Buchholz relay	Set	1	N.A.
(2)	Oil temperature indicator (oil and secondary wiring)	Piece	1	N.A.
(3)	Oil level indicator	Piece	1	N.A.
2.	66/33 kV Transformer			
(1)	Buchholz relay	Set	1	1
(2)	Oil temperature indicator (oil and secondary wiring)	Piece	1	1
(3)	Oil level indicator	Piece	1	1
3.	66/11 kV Transformer			
(1)	Buchholz relay	Set	1	1
(2)	Oil temperature indicator (oil and secondary wiring)	Piece	1	1
(3)	Oil level indicator	Piece	1	1
4.	132 kV Circuit breaker			
(1)	Closing coil	Set	1	N.A.
(2)	Tripping coil	Set	1	N.A.
5.	66 kV Circuit breaker			
(1)	Closing coil	Set	1	1
(2)	Tripping coil	Set	1	1
6.	66 kV Disconnecting switch			
(1)	Fixed and moving contact for Disconnecting switch	Set	1	1
(2)	Fixed and moving contact for Earthing switch (3 phase)	Set	N.A.	1
7.	33 kV Circuit breaker			
(1)	Closing coil	Set	1	N.A.
(2)	Tripping coil	Set	1	N.A.
8.	33 kV Disconnecting switch			
(1)	Fixed and moving contact for Disconnecting switch (3 phase)	Set	1	N.A.
9.	11 kV Switchgear			
(1)	Withdrawable Circuit breaker with accessory (each type)	Set	1 each	1 each
10.	Control and protection panel			
(1)	Protection relay (each type)	Set	1 each	1 each
(2)	Bay control unit (each type)	Set	1 each	1 each
(3)	Ethernet switch (each type)	Set	1 each	1 each
(4)	Media converter, if any (each type)	Set	1 each	1 each
(5)	Fuse (each type)	%	100%	100%
(6)	Meter (each type)	Set	1 each	1 each
(7)	Auxiliary relay (each type)	Set	1 each	1 each
(8)	Control and selector switch, if any (each type)	Set	1 each	1 each
11.	11/0.4 kV Station transformer			
(1)	Oil temperature indicator	Piece	1	1
12.	Auxiliary AC distribution panel			
(1)	MCCB (each type)	Set	1 each	1 each
(2)	Indicating lamp, if any (each type)	%	100%	100%
(3)	Fuse, if any (each type)	%	100%	100%
(4)	Meter (each type)	Set	1 each	1 each
13.	Auxiliary DC distribution panel			
(1)	MCCB (each type)	Set	1 each	1 each
(2)	Indicating lamp, if any (each type)	%	100%	100%
(3)	Fuse, if any (each type)	%	100%	100%
(4)	Meter (each type)	Set	1 each	1 each
14.	110 V DC Charger and 48 V DC Charger			
(1)	Control board (or module) for rectifier, and Diode for rectifier (or	Set	1 each	1 each

No.	Spare Part	Unit	Quantity	
			Kanengo	Old Town
	equivalent)			
(2)	Indicating lamp, if any (each type)	%	100%	100%
(3)	Fuse, if any (each type)	%	100%	100%
(4)	Meter (each type)	Set	1 each	1 each

Table 2-4-3-2.2 Lists of Consumables

No.	Consumables	Unit	Quantity	
			Kanengo	Old Town
1.	Transformer			
(1)	Silica gel (each Transformer)	%	200%	200%
2.	Cables for communication			
(1)	Ethernet cable (each panel)	%	100%	100%

2-4-3-3 Testing Instrument and Maintenance Tools Plan

Testing equipment and maintenance tools should be considered by the Project for main equipment of transformers and their protection relay devices. Testing equipment and maintenance tools of minimum requirement to be prepared from the beginning of the installation are shown in Table 2-4-3-3.1 for continuous steady operation and maintenance.

1) Withstand voltage testing device for insulation oil of transformer
   Electrical insulating oil is needed to inspect insulation performance by measuring and recording withstand voltage with oil sampling periodically because performance of the oil gradually deteriorates as transformers operate.
2) Vacuum insulation oil degassing apparatus (Incl. tank)
   When the replacement of deterioration of electrical insulating oil is confirmed, that oil is needed to remove and purify impurities such as flammable gases.
3) Testing device for protection relays
   The protection relays of the transformers need to be periodically inspected to confirm their reliability.

Table 2-4-3-3.1 Lists of Testing Equipment

No.	Testing Equipment	Unit	Quantity	
			Kanengo	Old Town
1	Withstand voltage testing device for insulation oil of transformer	Set	1	
2	Vacuum insulation oil degassing apparatus (Incl. tank)	Set	1	
3	Testing device for protection relays	Set	1	

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

(1) Condition of the estimation

1) Time of estimation: May 2020
2) Exchange rate:
   1 US$ = 109.37 JPY (TTS average from February 2020 to April 2020)
   1 EURO = 120.22 JPY (TTS average from February 2020 to April 2020)
3) Construction/procurement period: Periods for detailed design, equipment procurement and installation are as shown in the construction schedule.
4) Other: This project is implemented according to the Japan's Grant Aid Scheme.

(2) Costs borne by the Malawian side

2,124,832 US$ (approximately 232 million yen)

The cost borne by Malawi side by work item is given in Table 2-5-1.1:

Table 2-5-1.1 Breakdown of costs borne by the Malawian side

No.	Work Items	Responsibility	Cost (USD)
1. Before the Bid			
1	【Common】Secure and clear the project sites (Kanengo Substation and Old Town Substation)	TL (Transmission)	5,713
2	【Kanengo Substation】 Replacement of existing overhead conductor with underground cable Relocation of all existing underground cables and 33 kV VT	DL (Distribution)	282,923
3	【Old Town Substation】 Relocation 5x11kV UGCs and 2x33kV OHL/UGCs	DL (Distribution)	453,102
4	【Common】Approval of construction work from City council	Admin	5,364
	SUB TOTAL		**747,102**
2. Before the Project Implementation			
1	【Common】Clearance of the project site (the existing obstacle, Materials and Trees)	TL	1,575
2	【Common】Preparation of Stockyard for the project sites (during the implementation period)	DOPD (Directorate of Planning and Development)	27,726
3	【Kanengo Substation】 Removal of existing 132/11kV 20MVA transformer (T4T) and related bay equipment and its foundation	TL	25,128
4	【Kanengo Substation】 Removal of existing 66/11kV 12.5MVA transformer (currently out of service) and related bay equipment and its foundation	TL	25,128
	SUB TOTAL		**79,557**
3. During the Project Implementation			
1	【Common】Modification, relocation, re-connection, testing and adjustment of SCADA system in National Control Center or other substation	TL	5,713
2	【Common】To bear the following commissions to a bank in Japan for the banking services based upon the B/A 1) Advising commission of A/P 2) Payment commission for A/P	MOF	 250 26,000

No.	Work Items	Responsibility	Cost (USD)
3	【Kanengo Substation】 Electrical isolation work including cables for existing equipment before removal work	TL	5,713
4	【Kanengo Substation】 Installation of disconnecting switch for new 132/66kV transformer including connection work to the 132kV busbars	TL	16,603
5	【Kanengo Substation】 Switching over of outgoing feeder of 11kV switchgear from existing control building to new one	DL	5,713
6	【Old Town Substation】 Switching over of outgoing feeder of 33kV and 11kV switchgear from existing control building to new one	DL	5,713
7	【Old Town Substation】 Rerouting of 66 kV existing transmission line to gantry with support structure, if necessary	TL	766,645
8	【Common】Gate and Fence for substation	Admin	20,480
9	【Common】FAT ESCOM participation	DOPD	15,100
	SUB TOTAL		**867,930**
4. After the Project			
1	【Common】To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid 1) Allocation of maintenance cost 2) Operation and maintenance structure 3) Routine check/Periodic inspection	DOPD	300,000 /year [3]
2	【Kanengo Substation】 Expansion of control building	Admin	53,637
3	【Kanengo Substation】 Relocation and switching over of all of existing equipment from existing control building to expanded one	TL / DL	5,713
4	【Old Town Substation】 Removal and disposal of existing substation equipment	TL / DL	70,893
	SUB TOTAL		**430,243**
	GRAND TOTAL		**2,124,832**

2-5-2 Operation and Maintenance Cost

After the commencement of service, the Central Region Office of ESCOM shall be responsible for the operation and maintenance of the equipment procured and installed by the Project. Since Kanengo Substation and Old Town Substation are existing substations and have already been properly operated and maintained by ESCOM, no additional employment is expected.

As for the spare parts and consumables given in Table 2-4-3-2.1, ESCOM must stock them at all times in order to operate the new substation properly. This shall require regional offices to budget roughly 0.3 million US dollars (2% of equipment costs) if necessary. The cost for repair and maintenance of ESCOM was about 6 million US dollars (4,720 million MWK) in 2017, and the budget shall cover the O&M costs for the new substation of the Project.

[3] The Estimate cost is subject to change depend on the operation condition and surrounding environment of the facilities.

CHAPTER 3 PROJECT EVALUATION

Chapter 3 Project Evaluation

3-1 Preconditions

The preconditions of the implementation of this project is to secure spaces where the substation equipment will be installed. As this project is the replacement and reinforcement of existing main transformer at Kanengo Substation and Old Town Substation, which is managed by ESCOM, it has been confirmed that social and environmental impact investigation and approval are not necessary. Based on these preconditions, the followings are the requirement for the ESCOM prior to the commencement of bid opening:

(1) Banking Charge

ESCOM has to bear the banking charge for the payment to the Supllier and consultant, and prepare the budget in advance.

(2) Construction Permission

Any construction in the urban area is required to apply for construction permission by construction section of each city office. Since ESCOM has qualified architects or structural designers, ESCOM will apply for construction permission for this project.

(3) Issuance of Certificate of Tax exemption

The tax exemption procedure (including VAT) in Malawi for equipment and materials to be procured for the Project is as follows: (1) the Supplier requests ESCOM to ensure the tax exemption, (2) ESCOM requests the Ministry of Finance to issue a tax exemption letter via MOE, (3) the Ministry of Finance issues the tax exemption letter to customs, with a copy issued to MOE and the Supplier.

3-2 Necessary Inputs by the Recipient Country

(1) Before the Bid

1) 【Common】 Secure and clear the project sites (Kanengo Substation and Old Town Substation)

ESCOM needs to implement zoning project site including the site for construction offices and temporary storage yard.

2) 【Kanengo Substation】Replacement of existing overhead conductor with underground cable, removal of all existing underground cables and 33 kV VT

In order not to interfere with the project site, ESCOM needs to deal with the relocation work of the existing overhead line, the existing underground cable, the existing power cable, and the removal work of the existing 33kV voltage transformer.

3) 【Old Town Substation】Relocation 5x11kV UGCs and 2x33kV OHL/UGCs

In order not to interfere with the project site, ESCOM needs to deal with the relocation work of the existing overhead lines and the existing underground cables.

4) 【Common】Construction of access road to the project sites

ESCOM needs to repair an access road to the project site.

5) 【Common】Application for EIA approval (or Acquisition of Certificate of Exemption)

Since there is no need to acquire new land or expand the existing substations beyond their borders, it is assumed that obtaining an Environmental Impact Assessment license will not be necessary in this project. That being said, even if it is determined that an EIA is unnecessary, a Certificate of Exemption of EIA may still be required. ESCOM must submit a project brief (Field Report) to the Environmental Affairs Department of MOE to determine whether an EIA is required. After that, ESCOM will acquire either an EIA license if the assessment is required, or a Certificate of Exemption if it is not required.

6) 【Common】Banking Charge

ESCOM has to bear the banking charge for the payment to the Supllier and consultant, and prepare the budget in advance.

7) 【Common】Approval of construction work from City council

Any construction in the urban area is required to apply for construction permission by construction section of each city office. Since ESCOM has qualified architects or structural designers, ESCOM will apply for construction permission for this project.

8) 【Common】Issuance of Certificate of Tax exemption

The tax exemption procedure (including VAT) in Malawi for equipment and materials is to be procured for the Project

(2) Before the Project Implementation

1) 【Common】Clearance of the project site (the existing obstacle, materials and trees)

Prior to the start of construction, ESCOM needs to deal with the relocation work of the materials and containers and cutting trees in order not to interfere the project site.

2) 【Common】Preparation of stockyard for the project (during the implementation period)

ESCOM needs to implement zoning to secure the necessary temporary yard for the implementation of the Project.

3) 【Kanengo Substation】Removal of existing 132/11kV 20MVA transformer (T4T) and related bay facilities and its foundation

The existing 132/11 kV 20 MVA transformer (T4T), bay facilities, and its foundation will be removed.

4) 【Kanengo Substation】Removal of existing 66/11kV 12.5MVA transformer (currently out of service) and related bay facilities and its foundation

The existing 66/11kV 12.5MVA transformer (out of service), bay facilities, and its foundation will be removed.

(3) During the Project Implementation

1) 【Common】Modification, relocation, re-connection, testing and adjustment of SCADA system in the National Control Center (NCC) or other substations

ESCOM will undertake modification, connection test, and adjustment of the upper-level facilities (existing NCC SCADA System and related facilities) necessary for connect the Local SCADA System.

2) 【Common】Submission of necessary interface information to connect to local SCADA system, and attendance of witnessing test as requested

After contract is concluded with the Supplier, ESCOM provide the existing interface information the Supplier so that the Supplier can smoothly manufacture the Equipment. Also, ESCOM attend and confirm the operation by witnessing of a cooperative connection test of the Local SCADA System with existing NCC SCADA System.

3) 【Common】Temporary power outage management during the work

In order to minimize the power outage time, the power outage plan is prepared and implemented by ESCOM in cooperation with the Supplier. Power outages during installation are categorized four purposes as follows:

a. For removal of existing equipment (once)

b. To connect the bus bar and the new transformer (4 times)

c. To switch over the transmission lines and the distribution lines (3 times)

d. For parallel operation test (3 times)

4) 【Kanengo Substation】Electrical isolation work including cables for existing equipment before removal work by Japanese side

Operation of 132/66/11 kV 25MVA (IBT1) transformer and 66/33 kV 12.5MVA (T2) transformer will be stopped, and electrical insulation work and cable disconnection work will be undertaken by ESCOM. The removal work of the Equipment and foundation is done by Japanese side, but the disposal of waste equipment and materials after removal work is done by Malawi side.

5) 【Kanengo Substation】Disposal of removed equipment

After removal of existing equipment, disposal of waste equipment and materials such as transformers, bay facilities, and its foundation will be undertaken by ESCOM.

a. -Removed existing 132/11kV 20MVA transformer (T4T),

b. -Removed existing 66/11kV 12.5MVA transformer (out of service),

c. -Removed existing 132/66kV 25MVA transformer (IBT1),

d. -Removed existing 66/33kV 7.5MVA transformer,

e. -related bay facilities and those foundation, and

f. -Removed foundation for 66/33kV 25MVA transformer

6) 【Kanengo Substation】Installation of 132 kV disconnecting switch including connection work to the 132 kV bus-bars

To install one 132 kV Disconnecting Switch and recover the function of the main/sub bus switching of 132 kV Bus Tie for 132/66/11 kV transformer (IBT4).

7) 【Kanengo Substation】Switching over of outgoing feeder of 11kV switchgear from existing control building to new one, including test and adjustment

After switching work of the 11 kV distribution line from the old control building to the new control building, 11 kV distribution line will be switching over to new 11 kV circuit breaker panel.

8) 【Old Town Substation】Switching over of outgoing feeder of 33kV and 11kV switchgear from existing control building to new one, including test and adjustment

After switching work of the 33 kV distribution line and the 11 kV distribution line from the old control building to the new control building, 33 kV distribution line will be switching over to new 33 kV circuit breaker panel and 11 kV distribution line will be switching over to new 11 kV circuit breaker panel.

9) 【Old Town Substation】Rerouting of 66 kV existing transmission line to gantry with support structure, , including test and adjustment

After the 66 kV transmission line (and overhead ground wire) extension work, the connection of the 66 kV transmission line from the existing transmission tower to the new gantry will be switched over.

10) 【Common】Gate and fence for the substations

ESCOM plans and construct gates and fences for Kanengo Substation and Old Town Substation in accordance with the layout and arrangement of the equipment and facilities of the Project.

11) 【Common】FAT ESCOM participation

ESCOM staff will attend major Factory Inspections (Factory Acceptance Test: FAT) at his own

cost aside from the consultant of Japanese grant aid scheme.

(4) After the Project

1) 【Kanengo Substation】Expansion of the control building

The new control building will be expanded by ESCOM side in order to relocate existing equipment in old control building to the new control building.

2) 【Kanengo Substation】Relocation of all of the existing equipment from existing control building to expanded one

Existing equipment in old control building will be relocated to the new control building.

3) 【Old Town Substation】Removal and disposal of existing substation equipment

After switching over the substation, the existing equipment in the substations will be demolished, including waste disposal.

4) 【Common】Storage of the testing equipment, spare parts and consumables

ESCOM understands that the testing equipment, spare parts and consumables procured by the Project shall be used only for the facilities procured by the Project. Therefore, ESCOM shall make sure that these items are stored in Kanengo Substation and old Town Substation appropriately and not used at different stations.

3-3 Important Assumptions

The external conditions assumed for the project to achieve and sustain its results are as follows:

(1) For overall goal

- National policy on regional electrification does not change.
- The government and economy remain stable.

(2) For project objectives

- O&M is performed on a continuous basis.
- Fees are continuously collected, and government support continues.
- Facility security is maintained.

(3) For expected outcomes

- Power generation facilities and transmission facilities produce sufficient power.
- The O&M plan is implemented.
- Residents (or the government) can cover the connection fees and electricity charges.

3-4 Project Evaluation

3-4-1 Relevance

As shown below, relevance for this cooperation project is judged to be high as it helps to achieve the national energy policies of Malawi and benefits the public facilities and poor residents in a target area.

(1) Benefit

Electric power is absolutely essential as energy for the self-reliant, sustainable socioeconomic growth of a nation. Particularly in capital areas, which hold government agencies and head offices of the companies which support the national economy, power development projects to enhance the power supply capacity are one of the most important of economic infrastructure development.

The Project is to enhance the power supply capacity in Lilongwe City in Malawi as it faces a serious power system problem, such as chronic rolling blackout, caused by supply capacity shortage due to recent rapid economic growth. The enhancement of supply capacity of substation facilities, which is currently insufficient, is a fundamental solution to the loss of opportunity gain due to disrupted supply and thus it is highly beneficial.

When all the transformers procured by the Project are supplied to new Domestic Customers around Lilongwe City, the increase amount of capacity will be equivalent to approximately 55,000 households (48,750 households at the Kanengo Substation and 6,250 households at the Old Town Substation, respectively). This is equivalent to approximately 14% of the number of households in Lilongwe City.

Table 3-4-1.1 Lilongwe City Social Overview

Items	Unit	Amount
Total population in Lilongwe City *1	people	Approx. 1,833,079
Total households in Lilongwe City *2	household(s)	Approx. 390,017
Average electricity consumption per household in Lilongwe City*3	kVA	2*5
Number of beneficiary households per unit transformer capacity (1 MVA)	household(s)	500
Number of beneficiary households by the increased transformer capacity at Kanengo Substation (from 160.5 MVA to 258 MVA: Equivalent to 97.5 MVA) *4	household(s)	48,750
Number of beneficiary households by the increased transformer capacity at Old Town Substation (from 37.5 MVA to 50 MVA: Equivalent to12.5 MVA) *4	household(s)	6,250

*1 The population of Lilongwe as of 2026 based on the assumption of Census 2008, National Statistical Office of Malawi

*2 Assuming an average of 4.7 people/household in the Central region in Malawi. INTEGRATED HOUSEHOLD PANEL SURVEY 2016, National Statistical Office of Malawi

*3 Average electricity consumption of existing customers in Lilongwe City operated by ESCOM.

*4 Assuming that all new consumers are Domestic Customers.

*5 1 MVA/2 kVA=500 household

Source: National Statistical Office of Malawi, Documents from ESCOM

(2) Urgency

Power will be developed mainly as follows:

1) Capacity to supply power demand maintained

2) Supply reliability (reducing power downtime, etc.) improved by ensuring reserve supply capacity
3) Power quality improved by improving power system structure, etc.

Especially, 1) is the most urgent as it is an underlying factor in stable power supply.

In the result of the survey, the power supply capacity of the current equipment in Kanengo Substation had a margin of 21.8 MVA (14%) for the power demand in 2019. However, it is assumed that the power demand will exceed the power supply capacity approximately 21.4 MVA[1] (by 13%) in 2026. Also, ESCOM operates transformers in Old Town Substation manufactured in 1979, which have exceeded these expected lifetime[2]. In the case of the Project not implemented, chronic power outages caused by insufficient substation capacity and aging substation equipment will lead to prevent citizens' lives and social and economic development. Therefore, the urgency of this project is extremely high.

(3) Consistency with the Upper-Level Policy

The Government of Malawi has formulated the "Integrated Resource Plan for Malawi (IRP)" a strategic roadmap for the energy sector. The electricity demand forecast was reviewed from a long-term perspective for the next 20 years (2017-2037), and high-priority power development plan, grid development plan, and minimum cost investment plan were formulated. In addition, NEP2018 clearly states that government will intensify the expansion and rehabilitation of the transmission system in line with the IRP, and it mention about some specific projects: construction of 400/132 kV transmission line of 370 km, and interconnections with Zambia, Mozambique by 2023 with initial imports totaling 80MW of power supply, installation of new grid substation 645 MVA, construction of 66 kV transmission line of 30 km and renovation of 5 existing grid substations.

The installed capacity of the substation to be improved by the project is 200 MW (150 MW at Kanengo Substation (4 units) and 50 MW at Old Town Substation (2 units)), which is equivalent to about 35% of 579 MVA of total substation installed capacity in Lilongwe city.

Thus, the Project is deemed to be essential for achieving the upper-level plan.

Table 3-4-2.1 Comparison between total capacity to be improved by the Project and substations in Lilongwe City

Items	Total capacity of 19 Substations in Lilongwe City	Total capacity of The Project	Percentage
132/66 kV Transformer	200 MVA	100 MVA	50 %
132/33 kV, 66/33 kV Transformer	148 MVA	50 MVA	34 %
66/11 kV, 33/11 kV Transformer	219 MVA	50 MVA	23 %
Total	579 MVA	200 MVA	35 %

Source: Preparatory Survey Team

[1] Kanengo Substation: 66kV system exceeds 11.1 MVA, 33kV system exceeds 6.9 MVA, 11kV system exceeds 3.4 MVA. Based on the result of power flow analysis by JICA Study Team

[2] According to the research by The Institute of Electrical Engineers of Japan (IEEJ), The Japan Electrical Manufacturers' Association (JEMA) and Ministry of Land, Infrastructure, Transport and Tourism (MLIT), expected lifetime of Power Transformer is 27.6-32.4 years

(4) Consistency with Japan's Grant Aid Policy

The contents and schedule of the Project are achievable in the scheme of a Grant Aid Project as major equipment will be sourced from Japan and the Project will be completed within the timeframe of the E/N. Therefore, the Project can be implemented with no special difficulty.

3-4-2 Effectiveness

The impacts expected from the implementation of the Project are as follows.

(1) Quantitative Impacts

Table 3-4-3.1 Quantitative Impacts

Outcome Indicator	Base Value (2019 Current Value)	Target Value (2026) (3 years after the completion of the Project)	
		Without the Project	With the Project
1. Installed capacity in Kanengo Substation *1(MVA)	83.0 *2	83.0 *2	158.0 *2
2. Installed capacity in Old Town Substation *3 (MVA)	37.5	37.5	50.0
3. Capacity utilization ratio of Kanengo Substation *4 (%)	101.7	134.1	70.4
4. Capacity utilization ratio of Old Town Substation *4 (%)	65.4	80.1	60.4

*1 Indicate the installed capacity of 132kV System Voltage in Kanengo Substation
*2 Indicate the installed capacity when using Oil Natural Air Forced(ONAF)
*3 Indicate the installed capacity of 66kV System Voltage in Old Town Substation
*4 Ratio of power demand to installed capacity. Forecasted Demand in 2026 at Kanengo Substation is 111.3 MVA (132 kV) and at Old Town Substation is 30.2 MVA (66 kV)

Source: Preparatory Survey Team

(2) Qualitative Impacts (Whole Project)

The following table shows impacts of each component of the Project.

Table 3-4-2.2 Qualitative Impacts (Whole Project)

Present Status and Problems	Project Countermeasures (Grant Aid Project)	Extent of Project Effects and Improvement
In Malawi, the demand for electric power is increasing rapidly. On the other hand, the unstable electric supply due to the insufficient of transformer capacity and aging of substation facilities, causing frequent power outages including chronic rolling blackouts, cause the following problems. 1. It cause reduction of the quality of lives of residents. 2. It cause trouble the operation of public facilities, especially medical facilities and airport facilities. 3. It slows down industrial and economic development.	Rehabilitation of Kanengo Substation and renewal of Old Town Substation	After implementation of the Project, installation capacity of substation will be increased and supply capacity be recovered to the Lilongwe City, which contribute to economic activities, public services and the lives of residents.

Source: Preparatory Survey Team

APPENDICES

1. Member List of the Survey Team

1. Member List of the Survey Team

(1) First Field Survey

Name	Assignment	Organization
Daisuke IIJIMA	Team Leader	Japan International Corporation Agency
Taisuke MORIMOTO	Deputy Team Leader	Japan International Corporation Agency
Tadaaki FUKUSHIMA	Deputy Team Leader	Japan International Corporation Agency
Makoto ABE	Chief Consultant/ Power Development Planning	Yachiyo Engineering Co., Ltd.
Hiroshi IMAMURA	Substation Facilities -1	West Japan Engineering Consultants, Inc.
Masao YAMAKAWA	Substation Facilities-2	Yachiyo Engineering Co., Ltd.
Teruaki MATSUO	Power System Analysis	West Japan Engineering Consultants, Inc.
Teruo KURUMADA	Facility Planning/ Natural Condition	Yachiyo Engineering Co., Ltd
Mari OHUCHI	Construction Planning/ Cost Estimation	Yachiyo Engineering Co., Ltd
Masataka SATO	Equipment Planning/ Cost Estimation	Yachiyo Engineering Co., Ltd.

(2) Second Field Survey

Name	Assignment	Organization
Yoshikazu WADA	Mission Leader	Japan International Corporation Agency Malawi Office
Shitau MIURA	Mission Coordinator	Japan International Corporation Agency Malawi Office
Makoto ABE	Chief Consultant/ Power Development Planning	Yachiyo Engineering Co., Ltd.
Masataka SATO	Equipment Planning/ Cost Estimation	Yachiyo Engineering Co., Ltd.

2. Survey Schedule

2. Survey Schedule

Table 1 First Field Survey Schedule

№	Date	Day	Contents of Survey				Accommodation
			JICA Member	Consultants			
				Group A (Abe, Sato)	Group B (Substation) (Imamura, Yamakawa, Matsuo)	Group C (Facilities) (Kurumada, Ohuchi)	
1	Jan.19, 2019	Sat		• Abe, Yamakawa, Sato Trip{Narita18:35→Hong Kong22:15 by SA7139} • Imamura, Matsuo Trip{Fukuoka16:35→Hong Kong19:40 by K381} • Trip{Hong Kong23:50→			Flight
2	Jan.20	Sun		→Johannesburg7:05 by SA-287}, • Trip{Johannesburg10:00→Lilongwe12:20 by SA-170}			Lilongwe
3	Jan.21	Mon		• AM: Courtesy call to JICA Malawi Office, Explanation and discussion of the schedule of the field survey and project contents [9:00-10:30] • AM: Courtesy call and explanation of the survey (ESCOM: IC/R, the schedule of the field survey, questionnaire, requested component, confirmation of the counterpart / office room / facilities on Malawi side and the methodology of the site survey, etc.) [11:00-12:00] • PM: Site survey of the existing substations (133/66 kV and 66/33 kV Substations)[13:30-17:00]			Lilongwe
4	Jan.22	Tue		• Technical discussion (MNREM and ESCOM: national development plan, power supply and demand, activities of other donors, power sector structural reform, process of tax exemption, balance of payments, electricity tariff, socioeconomic conditions, etc.)			Lilongwe
5	Jan.23	Wed		• Technical discussion (MNREM and ESCOM: above mentioned issue, continuously) • Site survey of the existing substations (133/66 kV and 66/33 kV Substations)			Lilongwe
6	Jan.24	Thu		• Site survey of the existing substations (133/66 kV and 66/33 kV Substations) • Market survey of equipment and material			Lilongwe
7	Jan.25	Fri		• Visit to the World Bank [9:00] • Visit to Malawi Millennium Development(MMD) [10:00] • Visit to the African Development Bank [11:30] • Technical discussion (ESCOM: prioritization of project components) • Site survey of the existing substations (133/66 kV and 66/33 kV Substations) • Market survey of equipment and material			Lilongwe
8	Jan.26	Sat		• Site survey (Supplementary survey) • Team discussions, arrangement of collected data			JICA : Flight Lilongwe
9	Jan.27	Sun		• Team discussions, arrangement of collected data			Lilongwe
10	Jan.28	Mon		• AM: Technical discussion (ESCOM: national development plan, power supply and demand, activities of other donors, power sector structural reform, process of tax exemption, balance of payments, electricity tariff, socioeconomic conditions, etc.) • Market survey of equipment and material • Survey of customs clearance • Survey of port and transportation route			Lilongwe

№	Date	Day	Contents of Survey				Accommodation
			JICA Member	Consultants			
				Group A (Abe, Sato)	Group B (Substation) (Imamura, Yamakawa, Matsuo)	Group C (Facilities) (Kurumada, Ohuchi)	
11	Jan.29	Tue		• Technical discussion (MOF: process of tax exemption) [9:00] • Survey of technical specification of existing equipment • Survey of power supply and demand • Market survey of equipment and material • Survey of customs clearance • Survey of port and transportation route			Lilongwe
12	Jan.30	Wed		• Survey of technical specification of existing equipment • Survey of power supply and demand			Lilongwe
13	Jan.31	Thu		• Survey of technical specification of existing equipment • Survey of power supply and demand • Market survey of equipment and material • Survey of customs clearance • Survey of port and transportation route			Lilongwe
14	Feb.1	Fri		• Survey of technical specification of existing equipment • Survey of power supply and demand • Market survey of equipment and material • Survey of customs clearance • Survey of port and transportation route • Meeting with local contractors on topographic & geological investigation			Lilongwe
15	Feb.2	Sat	• Trip	• Site survey (Supplementary survey) • Team discussions, arrangement of collected data		• Trip {Narita18:35→Hong Kong22:15 by SA7139}, • Trip [Hong Kong 23:50 →	Lilongwe
16	Feb.3	Sun	• Trip	• Team discussions, arrangement of collected data		→Johannesburg7:05 by SA-287} • Trip {Johannesburg10:00→ Lilongwe12:20 by SA-170}	Lilongwe
17	Feb.4	Mon	• AM: Site Visit [9:00-11:00] • AM: Discussion with JICA Malawi Office [11:00] • PM: Courtesy call and technical discussion (MNREM: explanation of Japan Grant aid scheme, implementation plan, requested component, prioritization of project components, obligations of Malawi side, etc.) [13:30] • PM: Courtesy call and technical discussion (ESCOM: explanation of Japan Grant aid scheme, implementation plan, requested component, prioritization of project components, obligations of Malawi side, etc.) [15:00]		• Preparation of Field Report • Preparation of draft Technical Specifications • Data collection of Supplementary material, etc.		• Site survey • Supervision of the surveyor's work	Lilongwe
18	Feb.5	Tue	• Trip JICA Member, Consultants(Abe, Sato, Yamakawa){Lilongwe 8:20→ Blantyre 9:00 by ET20} • AM: Courtesy call and Discussion of the draft M/D (CEO of ESCOM) [11:00] • PM: Courtesy call and technical discussion (ESCOM: explanation of Japan Grant aid scheme, implementation plan, requested component, prioritization of project components, obligations of Malawi side, etc.) [14:00]		• Preparation of Field Report • Preparation of draft Technical Specifications • Data collection of Supplementary material, etc.		• Site survey • Supervision of the surveyor's work	Blantyre /Lilongwe
19	Feb.6	Wed	• AM: Site Visit (Chichiri Substation, Transmission SCADA National Control Centre, Distribution Dispatch Centre) [9:00-11:00] • Data collection of Supplementary material, etc.		• Preparation of Field Report • Preparation of draft Technical Specifications • Data collection of Supplementary material, etc.		• Site survey • Market survey of facilities Materials, subcontractor, etc.	Blantyre /Lilongwe

№	Date	Day	Contents of Survey				Accommodation
			JICA Member	Consultants			
				Group A (Abe, Sato)	Group B (Substation) (Imamura, Yamakawa, Matsuo)	Group C (Facilities) (Kurumada, Ohuchi)	
20	Feb.7	Thu	• JICA: Trip{Blantyre 11:00→Lilongwe 18:00 by car} (On the Way) Site Visit Tedzani Hydro Power Plant • Data collection of Supplementary material, etc. • Consultants(Abe, Sato, Yamakawa): Trip{Blantyre 16:00→Lilongwe 16:40 by ET21}		• Preparation of Field Report • Preparation of draft Technical Specifications • Data collection of Supplementary material, etc.	• Site survey • Market survey of facilities Materials, subcontractor, etc.	Lilongwe
21	Feb.8	Fri	• PM: Report to EoJ and JICA Malawi office [14:00]		• Preparation of Field Report • Preparation of draft Technical Specifications • Data collection of Supplementary material, etc.	• Site survey • Market survey of facilities Materials, subcontractor, etc.	Lilongwe
22	Feb.9	Sat	• Trip	• Preparation of Field Report • Preparation of draft Technical Specifications • Team discussions, arrangement of collected data			Lilongwe
23	Feb.10	Sun	• Trip	• Preparation of Field Report • Preparation of draft Technical Specifications • Team discussions, arrangement of collected data			Lilongwe
24	Feb.11	Mon		• Technical discussion (MERA: Regulation, Malawi Standard) [8:00] • Preparation of Field Report • Preparation of draft Technical Specifications • Data collection of Supplementary material, etc.			Lilongwe
25	Feb.12	Tue		• Explanation and discussion of Field Report to ESCOM • Preparation of Field Report • Preparation of draft Technical Specifications • Data collection of Supplementary material, etc.			Lilongwe
26	Feb.13	Wed		• Explanation and discussion of Field Report to ESCOM • Signing of the Field Report with ESCOM [15:00]			Lilongwe
27	Feb.14	Thu		• Report to EoJ and JICA Malawi office [14:00]			Lilongwe
28	Feb.15	Fri		• Trip{Lilongwe13:05→Johannesburg15:30 by SA-171}, • Trip{Johannesburg17:55→			Flight
29	Feb.16	Sat		→Hong Kong12:45 by SA-286} • Abe, Sato, Yamakawa, Kurumada, Ohuchi Trip{Hong Kong14:25→Haneda19:15 by SA-7134}			Imamura, Matsuo: Hong Kong
30	Feb.17	Sun		• Imamura, Matsuo Trip{Hong Kong11:05→Fukuoka 15:25 by KA-380}			-

【Remarks】(Alphabetical order)

EoJ : Embassy of Japan
ESCOM : Electricity Supply Corporation of Malawi
JICA : Japan International Cooperation Agency
MNREM : Ministry of the Ministry of Natural Resources, Energy and Mining
MFEPD : Ministry of Finance, Economic Planning and Development
MERA : Malawi Energy Regulatory Authority

Table 2 Second Field Survey Schedule

№	Date	Day	Contents of Survey		Accommodation
			JICA Member	Consultants (Abe, Sato)	
1	Jan. 19, 2020	Sun		• Trip{Haneda16:40→Singapore 23:10 by SQ-633}	Flight
2	Jan. 20	Mon	Mr. Kito, Mr. Wada, Mr. Miura	• Trip{Singapore 1:30→Johannesburg6:10 by SQ-478} • Trip{Johannesburg10:00→Lilongwe12:25 by SA-170} • 15:30-17:00 Courtesy call and explanation of the Project Component, etc. to JICA Malawi Office	Lilongwe
3	Jan. 21	Tue	Mr. Miura, Mr. Kapa	• 10:10-11:00 Courtesy call and explanation of current situation of the preparatory survey to MFEPD • 11:10-12:00 Courtesy call and explanation of current situation of the preparatory survey to MNREM • 14:10-17:00 Courtesy call and explanation of current situation of the preparatory survey to ESCOM	Lilongwe
4	Jan. 22	Wed	Mr. Miura, Mr. Kapa	• 8:00-12:00 Site survey for Kanengo Substation and Old Town Substation • 14:00-17:00 Discussion on the Project Component, etc. with ESCOM	Lilongwe
5	Jan. 23	Thu	Mr. Miura	• Trip{Lilongwe 8:10→Blantyre 8:50 by ET20} • 10:00-12:00 Courtesy call and explanation of current situation of the preparatory survey to ESCOM • 14:00-17:00 Discussion on the Project Component, etc. with ESCOM	Blantyre
6	Jan. 24	Fri	Mr. Miura	• Trip{Blantyre 9:10→Lilongwe 9:50 by ET43} • 14:00-15:00 Report to JICA Malawi office • 15:30-16:00 EOJ	Lilongwe
7	Jan. 25	Sat	-	• Sato: Trip{Lilongwe 13:10→Johannesburg 15:35 by SA-171} • Abe: Trip{Lilongwe 16:30→Dar es Salaam 20:40 by ET-42}	Johannesburg
8	Jan. 26	Sun	-	• Sato: Trip{Johannesburg 13:45→	Flight
9	Jan. 27	Mon	-	→Singapore 6:10 by SQ-479} • Sato: Trip{Singapore 8:05→Haneda 15:35 by SQ-632}	-

【Remarks】(Alphabetical order)

EoJ : Embassy of Japan
JICA : Japan International Cooperation Agency
ESCOM : Electricity Supply Corporation of Malawi Limited
MNREM : Ministry of Natural Resources, Energy and Mining
MFEPD : Ministry of Finance, Economic Planning and Development

3. List of Parties Concerned in the Recipient Country

3. List of Parties Concerned in the Recipient Country

Ministry of Finance, Economic Planning and Development (MFEPD)[1]

Mr. Twabi Ali	Acting Director of Debt and Aid
Mr. Davie Wirima	Deputy Director of Debt and Aid
Mr. Kenneth C. Matupa	Director of Revenue
Mr. Grecium Nandio	Deputy Director of Revenue
Mr. Fred Chanza	Principal Economist

Ministry of Natural Resources, Energy and Mining (MNREM)[2]

Mrs. Chimwemwe Gloria Banda	Chief Director of Energy
Mr. Khumbolawo Lungu	Assistant Director
Mr. Patric Simugue	Acting Deputy Director
Mr. Thokozani Malunga	Principal Energy Officer
Mr. Golden Nyasulu	Principal Energy Officer
Mr. Themba Nyasulu	Energy Officer
Mr. Christopher Kachinjika	Energy Officer

Electricity Supply Corporation of Malawi (ESCOM)

Mr. Allexon Chiwaya	Chief Executive Officer
Mr.Alfred O. Kaponda	Director of Distribution and Customer Services
Mr. Patrick Kadewa	Director of System & Market Operator
Mr. Daphter Z. Namandawa	Director of Procurement and Disposal of Asset
Mr. Charles Kagona	Senior Engineering Services Manager
Mr. Jack Thabwa	Senior Procurement Manager
Mr. Evilasio Mwale	Senior Planning Engineer
Mr. Youngie Chewele	Regional Manager Central
Mr. Tobias Nthani	Senior Protection Engineer
Mr. Gracious Banda	Senior Engineer Operations
Mr. Bernard Nkhulawe	Senior Engineer Transformer, Switchgear and Cables
Mr. MacDowell Kumatso	Ag Construction Manager
Mr. Absalom Chiwaula	Senior Procurement Officer
Mr. Lonnt Kumwenda	Senior Projects Engineer
Mr. Muhena Sam	Senior Projects Engineer
Mr. James Chanda	Senior Transmission Manager
Mr. Christopher Mapata	Senior Marketing Operators Engineer
Mr. Gilbert Chodzaza	Regional Manager North

[1] Ministry of Finance : MOF, as of November 2020
[2] Ministry of Energy : MOE, as of November 2020

Mr. MacDonald Nazombe	Senior Distribution Planning Engineer
Mr. L. Chanza	Distribution Planning Engineer
Mr. Nicholas Bisika	Substations Engineer

Malawi Energy Regulatory Authority (MERA)

Mr. Shaibu Mludi	Senior Electricity Specialist

World Bank Group (WB)

Mr. Kagaba Paul Mukiibi	Energy Specialist, Malawi Country Office

Malawi Millennium Development (MMD)

Mr. Mc Donald C. Banda	Project Control Logistics and Operations Specialist

African Development Bank (AfDB)

Ms. Fasika, Eyerusalem	Assistant Director

Embassy of Japan in Malawi (EOJ)

Mr. Satoshi Iwakiri	Ambassador Extraordinary and Plenipotentiary
Ms. Kae Yanagisawa	Ambassador Extraordinary and Plenipotentiary (Former)
Mr. Hirotsugu Ikeda	Deputy Head of Mission / Counsellor
Ms. Ayumi Hirano	Researcher in Economy and Development Cooperation Section

JICA Malawi Office

Mr. Yoshikazu Wada	Resident Representative
Mr. Koichi Kito	Resident Representative (Former)
Mr. Naoto Sakonjyu	Senior Representative
Mr. Shitau Miura	Project Formulation Advisor (Economic Development)
Ms. Reiko Matsui	Project Formulation Advisor (Economic Development) (Former)
Mr. Kapalamula Godfrey	Chief Programme Officer

4. Minutes of Discussions

Minutes of Discussions
on the Preparatory Survey for the Project for
Improvement of Substations in Lilongwe City

In response to the request from the Government of Republic of Malawi (hereinafter referred to as "Malawi"), Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") of the Project for Improvement of Substations in Lilongwe City (hereinafter referred to as "the Project") to Malawi. The Team held a series of discussions with the officials of the Government of Malawi and conducted a field survey. In the course of the discussions, both sides have confirmed the main items described in the attached sheets.

Lilongwe, 8th, February, 2019

Mr. Daisuke IIJIMA
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

Mrs. Chimwemwe Gloria Banda
Chief Director of Energy
Ministry of Natural Resources, Energy and Mining
Republic of Malawi

Witness

Ms. Betty Ngoma
Director of Debt and Aid
Ministry of Finance, Economic Planning and Development

Dr. Allexon Chiwaya
Chief Executive Officer
Electricity Supply Corporation of Malawi Limited

ATTACHMENT

1. Objective of the Project
The objective of the Project is to achieve reliable and stable supply of electricity by rehabilitation and reinforcement of the substations in Lilongwe, thereby contributing to sustainable economic and social development in Lilongwe.

2. Title of the Preparatory Survey
Both sides confirmed the title of the Preparatory Survey as "the Preparatory Survey for the Project for Improvement of Substations in Lilongwe City".

3. Project sites
Both sides confirmed that the sites of the Project are in Lilongwe, which is shown in Annex 1.

4. Responsible authority for the Project
Both sides confirmed the authorities responsible for the Project are as follows:

4-1. ESCOM will be the executing agency for the Project (hereinafter referred to as "the Executing Agency"). The Executing Agency shall coordinate with all the relevant authorities to ensure smooth implementation of the Project and ensure that the undertakings for the Project shall be managed by relevant authorities properly and on time. The organization charts are shown in Annex 2.

4-2. The line ministry of the Executing Agency is the Ministry of Natural Resources, Energy and Mining, Department of Energy Affairs (hereinafter referred to as "MNREM"). MNREM shall be responsible for supervising the Executing Agency on behalf of the Government of Malawi and facilitating the tax exemption process conducted by the Executing Agency.

5. Items requested by the Government of Malawi

5-1. As a result of discussions, both sides confirmed that the main items requested by the Government of Malawi are as follows:

(1)Kanengo Substation

(A) Procurement and Installation
132kV Transformer Bay facilities
66kV Transformer Bay facilities

33kV Transformer Bay facilities
11kV Outgoing Feeder facilities and Switchgears for Transformers
Control and Protection panels
Power Transformers
Station Transformer
AC and D/C distribution facilities
Substation grounding facility
Control Building
(B) Procurement
Maintenance Tools and Testing Instruments for the Equipment to be installed
Spare parts for the Equipment to be installed
(C) Training
Basic training of operation and maintenance on installed equipment

(2)Old Town Substation
(A) Procurement and Installation
66kV Feeder Bay facilities
66kV Transformer Bay facilities
33kV Outgoing Feeder facilities and Switchgears for Transformers
11kV Outgoing Feeder facilities and Switchgears for Transformers
Control and Protection panels
Power Transformers
Station Transformer
AC and D/C distribution facilities
Substation grounding facility
Control Building
(B) Procurement
Maintenance Tools and Testing Instruments for the Equipment to be installed
Spare parts for the Equipment to be installed
(C) Training
Basic training of operation and maintenance on installed equipment

5-2. JICA will assess the feasibility of the above requested items through the survey and will report the findings to the Government of Japan. The final scope of the Project will be decided by the Government of Japan.

6. Procedures and Basic Principles of Japanese Grant

6-1. The Malawi side agreed that the procedures and basic principles of Japanese Grant as described in Annex 3 shall be applied to the Project.
As for the monitoring of the implementation of the Project, JICA requires Malawi side to submit the Project Monitoring Report that the form is attached as Annex 4.

6-2. The Malawi side agreed to take the necessary measures, as described in Annex 5, for smooth implementation of the Project. The contents of the Annex 5 will be elaborated and refined during the Preparatory Survey and be agreed in the mission dispatched for explanation of the Draft Preparatory Survey Report.
The contents of Annex 5 will be updated as the Preparatory Survey progresses, and eventually, will be used as an attachment to the Grant Agreement.

7. Schedule of the Survey

7-1. The Team will proceed with further survey in Malawi until 17th February.

7-2. JICA will prepare a draft Preparatory Survey Report in English and dispatch a mission to Malawi in order to explain its contents around early August 2019.

7-3. If the contents of the draft Preparatory Survey Report is accepted and the undertakings for the Project are fully agreed by the Malawi side, JICA will finalize the Preparatory Survey Report and send it to Malawi around November 2019.

7-4. The above schedule is tentative and subject to change.

8. Environmental and Social Considerations

8-1. The Malawi side confirmed to give due environmental and social considerations during implementation, and after completion of the Project, in accordance with the JICA Guidelines for Environmental and Social Considerations (April, 2010).

8-2. The Project is categorized as "C" from the following considerations:
Not located in a sensitive area, nor has it sensitive characteristics, nor falls it into sensitive sectors under the Guidelines, and its potential adverse impacts on the environment are not likely to be significant.

8-3. The Malawi side agreed to confirm the necessity of the environmental assessment (including stakeholder meetings, Environmental Impact Assessment(EIA) /Initial Environmental Examination (IEE) and information disclosure, etc.) for the Project under the laws and regulations of the Malawi side. The Malawi side also agreed that confirmation and required procedures will be completed by July, 2019.

9. Other Relevant Issues

9.1 Status of the Survey
The Team explained that the purpose of the Survey is to collect necessary

information for evaluating the relevance, appropriateness and urgency of the Project. The team will analyze power system in Malawi based on the collected information and identify the issues to be solved for implementation of the Project. The Malawi side has agreed to share all necessary information and data with the Team.

9.2 Counterpart Personnel

The Team requested for the Malawi side that necessary number of counterpart personnel shall be assigned to the Team and necessary arrangements with related organizations shall be made during the Survey and implementation stage in Malawi. The Malawi side has agreed to it.

9.3 Office Space

The Team requested the Malawi side that necessary arrangement of office space for the Team during the Survey in Malawi. The Malawi side agreed to arrange it.

9.4 Exemption of customs duties, internal taxes and other fiscal levies

Both sides confirmed that customs duties, internal taxes and other fiscal levies which may be imposed in Malawi with respect to the purchase of the products and/or the services be exempted. Both sides also confirmed that the tax exemption procedure in Malawi as Annex 6 as recognition at the present moment.

The contents of Annex 6 will be updated as the Preparatory Survey progresses.

9.5 Tentative Schedule of the Project

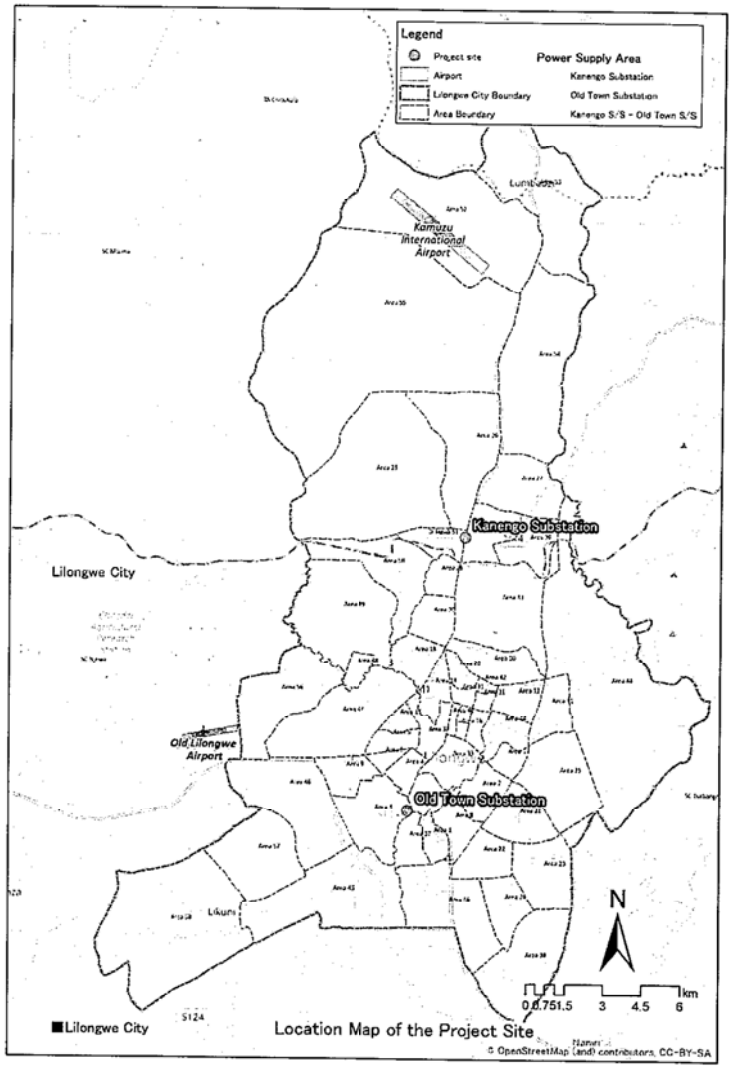
The Team explained to the Malawi side that the tentative schedule of the Project is as attached as Annex 7.

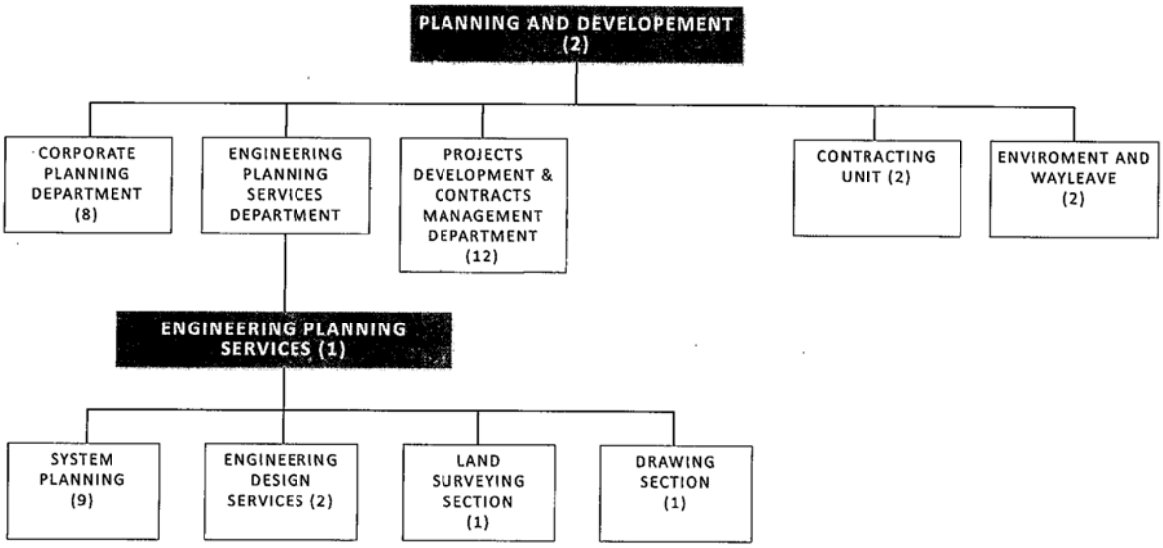
9.6 Budgetary measures of Malawi side

The team explained the estimated cost covered by Malawi side will be notified in the 2nd Preparatory Survey which is scheduled around early August 2019. Malawi side confirmed they will secure the necessary budget accordingly.

Annex 1 Project Sites
Annex 2 Organization Chart
Annex 3 Japanese Grant
Annex 4 Project Monitoring Report (template)
Annex 5 Major Undertakings to be taken by the Government of Malawi
Annex 6 Tax Exemption Information Sheet
Annex 7 Tentative Schedule of the Project

Annex 1 Project Sites

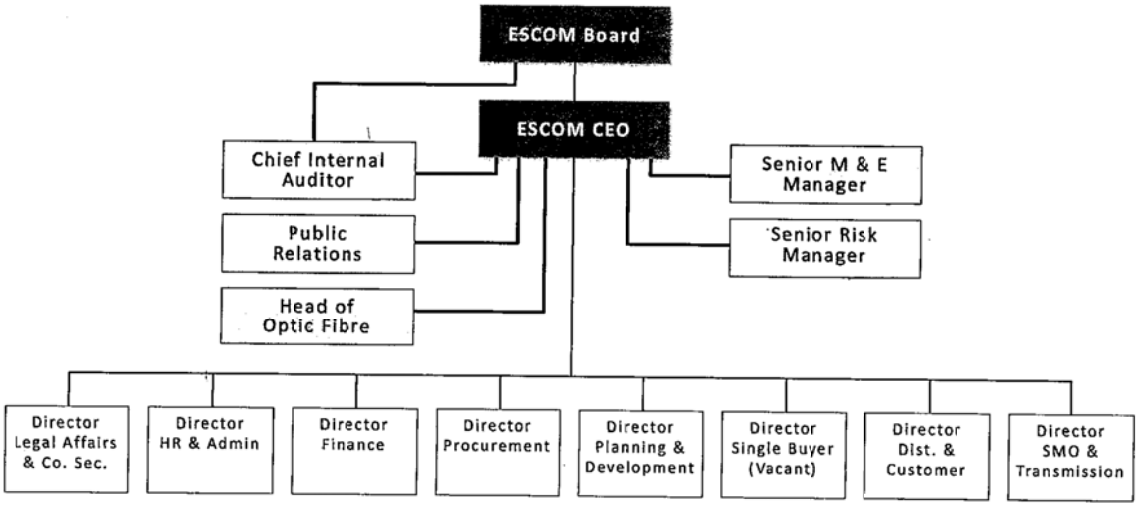




Note: Bracket ( ) means the number of personnel

ESCOM Organization Chart (PLANNING AND DEVELOPMENT DEPARTMENT)

Annex 2 Organization Chart of ESCOM



ESCOM Organization Chart (HIGH LEVEL)

Annex 3 Japanese Grant

JAPANESE GRANT

The Japanese Grant is non-reimbursable fund provided to a recipient country (hereinafter referred to as "the Recipient") to purchase the products and/or services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. Followings are the basic features of the project grants operated by JICA (hereinafter referred to as "Project Grants").

1. Procedures of Project Grants

Project Grants are conducted through following procedures (See "PROCEDURES OF JAPANESE GRANT" for details):

(1) Preparation

- The Preparatory Survey (hereinafter referred to as "the Survey") conducted by JICA

(2) Appraisal

-Appraisal by the government of Japan (hereinafter referred to as "GOJ") and JICA, and Approval by the Japanese Cabinet

(3) Implementation

Exchange of Notes

-The Notes exchanged between the GOJ and the government of the Recipient

Grant Agreement (hereinafter referred to as "the G/A")

-Agreement concluded between JICA and the Recipient

Banking Arrangement (hereinafter referred to as "the B/A")

-Opening of bank account by the Recipient in a bank in Japan (hereinafter referred to as "the Bank") to receive the grant

Construction works/procurement

-Implementation of the project (hereinafter referred to as "the Project") on the basis of the G/A

(4) Ex-post Monitoring and Evaluation

-Monitoring and evaluation at post-implementation stage

2. Preparatory Survey

(1) Contents of the Survey

The aim of the Survey is to provide basic documents necessary for the appraisal of the the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the Recipient necessary for the implementation of the Project.
- Evaluation of the feasibility of the Project to be implemented under the Japanese Grant from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.
- Confirmation of Environmental and Social Considerations

The contents of the original request by the Recipient are not necessarily approved in their initial form. The Outline Design of the Project is confirmed based on the guidelines of the Japanese Grant.

JICA requests the Recipient to take measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the executing agency of the Project. Therefore, the contents of the Project are confirmed by all relevant organizations of the Recipient based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA contracts with (a) consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the feasibility of the Project.

3. Basic Principles of Project Grants

(1) Implementation Stage

1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes (hereinafter referred to as "the E/N") will

be singed between the GOJ and the Government of the Recipient to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Recipient to define the necessary articles, in accordance with the E/N, to implement the Project, such as conditions of disbursement, responsibilities of the Recipient, and procurement conditions. The terms and conditions generally applicable to the Japanese Grant are stipulated in the "General Terms and Conditions for Japanese Grant (January 2016)."

2) Banking Arrangements (B/A) (See "Financial Flow of Japanese Grant (A/P Type)" for details)

a) The Recipient shall open an account or shall cause its designated authority to open an account under the name of the Recipient in the Bank, in principle. JICA will disburse the Japanese Grant in Japanese yen for the Recipient to cover the obligations incurred by the Recipient under the verified contracts.

b) The Japanese Grant will be disbursed when payment requests are submitted by the Bank to JICA under an Authorization to Pay (A/P) issued by the Recipient.

3) Procurement Procedure

The products and/or services necessary for the implementation of the Project shall be procured in accordance with JICA's procurement guidelines as stipulated in the G/A.

4) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the Recipient to continue to work on the Project's implementation after the E/N and G/A.

5) Eligible source country

In using the Japanese Grant disbursed by JICA for the purchase of products and/or services, the eligible source countries of such products and/or services shall be Japan and/or the Recipient. The Japanese Grant may be used for the purchase of the products and/or services of a third country as eligible, if necessary, taking into account the quality, competitiveness and economic rationality of products and/or services necessary for achieving the objective of the Project. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm, which enter into contracts with the Recipient, are limited to "Japanese nationals", in principle.

6) Contracts and Concurrence by JICA

The Recipient will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be concurred by JICA in order to be verified as eligible for using the Japanese Grant.

7) Monitoring

The Recipient is required to take their initiative to carefully monitor the progress of the Project in order to ensure its smooth implementation as part of their responsibility in the G/A, and to regularly report to JICA about its status by using the Project Monitoring Report (PMR).

8) Safety Measures

The Recipient must ensure that the safety is highly observed during the implementation of the Project.

9) Construction Quality Control Meeting

Construction Quality Control Meeting (hereinafter referred to as the "Meeting") will be held for quality assurance and smooth implementation of the Works at each stage of the Works. The member of the Meeting will be composed by the Recipient (or executing agency), the Consultant, the Contractor and JICA. The functions of the Meeting are as followings:

a) Sharing information on the objective, concept and conditions of design from the Contractor, before start of construction.

b) Discussing the issues affecting the Works such as modification of the design, test, inspection, safety control and the Client's obligation, during of construction.

(2) Ex-post Monitoring and Evaluation Stage

1) After the project completion, JICA will continue to keep in close contact with the Recipient in order to monitor that the outputs of the Project is used and maintained properly to attain its expected outcomes.

2) In principle, JICA will conduct ex-post evaluation of the Project after three years from the completion. It is required for the Recipient to furnish any necessary information as JICA may reasonably request.

(3) Others

1) Environmental and Social Considerations

The Recipient shall carefully consider environmental and social impacts by the Project and must comply with the environmental regulations of the Recipient and JICA Guidelines for Environmental and Social Considerations (April, 2010).

2) Major undertakings to be taken by the Government of the Recipient

For the smooth and proper implementation of the Project, the Recipient is required to undertake necessary measures

including land acquisition, and bear an advising commission of the A/P and payment commissions paid to the Bank as agreed with the GOJ and/or JICA. The Government of the Recipient shall ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the Recipient with respect to the purchase of the Products and/or the Services be exempted or be borne by its designated authority without using the Grant and its accrued interest, since the grant fund comes from the Japanese taxpayers.

3) Proper Use

The Recipient is required to maintain and use properly and effectively the products and/or services under the Project (including the facilities constructed and the equipment purchased), to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Japanese Grant.

4) Export and Re-export

The products purchased under the Japanese Grant should not be exported or re-exported from the Recipient.

Attachment1

PROCEDURES OF JAPANESE GRANT

Stage	Procedures	Remarks	Recipient Government	Japanese Government	JICA	Consultants	Contractors	Agent Bank
Official Request	Request for grants through diplomatic channel	Request shall be submitted before appraisal stage.	x	x				
1. Preparation	(1) Preparatory Survey Preparation of outline design and cost estimate		x		x	x		
2. Appraisal	(2)Preparatory Survey Explanation of draft outline design, including cost estimate, undertakings, etc.		x		x	x		
	(3)Agreement on conditions for implementation	Conditions will be explained with the draft notes (E/N) and Grant Agreement (G/A) which will be signed before approval by Japanese government.	x	x (E/N)	x (G/A)			
	(4) Approval by the Japanese cabinet			x				
3. Implementation	(5) Exchange of Notes (E/N)		x	x				
	(6) Signing of Grant Agreement (G/A)		x		x			
	(7) Banking Arrangement (B/A)	Need to be informed to JICA	x					x
	(8) Contracting with consultant and issuance of Authorization to Pay (A/P)	Concurrence by JICA is required	x			x		x
	(9) Detail design (D/D)		x			x		
	(10) Preparation of bidding documents	Concurrence by JICA is required	x			x		
	(11) Bidding	Concurrence by JICA is required	x			x	x	
	(12) Contracting with contractor/supplier and issuance of A/P	Concurrence by JICA is required	x				x	x
	(13) Construction works/procurement	Concurrence by JICA is required for major modification of design and amendment of contracts.	x			x	x	
	(14) Completion certificate		x			x	x	
4. Ex-post monitoring & evaluation	(15) Ex-post monitoring	To be implemented generally after 1, 3, 10 years of completion, subject to change	x		x			
	(16) Ex-post evaluation	To be implemented basically after 3 years of completion	x		x			

notes:

1. Project Monitoring Report and Report for Project Completion shall be submitted to JICA as agreed in the G/A.

2. Concurrence by JICA is required for allocation of grant for remaining amount and/or contingencies as agreed in the G/A.

Annex 4 Project Monitoring Report (templete)

G/A NO. XXXXXXX
PMR prepared on DD/MM/YY

Project Monitoring Report
on
Project Name
Grant Agreement No. XXXXXXX
20XX, Month

Organizational Information

Signer of the G/A (Recipient)	Person in Charge (Designation)	
	Contacts	Address:
		Phone/FAX:
		Email:
Executing Agency	Person in Charge (Designation)	
	Contacts	Address:
		Phone/FAX:
		Email:
Line Ministry	Person in Charge (Designation)	
	Contacts	Address:
		Phone/FAX:
		Email:

General Information:

Project Title	
E/N	Signed date: Duration:
G/A	Signed date: Duration:
Source of Finance	Government of Japan: Not exceeding JPY _____ mil. Government of (_____): _____

1

Attachment 2

Financial Flow of Japanese Grant (A/P Type)

1: Project Description

1-1 Project Objective

1-2 Project Rationale

- Higher-level objectives to which the project contributes (national/regional/sectoral policies and strategies)
- Situation of the target groups to which the project addresses

1-3 Indicators for measurement of "Effectiveness"

Quantitative indicators to measure the attainment of project objectives		
Indicators	Original (Yr)	Target (Yr)
Qualitative indicators to measure the attainment of project objectives		

A4-9

2: Details of the Project

2-1 Location

Components	Original (proposed in the outline design)	Actual
1.		

2-2 Scope of the work

Components	Original* (proposed in the outline design)	Actual*
1.		

Reasons for modification of scope (if any).

(PMR)

2-3 Implementation Schedule

Items	Original (proposed in the outline design)	Original (at the time of signing the Grant Agreement)	Actual

Reasons for any changes of the schedule, and their effects on the project (if any)

2-4 Obligations by the Recipient

2-4-1 Progress of Specific Obligations

See Attachment 2.

2-4-2 Activities

See Attachment 3.

2-4-3 Report on RD

See Attachment 11.

2-5 Project Cost

2-5-1 Cost borne by the Grant(Confidential until the Bidding)

Components			Cost (Million Yen)	
	Original (proposed in the outline design)	Actual (in case of any modification)	Original[1),2)] (proposed in the outline design)	Actual
	1.			
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = Yen

2-5-2 Cost borne by the Recipient

Components			Cost (1,000 Taka)	
	Original (proposed in the outline design)	Actual (in case of any modification)	Original[1),2)] (proposed in the outline design)	Actual
	1.			

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar =

Reasons for the remarkable gaps between the original and actual cost, and the countermeasures (if any)

(PMR)

2-6 Executing Agency

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

Original *(at the time of outline design)* name: role: financial situation: institutional and organizational arrangement (organogram): human resources (number and ability of staff):
Actual *(PMR)*

A4-10

2-7 Environmental and Social Impacts

- The results of environmental monitoring based on Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- The results of social monitoring based on in Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- Disclosed information related to results of environmental and social monitoring to local stakeholders (whenever applicable).

3: Operation and Maintenance (O&M)

3-1 Physical Arrangement

- Plan for O&M (number and skills of the staff in the responsible division or section, availability of manuals and guidelines, availability of spareparts, etc.)

Original *(at the time of outline design)*
Actual *(PMR)*

3-2 Budgetary Arrangement

- Required O&M cost and actual budget allocation for O&M

Original *(at the time of outline design)*

Actual *(PMR)*

4: Potential Risks and Mitigation Measures

- Potential risks which may affect the project implementation, attainment of objectives, sustainability
- Mitigation measures corresponding to the potential risks

Assessment of Potential Risks *(at the time of outline design)*

Potential Risks	Assessment
1. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
2. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
3. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:

	Contingency Plan (if applicable):
Actual Situation and Countermeasures	
(PMR)	

5: Evaluation and Monitoring Plan (after the work completion)

5-1 Overall evaluation

Please describe your overall evaluation on the project.

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

5-3 Monitoring Plan of the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

Attachment

1. Project Location Map
2. Specific obligations of the Recipient which will not be funded with the Grant
3. Monthly Report submitted by the Consultant

Appendix - Photocopy of Contractor's Progress Report (if any)
- Consultant Member List
- Contractor's Main Staff List

4. Check list for the Contract (including Record of Amendment of the Contract/Agreement and Schedule of Payment)
5. Environmental Monitoring Form / Social Monitoring Form
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries) (PMR (final)only)
8. Pictures (by JPEG style by CD-R) (PMR (final)only)
9. Equipment List (PMR (final)only)
10. Drawing (PMR (final)only)
11. Report on RD (After project)

Attachment 7

Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)
(Actual Expenditure by Construction and Equipment each)

		Domestic Procurement (Recipient Country) A	Foreign Procurement (Japan) B	Foreign Procurement (Third Countries) C	Total D
Construction Cost		(A/D%)	(B/D%)	(C/D%)	
	Direct Construction Cost	(A/D%)	(B/D%)	(C/D%)	
	others	(A/D%)	(B/D%)	(C/D%)	
Equipment Cost		(A/D%)	(B/D%)	(C/D%)	
Design and Supervision Cost		(A/D%)	(B/D%)	(C/D%)	
Total		(A/D%)	(B/D%)	(C/D%)	

Attachment 6

Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

	Items of Specified Materials	Initial Volume A	Initial Unit Price (¥) B	Initial total Price C=A×B	1% of Contract Price D	Condition of payment	
						Price (Decreased) E=C−D	Price (Increased) F=C+D
1	Item 1	●●t	●	●	●	●	●
2	Item 2	●●t	●	●	●		
3	Item 3						
4	Item 4						
5	Item 5						

2. Monitoring of the Unit Price of Specified Materials
(1) Method of Monitoring : ●●

(2) Result of the Monitoring Survey on Unit Price for each specified materials

	Items of Specified Materials	1st ●month, 2015	2nd ●month, 2015	3rd ●month, 2015	4th	5th	6th
1	Item 1						
2	Item 2						
3	Item 3						
4	Item 4						
5	Item 5						

(3) Summary of Discussion with Contractor (if necessary)

Annex 5 Major Undertakings to be taken by the Government of Malawi

1. Specific obligations of the Government of Malawi which will not be funded with the Grant

(1) Before the Tender

NO	Items	Deadline	In charge	Estimated Cost*	Ref.
1	To open bank account (B/A)	within 1 month after the signing of the G/A	MNREM/ MFEPD		
2	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the consultant	within 1 month after the signing of the contract(s)	MNREM/ MFEPD		
3	To secure necessary budget for the removal and demolition of existing equipment and facilities.	Before the signing of G/A	MNREM/ ESCOM		
5	To secure and clear the following lands 1) project sites 2) temporary storage yard for the Equipment and materials	before notice of the bidding document	ESCOM		
6	To obtain the planning, zoning, building permit	before notice of the bidding document	ESCOM		
7	To clear, level and reclaim the following sites 1) leveling and reclaiming the sites	before notice of the bidding document	ESCOM		
8	To submit Project Monitoring Report (with the result of Detail Design)	before preparation of bidding documents	ESCOM		

(B/A: Banking Arrangement, A/P: Authorization to pay,

MNREM: Ministry of Natural Resources, Energy and Mining, MFEPD: Ministry of Finance, Economic Planning and Development,

ESCOM: Electricity Supply Corporation of Malawi Limited)

(2) During the Project Implementation

NO	Items	Deadline	In charge	Estimated Cost*	Ref.
1	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the Supplier(s)	within 1 month after the signing of the contract(s)	MNREM/ MFEPD		
2	To bear the following commissions to a bank in Japan for the banking services based upon the B/A		MNREM/ MFEPD		
	1) Advising commission of A/P	within 1 month after the signing of the contract(s)			
	2) Payment commission for A/P	every payment			
3	To ensure prompt customs clearance and to assist the Supplier(s) with internal transportation in the country of the Recipient	during the Project	MNREM/ MFEPD		
4	To accord Japanese nationals and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work	during the Project	MNREM/ ESCOM		
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the products and/or the services be exempted	during the Project	MNREM/ MFEPD		
6	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project	during the Project	MNREM/ ESCOM		
7	1) To submit Project Monitoring Report after each work under the contract(s) such as shipping, hand over, installation and operational training	within one month after completion of each work	ESCOM		
	2) To submit Project Monitoring Report (final)	within one month after signing of Certificate of Completion for the works under the contract(s)	ESCOM		
8	To submit a report concerning completion of the Project	within six months after completion of the Project	ESCOM		
9	To take necessary measure for safety construction - traffic control - rope off - power outage	during the construction	ESCOM		

(3) After the Project

NO	Items	Deadline	In charge	Estimated Cost*	Ref.
1	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid 1) Allocation of maintenance cost 2) Operation and maintenance structure 3) Routine check/Periodic inspection	After completion of the construction	MNREM/ ESCOM		

* The Estimated Cost will be discussed in the next survey scheduled in August 2019.

Sheet 2 Tax with respect to personal income (Personal Income Tax)

[Points of Attention]
[Reference]

Items	Exemption	How to exempt	Applicable Law	rate(%)	How to calculation	Necessary Information	Previous Results, Lessons and Learned, etc
						Organization in charge : Procedure : Duration :	
						Organization in charge : Procedure : Duration :	

Annex 6 Tax Exemption Information Sheet

Sheet 1 Tax with respect to corporate income (Corporate Tax)

[Points of Attention]
[Reference]

Items	Exemption	How to exempt	Applicable Law	rate(%)	How to calculation	Necessary Information	Previous Results, Lessons and Learned, etc
						Organization in charge : Procedure : Duration :	
						Organization in charge : Procedure : Duration :	

(Sheet4) Duties etc.

[Points of Attention]
[Reference]

Items	Exemption	How to exempt	Applicable Law	rate(%)	How to calculation	Necessary Information	Previous Results, Lessons and Learned, etc
						Organization in charge : Procedure : Duration :	
						Organization in charge : Procedure : Duration :	

(Sheet3) indirect tax etc (such as VAT, Commercial Tax)

[Points of Attention]
[Reference]

Items	Exemption	How to exempt	Applicable Law	rate(%)	How to calculation	Necessary Information	Previous Results, Lessons and Learned, etc
						Organization in charge : Procedure : Duration :	
						Organization in charge : Procedure : Duration :	

Annex 7 Tentative Schedule of the Project

Steps \ Year	2019												2020												2021			2022		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	···	12	1	···	12
1st Preperatory Survey (Present Stage)	△	△																												
Examination (Developing outline design, Estimation, Undertakings etc.)																														
2nd Preperatory Survey (Explanation of Draft Preparatory Survey Report)								△																						
Cabinet meeting/approval											△																			
E/N, G/A													△																	
Construction supervision contract														△																
Detailed design																														
Tender/contract																														
Construction schedule (Procurement, Installation, Test and Inspection)																						2 years								

Legend: ☐: Work in Malawi ☐: Work in Japan

(Sheet 5) Other taxes and levies

[Points of Attention]
[Reference]

Items	Exemption	How to exempt	Applicable Law	rate(%)	How to calculation	Necessary Information	Previous Results, Lessons and Learned, etc
						Organization in charge : Procedure : Duration :	
						Organization in charge : Procedure : Duration :	

Minutes of Discussions
on the Preparatory Survey for the Project for
Improvement of Substations in Lilongwe City
(Explanation on Draft Preparatory Survey Report)

With reference to the minutes of discussions signed between the Ministry of Energy(hereinafter referred to as "MOE") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") on 8th February 2019 and in response to the request from the Government of Republic of Malawi (hereinafter referred to as " Malawi ") dated 30th August 2016, JICA dispatched the Preparatory Survey Team (hereinafter referred to as "the Team") for the explanation of Draft Preparatory Survey Report (hereinafter referred to as "the Draft Report") for the Project for Improvement of Substations in Lilongwe City (hereinafter referred to as "the Project").

As a result of the discussions, both sides agreed on the main items described in the attached sheets.

Lilongwe, 8th, October, 2020

Mr. Daisuke IIJIMA
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

Mr. Patrick MATANDA
Principal Secretary
Ministry of Energy
Republic of Malawi

Witness

Mr. Twabi Ali
Acting Director of Debt and Aid
Ministry of Finance

Dr. Allexon Chiwaya
Chief Executive Officer
Electricity Supply Corporation of Malawi Limited

ATTACHEMENT

1. Objective of the Project
The objective of the Project is to achieve reliable and stable supply of electricity by rehabilitation and reinforcement of the substations in Lilongwe, thereby contributing to sustainable economic and social development in Lilongwe.

2. Title of the Preparatory Survey
Both sides confirmed the title of the Preparatory Survey as "the Preparatory Survey for the Project for Improvement of Substations in Lilongwe City".

3. Project site
Both sides confirmed that the sites of the Project are in Lilongwe, which is shown in Annex 1.

4. Responsible authority for the Project
Both sides confirmed the authorities responsible for the Project are as follows:

4-1. ESCOM will be the executing agency for the Project (hereinafter referred to as "the Executing Agency"). The Executing Agency shall coordinate with all the relevant authorities to ensure smooth implementation of the Project and ensure that the undertakings for the Project shall be taken care by relevant authorities properly and on time. The organization charts are shown in Annex 2.

4-2. The line ministry of the Executing Agency is the MOE. MOE shall be responsible for supervising the Executing Agency on behalf of the Government of Malawi and facilitating the tax exemption process conducted by the Executing Agency..

5. Contents of the Draft Report
After the explanation of the contents of the Draft Report by the Team, the Malawi side agreed to its contents. JICA will finalize the Preparatory Survey Report based on the confirmed items. The report will be sent to the Malawi side around November 2020.

6. Cost estimate
Both sides confirmed that the cost estimate including the contingency explained by the Team is provisional and will be examined further by the Government of Japan for its approval. The contingency would cover the additional cost against natural disaster, unexpected natural conditions, etc.

7. Confidentiality of the cost estimate and technical specifications
Both sides confirmed that the cost estimate and technical specifications of the Project should never be disclosed to any third parties until all the contracts under the Project are concluded.

8. Procedures and Basic Principles of Japanese Grant
The Malawi side agreed that the procedures and basic principles of Japanese Grant (hereinafter referred to as "the Grant") as described in Annex 3 shall be applied to the Project. In addition, the Malawi side agreed to take necessary measures according to the procedures.

9. Timeline for the project implementation
The Team explained to the Malawi side that the expected timeline for the project implementation is as attached in Annex 4.

10. Expected outcomes and indicators
Both sides agreed that key indicators for expected outcomes are as follows. The Malawi side will be responsible for the achievement of agreed key indicators targeted in year 2026 and shall monitor the progress for Ex-Post Evaluation based on those indicators.

[Quantitative indicators]

indicator	Base Value (2019)	Target Value(2026) (3years after comminssioning)
Installed capacity in Kanengo Substation *1(MVA)	83.0*2	158.0*2
Installed capacity in Old Town Substation*3(MVA)	37.5	50.0
Capacity utilization ratio of Kanengo Substation*4(%)	101.7	70.4
Capacity utilization ratio of Old Town Substation*4(%)	65.4	60.4

*1 Indicate the installed capacity of 132kV System Voltage in Kanengo Substation
*2 Indicate the installed capacity when using Oil Nat ural Air Forced(ONAF)

*3 Indicate the installed capacity of 66kV System Voltage in Old Town Substation
*4 Ratio of power demand to installed capacity . Forecasted Demand in 2026 at Kanengo Substation is 111.3 MVA (132 kV)and at Old Town Substation is 30.2 MVA (66 kV)

[Qualitative indicators]

Economic activities,public services and the lives of residents are improved.

11. Ex-Post Evaluation

JICA will conduct ex-post evaluation after three (3) years from the project completion, in principle, with respect to five evaluation criteria (Relevance, Effectiveness, Efficiency, Impact, Sustainability). The result of the evaluation will be publicized. The Malawi side is required to provide necessary support for the data collection.

12. Undertakings of the Project

Both sides confirmed the undertakings of the Project as described in Annex 5. With regard to exemption of customs duties, internal taxes and other fiscal levies as stipulated in 3 (5) of Annex 5, both sides confirmed that such customs duties, internal taxes and other fiscal levies, which shall be clarified in the bid documents by ESCOM during the implementation stage of the Project.

The Malawi side assured to take the necessary measures and coordination including allocation of the necessary budget which are preconditions of implementation of the Project. It is further agreed that the costs are indicative, i.e. at Outline Design level. More accurate costs will be calculated at the Detailed Design stage.

Both sides also confirmed that the Annex 5 will be used as an attachment of G/A.

13. Monitoring during the implementation

The Project will be monitored by the Executing Agency and reported to JICA by using the form of Project Monitoring Report (PMR) attached as Annex 6. The timing of submission of the PMR is described in Annex 5.

14. Project completion

Both sides confirmed that the project completes when all the facilities constructed and equipment procured by the Grant are in operation. The completion of the Project will be reported to JICA promptly by the Executing Agency, but in any event not later than six months after completion of the Project.

15. Environmental and Social Considerations

15-1 General Issues

15-1-2 Environmental Guidelines and Environmental Category

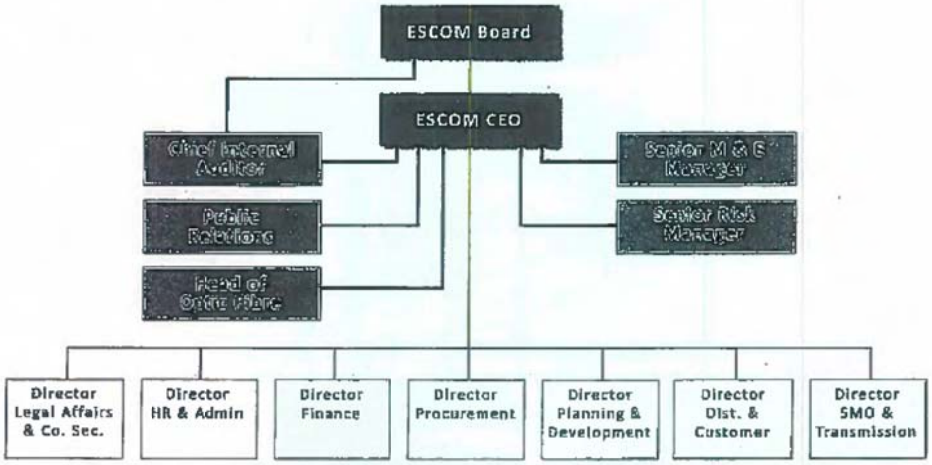
The Team explained that 'JICA Guidelines for Environmental and Social Considerations (April 2010)' (hereinafter referred to as "the Guidelines") is applicable for the Project. The Project is categorized as C because the Project is likely to have minimal adverse impact on the environment under the Guidelines.

16. Other Relevant Issue

MOF and JICA confirmed that all conditions under the jurisdiction of National Construction Industry Council, registration fees for consultants and contractor, one(1) percent of the total contract amount and the requirement of achieving a minimum work proportion of thirty(30) percent for Malawian construction firms, are exempt in this project.

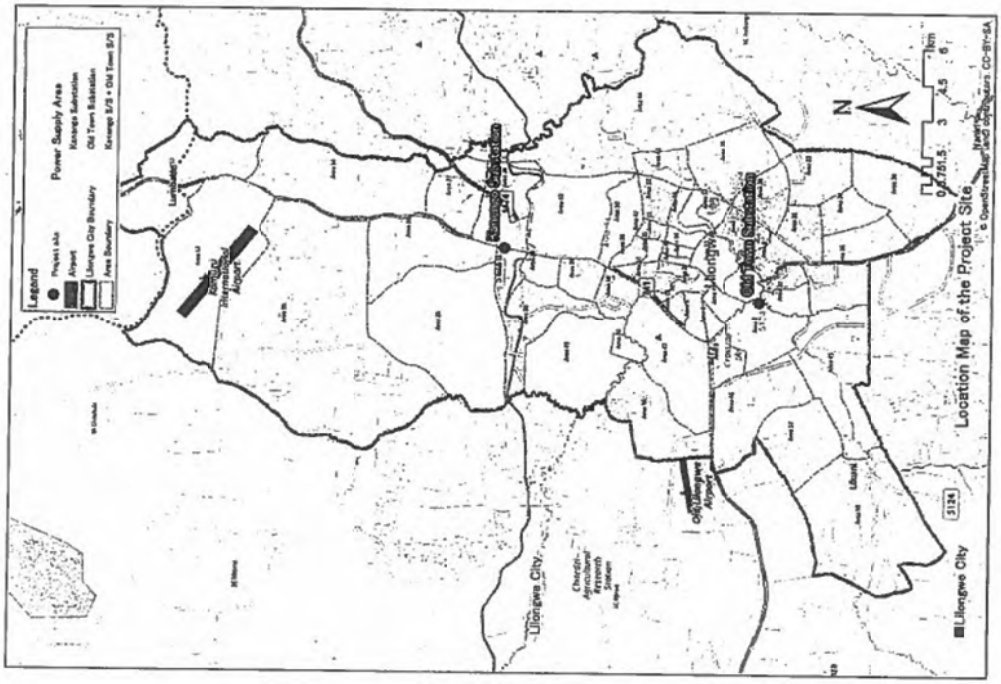
Annex 1 Project Sites
Annex 2 Organization Chart
Annex 3 Japanese Grant
Annex 4 Project Implementation Schedule
Annex 5 Major Undertakings to be taken by the Government of Malawi
Annex 6 Project Monitoring Report (template)

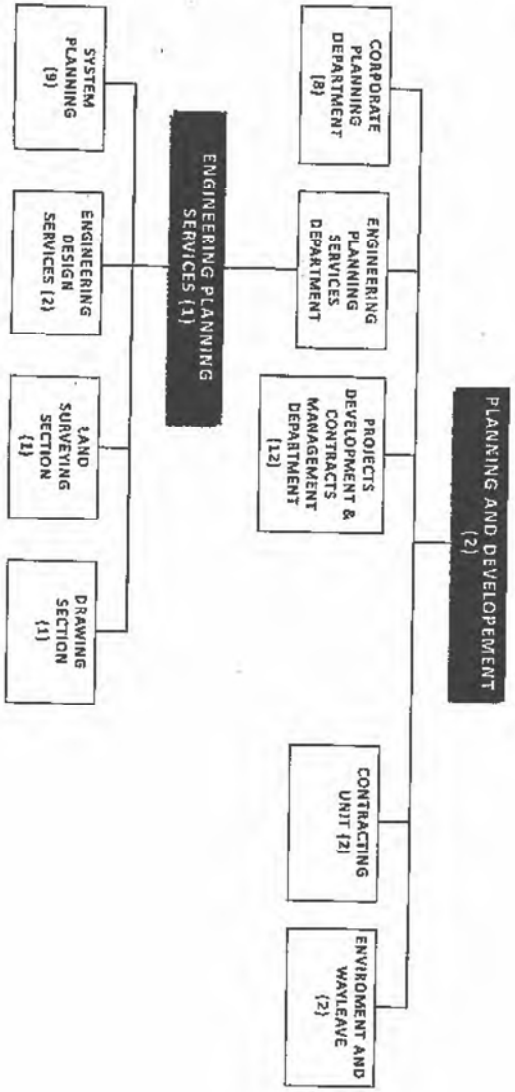
Annex 2 Organization Chart of ESCOM



ESCOM Organization Chart (HIGH LEVEL)

Annex 1 Project Sites





Note: Bracket ( ) means the number of personnel

ESCOM Organization Chart (PLANNING AND DEVELOPMENT DEPARTMENT)

JAPANESE GRANT

The Japanese Grant is non-reimbursable fund provided to a recipient country (hereinafter referred to as "the Recipient") to purchase the products and/or services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. Followings are the basic features of the project grants operated by JICA (hereinafter referred to as "Project Grants").

1. Procedures of Project Grants

Project Grants are conducted through following procedures (See "PROCEDURES OF JAPANESE GRANT" for details):

(1) Preparation

- The Preparatory Survey (hereinafter referred to as "the Survey") conducted by JICA

(2) Appraisal

-Appraisal by the government of Japan (hereinafter referred to as "GOJ") and JICA, and Approval by the Japanese Cabinet

(3) Implementation

Exchange of Notes

-The Notes exchanged between the GOJ and the government of the Recipient

Grant Agreement (hereinafter referred to as "the G/A")

-Agreement concluded between JICA and the Recipient

Banking Arrangement (hereinafter referred to as "the B/A")

-Opening of bank account by the Recipient in a bank in Japan (hereinafter referred to as "the Bank") to receive the grant

Construction works/procurement

-Implementation of the project (hereinafter referred to as "the Project") on the basis of the G/A

(4) Ex-post Monitoring and Evaluation

-Monitoring and evaluation at post-implementation stage

2. Preparatory Survey

(1) Contents of the Survey

The aim of the Survey is to provide basic documents necessary for the appraisal of the the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the Recipient necessary for the implementation of the Project.

- Evaluation of the feasibility of the Project to be implemented under the Japanese Grant from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.
- Confirmation of Environmental and Social Considerations

The contents of the original request by the Recipient are not necessarily approved in their initial form. The Outline Design of the Project is confirmed based on the guidelines of the Japanese Grant.

JICA requests the Recipient to take measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the executing agency of the Project. Therefore, the contents of the Project are confirmed by all relevant organizations of the Recipient based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA contracts with (a) consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the feasibility of the Project.

3. Basic Principles of Project Grants

(1) Implementation Stage

1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes (hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the Recipient to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Recipient to define the necessary articles, in accordance with the E/N, to implement the Project, such as conditions of disbursement, responsibilities of the Recipient, and procurement conditions. The terms and conditions generally applicable to the Japanese Grant are stipulated in the "General Terms and Conditions for Japanese Grant (January 2016)."

2) Banking Arrangements (B/A) (See "Financial Flow of Japanese Grant (A/P Type)" for details)

a) The Recipient shall open an account or shall cause its designated authority to open an account under the name of the Recipient in the Bank, in principle. JICA will disburse the Japanese Grant in Japanese yen for the Recipient to cover the obligations incurred by the Recipient under the verified contracts.

b) The Japanese Grant will be disbursed when payment requests are submitted by the Bank to JICA under an Authorization to Pay (A/P) issued by the Recipient.

3) Procurement Procedure

The products and/or services necessary for the implementation of the Project shall be procured in accordance with JICA's procurement guidelines as stipulated in the G/A.

4) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the Recipient to continue to work on the Project's implementation after the E/N and G/A.

5) Eligible source country

In using the Japanese Grant disbursed by JICA for the purchase of products and/or services, the eligible source countries of such products and/or services shall be Japan and/or the Recipient. The Japanese Grant may be used for the purchase of the products and/or services of a third country as eligible, if necessary, taking into account the quality, competitiveness and economic rationality of products and/or services necessary for achieving the objective of the Project. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm, which enter into contracts with the Recipient, are limited to "Japanese nationals", in principle.

6) Contracts and Concurrence by JICA

The Recipient will conclude contracts denominated in Japanese yen with Japanese nationals. These contracts shall be concurred by JICA in order to be verified as eligible for using the Japanese Grant.

7) Monitoring

The Recipient is required to take their initiative to carefully monitor the progress of the Project in order to ensure its smooth implementation as part of their responsibility in the G/A, and to regularly report to JICA about its status by using the Project Monitoring Report (PMR).

8) Safety Measures

The Recipient must ensure that the safety is highly observed during the implementation of the Project.

9) Construction Quality Control Meeting

Construction Quality Control Meeting (hereinafter referred to as the "Meeting") will be held for quality assurance and smooth implementation of the Works at each stage of the Works. The member of the Meeting will be composed by the Recipient (or executing agency), the Consultant, the Contractor and JICA. The functions of the Meeting are as

followings:

a) Sharing information on the objective, concept and conditions of design from the Contractor, before start of construction.

b) Discussing the issues affecting the Works such as modification of the design, test, inspection, safety control and the Client's obligation, during of construction.

(2) Ex-post Monitoring and Evaluation Stage

1) After the project completion, JICA will continue to keep in close contact with the Recipient in order to monitor that the outputs of the Project is used and maintained properly to attain its expected outcomes.

2) In principle, JICA will conduct ex-post evaluation of the Project after three years from the completion. It is required for the Recipient to furnish any necessary information as JICA may reasonably request.

(3) Others

1) Environmental and Social Considerations

The Recipient shall carefully consider environmental and social impacts by the Project and must comply with the environmental regulations of the Recipient and JICA Guidelines for Environmental and Social Considerations (April, 2010).

2) Major undertakings to be taken by the Government of the Recipient

For the smooth and proper implementation of the Project, the Recipient is required to undertake necessary measures including land acquisition, and bear an advising commission of the A/P and payment commissions paid to the Bank as agreed with the GOJ and/or JICA. The Government of the Recipient shall ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the Recipient with respect to the purchase of the Products and/or the Services be exempted or be borne by its designated authority without using the Grant and its accrued interest, since the grant fund comes from the Japanese taxpayers.

3) Proper Use

The Recipient is required to maintain and use properly and effectively the products and/or services under the Project (including the facilities constructed and the equipment purchased), to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Japanese Grant.

4) Export and Re-export

The products purchased under the Japanese Grant should not be exported or re-exported from the Recipient.

Attachment1

PROCEDURES OF JAPANESE GRANT

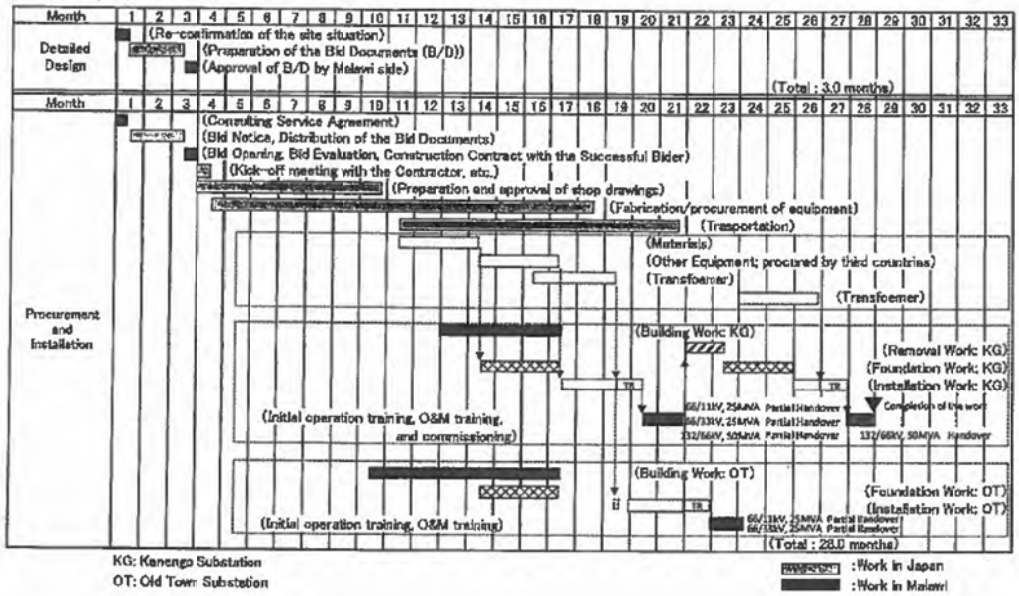
Stage	Procedures	Remarks	Recipient Government	Japanese Government	JICA	Consultant	Contractor	Agent Bank
Official Request	Request for grants through diplomatic channel	Request shall be submitted before appraisal stage.	x	x				
1. Preparation	(1) Preparatory Survey Preparation of outline design and cost estimate		x		x	x		
2. Appraisal	(2)Preparatory Survey Explanation of draft outline design, including cost estimate, undertakings, etc.		x		x	x		
	(3)Agreement on conditions for implementation	Conditions will be explained with the draft notes (B/N) and Grant Agreement (G/A) which will be signed before approval by Japanese government.	x	x (B/N)	x (G/A)			
	(4) Approval by the Japanese cabinet			x				
3. Implementation	(5) Exchange of Notes (E/N)		x	x				
	(6) Signing of Grant Agreement (G/A)		x		x			
	(7) Banking Arrangement (B/A)	Need to be informed to JICA	x					x
	(8) Contracting with consultant and Issuance of Authorization to Pay (A/P)	Concurrence by JICA is required	x			x		x
	(9) Detail design (D/D)		x			x		
	(10) Preparation of bidding documents	Concurrence by JICA is required	x			x		
	(11) Bidding	Concurrence by JICA is required	x			x	x	
	(12) Contracting with contractor/supplier and issuance of A/P	Concurrence by JICA is required	x				x	x
	(13) Construction works/procurement	Concurrence by JICA is required for major modification of design and amendment of contracts.	x			x	x	
	(14) Completion certificate		x			x	x	
4. Ex-post monitoring & evaluation	(15) Ex-post monitoring	To be implemented generally after 1, 3, 10 years of completion, subject to change	x		x			
	(16) Ex-post evaluation	To be implemented basically after 3 years of completion	x		x			

notes:

1. Project Monitoring Report and Report for Project Completion shall be submitted to JICA as agreed in the G/A.

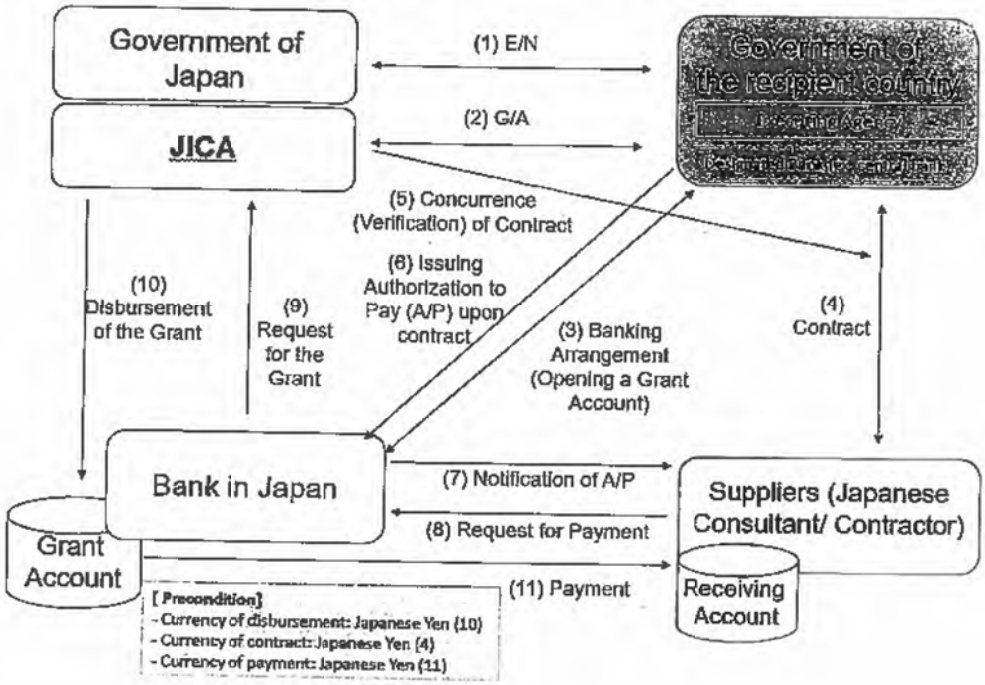
2. Concurrence by JICA is required for allocation of grant for remaining amount and/or contingencies as agreed in the G/A.

Annex 4 Project Implementation Schedule



Attachment 2

Financial Flow of Japanese Grant (A/P Type)



Annex 5

Major Undertakings to be taken by the Government of Malawi

(1) Before the Bid

NO	Items	Deadline	In charge	Estimated Cost (USD)	Ref.
1	【Common】 To open bank account (B/A)	within 1 month after the signing of the G/A	MOF	-	
2	【Common】 To issue A/P to a bank in Japan (the Agent Bank) for the payment to the consultant	within 1 month after the signing of the contract	MOF	-	
3	【Common】 To secure necessary budget for the removal and demolition of existing equipment and facilities	before the signing of the G/A	MOE/ ESCOM	-	
4	【Common】 To submit Project Monitoring Report (with the result of Detail Design)	before notice of the bidding document	ESCOM	-	
5	【Common】 Secure and clear the project sites (Kanengo Substation and Old Town Substation)	before notice of the bidding document	ESCOM	5,713	
6	【Kanengo Substation】 Replacement of existing overhead conductor with underground cable Relocation of all existing underground cables and 33 kV VT	before preparation of bidding documents	ESCOM	282,923	
7	【Old Town Substation】 Relocation 5x11kV UGCs and 2x33kV OHL/UGCs	before preparation of bidding documents	ESCOM	453,102	
8	【Common】 Construction of access road to the project sites	before preparation of bidding documents	ESCOM	-	
9	【Common】 Approval of construction work from City council	before preparation of bidding documents	ESCOM	5,364	

(2) Before the Project Implementation

NO	Items	Deadline	In charge	Estimated Cost (USD)	Ref.
1	【Common】 Clearance of the project site (the existing obstacle, materials and trees)	before implementation the Project	ESCOM	1,575	
2	【Common】 Preparation of stockyard for the project (during the implementation period)	before implementation the Project	ESCOM	27,726	
3	【Kanengo Substation】 Removal of existing 132/11kV 20MVA transformer (T4T) and related bay equipment and its foundation	before implementation the Project	ESCOM	25,128	
4	【Kanengo Substation】 Removal of existing 66/11kV 12.5MVA transformer (currently out of service) and related bay equipment and its foundation	before implementation the Project	ESCOM	25,128	

(3) During the Project Implementation

NO	Items	Deadline	In charge	Estimated Cost (USD)	Ref.
1	【Common】 To issue A/P to a bank in Japan (the Agent Bank) for the payment to the Supplier(s)	within 1 month after the signing of the contract(s)	MOF	-	
2	【Common】 To bear the following commissions to a bank in Japan for the banking services based upon the B/A		MOF		
	1) Advising commission of A/P	within 1 month after the signing of the contract(s)		250	
	2) Payment commission for A/P	every payment		26,000	
3	【Common】 To ensure prompt unloading and customs clearance at ports of disembarkation in recipient country and to assist the Supplier(s) with internal transportation therein	during the Project	MOE/ MOF	-	
4	【Common】 To accord Japanese nationals and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work	during the Project	MOE/ ESCOM	-	
5	【Common】 To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the products and/or the services be borne by its designated authority without using the Grant	during the Project	MOE/ MOF	-	
6	【Common】 To bear all the expenses, such as necessary registration fee to the related agency, other than those covered by the Grant, necessary for the implementation of the Project	during the Project	MOE/ ESCOM	-	
7	【Common】 To ensure that all conditions under the jurisdiction of National Construction Industry Council, registration fees for consultants and contractor, one(1) percent of the total contract amount and the requirement of achieving a minimum work proportion of thirty(30) percent for Malawian construction firms, are exempt in this project.	during the Project	MOF	-	
8	【Common】 1) To submit Project Monitoring Report after each work under the contract(s) such as shipping, hand over, installation and operational training	every month	ESCOM	-	
	2) To submit Project Monitoring Report (final)	within one month after signing of Certificate of Completion for the works under the contract(s)	ESCOM	-	
9	【Common】 To submit a report concerning completion of the Project	within six months after completion of the Project	ESCOM	-	
10	【Common】 To take necessary measure for safety construction	during the Project	ESCOM	-	
11	【Common】 Modification, relocation, re-connection, testing and adjustment of SCADA system in the National Control Center or other substation	during the Project	ESCOM	5,713	

NO	Items	Deadline	In charge	Estimated Cost (USD)	Ref.
12	【Common】 Submission of necessary interface information to connect to local SCADA system, and witnessing testing as requested.	during the Project	ESCOM	-	
13	【Common】 Temporary power outage management during the work	during the Project	ESCOM	-	
14	【Kanengo Substation】 Electrical isolation work including cables for existing equipment before removal work	during the Project	ESCOM	5,713	
15	【Kanengo Substation】 Disposal of removed equipment -Removed existing 132/11kV 20MVA transformer (T4T), -Removed existing 66/11kV 12.5MVA transformer (currently out of service), -Removed existing 132/66kV 25MVA transformer (IBT1), -Removed existing 66/33kV 7.5MVA transformer, -related bay equipment and those foundation, and -Removed foundation for 66/33kV 25MVA transformer	during the Project	ESCOM	-	
16	【Kanengo Substation】 Installation of disconnecting switch for new 132/66kV transformer including connection work to the 132kV busbars	during the Project	ESCOM	16,603	
17	【Kanengo Substation】 Switching over of outgoing feeder of 11kV switchgear from existing control building to new one	during the Project	ESCOM	5,713	
18	【Old Town Substation】 Switching over of outgoing feeder of 33kV and 11kV switchgear from existing control building to new one	during the Project	ESCOM	5,713	
19	【Old Town Substation】 Rerouting of 66 kV existing transmission line to gantry with support structure, if necessary	during the Project	ESCOM	766,645	
20	【Common】 Gate and fence for substations	during the Project	ESCOM	20,480	
21	【Common】 FAT ESCOM participation	during the Project	ESCOM	15,100	

(4) After the Project

NO	Items	Deadline	In charge	Estimated Cost (USD)	Ref.
1	【Common】 To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid 1) Allocation of maintenance cost 2) Operation and maintenance structure 3) Routine check/Periodic Inspection	After completion of the construction	ESCOM	300,000 /year *	
2	【Kanengo Substation】 Expansion of the control building	After completion of the construction	ESCOM	53,637	
3	【Kanengo Substation】 Relocation and switching over of all of the existing equipment from existing control building to expanded one	After completion of the construction	ESCOM	5,713	
4	【Old Town Substation】 Removal and disposal of existing substation equipment	After completion of the construction	ESCOM	70,893	
5	【Common】 Storage the testing equipment, spare parts and consumables	After completion of the construction	ESCOM	-	

* The Estimate cost is subject to change depend on the operation condition and surrounding environment of the facilities

Project Monitoring Report
on
Project Name
Grant Agreement No. XXXXXXX
20XX, Month

Organizational Information

Signer of the G/A (Recipient)	Person in Charge	(Designation)
	Contacts	Address: Phone/FAX: Email:
Executing Agency	Person in Charge	(Designation)
	Contacts	Address: Phone/FAX: Email:
Line Ministry	Person in Charge	(Designation)
	Contacts	Address: Phone/FAX: Email:

General Information:

Project Title	
E/N	Signed date: Duration:
G/A	Signed date: Duration:
Source of Finance	Government of Japan: Not exceeding JPY _____ mil. Government of (_____): _____

1: Project Description

1-1 Project Objective

1-2 Project Rationale
- Higher-level objectives to which the project contributes (national/regional/sectoral policies and strategies)
- Situation of the target groups to which the project addresses

1-3 Indicators for measurement of "Effectiveness"

Quantitative indicators to measure the attainment of project objectives		
Indicators	Original (Yr)	Target (Yr)
Qualitative indicators to measure the attainment of project objectives		

2: Details of the Project

2-1 Location

Components	Original *(proposed in the outline design)*	Actual
1.		

2-2 Scope of the work

Components	Original* *(proposed in the outline design)*	Actual*
1.		

Reasons for modification of scope (if any).

(PMR)

2-3 Implementation Schedule

Items	Original (proposed in the outline design)	Original (at the time of signing the Grant Agreement)	Actual

Reasons for any changes of the schedule, and their effects on the project (if any)

2-4 Obligations by the Recipient

2-4-1 Progress of Specific Obligations
See Attachment 2.

2-4-2 Activities
See Attachment 3.

2-4-3 Report on RD
See Attachment 11.

2-5 Project Cost

2-5-1 Cost borne by the Grant (Confidential until the Bidding)

Components			Cost (Million Yen)	
	Original (proposed in the outline design)	Actual (in case of any modification)	Original[1][2] (proposed in the outline design)	Actual
	1.			
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = Yen

2-5-2 Cost borne by the Recipient

Components			Cost (1,000 Taka)	
	Original (proposed in the outline design)	Actual (in case of any modification)	Original[1][2] (proposed in the outline design)	Actual
	1.			

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar =

Reasons for the remarkable gaps between the original and actual cost, and the countermeasures (if any)

(PMR)

2-6 Executing Agency
- Organization's role, financial position, capacity, cost recovery etc.
- Organization Chart including the unit in charge of the implementation and number of employees.

Original *(at the time of outline design)* name: role: financial situation: institutional and organizational arrangement (organogram): human resources (number and ability of staff):
Actual *(PMR)*

2-7 . Environmental and Social Impacts
- The results of environmental monitoring based on Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- The results of social monitoring based on in Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- Disclosed information related to results of environmental and social monitoring to local stakeholders (whenever applicable).

3: Operation and Maintenance (O&M)

3-1 Physical Arrangement
- Plan for O&M (number and skills of the staff in the responsible division or section, availability of manuals and guidelines, availability of spareparts, etc.)

Original *(at the time of outline design)*
Actual *(PMR)*

3-2 Budgetary Arrangement
- Required O&M cost and actual budget allocation for O&M

Original *(at the time of outline design)*

Actual *(PMR)*

4: Potential Risks and Mitigation Measures

- Potential risks which may affect the project implementation, attainment of objectives, sustainability
- Mitigation measures corresponding to the potential risks

Assessment of Potential Risks *(at the time of outline design)*

Potential Risks	Assessment
1. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
2. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
3. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:

	Contingency Plan (if applicable):
Actual Situation and Countermeasures (PMR)	

5: Evaluation and Monitoring Plan (after the work completion)

5-1 Overall evaluation

Please describe your overall evaluation on the project.

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

5-3 Monitoring Plan of the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

Attachment 6

Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

	Items of Specified Materials	Initial Volume A	Initial Unit Price (¥) B	Initial total Price C=A×B	Tax of Contract Price D	Condition of payment Price (Decreased) E=C−D	Condition of payment Price (Increased) F=C×D
1	Item 1	●●t	●	●	●	●	●
2	Item 2	●●t	●	●	●		
3	Item 3						
4	Item 4						
5	Item 5						

2. Monitoring of the Unit Price of Specified Materials

(1) Method of Monitoring : ●●

(2) Result of the Monitoring Survey on Unit Price for each specified materials

	Items of Specified Materials	1st ○month, 2015	2nd ○month, 2015	3rd ○month, 2015	4th	5th	6th
1	Item 1						
2	Item 2						
3	Item 3						
4	Item 4						
5	Item 5						

(3) Summary of Discussion with Contractor (if necessary)

G/A NO. XXXXXXX
PMR prepared on DD/MM/YY

Attachment

1. Project Location Map
2. Specific obligations of the Recipient which will not be funded with the Grant
3. Monthly Report submitted by the Consultant

Appendix - Photocopy of Contractor's Progress Report (if any)
- Consultant Member List
- Contractor's Main Staff List

4. Check list for the Contract (including Record of Amendment of the Contract/Agreement and Schedule of Payment)
5. Environmental Monitoring Form / Social Monitoring Form
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries) (PMR (final)only)
8. Pictures (by JPEG style by CD-R) (PMR (final)only)
9. Equipment List (PMR (final)only)
10. Drawing (PMR (final)only)
11. Report on RD (After project)

7

Attachment 7

Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)
(Actual Expenditure by Construction and Equipment each)

	Domestic Procurement (Recipient Country) A	Foreign Procurement (Japan) B	Foreign Procurement (Third Countries) C	Total D
Construction Cost	(A/D%)	(B/D%)	(C/D%)	
Direct Construction Cost	(A/D%)	(B/D%)	(C/D%)	
others	(A/D%)	(B/D%)	(C/D%)	
Equipment Cost	(A/D%)	(B/D%)	(C/D%)	
Design and Supervision Cost	(A/D%)	(B/D%)	(C/D%)	
Total	(A/D%)	(B/D%)	(C/D%)	

Attachment 6

Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

	Items of Specified Materials	Initial Volume A	Initial Unit Price (¥) B	Initial Total Price C=A×B	1% of Contract Price D	Contract Adjustment Price (Decreased) E=C−D	Contract Adjustment Price (Increased) E=C+D
1	Item 1	●●t	●	●	●	●	●
2	Item 2	●●t	●	●	●		
3	Item 3						
4	Item 4						
5	Item 5						

2. Monitoring of the Unit Price of Specified Materials
(1) Method of Monitoring : ●●

(2) Result of the Monitoring Survey on Unit Price for each specified materials

	Items of Specified Materials	1st Month, 2015	2nd Month, 2015	3rd Month, 2015	5th	6th	60th
1	Item 1						
2	Item 2						
3	Item 3						
4	Item 4						
5	Item 5						

(3) Summary of Discussion with Contractor (if necessary)