Federal Ministry of Power (FMP)
Transmission Company of Nigeria (TCN)
The Federal Republic of Nigeria

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR
EMERGENCY IMPROVEMENT OF
ELECTRICITY SUPPLY FACILITIES
IN ABUJA
IN
THE FEDERAL REPUBLIC OF NIGERIA

OCTOBER 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

YACHIYO ENGINEERING CO., LTD.

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to Yachiyo Engineering Co., Ltd.

The survey team held a series of discussions with the officials concerned of the Government of Nigeria, and conducted a field investigation. 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 the Federal Republic of Nigeria for their close cooperation extended to the survey team.

October, 2015

Yoshinobu IKURA
Director General,
Industrial Development and Public Policy Department
Japan International Cooperation Agency

SUMMARY

SUMMARY

① Overview of the Country

The Federal Republic of Nigeria (hereafter referred to as Nigeria) has a population of approximately 170 million (2013, UNFPA), making it the most populous country in Africa. The government of Nigeria launched a national development plan called 'Nigeria Vision 20: 2020' in 2009 and its objective is to become within the twentieth largest economic country in the world. This national development plan regards the power sector as a focused policy in the infrastructure sector for the further social and economic development. The President Jonathan, who led the Nigerian government from 2010, prioritized the augmentation of the power sector in the policy called 'Transformation Agenda 2011-2015'.

In the power sector, because power supply facilities did not undergo sufficient maintenance, renewal or construction in the past, supply capacity is overwhelmingly insufficient with respect to the latent demand, leading to daily planned outages and frequent power interruptions across all systems. In these circumstances, the Government of Nigeria utilizes the Excess Crude Account to construct thermal power stations and transmission lines and implement the National Integrated Power Project (NIPP), and it is also promoting privatization of the power sector with a view to improving efficiency and reducing the government investment burden.

However, although the economic development in parallel with the increase of the power demand is observed, the power supply in Nigeria remains unstable and this become the bottleneck of the further economic development and promotion of public investments. Therefore, securing the reliability of power supply is an urgent issue for the national policy.

② Background and outline of the Project

Nigeria is one of the world's major oil and natural gas producing countries. The actual peak load recorded is 4,810.7MW (25th August 2015) but the country's maximum power demand is estimated as 12,500 MW, and the power shortage hampers the economic growth.

Privatization of the power sector has enabled private companies to actively participate in Independent Power Producers (IPPs), which leads to an increase in the power generation capacity but also to the overloading of the transmission network capacity, which is currently approximately 5,000MW (2015). In Nigeria, a high ratio of reactive power, together with the insufficient capacity of power supply facilities, interferes with appropriate power supply. In particular, Federal Capital Territory (FCT), which has a higher population growth rate than any other cities in the country, is distant from power generation facilities and suffers considerably from voltage drops and power loss. The power supply to FCT and surrounding areas is unstable, resulting in only an average of eight hours power supply per day.

Possible measures to rectify such circumstances are to expand the capacity of substation facilities and

improve the power factor of the electricity load on one hand, and, on the other, introduce phase modifiers that help reduce reactive power. For the former, the French Development Agency (AFD) already plans to implement a project worth USD 170 million to strengthen the transmission network. For the latter, no specific measure has been taken, but the Government of Nigeria (GoN) requested the Government of Japan to implement a Grant Aid "Project for Emergency Improvement of Electricity Supply Facilities in Abuja" to improve transmission facilities at substations in and around FCT to compensate for the reactive power.

③ Outline of the Study findings and Project Contents

JICA dispatched the Preparatory Survey Team to Nigeria from November 2 to December 17, 2014 (First Field Survey). During this Survey, the Team reconfirmed the contents of the request and discussed the contents of implementation with related officials on the Nigerian side (Responsible Ministry: the Federal Ministry of Power (FMP), and implementing agency: Transmission Company of Nigeria (TCN)), surveyed and investigated the project site and collected related data and materials.

On returning to Japan, based on the data and materials obtained in the field investigation, the Team conducted examination on the necessity of the Project, its social and economic effects and its validity and compiled findings into the Preparatory Survey Report (Draft). JICA dispatched the Team to Nigeria again from June 18 to 26, 2015 to explain and discuss the Preparatory Survey Report (draft) and reach a basic agreement with the related officials on the Nigerian side.

Originally, improvement of four substations such as Apo Substation, Keffi Substation, Katampe Substation and Gwagwalada Substation were requested by the Government of Nigeria. As a result of the study, the contents of the Project include the procurement and installation of equipment for the improvement of power factors for the stabilization of power supply on the transmission lines. The table below shows the outline of the basic plan.

Outline of the Basic Plan

Site	132/33 kV Apo Substation		132/33 kV Keffi Substation	
Equipment Procurement and Installation	1. Power capacitor banks (132kV、60MVar)	1 set	1. Power capacitor banks (132kV、25MVar)	1 set
	2. Extra-high voltage switchgear	1 set	2. Switchgear for special high voltage	1 set
	3. Protection and control panel	1 set	3. Protection and control panel	1 set
	4. Substation earthing equipment	1 set	4. Substation earthing equipment	1 set
	5. Low voltage equipment	1 set	5. Low voltage equipment	1 set
	6. Foundation for equipment	1 set	6. 132 kV power cable (underground)	1 set
			7. DC supply system	1 set
			8. Foundation for equipment	1 set
Procurement	1. Spare parts		1 set	
	2. Test equipment and maintenance tools		1 set	

④ Project implementation period and project cost

In the case where the Project is implemented under the Government of Japan's Grant Aid scheme, the total project cost will be approx. (**confidential**) yen (Japan's burden: approximately: (**confidential**) yen, Nigeria's burden: approx. 3 million yen). The main items to be handled by the Nigerian side will be the leveling of project sites (approximately 1.1 million yen), removal of obstacles on sites (approximately 0.6 million yen) and bank commission (approximately 1.3 million). The Project implementation period including the detailed design and the tendering periods will be approximately 28.0 months.

⑤ Project Evaluation

(1) Relevance of the Project

The Project will contribute to the realization of Nigerian development plan and energy policies and bring benefits to the general public. Therefore, the relevance of the Project is considered high.

(2) Effectiveness of the Project

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

1) Quantitative Impacts

Indicator		Base Value (2014)	Target Value (2020 年) (3years from operation)
1. Voltage improvement at receiving end (%)*1	Apo Substation 132kV incoming side	N/A	2.90%
	Apo Substation 33kV outgoing side	N/A	3.01%
	Keffi Substation 132kV incoming side	N/A	6.19%
	Keffi Substation 33kV outgoing side	N/A	6.84%
2. Transmission power loss on 132kV line (MW)*1	Shiroro area (Target power system area of the Project) (%): Loss rate	N/A	101.4MW (6.85%)
3. Reducing of greenhouse gas (t/year)*1		N/A	6,404t/year
4. Additional number of household that will receive the power (household/day)*2	Apo Substation	N/A	5,400 household/day
	Keffi Substation	N/A	1,700 household/day
5. Additional number of consumer that will receive the power (person/day)*2	Apo Substation (4.5 person/household)	N/A	24,300 person/day
	Keffi Substation (5.5 person/household)	N/A	9,350 person/day

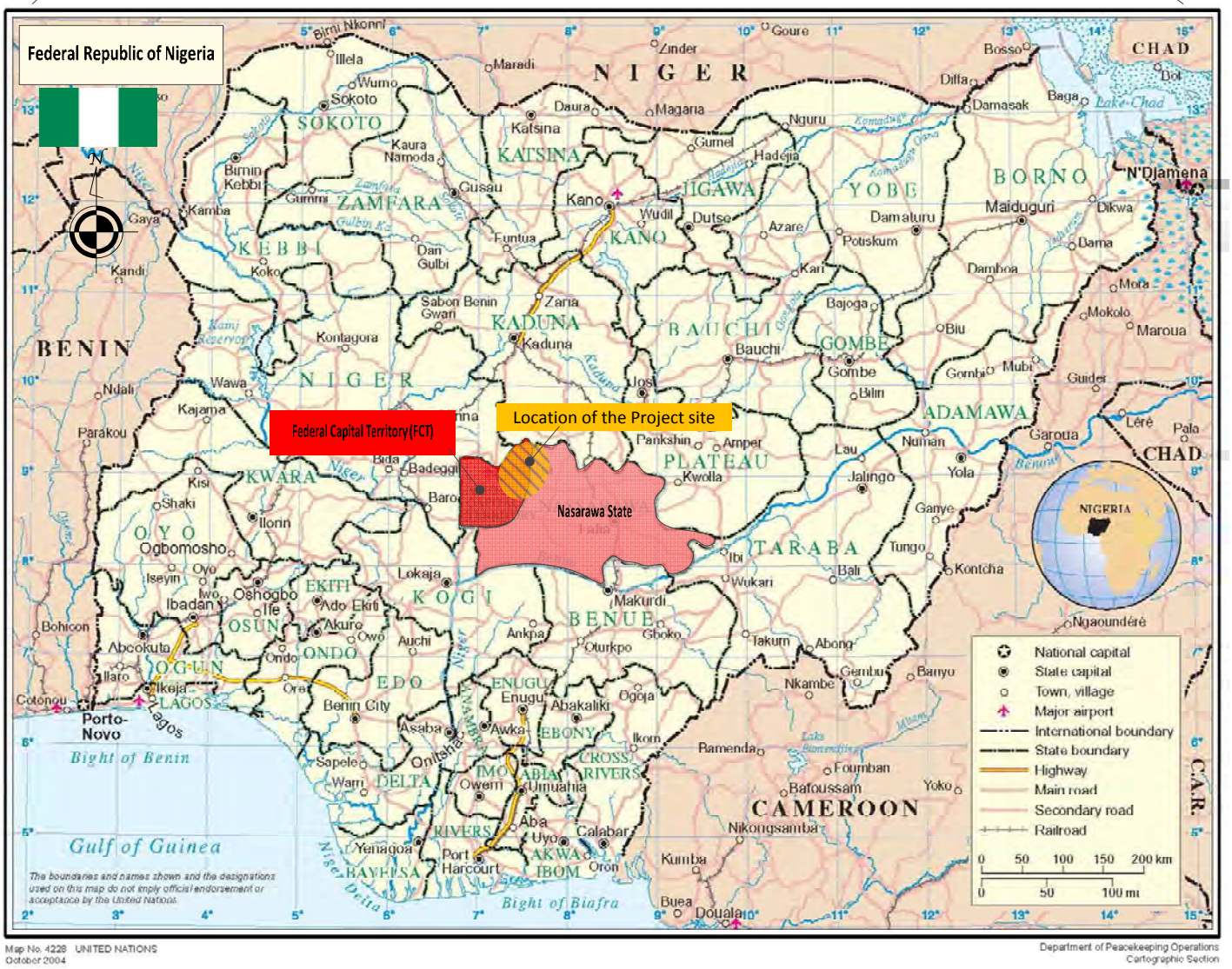
Note: *1 Every indicator was calculated based on power system model as of 2017 at the commencement of operation
*2Additional number of households and consumers were calculated based on power system model targeted in 2020

2) Qualitative Impacts

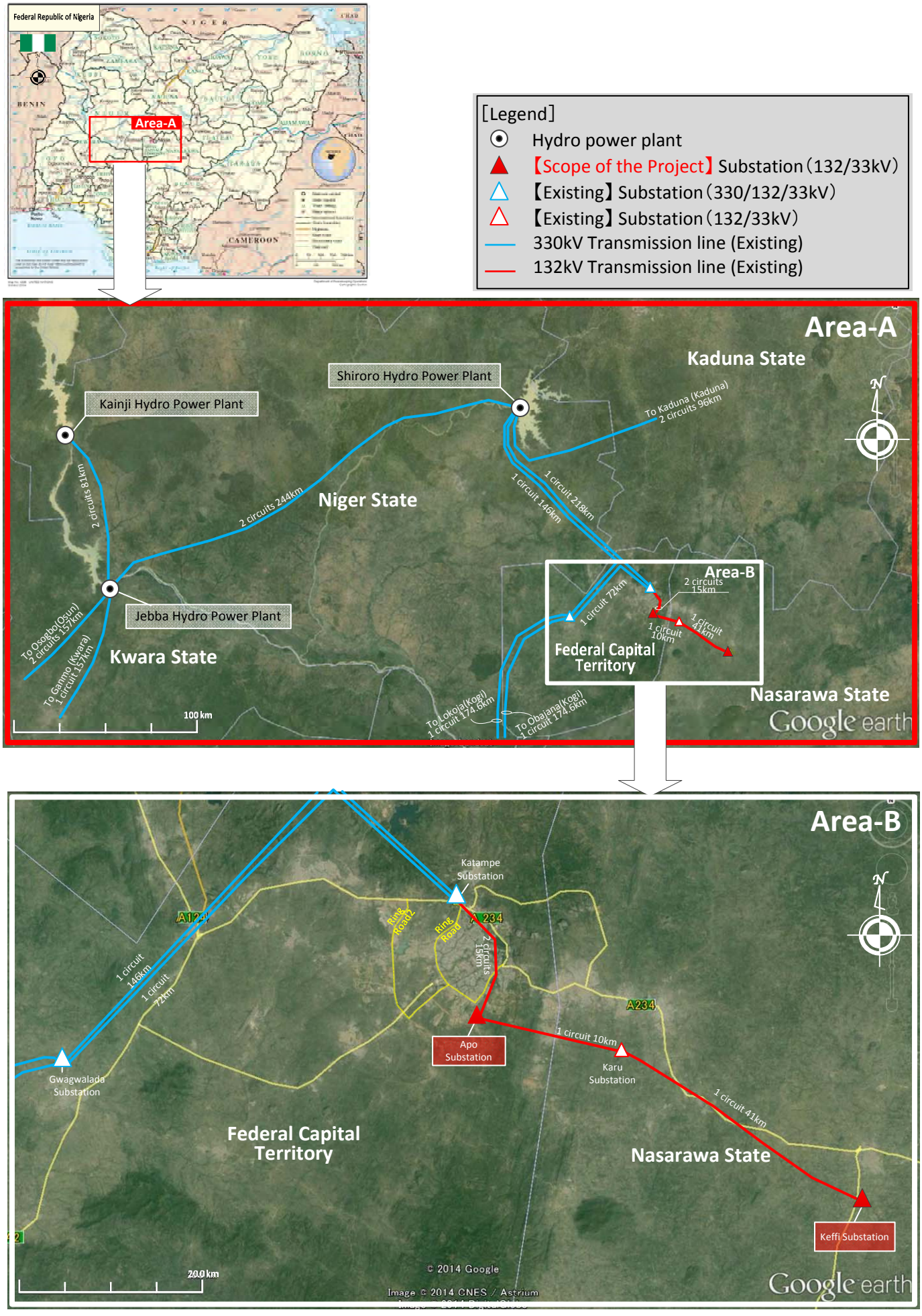
The following table shows impacts of each component of the Project.

Current state and issues	Introduction of power capacitors to the target substations of the Project (Apo and Keffi Substations) (Cooperation project)	Level of effect and improvement
There is significant voltage drop at customers' receiving ends in the target area of the Project. Customers' electric appliances can easily break down.	Introduce power capacitors.	Voltage at customers' receiving ends is determined by the distribution voltage of the distribution company. Operation voltage of the distribution company is low because it is at the demarcation point with the transmitter. Introduction of power capacitors will improve the transmission operation voltage and is also expected to improve the voltage of power supply to the distributor. Supply of higher-quality power from the distribution company that almost achieves the rated voltage will contribute to extending the service life of customers' fluorescent lamps, PC batteries and other electric appliances.
Frequent power outage caused by low-quality power supply to customers makes the entire power supply unstable and hinders social and economic development.	Introduce power capacitors.	Introduction of power capacitors is expected to improve the state of planned outage and contribute to the promotion of social and economic development of the target area of the Project. It is also expected to improve the operation of the power supply through the enhancement of the reliability of the transmission system operation.
Significant voltage drop creates problems in the operation of hospitals, schools and other public facilities.	Introduce power capacitors.	High-quality power supply is necessary for the stable use of medical instruments at hospitals, where precision instruments are often used. Moreover, use of stable lighting at school is expected to contribute to the improvement of learning efficiency of the students.
Night-time outage worsens the security situation because street lamps and security lamps cannot be used.	Introduce power capacitors.	Reduction of outage time will increase the number of hours when street lamps and security lamps can be used and is expected to help maintain security in the target area of the Project.

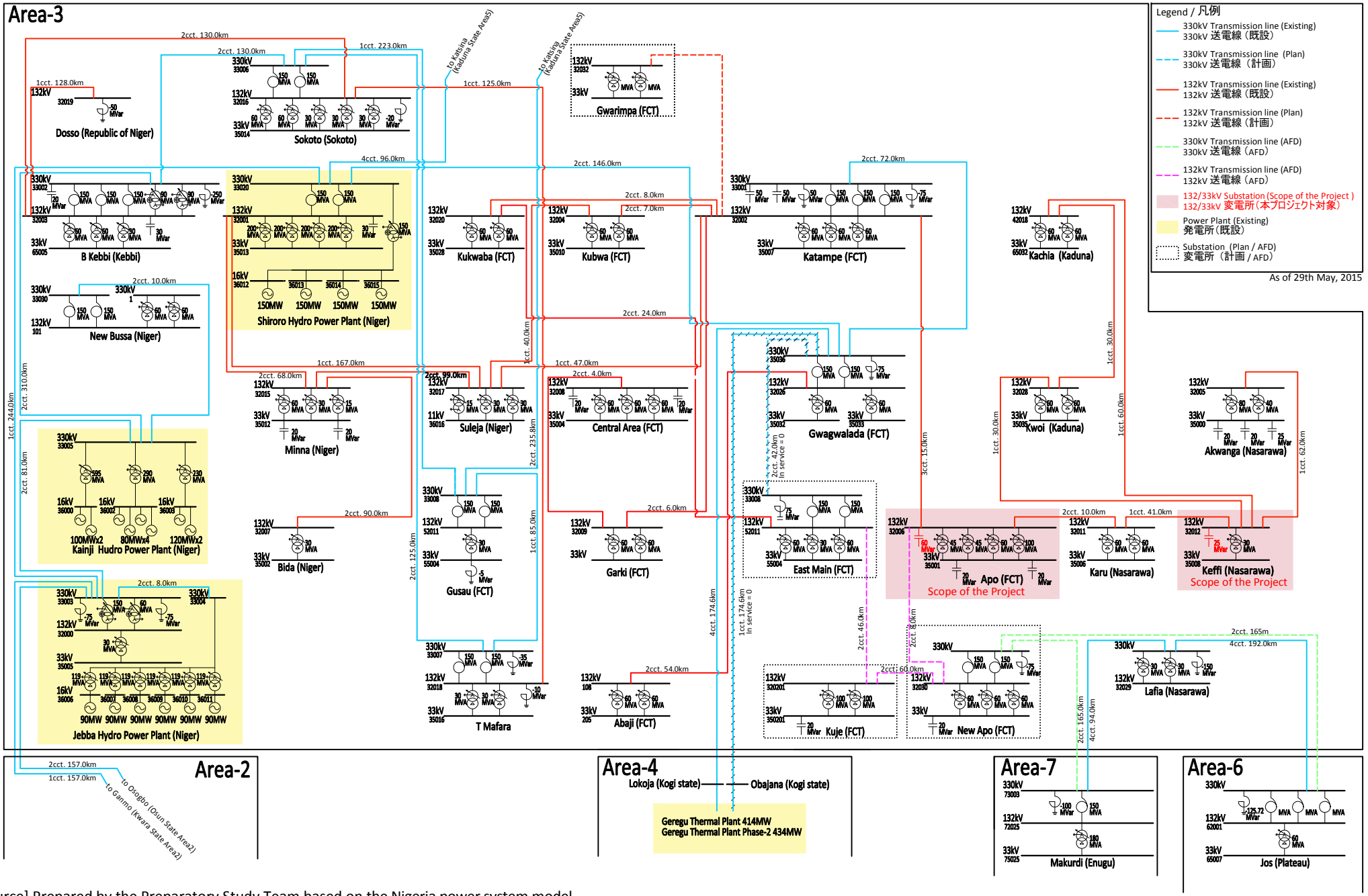
Contents



Project site (Federal Republic of Nigeria and neighboring countries)

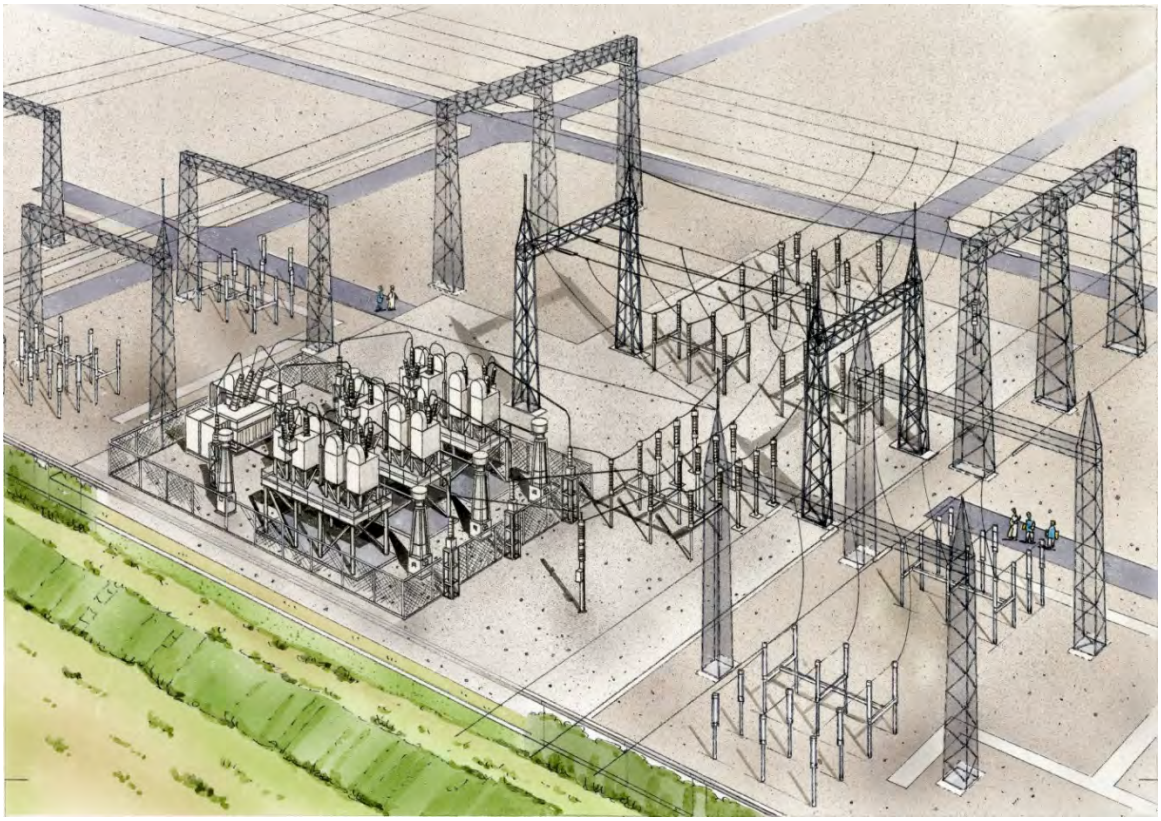


Project site (Federal Capital Territory and surrounding area)

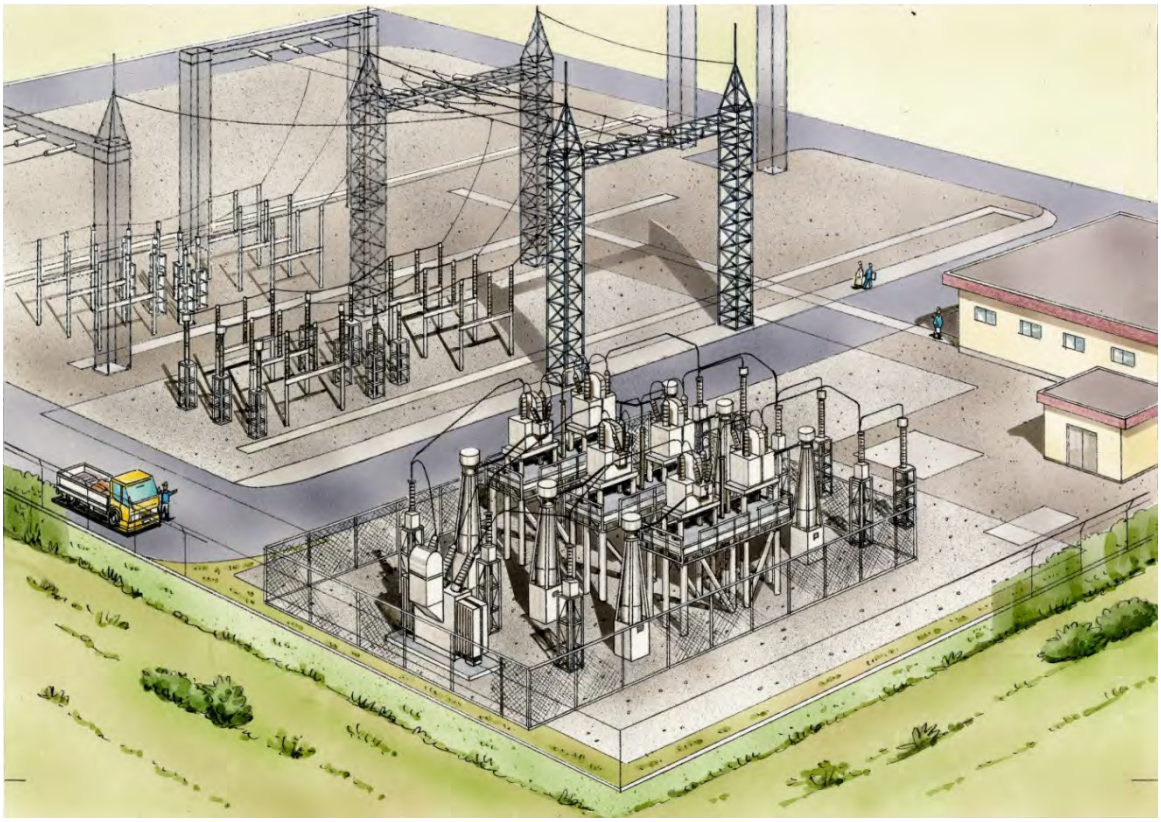


[Source] Prepared by the Preparatory Study Team based on the Nigeria power system model

Network diagram of Shiroro Region (Area-3)(2017)



Perspective of the power capacitor equipment (Apo Substation)



Perspective of the power capacitor equipment (Keffi Substation)

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ABBREVIATIONS

ACSR	Aluminum Conductor Steel Reinforced
AFD	Agence Française de Developpement
AfDB	African Development Bank
CPT	Cone Penetration Test
Disco	Distribution Company
ECN	Energy Commission of Nigeria
ECOWAS	Economic Community Of West African States
E/N	Exchange of Notes
EIA	Environmental Impact Assessment
ERP	Enterprise Resource Planning
EPSERP	Economic and Power Sector Reform Program
EPSRA	Electric Power Sector Reform Act
FCT	Federal Capital Territory
FME	Federal Ministry of Environment
FMF	Federal Ministry of Finance
FMP	Federal Ministry of Power
FS	Feasibility Study
G/A	Grant Agreement
GDP	Gross Domestic Product
Genco	Generation Company
GPS	Global Positioning System
GSM	Global System for Mobile communications
IEC	International Electrotechnical Commission
IEE	Initial Environmental Examination
IMF	International Monetary Fund
IOC	International Oil Companies
IPP	Independent Power Producer
ISO	International Organization for Standardization
JCS	Japanese Cable Maker's Association Standard
JEC	Japanese Electrotechnical Committee
JEAC	The Japan Electric Association
JEM	The Japan Electrical Manufacturers' Association
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
LNG	Liquefied Natural Gas
M/D	Minutes of Discussions
MCCB	Molded Case Circuit Breaker
MO	Market Operator

NBET	Nigeria Bulk Electricity Trading Plc
NBS	National Bureau of Statistics
NCC	National Control Center
NEGIP	Nigeria Electricity and Gas Improvement Project
NERC	Nigeria Electricity Regulatory Commission
NEPA	National Electric Power Authority
NIPP	National Integrated Power Project
NGL	Natural Gas Liquid
OJT	On the Job Training
OPEC	Organization of the Petroleum Exporting Countries
PHCN	Power Holding Company of Nigeria
PPP	Public Private Partnership
SCADA	Supervisory Control and Data Acquisition System
SVC	Static Var Compensator
SO	System Operation
TCN	Transmission Company of Nigeria
TSP	Transmission Services Provider
UNFPA	United Nations Fund for Population Activities
WMO	World Meteorological Organization
WB	World Bank

CHAPTER 1 BACKGROUND OF THE PROJECT

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1-1 Background of the Project

Nigeria is one of the world's major oil and natural gas producing countries. The actual peak load recorded is 4,810.7MW (25th August 2015) but the country's maximum power demand is estimated as 12,500 MW, and the power shortage hampers the economic growth.

Privatization of the power sector has enabled private companies to actively participate in Independent Power Producers (IPPs), which leads to an increase in the power generation capacity but also to the overloading of the transmission network capacity, which is currently approximately 5,000MW (2015). In Nigeria, a high ratio of reactive power, together with the insufficient capacity of power supply facilities, interferes with appropriate power supply. In particular, Federal Capital Territory (FCT), which has a higher population growth rate than any other cities in the country, is distant from power generation facilities and suffers considerably from voltage drops and power loss. The power supply to FCT and surrounding areas is unstable, resulting in only an average of eight hours power supply per day.

Possible measures to rectify such circumstances are to expand the capacity of substation facilities and improve the power factor of the electricity load on one hand, and, on the other, introduce phase modifiers that help reduce reactive power. For the former, the French Development Agency (AFD) already plans to implement a project worth USD 170 million to strengthen the transmission network. For the latter, no specific measure has been taken, but the Government of Nigeria (GoN) requested the Government of Japan to implement a Grant Aid "Project for Emergency Improvement of Electricity Supply Facilities in Abuja" to improve transmission facilities at substations in and around FCT to compensate for the reactive power.

1-2 Natural Conditions

(1) Topographical and Geological Survey Results

Prior to the Outline Design, the Team has collected documents and materials on the natural conditions, and conducted topographical and geological surveys on the project sites. The topographical surveys – more specifically, plane-table surveys using GPS – have been conducted to identify the locations of existing facilities and their landforms. The geological surveys – more specifically, cone penetration tests (CPTs) – have been conducted to find out the bearing capacities of the grounds, which are necessary to formulate equipment and facility plans.

Table 1-2.1 outlines the locations of the substations which are subject to the Project and have been surveyed on a subcontracting basis, together with the number of surveys conducted.

Table 1-2.1 Locations and Number of Subcontracted Surveys

No	Location	Latitude	Longitude	Geological survey	Topographical survey
1	Apo Substation	N 9°0’3.6”	E 7°29’21.8”	2 sites	2,783 m^2
2	Keffi Substation	N 8°48'20.9”	E 7°51’46.1”	2 sites	1,732 m^2
			Total	4 sites	4,515 m^2

Source: the Preparatory Survey Team

1) Topographical Conditions

Facilities to be procured under the Project will be installed within the premises of both Apo and Keffi Substations, where the landform is more or less flat. The grounds of the substations are sloped and designed to let rainwater run off to the surrounding of the premises or drainage trenches. Thus, it is desirable to adopt a form of foundation that will not interfere with the existing rainwater drainage as much as possible.

Appendix-6 shows drawings created based on the topographical surveys on Apo and Keffi Substations.

2) Ground Conditions

The locations of Apo and Keffi Substations are on the base rock zone of crystalline rock formed during the Precambrian, and the surface is made of sedimentary layers chiefly made of weathered base rock. The surveys show that the foundations of the project sites have relatively strong soil bearing capacities, and that the capacities are strong enough even at a shallow point.

Appendix-7 presents reports on the results of geological surveys at Apo and Keffi Substations.

(i) Apo Substation

The CPT has confirmed the presence of a fairly sound foundation 2.5m deep from the surface. The bearing capacity of the foundation around 1.5m deep varies. Thus, the minimum value out of the test findings (107kN/m^2) will need to be adopted as the bearing capacity of the foundation less than 1.5m deep.

Table 1-2.2 outlines the results of the CPT at Apo Substation.

Table 1-2.2 Results of Cone Penetration Test (Apo Substation)

Measurement depth (m)	Nature of layer	Geological feature	Bearing capacity (kN/m^2)
0.00-0.50	Firm cohesive soil	Having moderate shear strength and moderate compressibility	107
0.50-1.00	Firm cohesive soil	Having moderate shear strength and moderate compressibility	134

Measurement depth (m)	Nature of layer	Geological feature	Bearing capacity (kN/m^2)
1.00-1.50	Transition from firm cohesive soil to firmer cohesive soil	Having high shear strength but low compressibility	134
1.50-2.00	Transition from firm cohesive soil to firmer cohesive soil	Having high shear strength but low compressibility	222

Source: Preparatory Survey Team

(ii) Keffi Substation

The CPT has confirmed the presence of a fairly sound foundation 2.0m deep from the surface. The bearing capacity of the foundation down to 1.5m deep varies. The bearing capacity of the embankment foundation on the surface is likely to vary considerably, so the foundation will need to be constructed by avoiding the layer of a depth of 0.5m.

Table 1-2.3 outlines the results of the CPT at Keffi Substation.

Table 1-2.3 Results of Cone Penetration Test (Keffi Substation)

Measurement depth (m)	Nature of layer	Geological feature	Bearing capacity (kN/m^2)
0.00-0.50	Embankment	Having moderate shear strength and moderate compressibility	85
0.50-1.00	Firmer cohesive soil with gravels	Having high shear strength but low compressibility	208
1.00-1.50	Transition from firm cohesive soil with gravels and pebbles to firmer cohesive soil	Having high shear strength but low compressibility	257
1.50-2.00	Transition from firm cohesive soil with gravels and pebbles to firmer cohesive soil	Having high shear strength but low compressibility	505

Source: Preparatory Survey Team

(2) Climate Conditions

The climate of the project area can be divided into three seasons: the dry season (November to March), the rainy season (April to October) and Harmattan, the northeasterly dusty trade wind blowing from the Sahara Desert into the Gulf of Guinea between the dry and rainy seasons.

In the dry season, the maximum daytime temperature reaches around 37°C with a record high temperature of 40°C. The maximum daytime temperature is around 30°C in the rainy season and slightly above 28°C in August when it is the lowest. Thus, the temperature fluctuation throughout the year is fairly small, around 10°C. The daily temperature fluctuation ranges from 10°C to 20°C: it tends to be large in December (dry season) and small in the rainy season. The annual fluctuation in rainfall is fairly small, and it mostly rains in seven months of

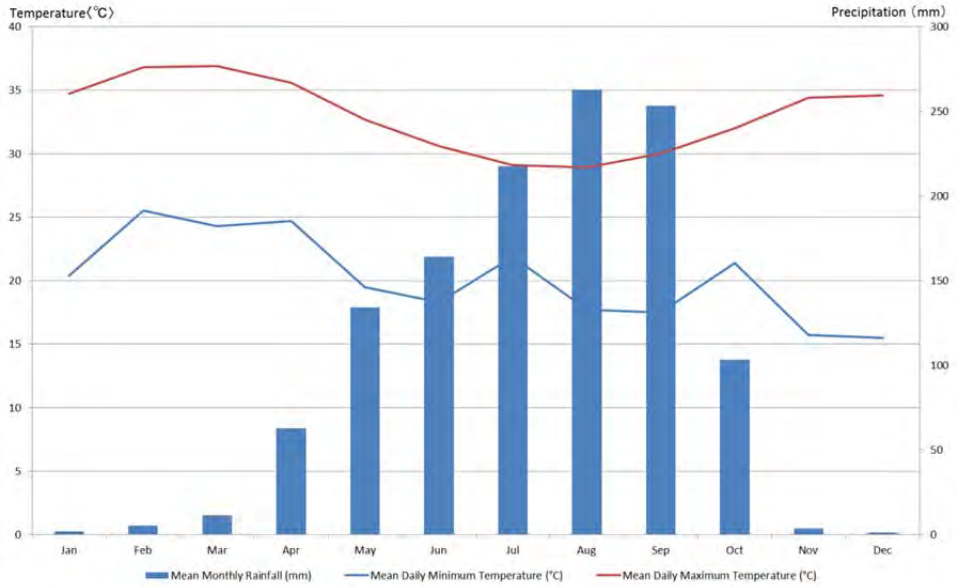
the rainy season (April to October).

Table 1-2.4 and Figure 1-2.1 show the annual temperature fluctuation and rainfall in the city of Abuja.

Table 1-2.4 Annual Temperature Fluctuation and Rainfall in Abuja

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean daily minimum temperature (°C)	20.4	25.5	24.3	24.7	19.5	18.3	21.9	17.7	17.5	21.4	15.7	15.5
Mean daily maximum temperature (°C)	34.7	36.8	36.9	35.6	32.7	30.6	29.1	28.9	30.0	32.0	34.4	34.6
Mean monthly rainfall (mm)	1.7	5.4	11.3	62.8	134.1	164.2	217.5	262.7	253.4	103.2	3.7	1.2
Mean number of rainy days (days)	0.1	0.2	1.3	4.2	9.4	12.3	14.0	16.2	15.9	8.0	0.3	0.0

Note: The figures are for the period from June 2003 to November 2014.
Source: WMO (World Meteorological Organization)World Weather Information Service



Note: The figures are for the period from June 2003 to November 2014.
Source: WMO （World Meteorological Organization）World Weather Information Service

Figure 1-2.1 Annual Temperature Fluctuation and Rainfall in Abuja

(3) Earthquake

There is no record of any earthquake in Nigeria.

1-3 Environmental and Social Considerations

(1) Legal System on Environmental Impact Assessment

1) Major laws and regulations

The table below lists major environmental laws and regulations in Nigeria.

Table 1-3.1 Major Environmental Laws and Regulations

Name of law	Year
The Constitution of the Federal Republic of Nigeria	1998
The Land Use Act	1990
The Nigerian Urban and regional Planning Act	1992
Harmful Waste (Special Criminal Provisions) Act	1988
Hydrocarbon oil Refinery Act	1965
Forest Act	1958
Endangered Species Act	1985
Inland Fisheries Act	1992
Sea Fisheries Act	1992
Exclusive Economic Zone Act	1978
Factories Act	1987
Nigeria Water Resources Decree	1974
Nigerian Mineral and Mining Act	1993
Federal National Parks Act	2007

Source: Preparatory Survey Team

The Constitution of the Federal Republic of Nigeria refers to the importance of protection and improvement of the environment, but there is no particular law such as “environmental protection law” that comprehensively covers the environmental preservation, protection and management.

The environmental preservation in the country is under the management of the Federal Ministry of Environment (FME).

2) Environmental Assessment System

(i) Outline of the System

Nigeria has the following laws and regulations on environmental assessment.

- Environment Impact Assessment (EIA) Decree No.86, 1992

  The decree requires environmental assessments for all development projects that have any possible negative impact on the environment.

- EIA Procedural Guideline, 1992

  The guideline prescribes the procedures related to EIA in projects ranging from the planning to implementation, and the procedures for acquisition of EIA approvals.

- EIA Sectoral Guidelines for Transmission Lines

  EIA guidelines for each major sector are available. A guideline for the development of power transmission and distribution lines is also available, which refers to general negative impact of the development of power transmission lines such as land acquisition and relocation of residents under transmission lines, impact on landscape, impact of removal of vegetation on ecological systems, and noise and vibration.

(ii) Categorization of Development Projects

The EIA Decree No.86 of 1992 divides development projects into three categories in the light of the nature, magnitude and other factors of their environmental impacts.

Category I: projects requiring approval based on full-scale EIA survey (equivalent to Category A of the JICA Guidelines)

Category II: projects requiring approval based on "Initial Environmental Examination (IEE) level" survey (equivalent to Category B of the JICA Guidelines)

Category III: Projects that can be approved without EIA or IEE-level survey

A supplementary provision of the EIA Decree No. 86, "13. Power Generation and Transmission", classifies power development projects into Category I and divides them into the development of thermal power generation (10MW or greater), hydropower generation and dam, combined cycle power generation and nuclear power generation. It includes no particular description about power transmission networks.

(2) EIA of the Project

The Project plans to enhance power supply facilities on the premises of the substations owned and operated by TCN and requires none of land acquisition, deforestation, soil improvement and any other activity having negative impact on the environment. Thus, it is not necessary to conduct environmental assessment.

CHAPTER 2 CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Project Purpose

Transmission Company of Nigeria (TCN) plans to extend the country's power transmission network to enhance the transmission capacity and improve the reliability of the power system toward the target year of 2020. To this end, TCN prepared a report entitled "Appraisal of Transmission Project (March 2014)" that outlines power transmission projects and investment plans. Currently, TCN is enhancing the power transmission network and substation facilities across the country based on the report. The report regards the facilities in FCT which the Nigerian government requested the Japanese government to improve in this Project as components that in fact need to be urgently improved. The project purpose has been set out as follow.

Project Purpose: The power supply to Federal Capital Territory and surrounding areas is improved.

To avoid the necessity of replacement of facilities before they complete their service lives, the target year of the facility plan will be set at 10 years after the commencement of services in the light of consistence with the other similar Grant Aid projects. On the other hand, the target year of the project evaluation including beneficiary effects will be set at three years after the commencement of services.

Target year of project evaluation: **3 years' time after the commencement of services (scheduled to be 2020)**

Target year of facility plan: **10 years' time after the commencement of services (scheduled to be 2027)**

2-1-2 Outline of the Project

This Project will procure and install necessary materials and equipment to improve the power supply facilities in Federal Capital Territory (FCT), thereby contributing to improvements in the power supply situations in the territory and surrounding areas where the insufficient capacity of power supply facilities and insufficient upgrading of these facilities due to financial constraints seriously interfere with social and economic activities.

The Project will cover procurement and installation of major facilities outlined in table 2-1-2.1, on-the-job training (OJT) and soft components, and related materials and equipment.

Table 2-1-2.1 Outline of Major Facilities subject to the Project

Substation	Location	Contents	Major equipment and specifications
132/33kV Apo Substation	FCT	Procurement and installation of equipment related to power capacitor	Power capacitor 60MVar, 132kV

Substation	Location	Contents	Major equipment and specifications
132/33kV Keffi Substation	Nasarawa State	Procurement and installation of equipment related to power capacitor	Power capacitor 25MVar, 132kV

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

The Project will procure and install power capacitor and switchgear necessary for maintenance, operation and protection of the power capacitors in the premises of the existing 132/33kV Apo and 132/33kV Keffi Substations. Any expansion programs of the substations will be carefully considered and the Project will be designed in line with future plans of TCN.

The expected effects of the Project on the power transmission network will be analyzed, and the most efficient set of components with appropriate capacities will be selected. The Project will install a set of power capacitor, substation equipment and switchgear, and control/protection panel for these components in the existing control room of each substation. A set of power capacitor consists of capacitor unit, series reactor, discharge coil, insulating transformer, surge arrestor and insulating pedestal, and the substation equipment and switchgear include gas circuit breaker, disconnecting switch and gantry.

2-2-1-2 Policy on Natural Conditions

(1) Temperature/Humidity Conditions

The monthly average maximum daytime temperature is high throughout the year on the project sites, ranging between 28.9°C and 36.9°C. Thus, the Project will procure substation facilities in the light of the high temperature and ensure that these facilities will operate and be maintained properly even if the room temperature or humidity rises temporarily because of high outdoor air temperature or direct sunlight from outside.

(2) Rainfall and Lightening

It heavily rains around the project sites in the rainy season so that drainage measures must be taken to prevent rainfall from interfering with the operations of equipment to be installed. The sites where equipment is installed are on well-prepared grounds, but the grounds must be reasonably sloped to let rainwater run off to the surrounding of the premises or drainage trenches when the Nigerian side performs land preparation and ground leveling.

The surge counters installed on the project sites indicate that there were lightning strikes on the premises of the substations, and thus it is necessary to take measures against lightning strikes during the installation work of structures, build protection facilities against lightning infiltration from the power transmission and distribution lines, and ensure grounding.

2-2-1-3 Policy on Social and Economic Conditions

Electric outage is frequent in FCT, where the capital city of Abuja is located and the Nigerian government encourages private investment in construction of power stations and substations. The country thus has large expectations for improvements in the power supply conditions.

Equipment to be procured and supplied under the Project must greatly contribute to improvement in the power supply conditions of FCT in the light of a long-term perspective of Nigerian social and economic circumstances. To this end, the Project must not just develop physical infrastructure such as procurement of equipment but also promote better operations of the substation facilities through technological transfer and other means.

2-2-1-4 Policy on Circumstances Affecting Construction

In FCT, there are quite a few local and foreign-capital construction companies, which have experienced various construction works ranging from large to small projects. But there are not enough engineers and skilled workers with advanced skills and knowledge about process control from quality control to completion of construction.

Thus, when the foundation work and installation work are conducted for the substation facilities, it is important to have Japanese engineers with such advanced skills and knowledge engaged in process control to ensure the technological transfer related to quality and process control and skills of management and supervision of equipment facilitation.

2-2-1-5 Policy on Use of Local Contractors, Materials and Equipment

Substation facilities including structure and post insulators will be procured in Japan, but because construction materials and equipment necessary for the foundation work of the facilities can be locally procured, the Project will actively use local contractors, materials and equipment.

2-2-1-6 Policy on Operation and Maintenance Capacity of the Implementing Agency

TCN has conducted power transmission projects across the country since 2012 when it was unbundled from the electricity authority and has the O&M capacity for equipment to be procured under the Project.

However, there is room for improvement at the substations, where currently no maintenance workers are stationed, only system operators work in shifts for 24 hours every day daily inspects are not regularly conducted. Thus, the Project will review and reorganize the O&M system through technology transfer, and improve the O&M capacity at the target substations.

2-2-1-7 Policy on the Scope and Technological Level of Facilities, Equipment, etc.

The scope and technological level of materials and equipment to be procured and installed under the Project will be determined in the light of the conditions described so far and in accordance with the following basic policies.

(1) The Scope of Facilities and Equipment

To make technically and economically appropriate designing, the Project will adopt standard materials and equipment satisfying IEC or other international standards, as well as the minimum necessary compositions, specifications and quantities by using small numbers of types of materials and equipment, and work items for higher compatibility.

(2) The Technological Level

The Project will take into account the technological level of the sections and departments that will be in charge of O&M after the completion of the Project, and thus adopt components of simple specifications.

2-2-1-8 Policy on Construction/Procurement Methods, and Construction Schedule

Materials and equipment to be procured in Japan will be transported to Nigeria mainly by sea. They will be then transported from Port of Lagos by land to the project sites. But the distance from the port to the furthest project site, Keffi Substation, is approximately 800km, so that it is necessary to make an appropriate transport schedule that meets the local situations by taking into account the necessary travel time and ensuring the safety transport.

The schedule of local construction work will be determined chiefly in the light of the following matters.

- The actual work will be conducted near live parts within the existing substations and thus must be scheduled so that it will neither interfere with the O&M of the existing facilities nor impair their functions. To this end, it is necessary to find out the nature, dates, periods and other details of O&M operations for the existing facilities in advance.
- A half of Nigeria's population are Muslim, and Islamic practices including the one-month long Ramadan (once a year) and religious exercise during working hours may lead to a fall in the work efficiency. The number of Muslims in Abuja is smaller than that in the northern part of the country, but the construction schedule must be made in the light of these factors.

2-2-2 Basic Plan

2-2-2-1 Prerequisites for Planning

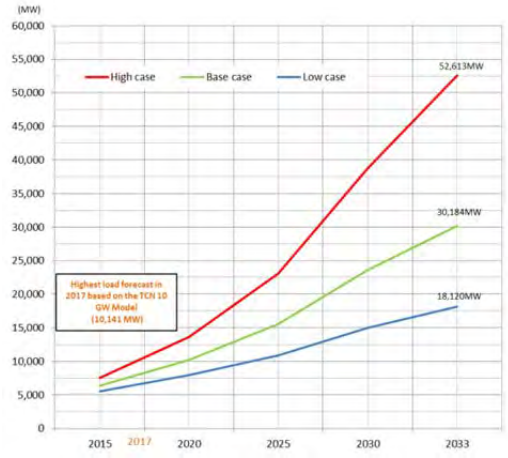
(1) Existing Power Demand Forecasts and TCN Demand Forecast

As for power demand forecasts for Nigeria, forecasts by a Belgian consultant Tractebel

Engineering and a local consultant Omega System are available. They worked together and issued the final report in April 2009.

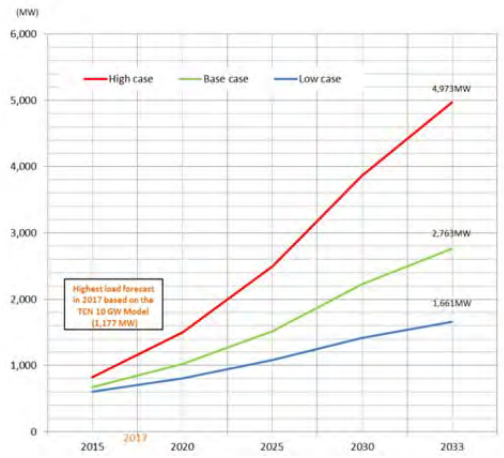
TCN does not regularly update the forecasts by Tractebel Engineering and Omega System, and the power demand has been considerably growing lately and there is also potential demand, so TCN is planning to update the forecasts for the entire country with the support of donors.

TCN also conducts system analysis by using values of “high case” demand forecast published in April 2009. Figure 2-2-2-1.1 shows the nationwide power demand forecast together with the value which TCN adopted in the power system model. Figure 2-2-2-1.2 shows the power demand forecast of Shiroro Area as well. Considering that this report is the sole official one and TCN also utilized its values, this Survey will use the same values of the power demand forecast for the power flow analysis.



Sources: Prepared by the Study Team based on the Final Report National Load Demand Forecast-2009 and nationwide power system model of Nigeria

Figure 2-2-2-1.1 Comparison between Existing Power Demand Forecasts and TCN Demand Forecast (2017) (nationwide)



Sources: Prepared by the Study Team based on the Final Report National Load Demand Forecast-2009 and nationwide power system model of Nigeria

Figure 2-2-2-1.2 Comparison between Existing Power Demand Forecasts and TCN Demand Forecast (2017) (Shiroro Area)

(2) Implementation of Undertakings by the Nigerian Side

Before the Japanese side starts construction work, the Nigerian side will be required to procure some materials and equipment and conduct installation work out of the components they themselves requested. The Nigerian side will also be requested to undertake the following tasks for appropriate, sustainable and effective use of the facilities to be procured under the Project, and for appropriate operations of voltage (O&M) and the substations (management).

Incidentally, the Federal Ministry of Power, TCN and JICA discussed and agreed on these undertakings by the Nigerian side in the Minute of Discussion (M/D) signed on November 19,

2014.

[Apo Substation]

- The Nigerian side will restore transformer, switchgear, structure, arrestor and other pieces of equipment that became unusable or were damaged due to the lightning strike in September 2014.
- The Nigerian side will replace or repair damaged control panels and related facilities in the control building by December 2015 so that they will not interfere with the installation work by the Japanese side.

[Keffi Substation]

- The Nigerian side will calibrate power meters of the 132kV control panel, and reactive power meters and other indicators in the control building for the existing transformer by December 2015.

[Katampe Substation]

- The Nigerian side will commission inspections of power capacitors (2 sets of 330kV, 50MVar) and transformer (330/132kV, 150MVA) which are under installation by the end of 2015.

[Gwagwalada Substation]

- TCN will install the shunt reactor (330kV, 75MVar) delivered to the substation.

(3) The Power System in FCT in the Project Target Year

1) Current State of Power Distribution Facilities

TCN formulated a project plan to increase the power transmission capacity to 20,000MW by 2020 and is working to expand the power transmission network through the National Integrated Power Project (NIPP) with the support of various donors. TCN also has projects to expand the transmission network and build substations with the financial support of French Development Agency (AFD) worth USD 170 million in FCT. Currently, electricity to FCT is supplied chiefly from hydropower stations in the Mid-Western Region such as Jebba and Shiroro Hydropower Stations, and thermal power stations in the south. But the power source of FCT is shifting to thermal power generation to avoid supply shortage from hydro power stations in the dry season. When the AFD-financed project is completed and the facilities are put into services, electricity generated by thermal power stations in the southeast will also be supplied to FCT, which changes the trend in the power system. According to hearings to AFD, the project will be completed by 2017, so the power flow analysis in this Survey has covered the components of the AFD-financed projects.

2-2-2-2 Power Flow Analysis

The Team has conducted power flow analysis on the Project after the commencement of services to confirm the relevance and effectiveness of components requested by the Nigerian government.

(1) Basic Policy on Power Flow Analysis in the Survey

Table 2-2-2-2.1 shows the basic policy on power flow analysis, which has chiefly focused on FCT and Shiroro Area, where the surrounding area is included, out of the nationwide power system model (hereinafter called the "10GW Power System Model") obtained from TCN.

Table 2-2-2-2.1 Basic Policy on Power Flow Analysis

Item	Basic policy
Purpose	- Verifying the relevance and necessity of the requested components, and considering the rated capacity of substation facilities to be provided under the Project
Scope	- Shiroro Area (Area-3) (System mock covers Nigeria as a whole.)
Voltage	- Power substation facilities at the four substations covered by the request (132kV and 33kV bus line voltages)
Demand	- TCN power demand forecast is adopted. - Power factor: 93% (the average PF in Shiroro Area from the TCN 10GW Power System Model in 2017)
Major cross-section	- Period around the introduction of the requested components in the service commencement year scheduled in 2017
Evaluation method	- Confirming overload of transformer (within 100% of the regular capacity) - Confirming voltage sensitivity after the installation of phase modifying facilities - Confirming three-phase short-circuit electric current at the substations
Prerequisite	- Components under preparation with the support from AFD are connected to the power system and put into service.

Source: Preparatory Survey Team

(2) Basic Data for Power Flow Analysis

1) Demand Forecast

The power flow analysis has used TCN power demand forecast (based on the "10GW Power System Model"). The forecast is based on the currently available National Load Demand Forecast-2009 as nationwide power demand forecast.

To clarify the effects of power capacitor and shunt reactor, the analysis was made on the peak load time and off peak load time.

2) Supply Facilities

The analysis has regarded the TCN 10GW Power System Model as a base, and included the facility plan of the afore-mentioned AFD-financed project.

3) Phase Modifying Facilities

The analysis has taken the phase modifying facilities on the 2017 data in the "10GW power System Model" as existing facilities, and added capacitor or reactor if either of them is needed

to maintain the voltage within the appropriate range.

4) Short Circuit Current

The analysis has used a constant set in the power flow analysis model data as the generator constant necessary for calculation of short-circuit electric current.

(3) Building of System Model

Based on the basic data described above, the analysis has built a system model by incorporating the components of the AFD-financed project into the “10GW Power System Model”.

The analysis has built the system model appropriate for the Project, while confirming the consistency with the “10GW Power System Model”, the TCN plan to expand the transmission network, the NIPP in progress, and other power development projects.

(4) Power Flow Analysis

1) Case Studies

Because phase modifying facilities are the major components requested under the Project, the analysis has examined the peak load and off-peak load as described in the basic policy for power flow analysis, and conducted the following case studies to verify the relevance and necessity of the components requested.

<Assumptions at the peak load time>

Case 01: Prior to the commencement of services of the components requested

Case 02: Installation of the component requested, 60[MVar] power capacitor in Apo Substation

Case 03: Installation of the component requested, 25[MVar] power capacitor in Keffi Substation

Case 04: Installation of the component requested, SVC＋25[MVar] leading reactive power in Katampe Substation

Case 05: Installation of the component required, combination of 60[MVar] power capacitor in Apo Substation and 25[MVar] power capacitor in Keffi Substation

Table 2-2-2-2.2 Case Studies for Peak Load Time

Substation	No. S/N	Voltage [kV]	Capacity [MVar]	Case 01	Case 02	Case 03	Case 04	Case 05
Apo	26	132	60	×	○	×	×	○
	60	132	20	○	○	○	○	○
Keffi	29	132	25	×	×	○	×	○
Katampe	-	330	-75	×	×	×	×	×
	Unknown	330	50(±25)/SVC	×	×	×	○ (+25MVar)	×
Gwagwalada	-	330	-75	×	×	×	×	×

Remarks: Blue-hatching: facilities other than the components requested, and orange-hatching: components outside the peak time
Source: Preparatory Survey Team

<Assumptions at the off-peak load time>

Case 06: Prior to the commencement of services of the components requested

Case 07: Installation of the component requested, 75[MVar] shunt reactor in Gwagwalada Substation

Case 08: Installation of the component requested, SVC－25[MVar] lagging reactive power in Katampe Substation

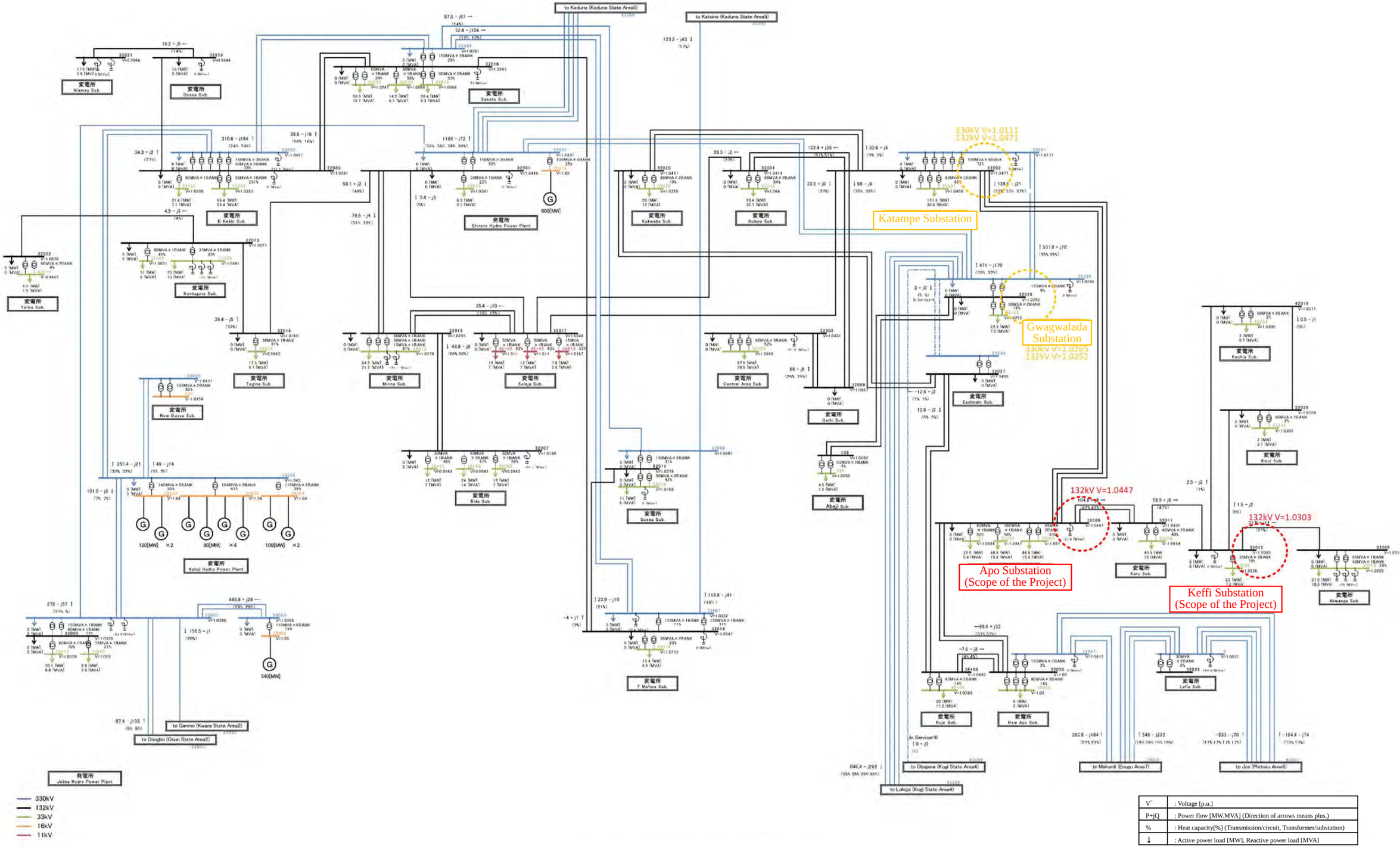
Table 2-2-2-2.3 Case Studies for Off-Peak Load Time

Substation	No. S/N	Voltage [kV]	Capacity [MVar]	Case 06	Case 07	Case 08
Apo	26	132	60	×	×	×
	60	132	20	×	×	×
Keffi	29	132	25	×	×	×
Katampe	-	330	-75	○	○	○
	Unknown	330	50(±25)/SVC	×	×	○(－25MVar)
Gwagwalada	-	330	-75	×	○	×

Remarks: Blue-hatching: facilities other than the components requested, and orange-hatching: components outside the off-peak time
Source: Preparatory Survey Team

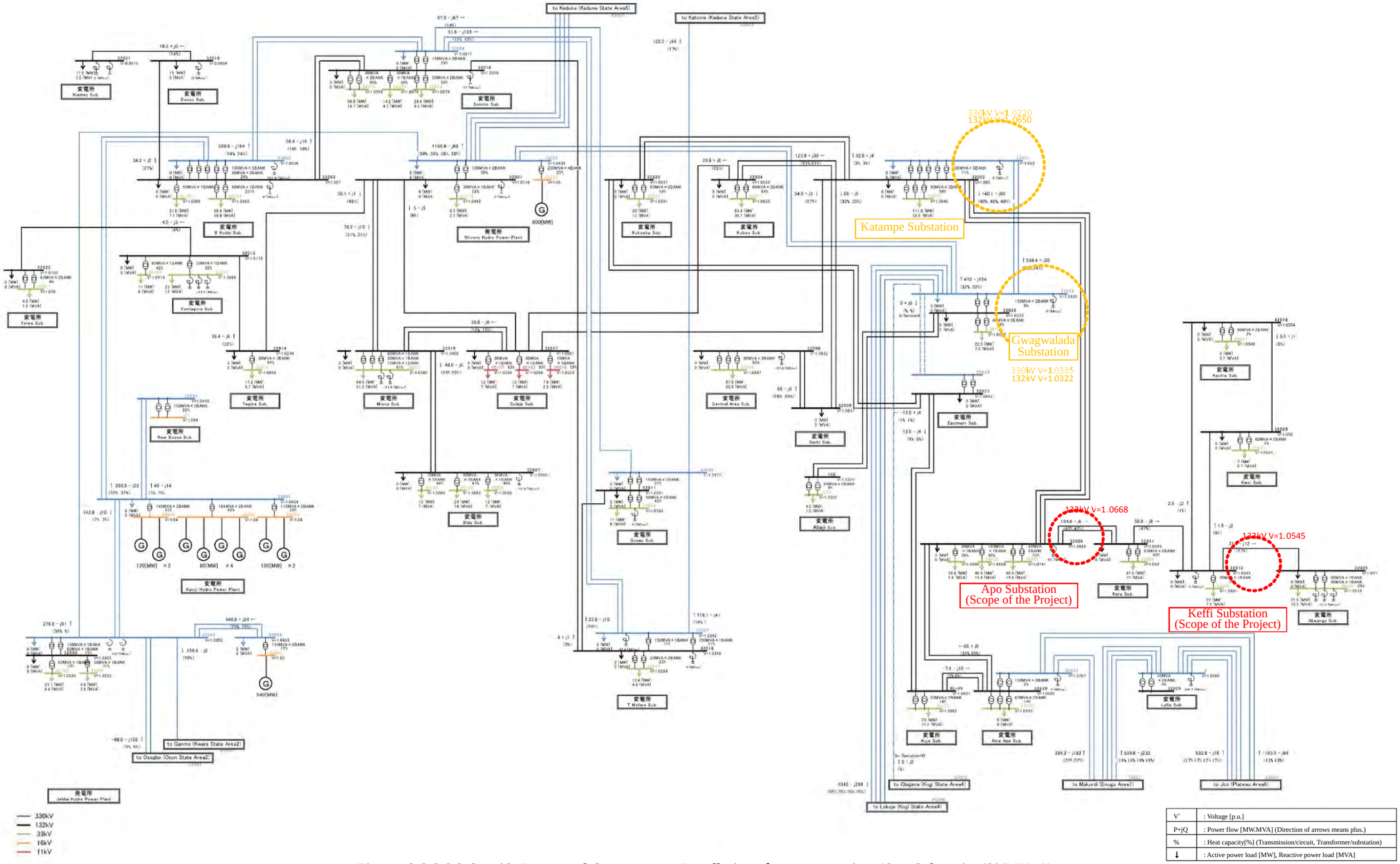
2) Results of Power Flow Analysis

Figures 2-2-2-2.1 to 2-2-2-2.8 show the results of power flow analysis at the cross-section in each fiscal year.

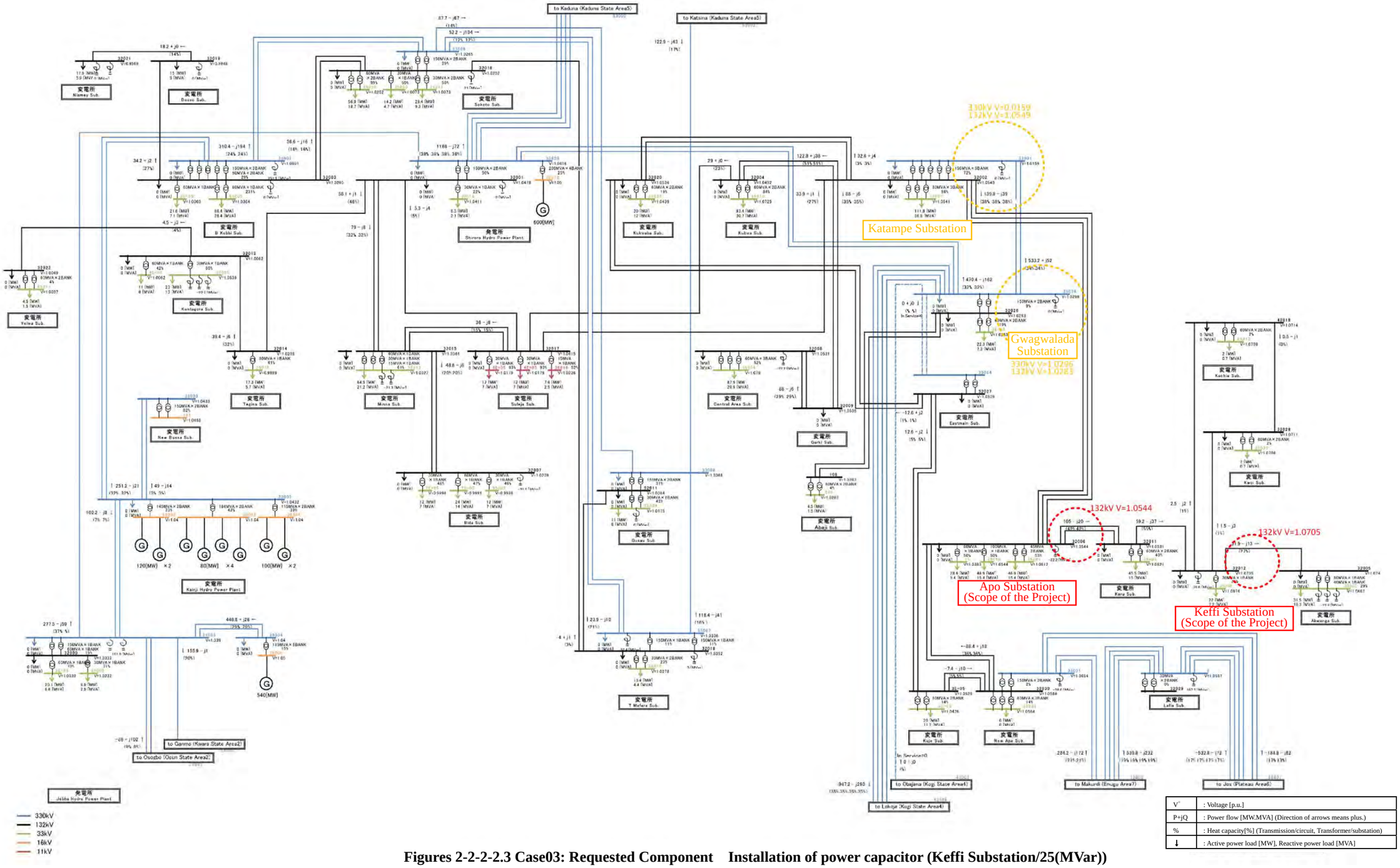


V˙	: Voltage [p.u.]
P+jQ	: Power flow [MW,MVA] (Direction of arrows means plus.)
%	: Heat capacity[%] (Transmission/circuit, Transformer/substation)
↓	: Active power load [MW], Reactive power load [MVA]

Figures 2-2-2-2.1 Case01: Before the operation of the requested components

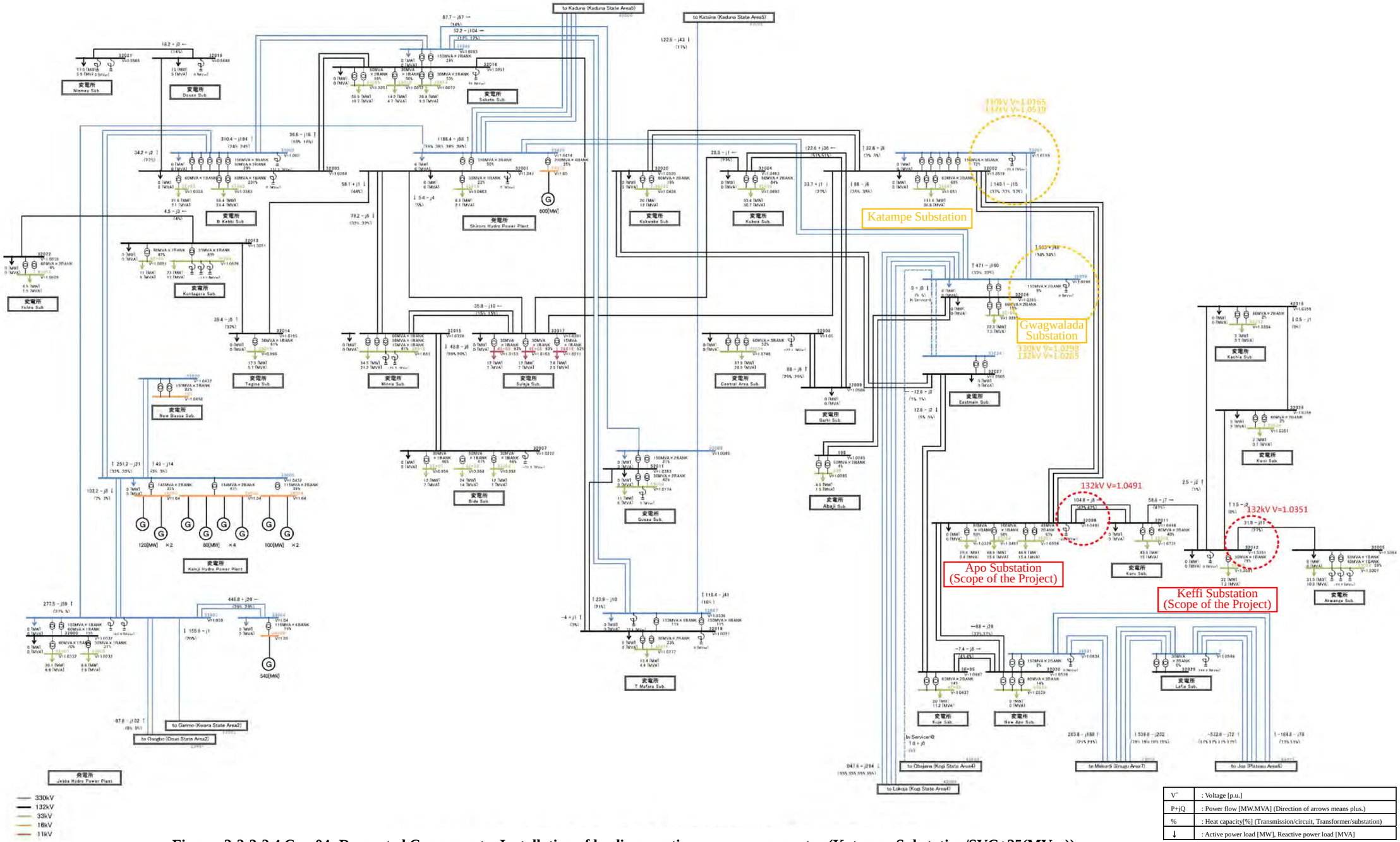


Figures 2-2-2-2.2 Case02: Requested Component Installation of power capacitor (Apo Substation/60(MVar))

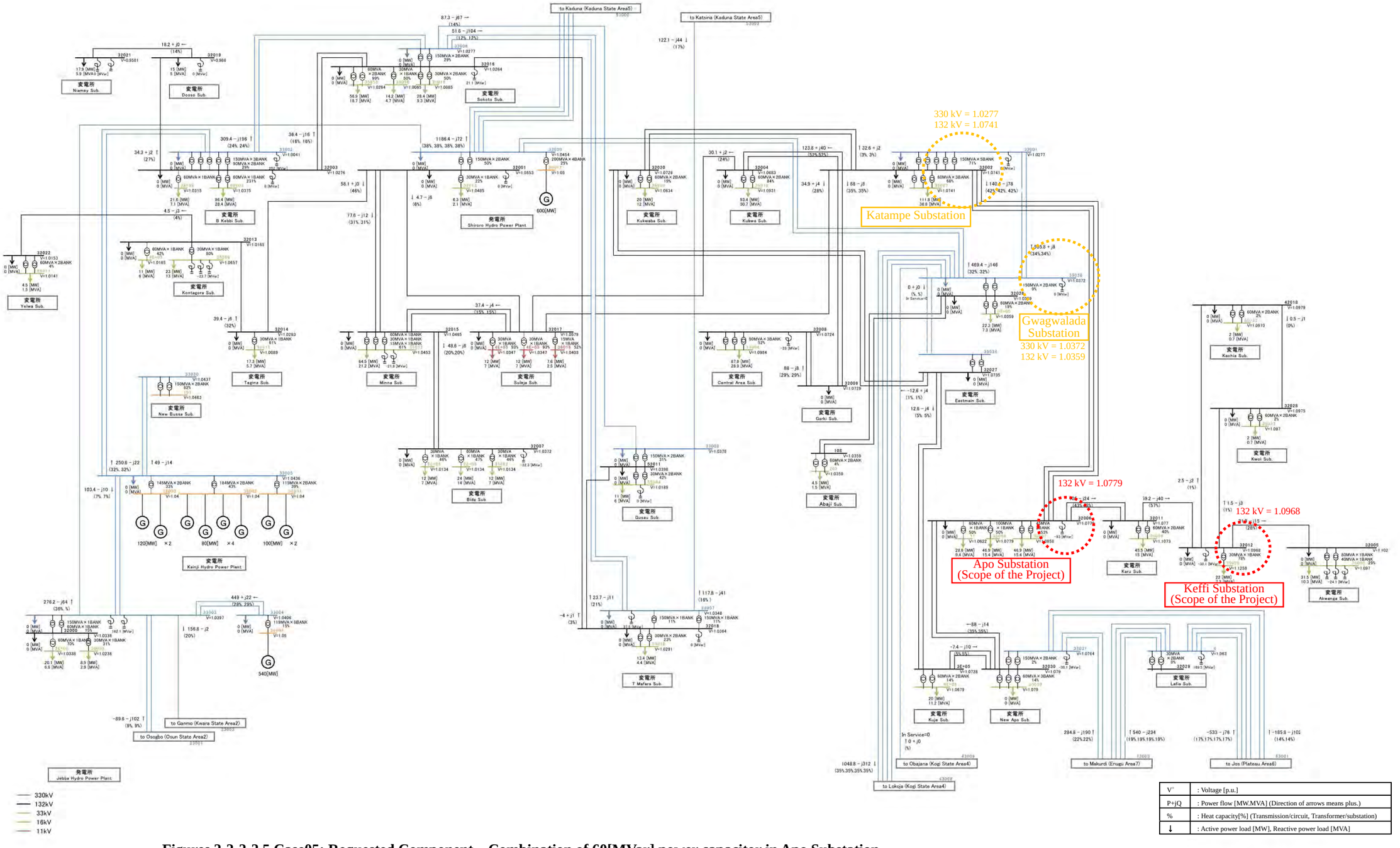


V⁻	: Voltage [p.u.]
P+jQ	: Power flow [MW,MVA] (Direction of arrows means plus.)
%	: Heat capacity[%] (Transmission/circuit, Transformer/substation)
↓	: Active power load [MW], Reactive power load [MVA]

Figures 2-2-2-2.3 Case03: Requested Component　Installation of power capacitor (Keffi Substation/25(MVar))

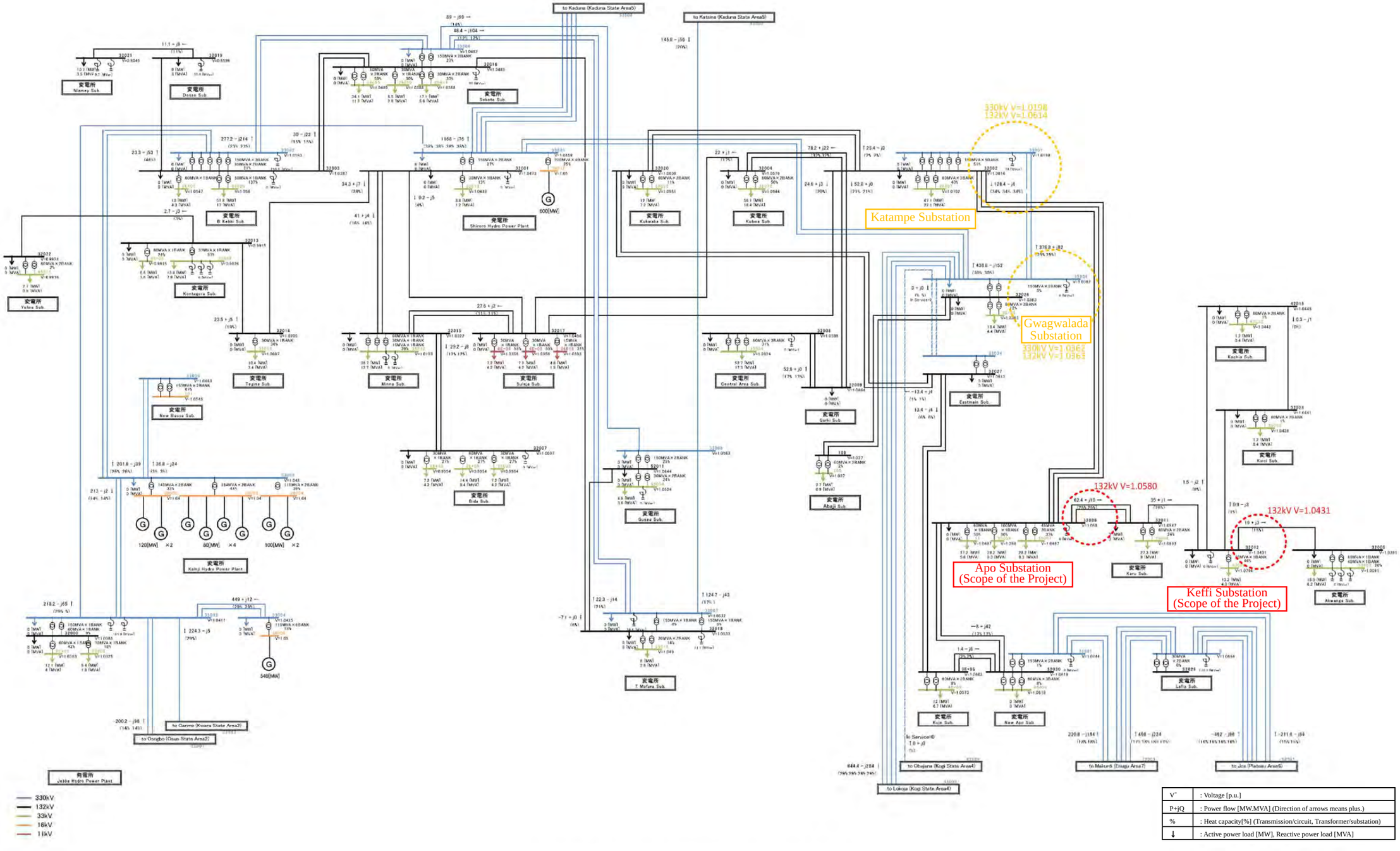


Figures 2-2-2-2.4 Case04: Requested Component　Installation of leading reactive power compensator (Katampe Substation/SVC+25(MVar))

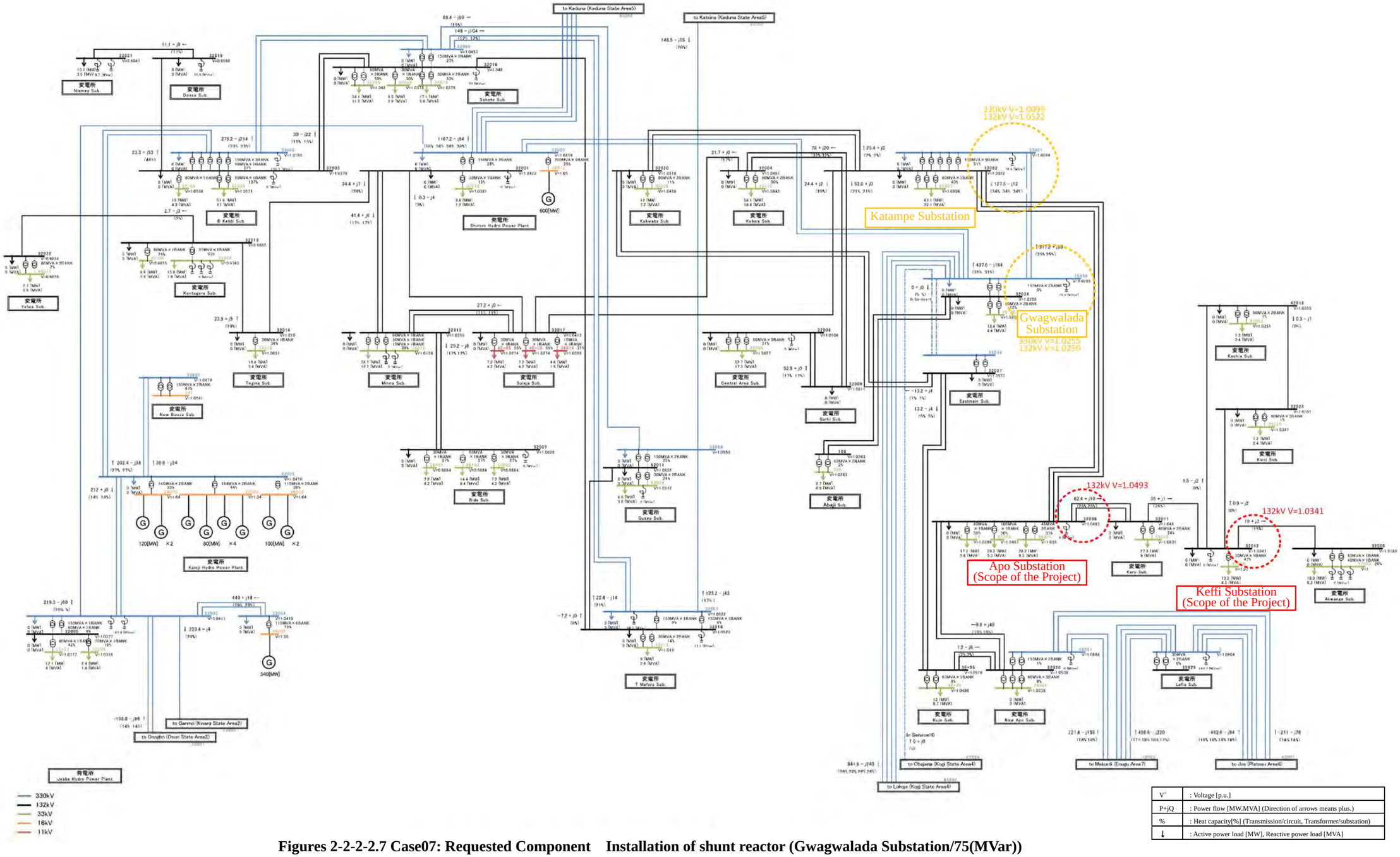


V=	: Voltage [p.u.]
P+jQ	: Power flow [MW,MVA] (Direction of arrows means plus.)
%	: Heat capacity[%] (Transmission/circuit, Transformer/substation)
↓	: Active power load [MW], Reactive power load [MVA]

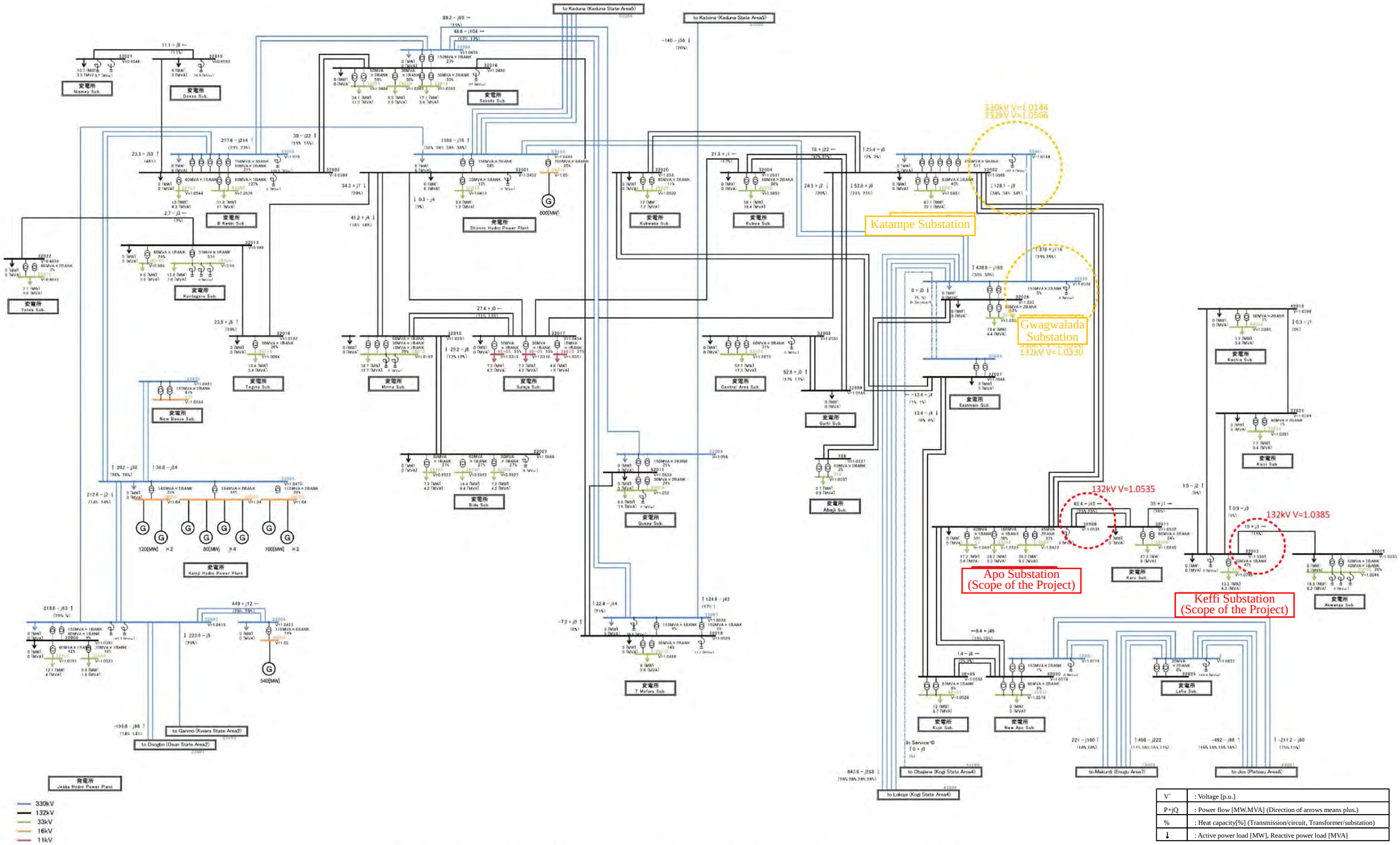
Figures 2-2-2-2.5 Case05: Requested Component　Combination of 60[MVar] power capacitor in Apo Substation and 25[MVar] power capacitor in Keffi Substation



Figures 2-2-2-2.6 Case06: Before the operation of the requested components (off-peak)



Figures 2-2-2-2.7 Case07: Requested Component　Installation of shunt reactor (Gwagwalada Substation/75(MVar))



Figures 2-2-2-2.8 Case08: Requested Component　Installation of lagging reactive power compensator (Katampe Substation/SVC-25(MVar))

3) Effects of the Components Requested under the Project

(i) Installation of 60[MVar] power capacitor in Apo Substation

A comparison has been made between Case 01, the state prior to the commencement of services of the components requested, and Case 02, where 60MVar power capacitor is installed in Apo Substation. As Table 2-2-2-2.4 shows, the voltage sensitivity (percentages in the brackets) at Apo and Keffi Substations is expected to increase by 2.0 – 2.5%. The average voltage sensitivity of 132kV bus line is also expected to increase by nearly 2%.

(ii) Installation of 25[MVar] power capacitor in Keffi Substation

A comparison has been made between Case 01, the state prior to the commencement of services of the components requested at the peak load time, and Case 03, where 25MVar power capacitor is installed in Keffi Substation. As Table 2-2-2-2.4 shows, the voltage sensitivity at Keffi Substation is expected to increase by 4.02%, indicating a considerable effect of the installation.

(iii) Installation of 50[MVar (±25MVar)] static var compensator (SVC) in Katampe Substation

Because SVC is requested to be introduced to Katampe Substation, the effects of the installation have been examined in terms of both leading and lagging reactive power. The examination of lagging reactive power is conducted at the item (v) in the next page.

<Installation of SVC＋25[MVar] leading reactive power in Katampe Substation>

A comparison has been made between Case 01 at the peak load time and Case 04, where SVC (+25MVar) leading reactive power is installed in Katampe Substation. As Table 2-2-2-2.4 shows, the voltage sensitivity at the substation increased by approximately 0.48% only, indicating a small effect of the installation.

Table 2-2-2-2.4 Results of Power Flow Analysis at Peak Load Time

Substation	Rated voltage [kV]	Voltage [pu]				
		Case 01	Case 02	Case 03	Case 04	Case05
Appo	132	1.0447	1.0668 (2.21%)	1.0544 (0.97%)	1.0491 (0.44%)	1.0779(3.32%)
Keffi	132	1.0303	1.0545 (2.42%)	1.0705 (4.02%)	1.0351 (0.48%)	1.0968(6.65%)
Katampe	330	1.0111	1.0220 (1.09%)	0.0159 (0.48%)	1.0165 (0.54%)	1.0277(1.66%)
	132	1.0471	1.0650 (1.79%)	1.0549 (0.78%)	1.0519 (0.48%)	1.0741(2.70%)
Gwagwalada	330	1.0265	1.0335 (0.70%)	1.0296 (0.31%)	1.0298 (0.33%)	1.0372(1.07%)
	132	1.0252	1.0322 (0.70%)	1.0283 (0.31%)	1.0285 (0.33%)	1.0359(1.07%)
Average voltage sensitivity of 132kV bus line*1			1.78%	1.52%	0.43%	4.17%
Average voltage sensitivity of 330kV bus line*1			0.90%	0.40%	0.43%	1.36%

Remarks: The percentages in the brackets are all voltage sensitivity with Case 06 as the base.
*1 an average of the 4 substations subject to the Project.
Source: Preparatory Survey Team

(iv) Installation of 75[MVar] shunt reactor in Gwagwalada Substation

A comparison has been made between Case 06, the state prior to the commencement of services of the components requested at the off-peak load time, and Case 07, where 75MVar shunt reactor is installed in Gwagwalada Substation. As Table 2-2-2-2.5 shows, the voltage sensitivity at Gwagwalada Substation will decrease by approximately 1.0%, indicating a small effect of the installation.

(v) Installation of 50 [MVar (±25MVar)] SVC in Katampe Substation

<Installation of SVC－25[MVar] lagging reactive power in Katampe Substation>

A comparison has been made between Case 06 at the off-peak load time and Case 08, where SVC (-25MVar) lagging reactive power is installed in Katampe Substation. As Table 2-2-2-2.5 shows, the voltage sensitivity at Katampe Substation will decrease by approximately 0.48%, indicating a small effect of the installation.

Table 2-2-2-2.5 Results of Power Flow Analysis at Off-Peak Load Time

Substation	Rated voltage [kV]	Voltage [pu]		
		Case 06	Case 07	Case 08
Apo	132	1.0580	1.0493 (-0.87%)	1.0535 (-0.45%)
Keffi	132	1.0431	1.0341 (-0.90%)	1.0385 (-0.46%)
Katampe	330	1.0198	1.0099 (-0.99%)	1.0144 (-0.54%)
	132	1.0614	1.0522 (-0.92%)	1.0566 (-0.48%)
Gwagwalada	330	1.0362	1.0255 (-1.07%)	1.0328 (-0.34%)
	132	1.0363	1.0256 (-1.07%)	1.0330 (-0.33%)
Average voltage sensitivity of 132kV bus line[*1]			-0.94%	-0.43%
Average voltage sensitivity of 330kV bus line[*1]			-1.03%	-0.44%

Remarks: The percentages in the brackets are all voltage sensitivity with Case 06 as the base. *1* an average of the 4 substations subject to the Project.

Source: Preparatory Survey Team

4) Confirmation of Short Circuit Current

The three-phase short circuit current has been calculated with the PSSE data which has been used for the power flow analysis. Table 2-2-2-2.6 shows the results of the calculation, indicating that it is within the indicator of short circuit current of 31.5kA (132 kV and 330 kV) and 25 kA (33 kV) respectively, and that the facilities planned have no particular problem.

Table 2-2-2-2.6 Short Circuit Current

Substation	Bus line voltage [kV]	Short-circuit electric current [kA]
Apo	132	13.69
	33(45MVA×2Banks)	12.48
	33(100MVA×1Bank)	14.41
	33(60MVA×1Bank)	9.66
Keffi	132	3.13
	33	3.64
Gwagwalada	330	12.20
	132	8.79
Katampe	330	8.38
	132	15.30
	33	21.48

Remarks: For reactance of power generator, the default value in the PSSE data has been used. In this regard, it has been compared with the value corresponding to Xd (subtransient reactance) when comparing with reactance of Japanese power generator.

Source: Preparatory Survey Team

(i) Evaluation of Relevance and Effectiveness of the Equipment as Project Components

The introduction of power capacitors to Apo and Keffi Substations is expected to increase the voltage sensitivity at all the substations subject to the Project by approximately 1.5 – 2.0% on average. On the other hand, the introduction of shunt reactor to Gwagwalada Substation and SVC to Katampe Substation will have a small effect, a decrease in the voltage sensitivity of 1.0% or less only.

Based on the findings of the power flow analysis, the Team has concluded that the importance and priority should be given to project components to be installed in Apo and Keffi Substations.

2-2-2-3 Overall Plan

(1) Design Conditions

The design conditions for the project planning will be as follows.

1) Meteorological Conditions

Table 2-2-2-3.1 shows the meteorological conditions to be applied to designing of substation facilities and the foundation.

Table 2-2-2-3.1 Meteorological Conditions

Item	Apo Substation	Keffi Substation
Altitude of the ground	483 m above sea level	314 m above sea level
Ambient temperature (max)	36.9℃	
Ambient temperature (min)	15.5℃	
Ambient temperature (ave.)	27.0℃	
Maximum wind speed	33.5 m/sec.	
Annual rainfall	1,221 mm	
Seismic force	Not taken into account	
Soil bearing capacity	8.5 t/m^2 (based on the geological survey results)	

Source: Preparatory Survey Team

2) Design Conditions (132kV System)

Table 2-2-2-3.2 132 kV Electric System

Item	Applicable specifications
Nominal voltage	132kV (3-phase 3-wire system)
System maximum voltage	145.0 kV
System minimum voltage	118.8 kV
Frequency	50 Hz
Maximum short-circuit capacity	31.5 kA (1sec.)
Grounding system	Direct grounding
Grounding resistance	1 Ω or lower

Sources: TCN and Nigeria Electricity Regulatory Commission (NERC)

(2) Applicable Standards and Units

When designing the Project, IEC, ISO and international and Japanese standards will be applied to the major equipment. For units, the international System of Units (SI Units) will be used.

1) International Electrotechnical Commission (IEC): Applied to major functions of electrical products in general
2) International Organization for Standardization (ISO): Applied to performance evaluation of industrial products in general
3) Japanese Industrial Standards (JIS): Applied to industrial products in general
4) Japanese Electrotechnical Commission (JEC): Applied to electrical products in general
5) Standards of the Japan Electrical Manufacturers' Association (JEM): Ditto
6) Japan Electric Association Code (JEAC): Ditto
7) Standards of the Japanese Electrical Wire and Cable Makers' Association (JCS): Applied to electric wire and cables
8) Technical Standards concerning Electrical Equipment (Japan): Applicable to a wide range of electrical works

2-2-2-4 Outline of the Basic Plan

Table 2-2-2-4.1 outlines the basic plan of the Project formulated in line with the design policy cited above (see Section 2-2-1).

Table 2-2-2-4.1 Outline of the Basic Plan

Site	132/33 kV Apo Substation		132/33 kV Keffi Substation	
Equipment Procurement and Installation	1. Power capacitor banks (132kV、60MVar)	1 set	1. Power capacitor banks (132kV、25MVar)	1 set
	2. Extra-high voltage switchgear	1 set	2. Switchgear for special high voltage	1 set
	3. Protection and control panel	1 set	3. Protection and control panel	1 set
	4. Substation earthing equipment	1 set	4. Substation earthing equipment	1 set
	5. Low voltage equipment	1 set	5. Low voltage equipment	1 set
	6. Foundation for equipment	1 set	6. 132 kV power cable (underground)	1 set
			7. DC supply system	1 set
			8. Foundation for equipment	1 set
Procurement	1. Spare parts		1 set	
	2. Test equipment and maintenance tools		1 set	

Source: Preparatory Survey Team

(1) Outline of the Material and Equipment Plan

1) Basic Matters

This Project will procure equipment which contribute to stable power supply to the areas connected to 132/33kV Apo and 132/33kV Keffi Substations with an eye to the power transmission system in 10 years' time after the commencement of services, the target year of the facility plan. The substations distribute electricity to the southern part of FCT and adjacent Nasarawa State, and the Project aims to interconnect power capacitors in 132/33kV Apo and 132/33kV Keffi Substations with transmission lines for stable power supply. Thus, the Project will also procure switchgear necessary for interconnection with the existing substation facilities at the substations, as well as protection and control panels for power capacitor.

To make the design cost-efficient, the Project will use materials and equipment which meet international standards as much as possible, and set and select the minimum necessary number of equipment components and specifications.

2) Outline of Power Capacitor

(i) Facility Capacity

The Team has examined the capacities of power capacitors (60 MVar at Apo Substation and 25 MVar at Keffi Substation) requested by TCN and found that the capacities requested will improve the voltage ranging from 3 to 6 percent as stated in the Table 2-2-2-2.4, making the Project have enough effect and supporting the relevance of the components requested. Thus, the Project will adopt these capacities of power capacitors.

(ii) Functions

The existing 132kV bus lines at the substations will be used as points to interconnect the power capacitor with the power system. While power factor of the system is monitored, the power capacitor will be connected/disconnected to/from the power system at the discretion of operators and TCN power supply direction center. In the light of load on the substations, the power capacitor will be basically connected on a permanent basis. At the light load time, the power capacitor will be disconnected from the power system with gas circuit breaker which will be procured and installed under the Project.

3) Outline of Extra-High Voltage Switchgear

(i) Apo Substation

Switchgear at the interconnection must be able to promptly disconnect, if any, a troubled part of the power capacitor from the power system, and sufficiently allow any accidental current. The specifications of switchgear have been determined in consistency with the current value and existing facilities. In this substation, the connection of bus lines to the capacitor bank will be switched with the line switch. The Project will adopt line switch

without grounding device for this purpose, but adopt disconnect switch with grounding device to be directly connected with the power capacitor to ensure the safety of maintenance workers.

(ii) Keffi Substation

Keffi Substation will be equipped with switchgear consisting of circuit breaker, line switch and line switch with grounding device. Because switchgear will be connected to single bus in this substation, the Project will procure only one disconnect switch to be connected with the power system. In addition, because the existing bus line needs to be connected to the power capacitor by passing the road on the premises, underground cable will be installed.

4) Outline of Equipment to be Installed in the Control Building

(i) Apo Substation

If the power capacitor to be procured under the Project becomes faulty, it needs to be promptly disconnected from the power system to protect the existing 132kV system. To detect accidental power current, 132kV control panel with overcurrent relay will be installed to disconnect troubled part of the power capacitor from the power system. In addition, to enable operators to monitor the facilities on a daily basis and detect any abnormality promptly, the Project will procure 132kV capacitor bank protection panel with the functions of displaying reactive power as well as electric current and voltage, and protecting the power capacitor against internal abnormality.

At Apo Substation, facilities to be procured under the Project can be powered by the existing DC supply system, so the Project will not procure DC power supply system to Apo Substation.

(ii) Keffi Substation

Panels to control 132kV switchgear and protect the power capacitor will be installed. Because Keffi Substation uses the DC supply system for the existing control equipment to the maximum capacity, facilities to be procured under the Project needs to be powered by other power source. Thus, the Project will procure additional DC supply system consisting of lead storage battery, DC rectifier and battery charger in the existing battery room in the control building.

(2) Outline of Equipment to Be Procured and Installed

To make the installation work easily and shorten the installation period, the Project will minimize the number of specifications of items, and adopt standard models as much as possible. Tables 2-2-2-4.2 to 2-2-2-4.3 list equipment to be procured, their specifications, and outline specifications of major equipment.

Table 2-2-2-4.2 Outline of Equipment to Be Procured and Installed (Apo Substation)

No.	Equipment	Specifications	Quantity
AP-1	132 kV Gas Circuit Breaker		1 unit
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Outdoor use, porcelain (Creepage distance: 31 mm/kV or more) three-phase	
	(3) Rated voltage	145 kV or higher	
	(4) Rated current	1,250 A or higher	
	(5) Rated interrupting current	31.5 kA or higher	
	(6) Rated interrupting time	3 cycles or lower	
	(7) Rated short-time current	31.5 kA (1 sec.) or higher	
	(8) Operating sequence	O - 0.3 sec. - CO - 3 min. CO	
	(9) Lightning impulse withstand voltage	650 kV or higher	
	(10) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(11) Control power	DC110 V, AC415 V (3-phase)-240 V (Single phase)	
	(12) Accessories	Operation counter, marshalling box and ODA sticker	
	(13) Other	The level of the bottom of porcelain is 2.5 m or more above the ground level.	
AP-2	132 kV Line Switch		2 units
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Horizontal double break rotating and insulator type, outdoor use, three-phase (Creepage distance: 31 mm/kV or more)	
	(3) Rated voltage	145 kV	
	(4) Rated current	1,250 A	
	(5) Rated short-time current	31.5 kA (1 sec.) or higher	
	(6) Lightning impulse withstand voltage	650 kV or higher	
	(7) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(8) Control power	DC110 V	
	(9) Marshalling box	Controlling device and equipment required for the remote control are included.	
	(10) Accessories	Handle, mounting structure (2 m or higher) and ODA sticker	
AP-3	132 kV Line Switch with Earthing Device		1 unit
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Horizontal double break rotating and insulator type, outdoor use, three-phase (Creepage distance: 31 mm/kV or more)	
	(3) Rated voltage	145 kV	
	(4) Rated current	1,250 A	
	(5) Rated short-time current	31.5 kA (1 sec.) or higher	
	(6) Lightning impulse withstand voltage	650 kV or higher	
	(7) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(8) Control power	DC110 V	
	(9) Marshalling box	Controlling device and equipment required for the remote control are included.	
	(10) Electrically operated earthing device	Included.	
	(11) Accessories	Handle, mounting structure (2 m or higher) and ODA sticker	
AP-4	132 kV Current Transformer		3 units
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Outdoor use, porcelain (Creepage distance: 31 mm/kV or more) , single-phase	

No.	Equipment	Specifications	Quantity
	(3) System voltage	145 kV	
	(4) Number of cores	Three cores/phase (Core 1: Measuring, Core 2 and Core 3: Protection)	
	(5) Rated primary current	600 A	
	(6) Rated secondary current	1 A (3 cores)	
	(7) Tolerances	Core 1: 0.5, Core 2 and 3: 5P20	
	(8) Rated secondary burden	30 VA or higher (3 cores)	
	(9) Rated short-time current	31.5 kA (1 sec.) or higher	
	(10) Lightning impulse withstand voltage	650 kV or higher	
	(11) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(12) Accessories	One set of fitting metals and ODA sticker	
AP-5	132 kV Condenser Type Voltage Transformer		3 units
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Outdoor use, porcelain (Creepage distance: 31 mm/kV or more) single-phase	
	(3) System voltage	145 kV	
	(4) Secondary circuit number	2 circuits (Circuit 1: Measuring, Circuit 2: Protection)	
	(5) Rated primary voltage	132/√3 kV	
	(6) Rated secondary voltage	110/√3 V (2 circuits)	
	(7) Tolerances	Circuit 1: 0.5, Circuit 2: 3P	
	(8) Rated secondary burden	100 VA or higher (2 circuits)	
	(9) Lightning impulse withstand voltage	650 kV or higher	
	(10) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(11) Accessories	One set of fitting metals and ODA sticker	
AP-6	132 kV Lightning Arrestor		3 units
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Outdoor use, zinc oxide type, single-phase, Creepage distance: 31 mm/kV or more	
	(3) Rated voltage	120 kV	
	(4) Rated discharge current	10 kA	
	(5) Accessories	Surge counter (each phase), one set of fitting metals and ODA sticker	
AP-7	132 kV Power Capacitor		1 set
	Common specification		
	(1) Standard	JEC, JIS, IEC or equivalent	
	(2) Type	Outdoor use, Creepage distance: 31 mm/kV or more	
	(3) Rated equipment	Three-phase, 50 Hz, 132 kV	
	(4) Rated capacity	60 MVar (total)	
	(5) Lightning impulse withstand voltage	650 kV or higher	
	(6) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(7) Others	One set of fitting metals and ODA sticker	
	Power capacitor		1 set
	(1) Rated phase voltage	81.2 kV (Single phase)	
	(2) Rated total capacity	63.8 MVar	
	(3) Accessories	Oil controller	
	Series reactor		1 set
	(1) Rated voltage	4860 x √3 V (Three phases)	
	(2) Reactance	6% of the capacitor reactance	
	(3) Lightning impulse withstand voltage	400 kV or higher (The withstand voltage is reduced by the lightning arrestor)	
	(4) Power frequency withstand voltage (1 min.)	160 kV or higher (The withstand voltage is reduced by the lightning arrestor)	

No.	Equipment	Specifications	Quantity
	(5) Accessories	Oil controller (alarm contact attached), dial type thermometer (alarm contact attached)	
	Discharge coil		1 set
	(1) Rated voltage	To be specified	
	(2) Total discharge capacity	63.8 MVar or higher	
	(3) Secondary voltage	110 V	
	(4) Secondary capacity	100 VA	
	(5) Allowable transformer ratio-error	±1.0%	
	(6) Accessories	Oil controller	
	Insulation transformer		1 set
	(1) Primary voltage	110 V (Single phase)	
	(2) Secondary voltage	To be specified	
	(3) Secondary capacity	600 VA (100 VA x 6 units)	
	(4) Lightning impulse withstand voltage	650 kV or higher	
	(5) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(6) Allowable transformer ratio-error	±1.0%	
	(7) Accessories	Oil controller	
	Lightning arrestor		3 units
	(1) Type	Porcelain, zinc oxide type	
	(2) Rated voltage	98 kV	
	Insulated mounting structure		1 set
	(1) Rated voltage	132 kV	
	(2) Lightning impulse withstand voltage	650 kV or higher	
	(3) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(4) Others	Capacitor banks and discharge coil shall be mounted.	
	(5) Accessories	Cabling materials	
AP-8	Power Line Equipment		1 set
	132 kV Busbar		70 m
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Material	ACSR (320 mm^2)or equivalent	
	(3) Number of wires	2 wires/phase	
	(4) Remark	It shall be used for the new 132 kV busbar.	
	132 kV Gantry		2 sets
	(1) Standard	JIS or equivalent	
	(2) Size	Width: approx. 14 m, height: approx. 10 m	
	(3) Material	Galvanized steel	
	(4) Remark	It shall be used for the 132 kV busbar.	
	Insulators for 132 kV Busbar		1 set
	(1) Standard	JIS or equivalent	
	(2) Material	Porcelain, creepage distance: 31 mm/kV。	
	(3) Remark	One set of fitting metals shall be included.	
	132 kV Overheadline		200 m
	(1) Standard	JIS or equivalent	
	(2) Material	ACSR (320 mm^2 or higher) or equivalent	
	(3) Remark	It shall connect the capacitor bank equipment to the existing 132 kV line.	
	132 kV Post Insulator		9 units
	(1) Standard	JIS or equivalent	
	(2) Material	Porcelain, creepage distance: 31 mm/kV。	
	(3) Remark	It mounts 132 kV overhead lines between the capacitor bank and the gantry.	

No.	Equipment	Specifications	Quantity
	Overhead grounding wire		120 m
	(1) Standard	JIS or equivalent	
	(2) Material	Galvanized iron-wire (55 mm^2 or higher)	
	(3) Remark	It shall be installed between the existing and new gantries to protect the capacitor bank from lightning.	
	Other Material		1 set
	(1) Remark	It shall include supporting wire for the gantry, one set of fitting metal and terminals	
AP-9	Substation Earthing Device		1 set
	(1) Earthing method	Earthing conductors (copper wire) and terminals	
	(2) Materials		
	1) Buried earthing wire	Annealed copper stranded wire (A) or equivalent	
	2) Insulation coating earthing wire	Vinyl insulation wire (IV) or equivalent	
	3) Earthing bar	Copper-coating steel bar (D14-1500 mm) x2 or equivalent	
	4) Connecting material	Compressed connector or bolt connector T type or equivalent.	
	(3) Earthing resistance	Less than one ohm	
	(4) Other materials	Connecting materials for existing earthing net (Earthing wire, connecting terminal etc.)	
AP-10	132 kV Capacitor Bank Protection Panel		1 panel
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Indoor use, air insulated, metal enclosed self-standing type	
	(3) Control power	DC110 V, AC240 V (Single phase)	
	(4) Protection relay	- Under voltage relay (CVT) JEM #27	
		- Overvoltage relay (CVT) JEM #59	
		- Voltage balance relay (Capacitor bank, secondary side of the insulation transformer） Each phase JEM #60	
	(5) Warning system	- Static temperature switch（Dial type thermometer）JEM #26	
		- Static internal fault detector（Oil controller）JEM #96	
	(6) Others	Control switch, alarm device and other control parts and ODA sticker	
AP-11	132 kV Control Panel		1 panel
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Indoor use, air insulated, metal enclosed self-standing type	
	(3) Control power	DC110 V, AC415V (3-phase)-AC240 V (Single-phase)	
	(4) Protection relay	- Overvoltage relay (Instant/time-lag) （CT）JEM #51H, 51L	
	(5) Display function	-Current, voltage and reactive power shall be displayed. (CVT, CT)	
	(6) Others	-It shall control the switching equipment (circuit breaker, line switch).	
		- It includes mimic, switch, alarming device, other control parts and ODA sticker.	
		-The terminal has 10% or more of the contingency terminals.	
AP-12	Low Voltage Materials		1 set
	Low voltage power cable		1 set
	(1) Standard	IEC, JEC or equivalent	
	(2) Type	600 V CV, 600 V CV/MAZV cable or equivalent	
	Low voltage control cable		1 set
	(1) Standard	IEC, JEC or equivalent	
	(2) Type	CVVS or equivalent	
	Distribution wire material		1 set
	(1) Pipe	Steel pipe (G, C), VP, FEP-buried type or equivalent	
	(2) Cable rack	Steel-ladder type, galvanized or equivalent	
	Fire protection kit		1 set
	(1) Remark	Protect the building from outdoor fire through cable pits	

Source: Preparatory Survey Team

Table 2-2-2-4.3 Outline of Equipment to be procured and installed (Keffi Substation)

No.	Equipment	Specifications	Quantity
KF-1	132 kV Gas Circuit Breaker		1 unit
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Outdoor use, porcelain (Creepage distance: 31 mm/kV or more) three-phase	
	(3) Rated voltage	145 kV or higher	
	(4) Rated current	1,250 A or higher	
	(5) Rated interrupting current	31.5 kA or higher	
	(6) Rated interrupting time	3 cycles or lower	
	(7) Rated short-time current	31.5 kA (1 sec.) or higher	
	(8) Operating sequence	O - 0.3 sec. – CO – 3 min. CO	
	(9) Lightning impulse withstand voltage	650 kV or higher	
	(10) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(11) Control power	DC110 V, AC415 V (3-phase)-240 V (Single phase)	
	(12) Accessories	Operation counter, marshalling box and ODA sticker	
	(13) Other	The level of the bottom of porcelain is 2.5 m or more above the ground level.	
KF-2	132 kV Line Switch		1 unit
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Horizontal double break rotating and insulator type, outdoor use, three-phase (Creepage distance: 31 mm/kV or more)	
	(3) Rated voltage	145 kV	
	(4) Rated current	1,250 A	
	(5) Rated short-time current	31.5 kA (1 sec.) or higher	
	(6) Lightning impulse withstand voltage	650 kV or higher	
	(7) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(8) Control power	DC110 V	
	(9) Marshalling box	Controlling device and equipment required for the remote control are included.	
	(10) Accessories	Handle, mounting structure (2 m or higher) and ODA sticker	
KF-3	132 kV Line Switch with Earthing Device		1 unit
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Horizontal double break rotating and insulator type, outdoor use, three-phase (Creepage distance: 31 mm/kV or more)	
	(3) Rated voltage	145 kV	
	(4) Rated current	1,250 A	
	(5) Rated short-time current	31.5 kA (1 sec.) or higher	
	(6) Lightning impulse withstand voltage	650 kV or higher	
	(7) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(8) Control power	DC110 V	
	(9) Marshalling box	Controlling device and equipment required for the remote control are included.	
	(10) Electrically operated earthing device	Included.	
	(11) Accessories	Handle, mounting structure (2 m or higher) and ODA sticker	
KF-4	132 kV Current Transformer		3 units
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Outdoor use, porcelain (Creepage distance: 31 mm/kV or more) , single-phase	
	(3) System voltage	145 kV	

No.	Equipment	Specifications	Quantity
	(4) Core number	3 cores/phase (Core 1: Measuring, Core 2 and 3: Protection)	
	(5) Rated primary current	300 A	
	(6) Rated secondary current	1 A (3 cores)	
	(7) Tolerances	Core 1: 0.5, Core 2 and 3: 5P20	
	(8) Rated secondary burden	30 VA or higher (3 cores)	
	(9) Rated short-time current	31.5 kA (1 sec.) or higher	
	(10) Lightning impulse withstand voltage	650 kV or higher	
	(11) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(12) Accessories	One set of fitting metals and ODA sticker	
KF-5	132 kV Lightning Arrestor		3 units
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Outdoor use, zinc oxide type, single-phase, Creepage distance: 31 mm/kV or more	
	(3) Rated voltage	120 kV	
	(4) Rated discharge current	10 kA	
	(5) Accessories	Surge counter (each phase), one set of fitting metals and ODA sticker	
KF-6	132 kV Power Capacitor		1 set
	Common specification		
	(1) Standard	JEC, JIS, IEC or equivalent	
	(2) Type	Outdoor use, creepage distance: 31 mm/kV or more	
	(3) Rated equipment	3-phase, 50 Hz, 132 kV	
	(4) Rated capacity	25 MVar (total)	
	(5) Lightning impulse withstand voltage	650 kV or higher	
	(6) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(7) Others	One set of fitting metals and ODA sticker	
	Power capacitor		1 set
	(1) Rated phase voltage	81.2 kV (Single phase)	
	(2) Rated total capacity	26.6 MVar	
	(3) Accessories	Oil controller	
	Series reactor		1 set
	(1) Rated voltage	4860 x √3 V (3-phase)	
	(2) Reactance	6% of the capacitor reactance	
	(3) Lightning impulse withstand voltage	400 kV or higher (The withstand voltage is reduced by the lightning arrestor)	
	(4) Power frequency withstand voltage (1 min.)	160 kV or higher (The withstand voltage is reduced by the lightning arrestor)	
	(5) Accessories	Oil controller (alarm contact attached), Dial type thermometer (alarm contact attached)	
	Discharge coil		1 set
	(1) Rated voltage	To be specified	
	(2) Total discharge capacity	26.6 MVar or higher	
	(3) Secondary voltage	110 V	
	(4) Secondary capacity	100 VA	
	(5) Allowable transformer ratio-error	±1.0%	
	(6) Accessories	Oil controller	
	Insulation transformer		1 set
	(1) Primary voltage	110 V (Single phase)	
	(2) Secondary voltage	To be specified	
	(3) Secondary capacity	600 VA (100 VA x 6 units)	
	(4) Lightning impulse withstand voltage	650 kV or higher	
	(5) Power frequency withstand voltage (1 min.)	275 kV or higher	

No.	Equipment	Specifications	Quantity
	(6) Allowable transformer ratio-error	±1.0%	
	(7) Accessories	Oil controller	
	Lightning arrestor		3 units
	(1) Type	Porcelain, zinc oxide type	
	(2) Rated voltage	98 kV	
	Insulated mounting structure		1 set
	(1) Rated voltage	132 kV	
	(2) Lightning impulse withstand voltage	650 kV or higher	
	(3) Power frequency withstand voltage (1 min.)	275 kV or higher	
	(4) Others	Power capacitor and discharge coil shall be mounted.	
	(5) Accessories	Cabling materials	
KF-7	Power Line Equipment		1 set
	132 kV Busbar		45m
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Material	ACSR (320 mm^2)or equivalent	
	(3) Number of wires	2 wires/phase	
	(4) Remark	It shall be used for the new 132 kV busbar.	
	132 kV Gantry		1 unit
	(1) Standard	JIS or equivalent	
	(2) Size	Width: approx. 14 m, height: approx. 10 m	
	(3) Material	Galvanized steel	
	(4) Remark	It shall be used for the 132 kV busbar.	
	Insulators for 132 kV Busbar		1 set
	(1) Standard	JIS or equivalent	
	(2) Material	Porcelain, creepage distance: 31 mm/kV。	
	(3) Remark	One set of fitting metals shall be included.	
	132 kV Overhead Line		80m
	(1) Standard	JIS or equivalent	
	(2) Material	ACSR (320 mm^2 or higher) or equivalent	
	(3) Remark	It shall connect the capacitor bank equipment to the existing 132 kV line.	
	132 kV Outdoor Use Termination		6 units
	(1) Type	Outdoor use termination	
	(2) Power cable size	200 mm^2	
	(3) System voltage	132 kV or higher	
	(4) Other	One set of fitting metals is included.	
	132 kV Power Cable		130m
	(1) Standard	JIS,JEC,IEC or equivalent	
	(2) Type	XLPE	
	(3) Size	200 mm^2	
	(4) Conductor	Copper	
	(5) Number of cores	Single core	
	(6) Sheath type	Ant-proof PVC	
	(7) Color	Black	
	Overhead grounding wire		60m
	(1) Standard	JIS or equivalent	
	(2) Material	Galvanized iron-wire (55 mm^2 or higher)	
	(3) Remark	It shall be installed between the existing and new gantries to protect the capacitor bank from lightning.	
	Other Material		1 set
	(1) Remark	It shall include supporting wire for the gantry, one set of fitting metal and terminals	
KF-8	Substation Earthing Device		1 set
	(1) Earthing method	Earthing conductors (copper wire) and terminals	
	(2) Materials		

No.	Equipment	Specifications	Quantity
	1) Buried earthing wire	Annealed copper stranded wire (A) or equivalent	
	2) Insulation coating earthing wire	Vinyl insulation wire (IV) or equivalent	
	3) Earthing bar	Copper-coating steel bar (D14-1500 mm) x2 or equivalent	
	4) Connecting material	Compressed connector or bolt connector T type or equivalent.	
	(3) Earthing resistance	Less than one ohm	
	(4) Other materials	Connecting materials for existing earthing net (Earthing wire, connecting terminal etc.)	
KF-9	132 kV Capacitor Bank Protection Panel		1 panel
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Indoor use, air insulated, metal enclosed self-standing type	
	(3) Control power	DC110 V, AC240 V (Single phase)	
	(4) Protection relay	- Under voltage relay (CVT) JEM #27	
		- Overvoltage relay (CVT) JEM #59	
		- Voltage balance relay (Capacitor bank, secondary side of the insulation transformer） Each phase JEM #60	
	(5) Warning system	- Static temperature switch（Dial type thermometer）JEM #26	
		- Static internal fault detector（Oil controller）JEM #96	
	(6) Others	Control switch, alarm device and other control parts and ODA sticker	
KF-10	132 kV Control Panel		1 panel
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Indoor use, air insulated, metal enclosed self-standing type	
	(3) Control power	DC110 V, AC415V (3-phase)-AC240 V (Single-phase)	
	(4) Protection relay	- Overvoltage relay (Instant/time-lag) （CT）JEM #51H, 51L	
	(5) Display function	-Current, voltage and reactive power shall be displayed. (CVT, CT)	
	(6) Others	-It shall control the switching equipment (circuit breaker, line switch).	
		- It includes mimic, switch, alarming device, other control parts and ODA sticker.	
		-The terminal has 10% or more of the contingency terminals.	
KF-11	DC Supply System		1 set
	(1) Standard	IEC, JEC, JIS, JEM or equivalent	
	(2) Type	Indoor use, metal enclosed type, thyristor type	
	(3) Component	1 unit of battery charger	
	(4) Input AC voltage	AC240 V (Single-phase) ±10% or AC415V (Three-phase) ±10%	
	(5) Output DC voltage	DC110 V(±3 V) (120.42 V(=DC2.23 V x 54 cells)) shall be adjusted by load voltage compensator (Silicon dropper).	
	(6) Rate	100% continuous	
	(7) Rated input current	80 A	
	(8) Battery	Lead-acid batteries (valve regulated type), 100Ah/10 Hr 54 cells	
	(9) DC output circuit number	3 or more	
	(10) Accessories	Panel lighting, current and voltage meters, earthing fault protection relay, faulty detection lump, MCCB with alarm contact, Load voltage compensator and ODA sticker	
KF-12	Low Voltage Materials		1 set
	Low voltage power cable		1 set
	(1) Standard	IEC, JEC or equivalent	
	(2) Type	600 V CV, 600 V CV/MAZV cable or equivalent	
	Low voltage control cable		1 set
	(1) Standard	IEC, JEC or equivalent	
	(2) Type	CVVS or equivalent	
	Distribution wire material		1 set
	(1) Pipe	Steel pipe (G, C), VP, FEP-buried type or equivalent	
	(2) Cable rack	Steel-ladder type, galvanized or equivalent	
	Fire protection kit		1 set
	(1) Remark	Protect the building from outdoor fire through cable pits	

Source: Preparatory Survey Team

(3) Outline of Spare Parts and Test Devices

Table 2-2-2-4.4 shows the test equipment to be procured by the Project.

Table 2-2-2-4.4 Outline of Equipment to be procured and installed (Test equipment)

No.	Equipment	Specifications	Quantity
MT-1	Megger		1 set
	(1) Rated measuring voltage (2) Maximum indication value (3) Accessories	1 set	
MT-2	Static Capacity Measuring Device		1 set
	(1) Type (2) Static capacitor measuring range (3) Accuracy (4) Accessories	Handy type 2nF ～ 200 μF or higher ±0.5%rdg＋1digit Measurement cord (one set), operation manual (English), one set of fuses is included.	
MT-3	Earthing Resistor Tester		1 set
	(1) Earthing resistance range (2) Measuring method (3) Accessories	20Ω、200 Ω、2000 Ω Two-pole or Three-pole Supplementary earthing bar, measurement cord (one set), operation manual (English)	
MT-4	Switchgear Testing Device		1 set
	(1) Measuring item (2) Time measuring range (3) Time measuring accuracy (4) Output voltage (5) Measuring current (6) Data record (7) Others	Operating time, Lowest operating voltage, trip/input current wave measuring 0.1ms～15s ±0.5ms (Interval 0.1ms (Range: 0.1～999.9ms) ±2ms, Interval: 1ms (Range: 1～9999ms) 75～10V Accuracy ±0.5V 10A (Maximum 20 A Accuracy: ±0.5A) 100A (Maximum 200 A, Accuracy ±5A) Printing, memory card recording Measuring cable: 1 set, operation manual (English), and other accessories	
MT-5	PC for the operation		2 sets
	(1) Type (2) Operation system (3) Memory (4) Bit (5) Application	Desktop type or laptop type Windows7 or later 2GB or higher 64 Microsoft Word and Excel	

Source: Preparatory Survey Team

Table 2-2-2-4.5 to Table 2-2-2-4.11 show the spare parts to be procured by the Project.

Table 2-2-2-4.5 Spare Parts for 132 kV Gas Circuit Breaker

Part	Unit	Volume
Trip coil	pcs	1
Closing coil	pcs	1
MCCB(various types)	pcs	1
Auxiliary relay (various types)	pcs	1

Source: Preparatory Survey Team

Table 2-2-2-4.6 Spare Parts for 132 kV Line Switch

Part	Unit	Volume
MCCB (various types)	pcs	1
Electromagnetic contactor (various types)	pcs	1
Auxiliary relay (various types)	pcs	1

Source: Preparatory Survey Team

Table 2-2-2-4.7 Spare Parts for 132 kV Line Switch with Earthing Device

Part	Unit	Volume
MCCB (various types)	pcs	1
Electromagnetic contactor (various types)	pcs	1
Auxiliary relay (various types)	pcs	1

Source: Preparatory Survey Team

Table 2-2-2-4.8 Spare Parts for 132 kV Capacitor Bank Protection Panel

Part	Unit	Volume
Protective replay (various types)	Set	1
Switch (various types)	pcs	1
Lamp (various types)	pcs	1
MCCB (various types)	pcs	1
Auxiliary relay (various types)	Set	1
Electromagnetic contactor (various types)	Set	1

Source: Preparatory Survey Team

Table 2-2-2-4.9 Spare Parts for 132 kV Control Panel

Part	Unit	Volume
Protective relay (various types)	Set	1
Switch (various types)	pcs	1
Lamp (various types)	pcs	1
MCCB (various types)	pcs	1
Auxiliary relay (various types)	Set	1
Electromagnetic contactor (various types)	Set	1

Source: Preparatory Survey Team

Table 2-2-2-4.10 Spare Parts for DC Supply System

Part	Unit	Volume
Switch (various types)	pcs	1
Lamp (various types)	pcs	1
MCCB (various types)	pcs	1
Auxiliary relay (various types)	Set	1
Electromagnetic contactor (various types)	Set	1

Source: Preparatory Survey Team

Table 2-2-2-4.11 Spare Parts for Low Voltage Materials

Part	Unit	Volume
Fireproof kit for cable penetration	Set	1

Source: Preparatory Survey Team

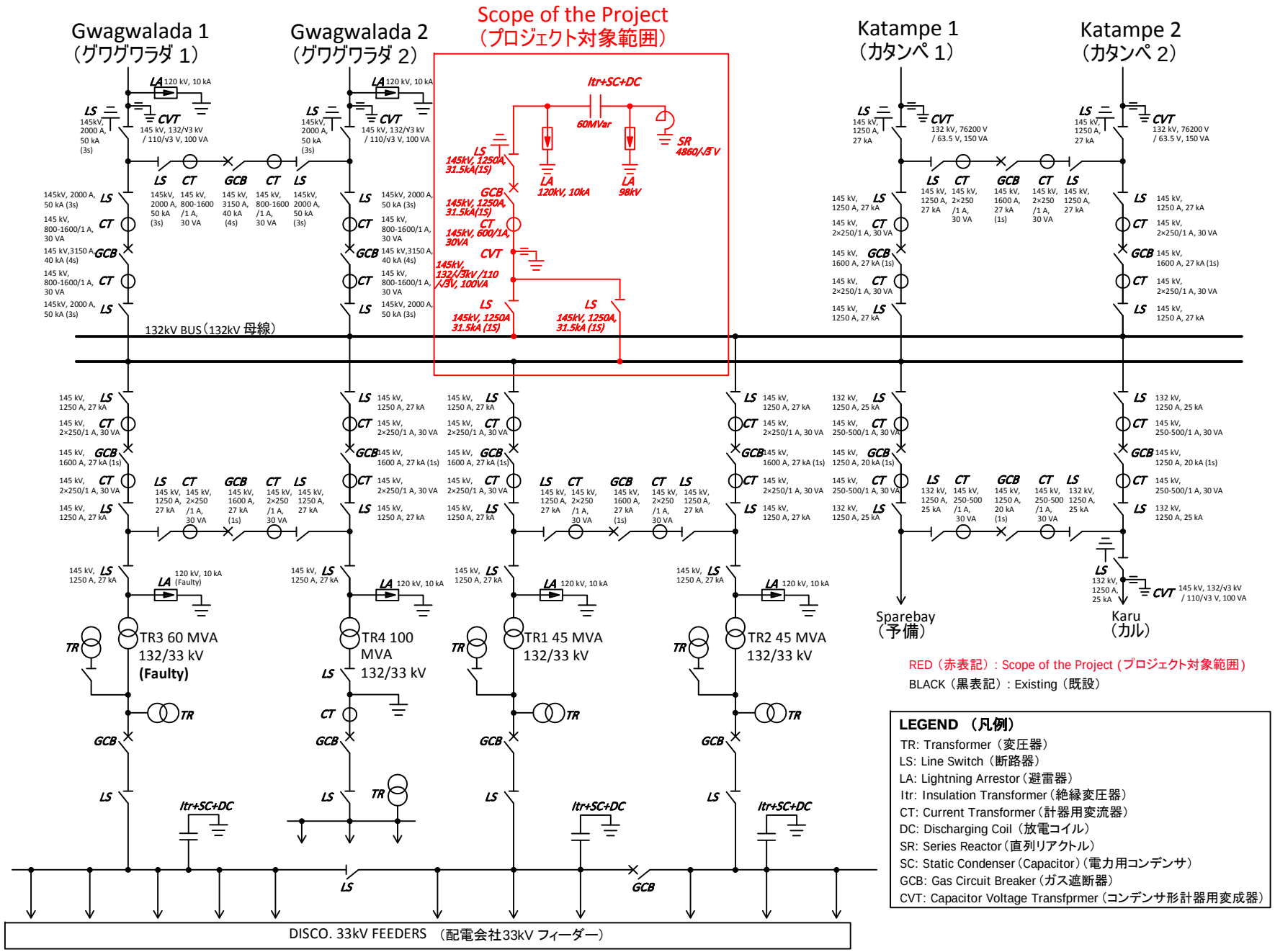
2-2-3 Outline Design Drawing

Table 2-2-3.1 is a list of outline design drawings of the Project.

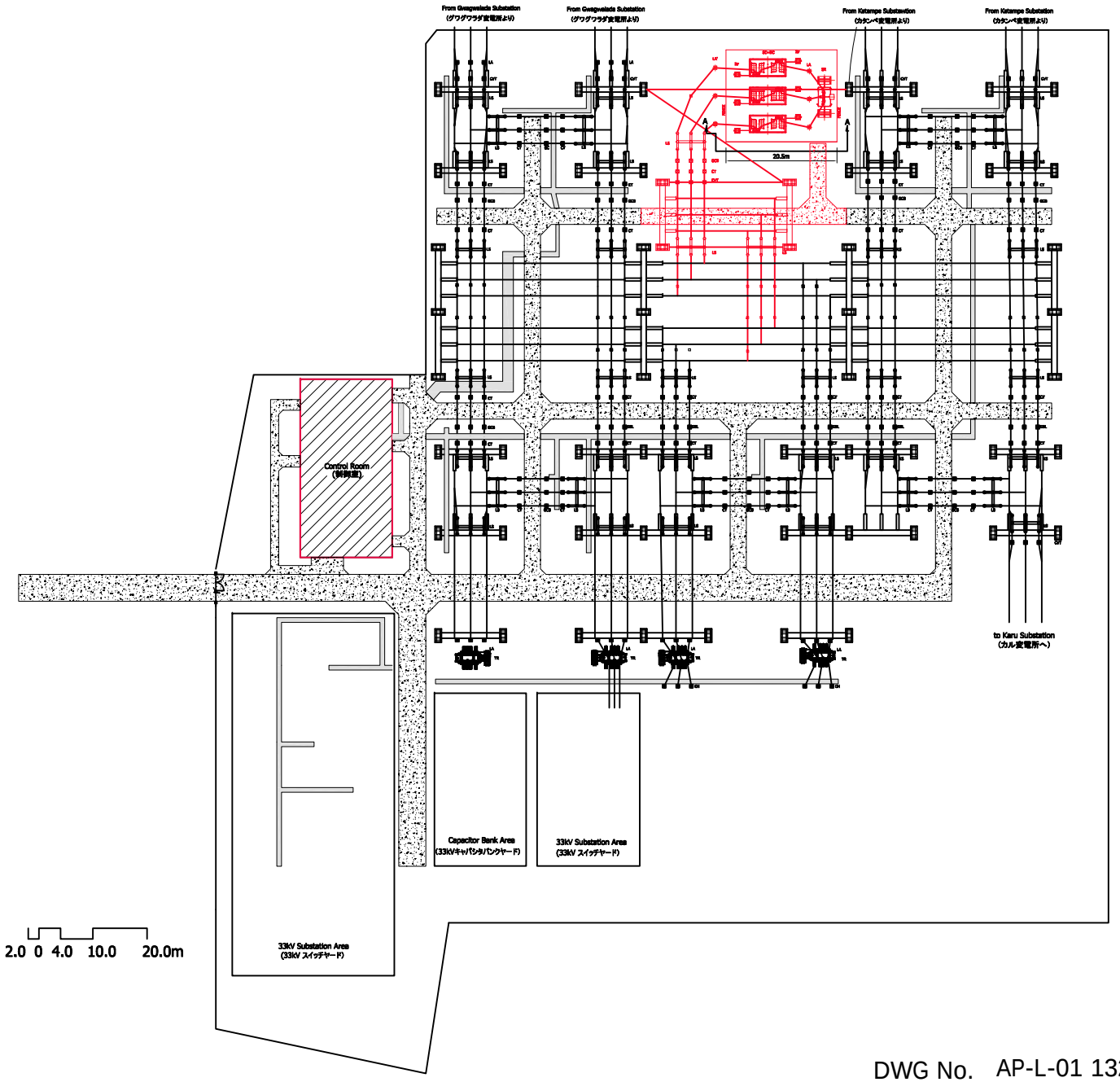
Table 2-2-3.1 List of Outline Design Drawings

Drawing No.	Drawing title
Apo Substation	
DWG No. AP-E-01	132/33kV Apo Substation Single Line Diagram
DWG No. AP-L-01	132/33kV Apo Substation Layout Plan (Entire site)
DWG No. AP-L-02	132/33kV Apo Substation Layout Plan (Scope of the Project)
DWG No. AP-L-03	132/33kV Apo Substation Side view for Capacitor Bank
DWG No. AP-L-04	132/33kV Apo Substation Layout Plan (Control Room)
DWG No. AP-A-01	132/33kV Apo Substation Foundation Plan (Capacitor Bank) (1/2)
DWG No. AP-A-02	132/33kV Apo Substation Foundation Plan (Capacitor Bank) (2/2)
DWG No. AP-A-03	132/33kV Apo Substation Excavation Plan for Foundation
Keffi Substation	
DWG No. KF-E-01	132/33kV Keffi Substation Single Line Diagram
DWG No. KF-L-01	132/33kV Keffi Substation Layout Plan (Entire site)
DWG No. KF-L-02	132/33kV Keffi Substation Layout Plan (Scope of the Project)
DWG No. KF-L-03	132/33kV Keffi Substation Side view for Capacitor Bank
DWG No. KF-L-04	132/33kV Keffi Substation Layout Plan (Control Room)
DWG No. KF-A-01	132/33kV Keffi Substation Foundation Plan (Capacitor Bank) (1/2)
DWG No. KF-A-02	132/33kV Keffi Substation Foundation Plan (Capacitor Bank) (2/2)
DWG No. KF-A-03	132/33kV Keffi Substation Excavation Plan for Foundation
Common	
DWG No. C-01	Fencing Plan

Source: Preparatory Survey Team



DWG No. AP-E-01 132/33kV Apo Substation Single Line Diagram



RED（赤表記）：Scope of the Project（プロジェクト対象範囲）

BLACK（黒表記）：Existing（既設）

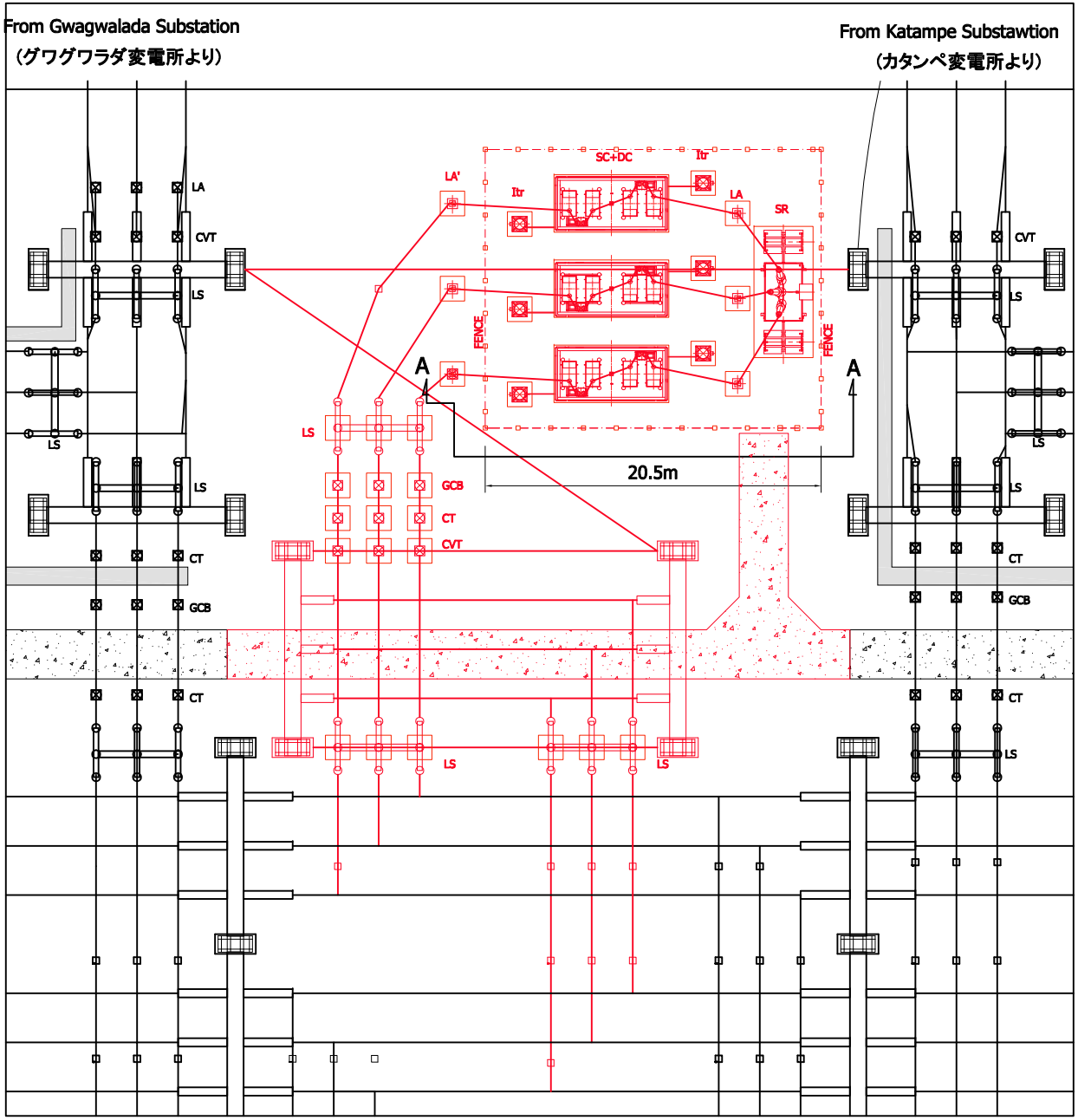
LEGEND （凡例）

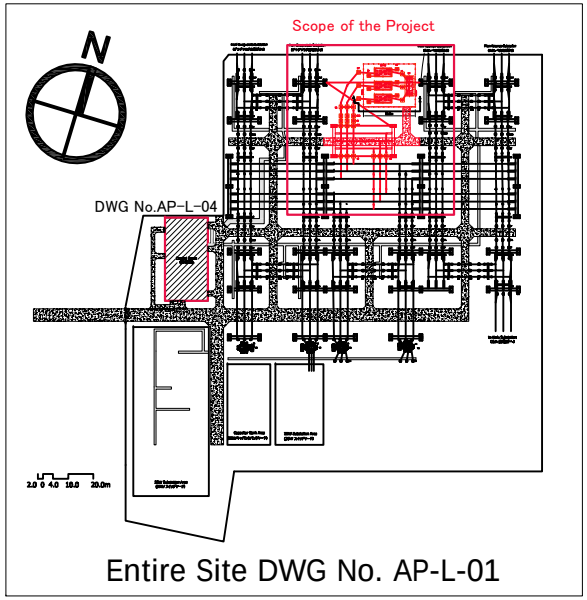
TR: Transformer（変圧器）
LS: Line Switch（断路器）
LA: Lightning Arrestor（避雷器）
Itr: Insulation Transformer（絶縁変圧器）
CT: Current Transformer（計器用変流器）
DC: Discharging Coil（放電コイル）
SR: Series Reactor（直列リアクトル）
SC: Static Condenser（Capacitor）（電力用コンデンサ）
GCB: Gas Circuit Breaker（ガス遮断器）
CVT: Capacitor Voltage Transfprmer（コンデンサ形計器用変成器）

DWG No. AP-L-01 132/33kV Apo Substation Layout Plan（Entire site）

S 1:800 (if only A3)

Enlarged view for the Scope of the Project





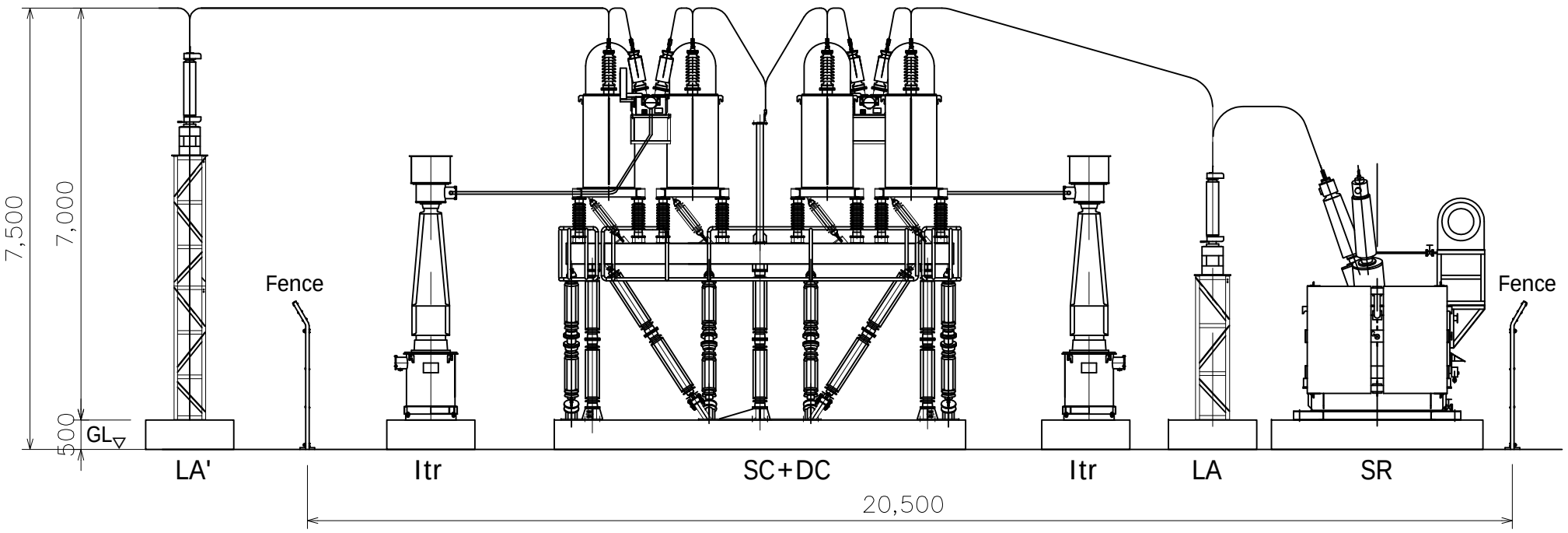
Entire Site DWG No. AP-L-01

RED（赤表記）: Scope of the Project（プロジェクト対象範囲）
BLACK（黒表記）: Existing（既設）

LEGEND （凡例）

TR: Transformer（変圧器）
LS: Line Switch（断路器）
LA: Lightning Arrestor（避雷器）
Itr: Insulation Transformer（絶縁変圧器）
CT: Current Transformer（計器用変流器）
DC: Discharging Coil (放電コイル)
SR: Series Reactor（直列リアクトル）
SC: Static Condenser（Capacitor）（電力用コンデンサ）
GCB: Gas Circuit Breaker（ガス遮断器）
CVT: Capacitor Voltage Transformer（コンデンサ形計器用変成器）

DWG No. AP-L-02 132/33kV Apo Substation Layout Plan（Scope of the Project）
S 1:250 (if only A4)

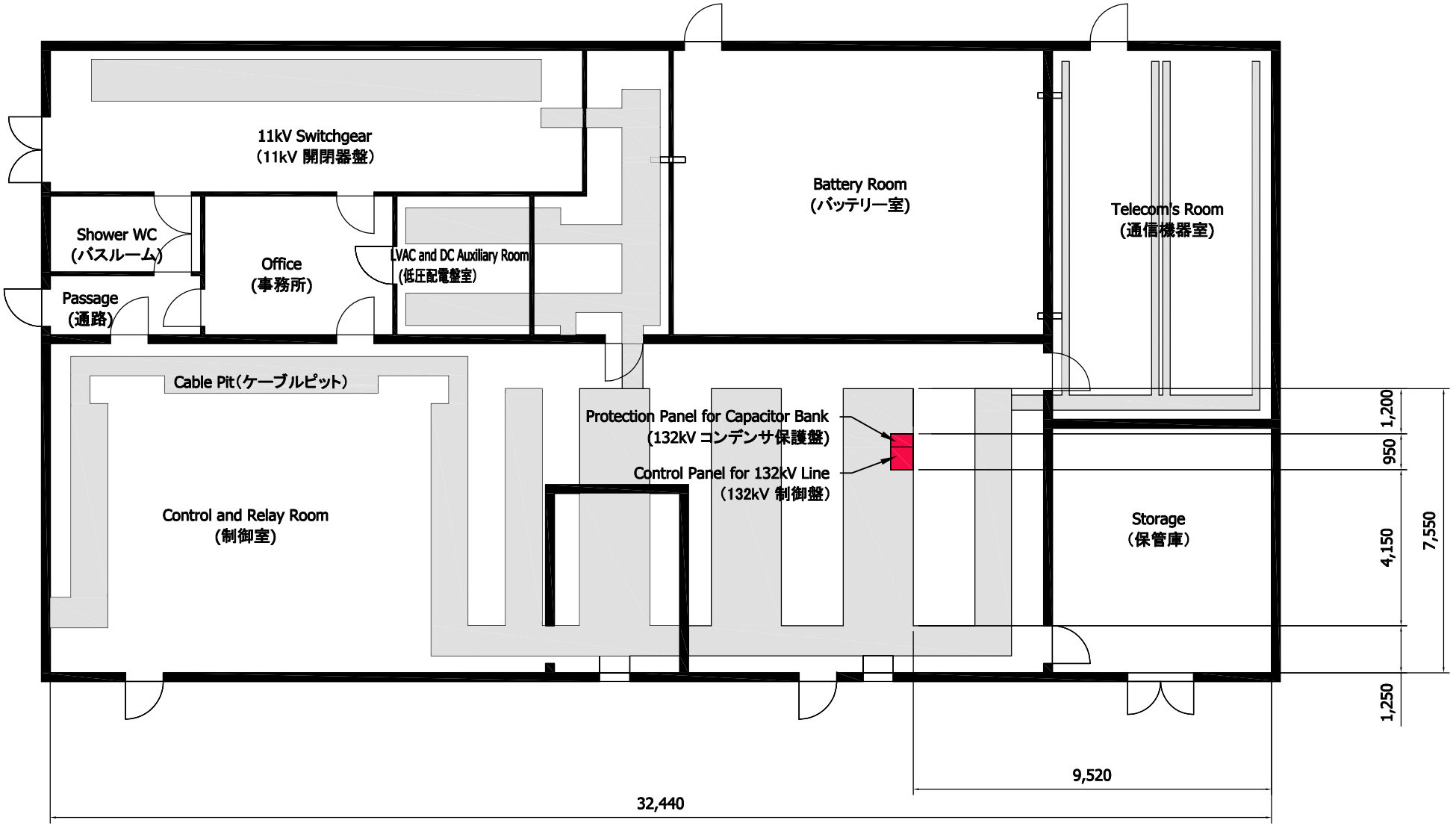


Side view (側面図)

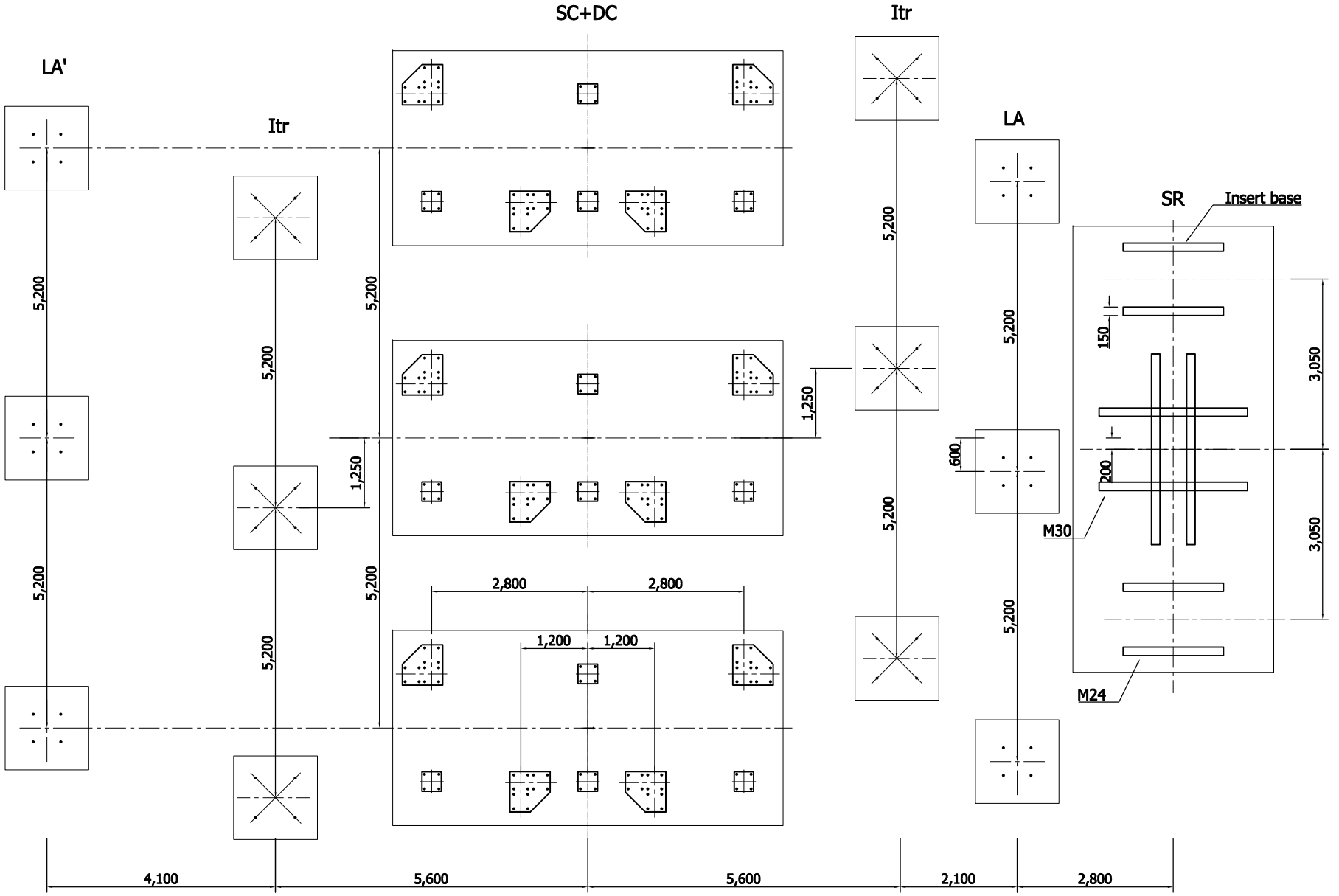
LEGEND （凡例）

LA: Lightning Arrestor（避雷器）
Itr: Insulation Transformer（絶縁変圧器）
DC: Discharging Coil（放電コイル）
SR: Series Reactor（直列リアクトル）
SC: Static Condenser（Capacitor）（電力用コンデンサ）

DWG No. AP-L-03 132/33kV Apo Substation Side view for Capacitor Bank



DWG No. AP-L-04 132/33kV Apo Substation Layout Plan (Control Room)
S 1:150 (if only A4)

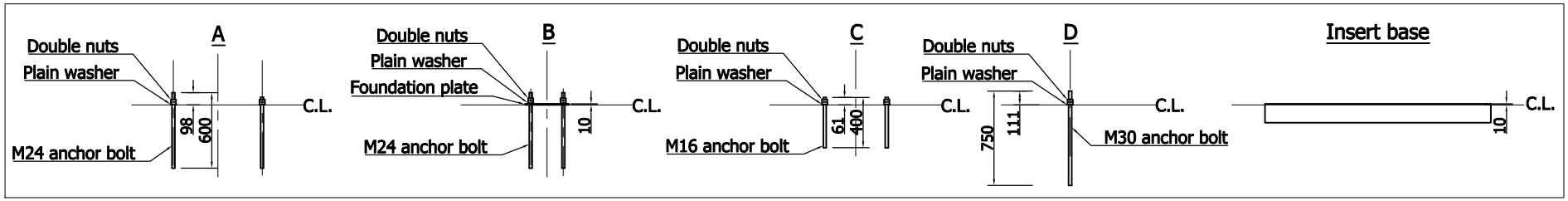


LEGEND （凡例）

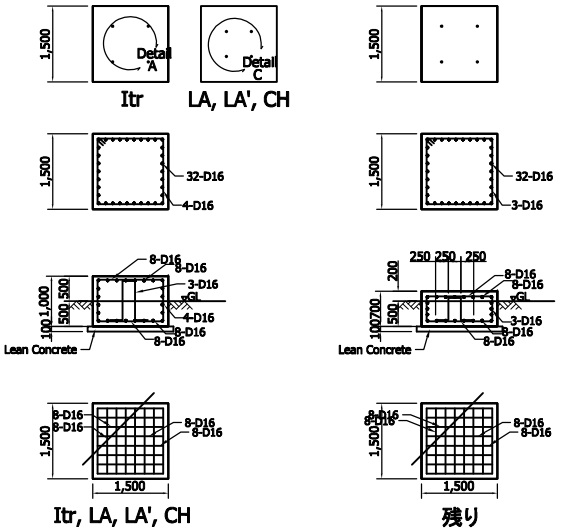
LA: Lightning Arrestor（避雷器）
Itr: Insulation Transformer（絶縁変圧器）
DC: Discharging Coil（放電コイル）
SR: Series Reactor（直列リアクトル）
SC: Static Condenser（Capacitor）（電力用コンデンサ）

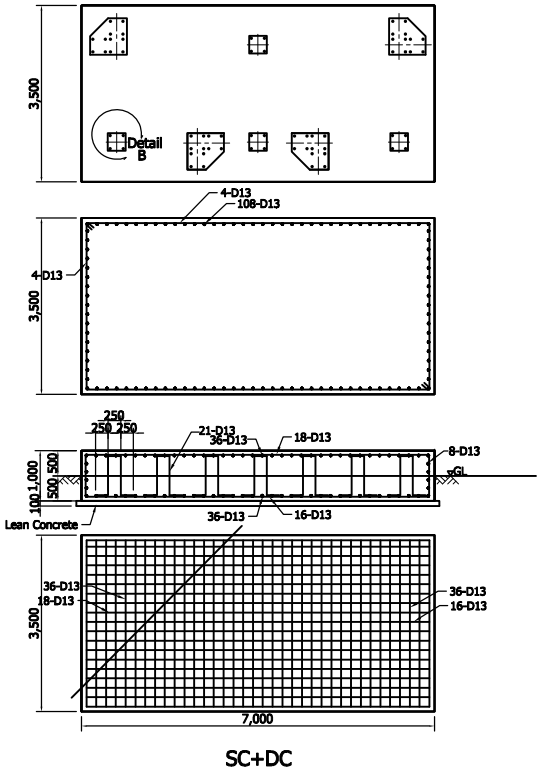
Foundation Arrangement Plan
S=1:100 (only if A4)

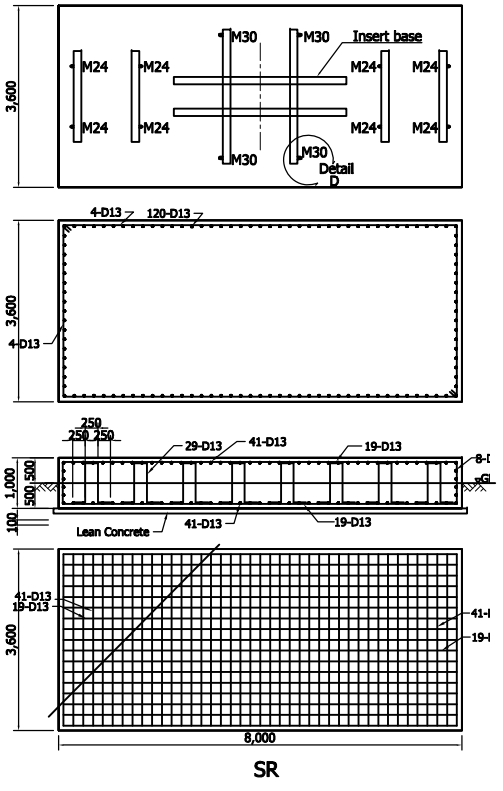
DWG No. AP-A-01 132/33kV Apo Substation Foundation Plan (Capacitor Bank) 1/2
S=1:100 (if only A4)



Datail
S=1:50 (only if A4)

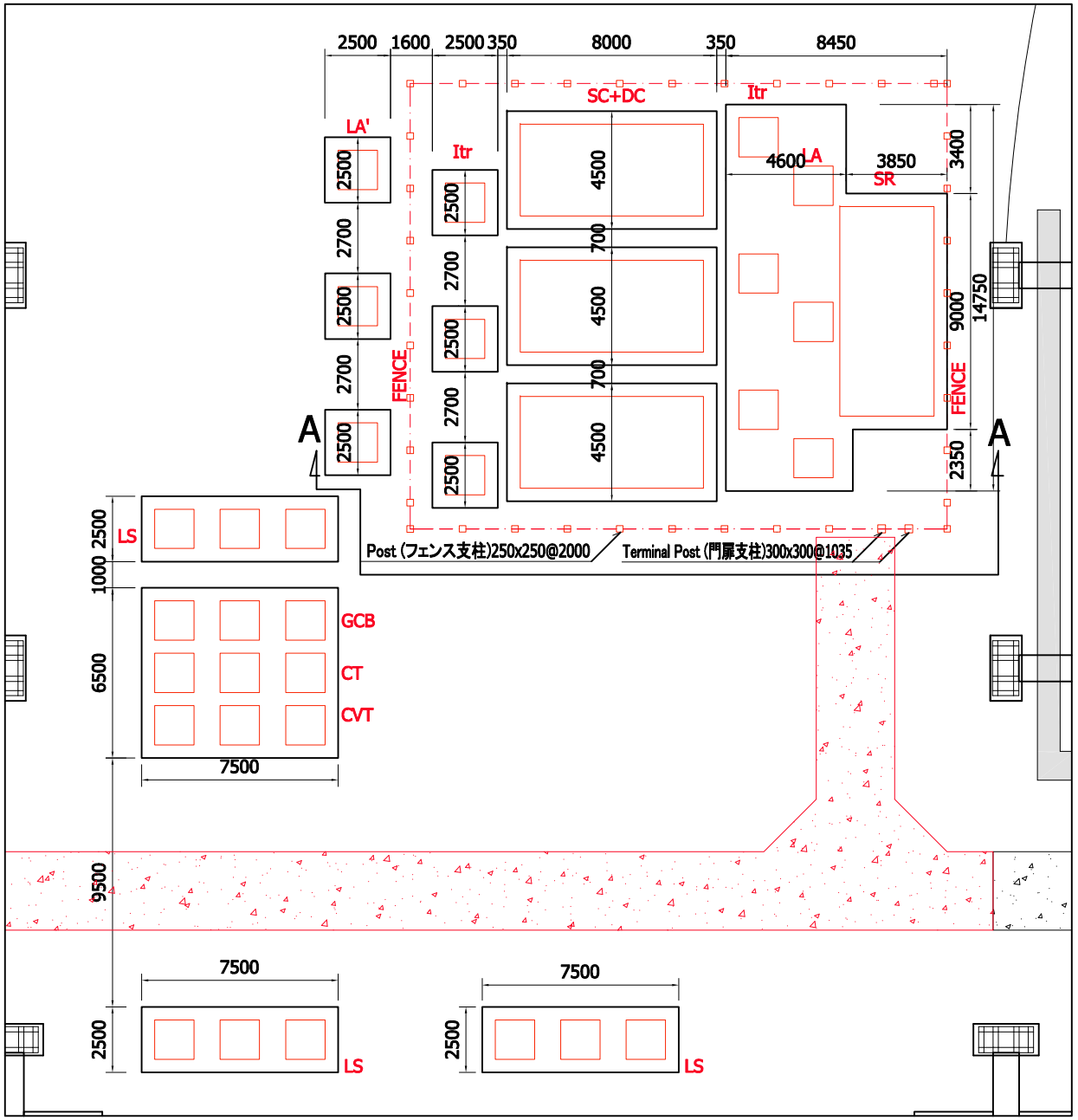


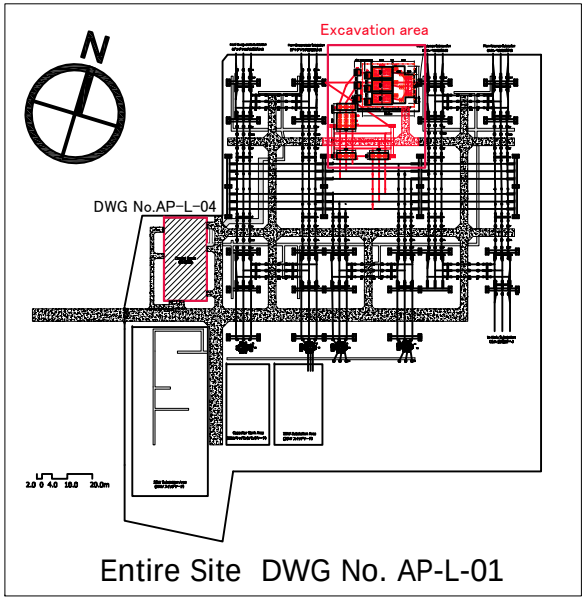




DWG No. AP-A-02 132/33kV Apo Substation Foundation Plan (Capacitor Bank) 2/2
S=1:150, 1:50 (if only A4)

Enlarged view for Excavation area



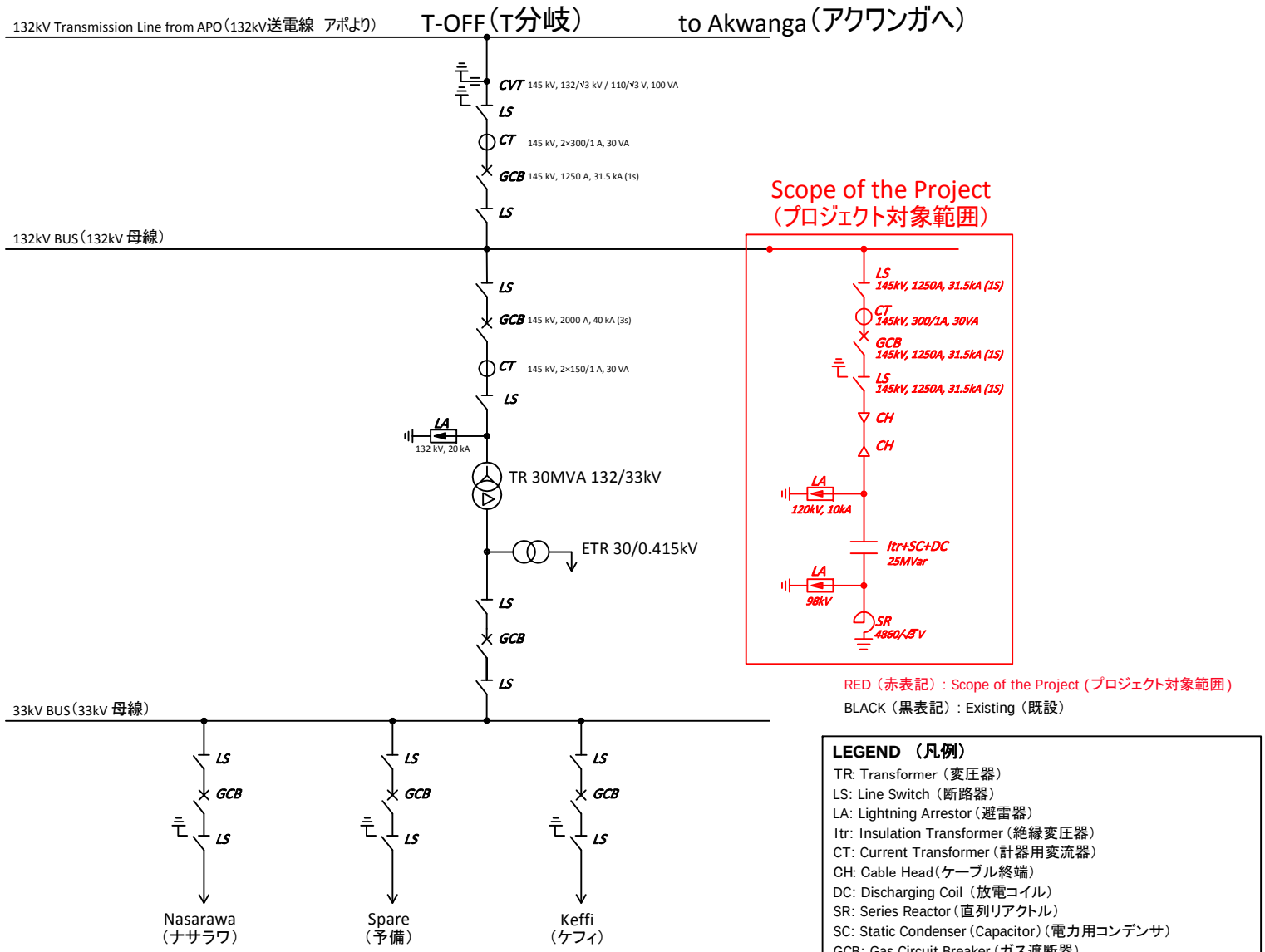


Entire Site DWG No. AP-L-01

LEGEND （凡例）

LS: Line Switch（断路器）
LA: Lightning Arrestor（避雷器）
Itr: Insulation Transformer（絶縁変圧器）
CT: Current Transformer（計器用変流器）
DC: Discharging Coil (放電コイル)
SR: Series Reactor（直列リアクトル）
SC: Static Condenser（Capacitor）（電力用コンデンサ）
GCB: Gas Circuit Breaker（ガス遮断器）
CVT: Capacitor Voltage Transfprmer（コンデンサ形計器用変成器）

DWG No. AP-A-03 132/33kV Apo Substation Excavation Plan for Foundation
S 1:250 (if only A4)



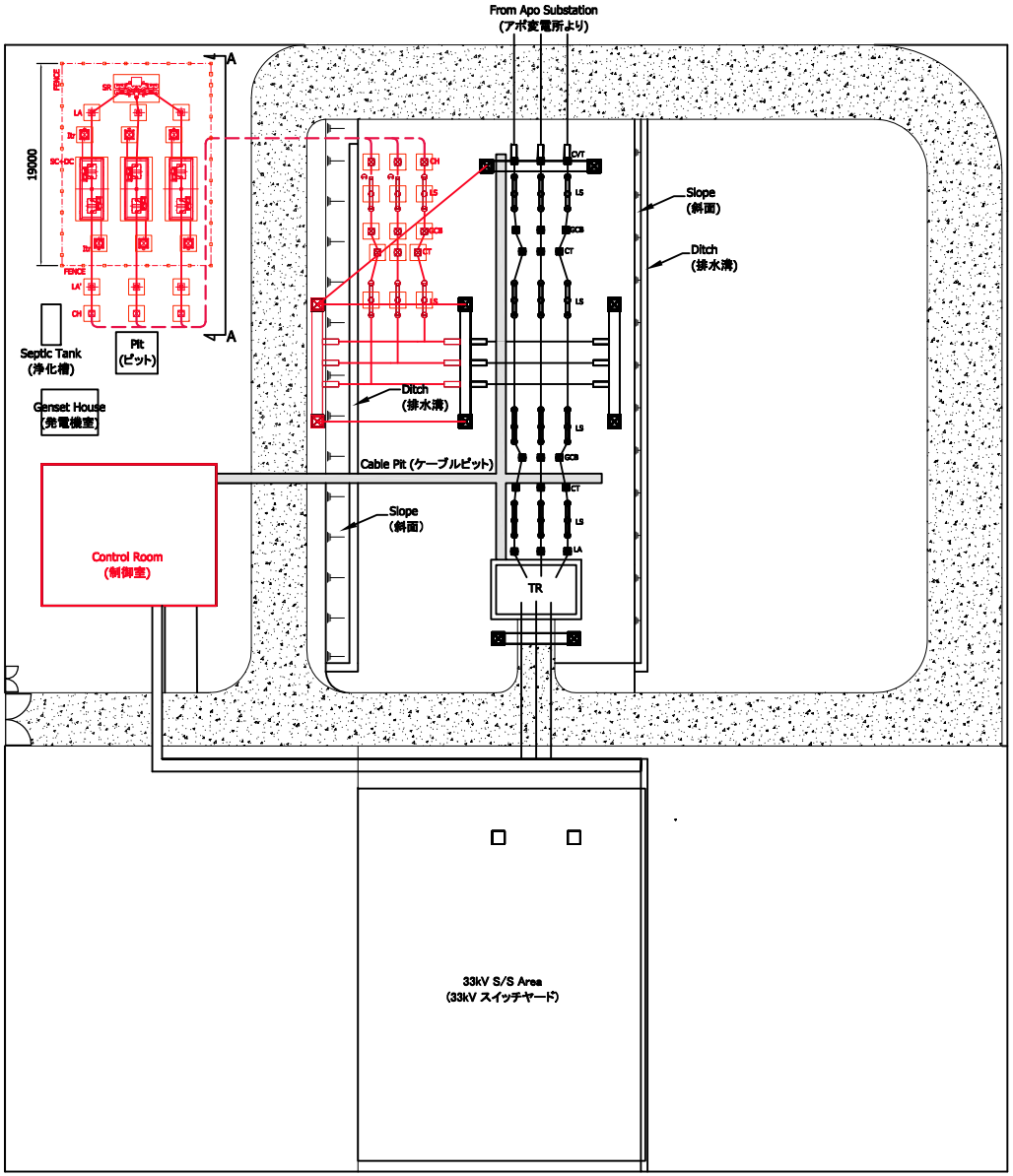
RED（赤表記）: Scope of the Project (プロジェクト対象範囲)

BLACK（黒表記）: Existing（既設）

LEGEND （凡例）

TR: Transformer（変圧器）
LS: Line Switch（断路器）
LA: Lightning Arrestor（避雷器）
Itr: Insulation Transformer（絶縁変圧器）
CT: Current Transformer（計器用変流器）
CH: Cable Head（ケーブル終端）
DC: Discharging Coil（放電コイル）
SR: Series Reactor（直列リアクトル）
SC: Static Condenser（Capacitor）（電力用コンデンサ）
GCB: Gas Circuit Breaker（ガス遮断器）
CVT: Capacitor Voltage Transformer（コンデンサ形計器用変成器）
ETR: Earthing Transformer（接地変圧器）

DWG No. KF-E-01 132/33kV Keffi Substation Single Line Diagram



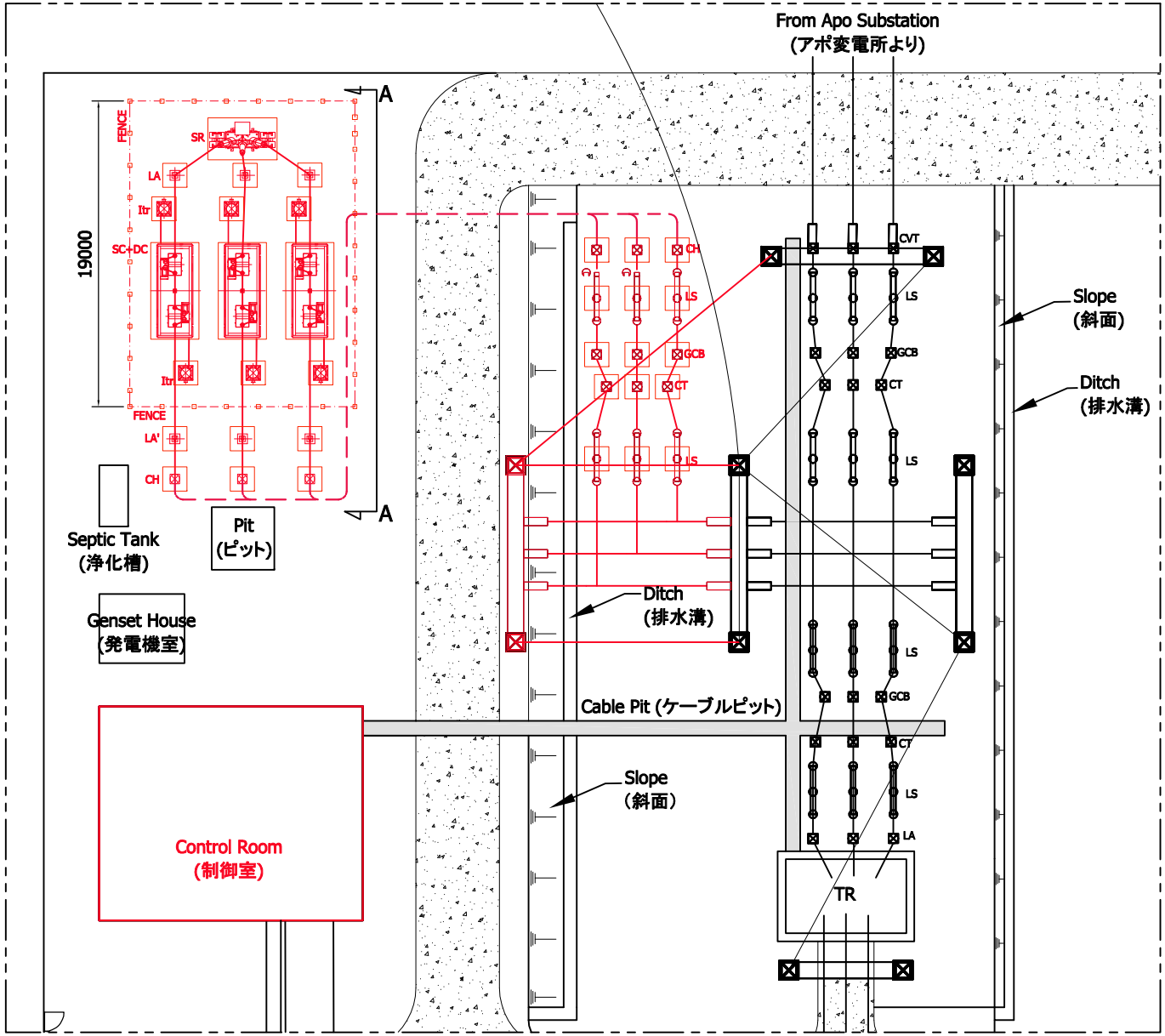
RED（赤表記）：Scope of the Project（プロジェクト対象範囲）
BLACK（黒表記）：Existing（既設）

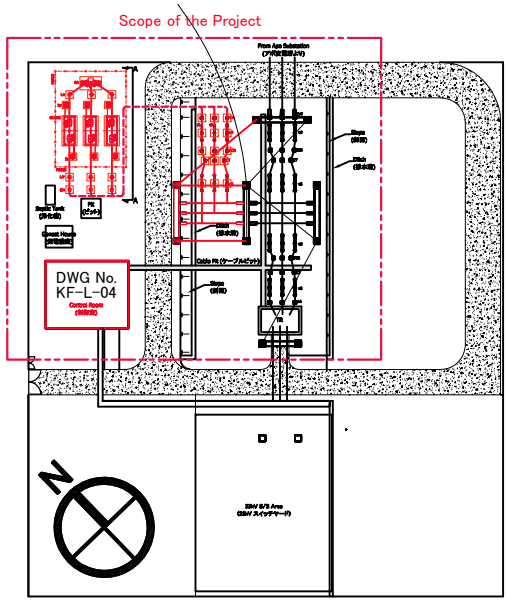
LEGEND （凡例）

TR: Transformer（変圧器）
LS: Line Switch（断路器）
LA: Lightning Arrestor（避雷器）
Itr: Insulation Transformer（絶縁変圧器）
CT: Current Transformer（計器用変流器）
CH: Cable Head（ケーブル終端）
DC: Discharging Coil（放電コイル）
SR: Series Reactor（直列リアクトル）
SC: Static Condenser（Capacitor）（電力用コンデンサ）
GCB: Gas Circuit Breaker（ガス遮断器）
CVT: Capacitor Voltage Transformer（コンデンサ形計器用変成器）

DWG No. KF-L-01 132/33kV Keffi Substation Layout Plan (Entire site)
S 1:700 (if only A4)

Enlarged view for the Scope of the Project





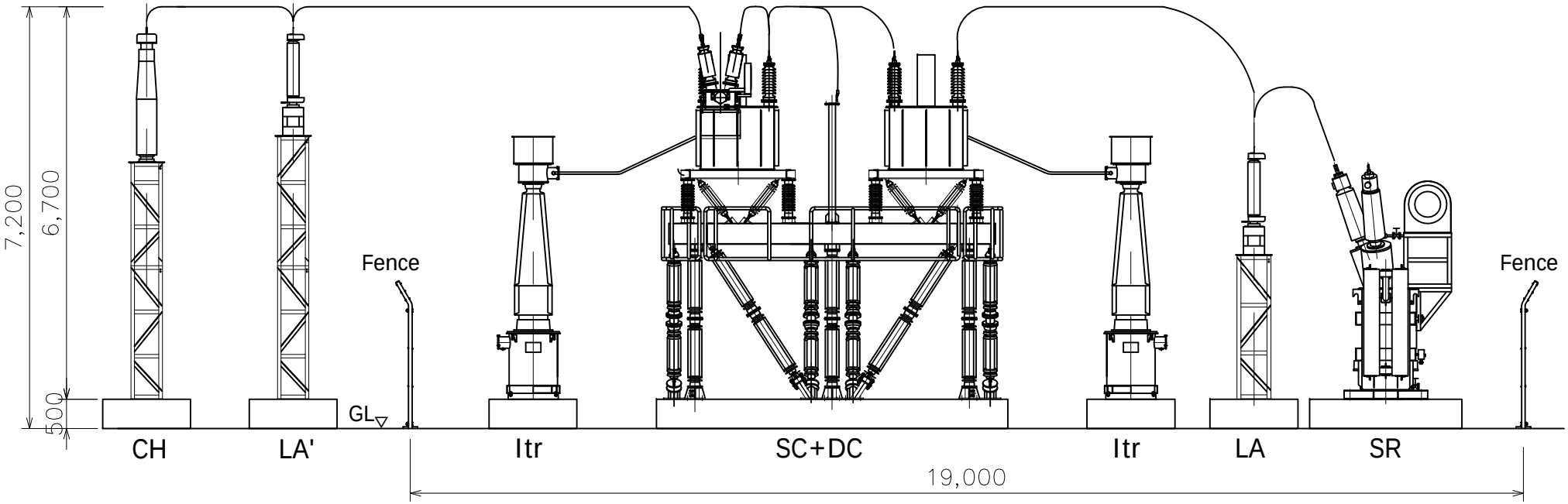
Entire Site DWG No. KF-L-01

RED（赤表記）: Scope of the Project（プロジェクト対象範囲）
BLACK（黒表記）: Existing（既設）

LEGEND （凡例）

TR: Transformer（変圧器）
LS: Line Switch（断路器）
LA: Lightning Arrestor（避雷器）
Itr: Insulation Transformer（絶縁変圧器）
CT: Current Transformer（計器用変流器）
CH: Cable Head(ケーブル終端）
DC: Discharging Coil（放電コイル）
SR: Series Reactor（直列リアクトル）
SC: Static Condenser（Capacitor）（電力用コンデンサ）
GCB: Gas Circuit Breaker（ガス遮断器）
CVT: Capacitor Voltage Transformer（コンデンサ形計器用変成器）

DWG No. KF-L-02 132/33kV Keffi Substation Layout Plan (Scope of the Project)
S 1:400 (if only A4)

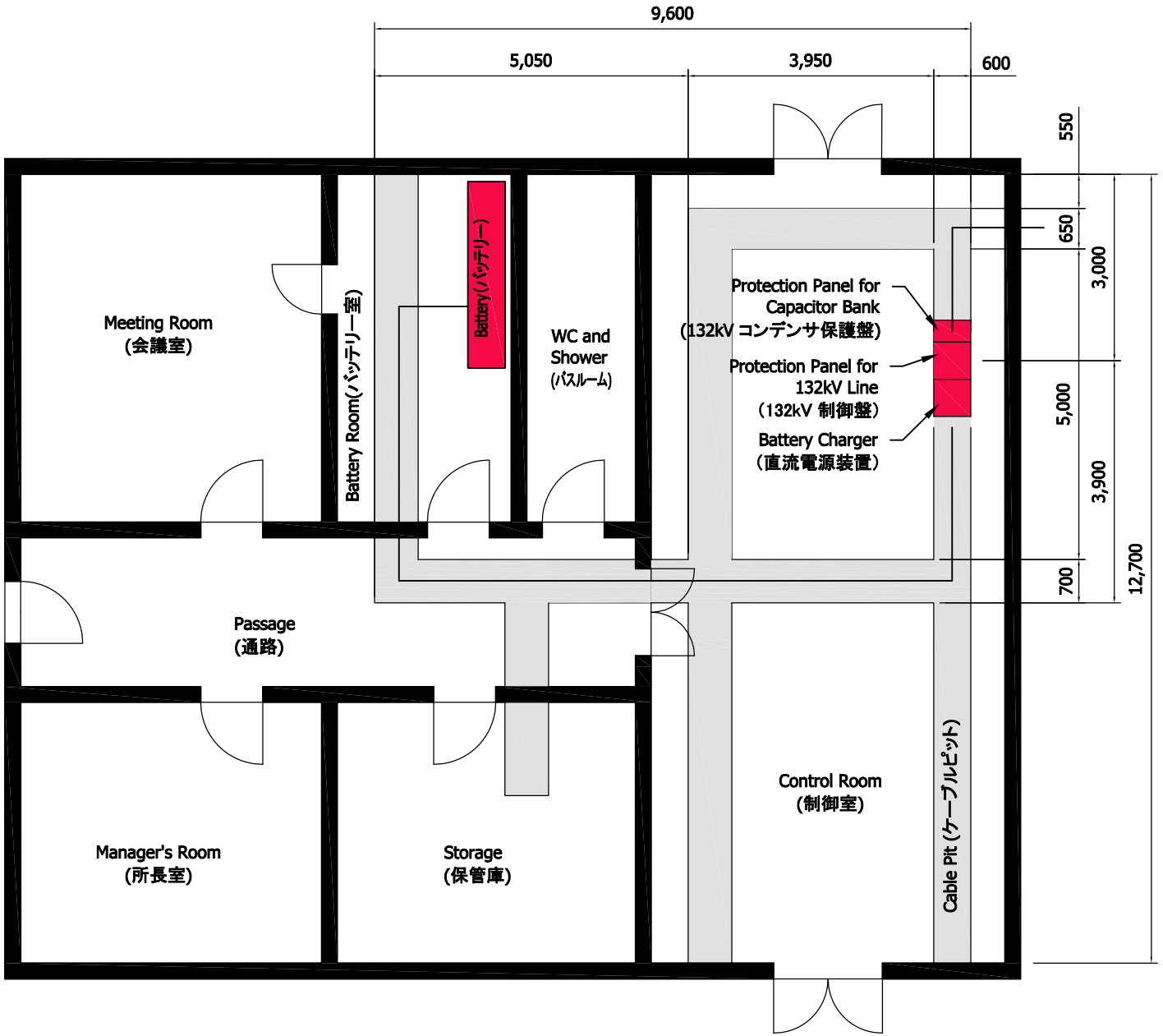


Side view (側面図)

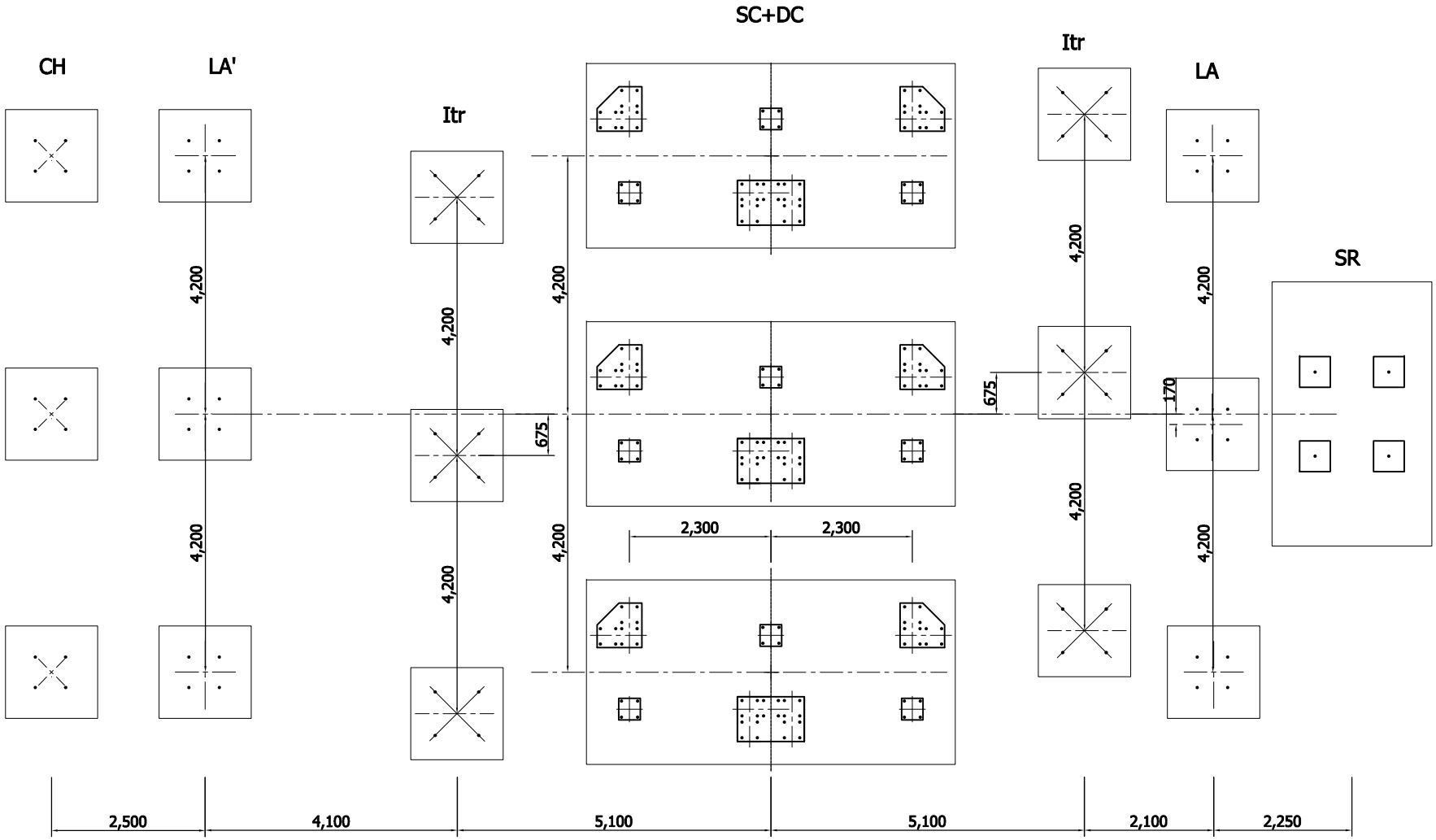
LEGEND （凡例）

CH: CABLE HEAD（ケーブル終端)
LA: Lightning Arrestor（避雷器）
Itr: Insulation Transformer（絶縁変圧器）
DC: Discharging Coil（放電コイル）
SR: Series Reactor（直列リアクトル）
SC: Static Condenser（Capacitor）（電力用コンデンサ）

DWG No. KF-L-03 132/33kV Keffi Substation Side view for Capacitor Bank



DWG No. KF-L-04 132/33kV Keffi Substation Layout Plan (Control Room)
S 1:100 (if only A4)

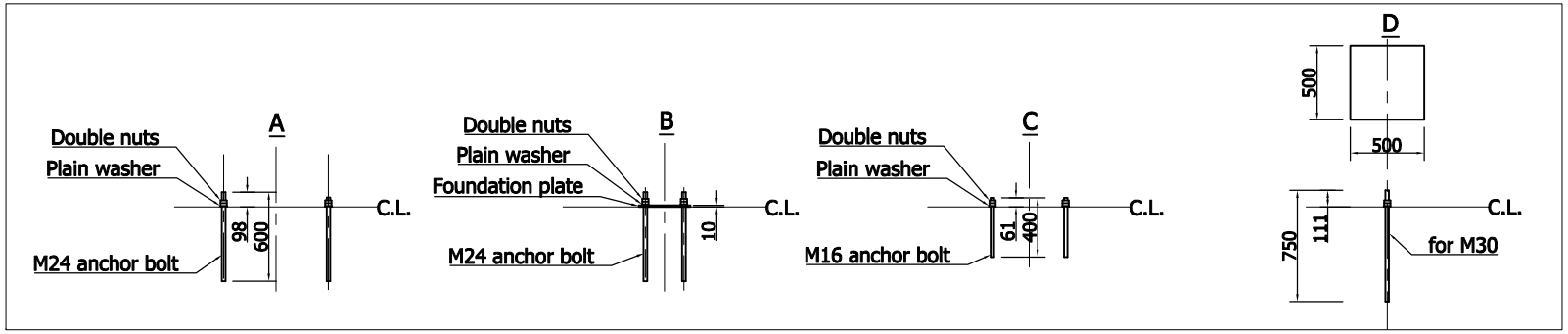


LEGEND （凡例）

LA: Lightning Arrestor（避雷器）
Itr: Insulation Transformer（絶縁変圧器）
DC: Discharging Coil（放電コイル）
SR: Series Reactor（直列リアクトル）
SC: Static Condenser（Capacitor）（電力用コンデンサ）
CH: Cable Head（ケーブルヘッド）

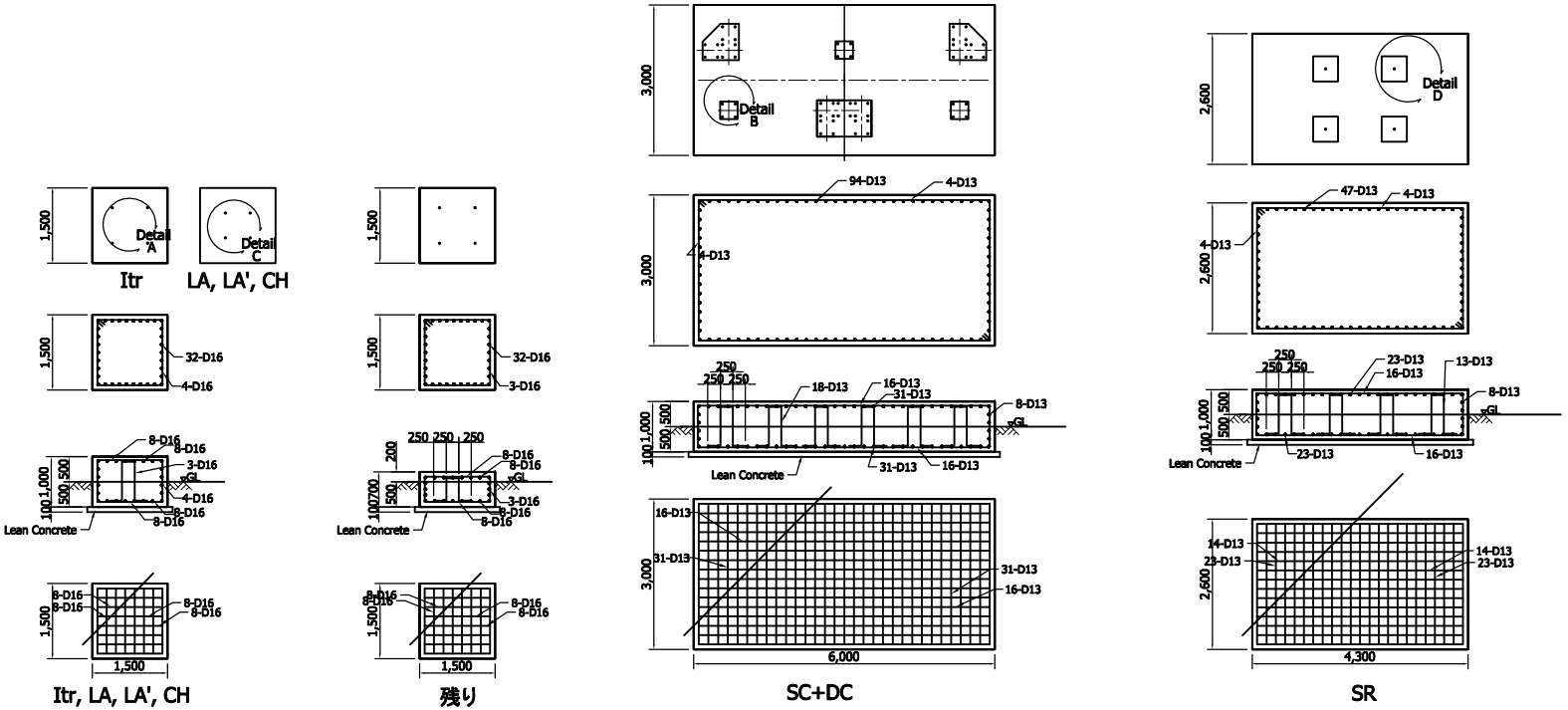
Foundation Arrangement Plan
S=1:100 (only if A4)

DWG No. KF-A-01 132/33kV Keffi Substation Foundation Plan (Capacitor Bank) 1/2
S=1:100 (if only A4)



Datail

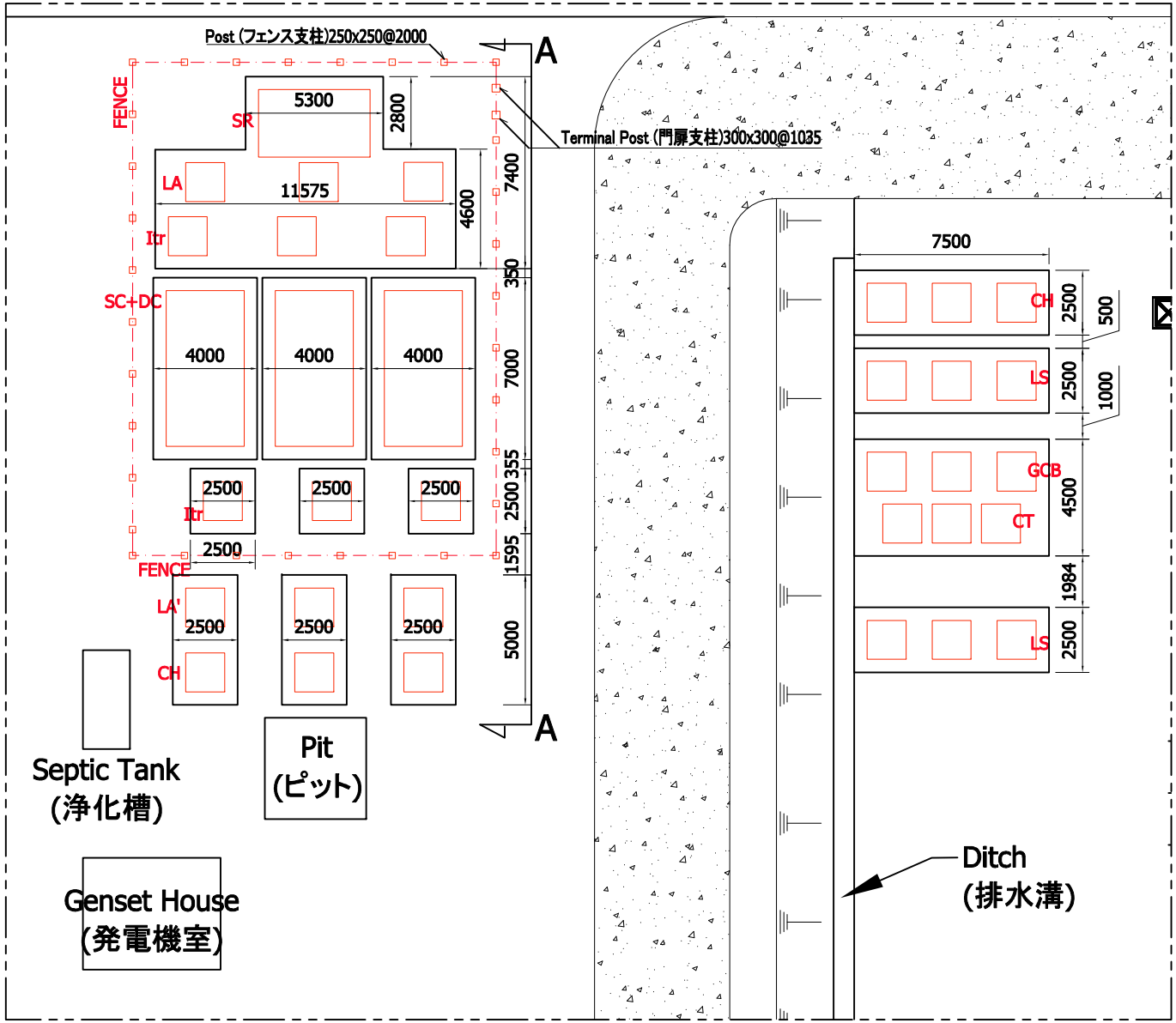
S=1:50 (only if A4)

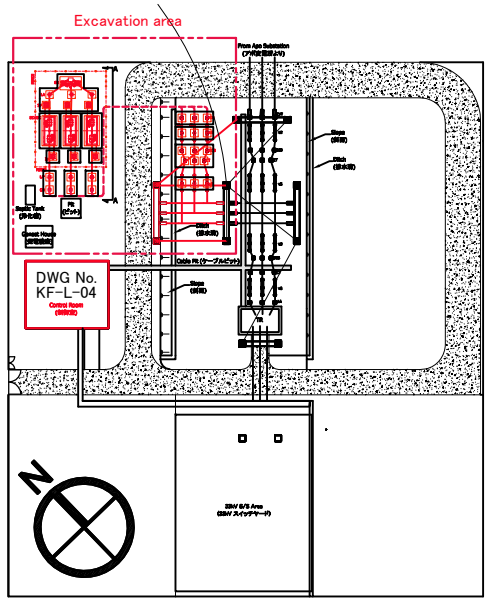


DWG No. KF-A-02 132/33kV Keffi Substation Foundation Plan (Capacitor Bank) 2/2

S=1:150, 1:50 (if only A4)

Enlarged view for Excavation area



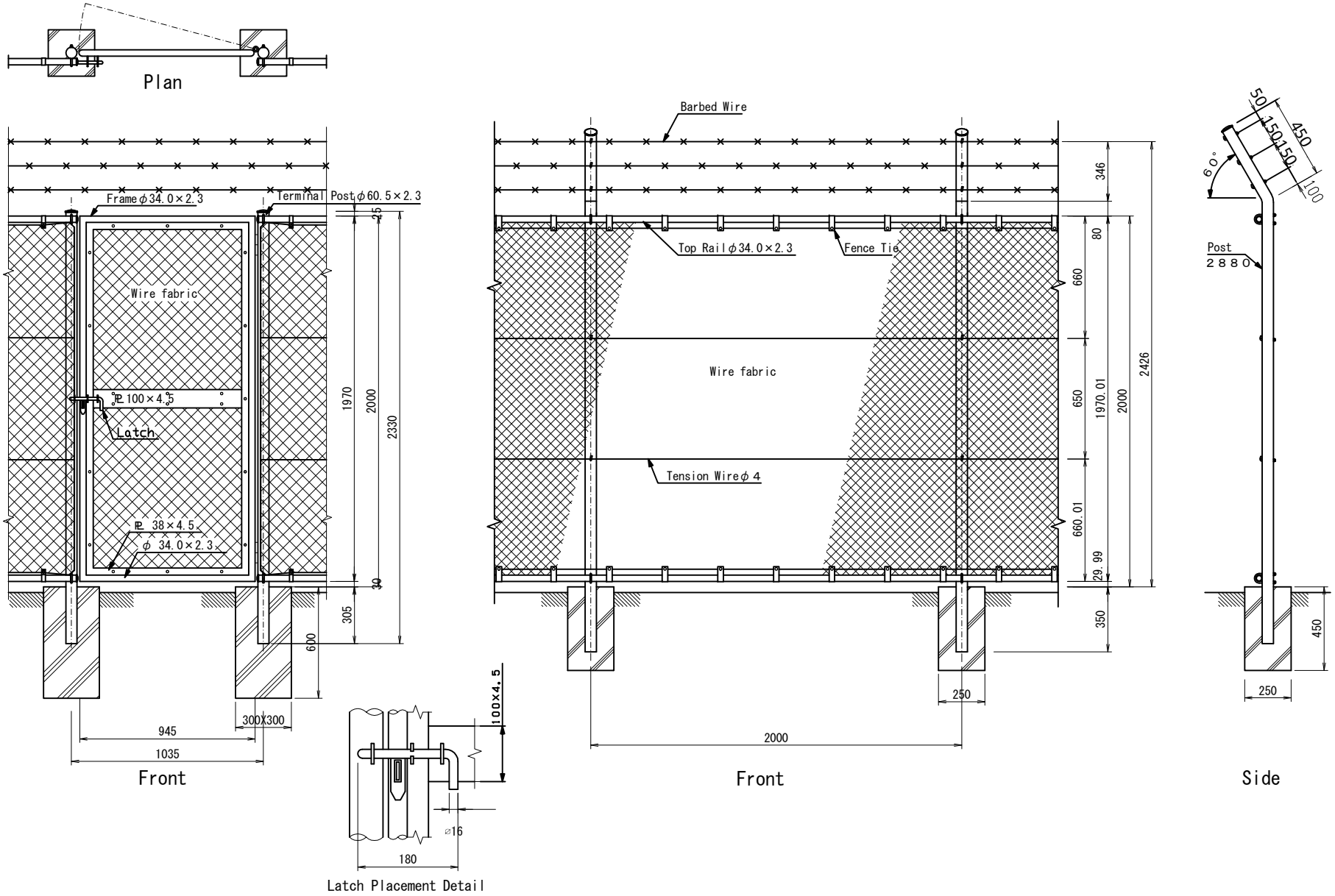


Entire Site DWG No. KF-L-01

LEGEND （凡例）

LS: Line Switch（断路器）
LA: Lightning Arrestor（避雷器）
Itr: Insulation Transformer（絶縁変圧器）
CT: Current Transformer（計器用変流器）
CH: Cable Head(ケーブル終端)
DC: Discharging Coil（放電コイル）
SR: Series Reactor（直列リアクトル）
SC: Static Condenser（Capacitor）（電力用コンデンサ）
GCB: Gas Circuit Breaker（ガス遮断器）
CVT: Capacitor Voltage Transformer（コンデンサ形計器用変成器）

DWG No. KF-A-03 132/33kV Keffi Substation Excavation Plan for Foundation
S 1:250 (if only A4)



DWG No. C-01 Fencing Plan

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. Thus, implementation of the Project will be initiated after the Japanese government gives approval for implementation and Exchange of Notes (E/N) between the governments of Japan and Nigeria and Grant Agreement (G/A) between JICA and Nigerian government are concluded.

(1) Project Implementing Agency

After Exchange of Notes (E/N) and Grant Agreement (G/A) concerning the Grant Aid for the Project are concluded, the Government of Nigeria shall enter into a consultancy contract negotiation with the consultant who conducted preparatory study for the Project.

(2) Consultant

The consultant for detailed design, procurement supervision and construction supervision shall be the one who conducted the preparatory study for the Project. After getting an approval from JICA and signing a contract with the implementing agency of the recipient country, the consultant shall provide management services including detailed design, tender assistance, construction supervision in such aspects as quality, process and safety as well as verification of quality, functions, performance and number and check of visual damage made during transportation.

In case there is any issue, the consultant shall promptly prepare a report and consult with relevant parties to seek countermeasures. The consultant shall also evaluate output of the contractor as part of its construction supervision services. The consultant shall dispatch personnel for all processes of the project implementation.

(3) Contractor

A Japanese corporation selected by the Nigerian party through an open tendering under the framework of Japan's Grant Aid shall conduct construction, procurement of equipment and materials, and installation works as a contractor.

The contractor shall give due consideration to coordination and communication after the equipment and facilities are delivered, because such follow-through services as supply of spare parts and failure handling will likely be required after the completion of the Project.

(4) Necessity of Dispatch of Engineers

As the Project will not only involve civil engineering works but also installation of extra-high voltage switchgear and other transformation units related to power capacitors in sites next to live parts of existing substations, planned outage has to be considered when construction processes are scheduled and carried out. Therefore, for process, quality, output and safety

management, it is essential to dispatch site supervisors from Japan who have understanding of Japan's Grant Aid scheme and capabilities to manage and lead all the processes.

2-2-4-2 Implementation Conditions

(1) Construction Situation in Nigeria and Technical Transfer

In Nigeria, while it is possible to find workers (laborers) for construction works, there are not many engineers or skilled technicians with expertise in construction process, quality or safety control. Therefore, the Japanese contractor should dispatch engineers or skilled technicians to Nigeria when necessary.

(2) Use of Local Equipment and Materials

Power capacitors and switchgears including frames and post insulators shall be procured from Japan as they need to withstand local weather conditions and operation by TCN for a long period of time. On the other hand, as construction equipment and materials for equipment foundations can be locally procured, local vendors, equipment and materials shall be actively utilized.

(3) Safety Measures

Although the target sites of the Project are in the Federal Capital Territory including the capital city of Abuja, attention shall be paid to the latest security information and costs for such safety measures as deployment of armed police and vehicle allocation planning shall be properly included in the budget for the project implementation.

(4) Tax Exemption

For customs clearance and duty exemption for equipment and materials procured for the Project, the contractor will have to submit application in advance to the Federal Ministry of Finance (FMF) via the Federal Ministry of Power (FMP). According to FMP, the responsible organization of the Project, the exemption will be carried out as complete exemption, not as prior tax refund; that is, there will be no tax payment.

2-2-4-3 Scope of Works

Table 2-2-4-3.1 shows the detailed undertakings for the Japanese side and the Nigerian side for the implementation of the Project.

Table 2-2-4-3.1 Undertakings for Each Government (Draft)

No.	Undertaking	To be covered by		Note
		Japanese side	Nigerian side	
1	(1) Acquisition of the Project sites for the installation of equipment		○	
	(2) Project site clearance		○	
2	To construct the following facilities			
	(1) Foundation for substation facilities	○		
	(2) Safety fences for power capacitors	○		
	(3) Access roads to the project sites		○	
3	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products			
	(1) Marine transportation of the Products from Japan to Nigeria	○		
	(2) Tax exemption and custom clearance of the Products at the port of disembarkation		○	
	(3) Internal transportation from the port of disembarkation to the project site	○		
4	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services be exempted		○	
5	To accord Japanese nationals 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 Nigeria and stay therein for the performance of their work		○	
6	To ensure that the facilities and the products be maintained and used properly and effectively for the implementation of the Project		○	
7	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project		○	
8	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A			
	(1) Advising commission of A/P		○	
	(2) Payment commission		○	
9	Measures necessary to obtain the following permits: - Permits for installation work - Permits to access to restricted areas		○	To be obtained as necessary before the implementation of the Project
10	Construction of gates and fences for temporary storeyard		○	
11	Securing of parking during the work		○	
12	Office for construction work	○		For the Japanese contractor
13	Appropriate storage and safety control for materials and equipment at temporary storage	○		
14	Provision of places to dispose of surplus soil and waste water		○	
15	Manufacturing and procurement of materials and equipment	○		
16	Installation, adjustment and tests of materials and equipment	○		
17	Temporary dead-line work during the work		○	
18	Confirmation and ensuring of ground resistance value (1Ω or below) for existing grounding devices		○	Apo Substation and Keffi Substation
19	Removal of a light between existing double bus arrangements		○	Apo Substation
20	Removal of an existing light		○	Keffi Substation

No.	Undertaking	To be covered by		Note
		Japanese side	Nigerian side	
21	Securement of place for control and protection panels in existing control buildings		○	Apo Substation and Keffi Substation
22	Power supply (DC and AC) for control and protection panels to be procured		○	Apo Substation
23	Power supply (AC) for control and protective boards to be procured		○	Keffi Substation
24	Installation of lights for procured equipment	○		Keffi Substation
25	Initial operation guidance and operational guidance for maintenance and management of equipment procured	○		
26	Securing of the safety of persons concerned with the project at the project sites		○	
27	Response to and compensation for users of electricity in relation to outages inevitable for the work		○	
28	Announcement of outage plans to users of electricity during the work		○	

Note: The party with ○ will be in charge.
Source: Preparatory Survey Team

2-2-4-4 Consultant Supervision

Pursuant to Japan's Grant Aid system, the consultant shall form a consistent project team for detailed design and construction supervision in line with the intent of the basic design carried out in the outline design study so that the services will be carried out in an efficient manner. As the Project will involve construction works in substations that are being charged and supervision services should be provided in coordination with TCN and with great attention especially to safety, the consultant shall always have at least one engineer at the site in the stage of construction supervision to provide comprehensive supervision on process, quality, output and safety. For such processes as installation, commissioning and adjustment and delivery test, the consultant shall also dispatch other professional engineers to supervise such works conducted by the contractor. Moreover, Japanese specialists shall participate in observed inspection and inspection before shipment at equipment factories in Japan when necessary to prevent trouble after delivery of the equipment to the local sites.

(1) Basic Policy for Construction Supervision

As a basic policy, the consultant shall supervise progress of works to ensure that the works will be completed within the planned construction period and meet requirements in the contract concerning quality, output and delivery date of equipment and materials; and give supervision and guidance to the contractor to ensure that the works at the site will be carried out in a safe manner. The following are the major points to consider for construction supervision.

1) Process Management

The consultant shall cross-check the implementation schedule developed at the time of contracting and the actual progress either monthly or weekly so that the contractor will meet the delivery dates specified in the contract. In case delays are expected, the consultant shall

remind the contractor and request submission and implementation of countermeasures so that works and delivery of equipment will be completed within the construction period specified in the contract. The planned schedule and the actual progress shall be cross-checked mainly in terms of the following items.

(i) Output (manufacturing work completed at equipment and material factories and amount of work completed at civil engineering work sites)

(ii) Delivery of equipment and materials (for transformation and civil engineering works)

(iii) Status of temporary works and preparation of construction equipment

(iv) Unit prices and actual number of engineers, technicians, laborers, etc.

2) Quality and Output

The consultant shall carry out the following management duties to check whether the manufactured/delivered/installed equipment and constructed facilities meet the quality and output requirements specified in the contract. In case quality or output is not likely to be ensured, the consultant shall immediately request the contractor to make corrections, changes or adjustments.

(i) Examination of manufacture drawings and specifications of equipment

(ii) Observation of equipment factory inspection or examination of the result of factory inspection

(iii) Examination of packaging, transportation and on-site temporary storage methods

(iv) Examination of execution drawings and installation instructions for equipment

(v) Examination of commissioning, adjustment, testing and inspection instructions for equipment

(vi) Supervision of equipment installation works at site and observation of commissioning, adjustment, testing and inspection

(vii) Cross-check of finished work quality with equipment installation drawings, manufacture drawings, and as-built drawings

3) Safety Management

The Project will be carried out on substations which will continue its operation even during the works to be borne by Japan side, safety management needs to be carefully considered such as securing the sufficient distance from power live parts, implementation of power outage work during night time. In consultation and cooperation with a supervisor of the contractor, the consultant shall conduct safety management to prevent industrial accidents and other accidents involving third parties at the site during the installation work period. Attention has to be paid to the following points for safety management.

(i) Establishment of safety management rules and appointment of a safety manager

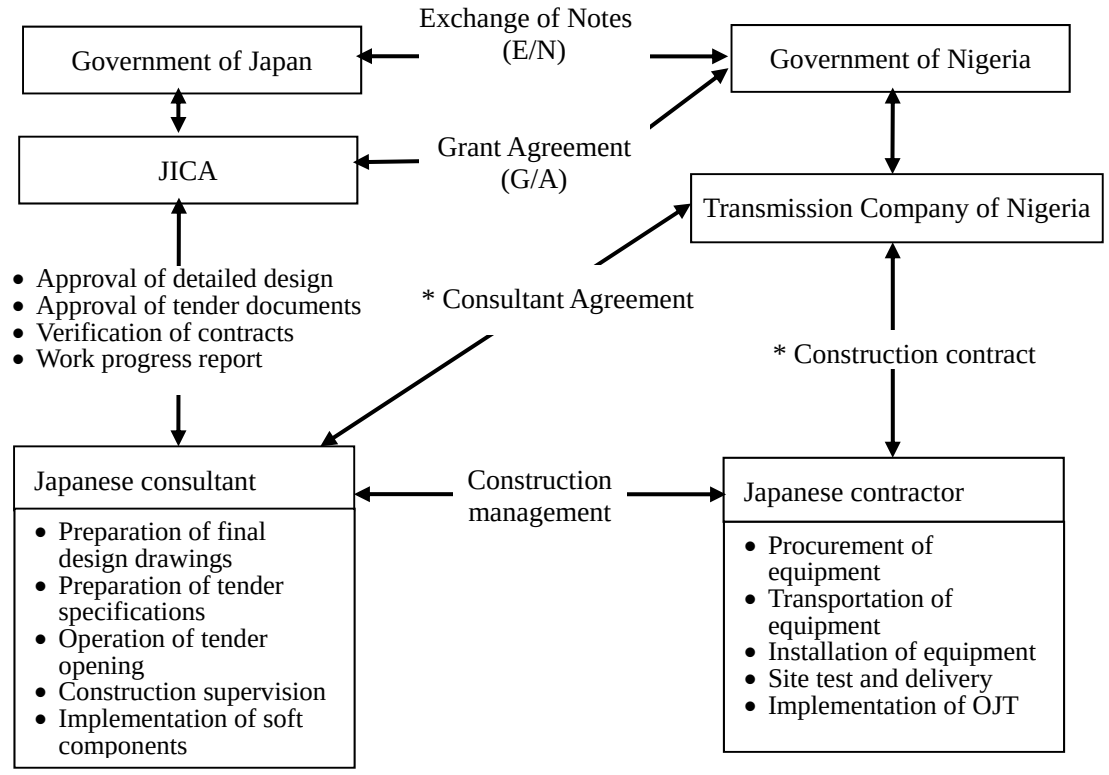
(ii) Accident prevention with periodic inspection of construction machinery

(iii) Establishment of traveling routes for construction vehicles, transporting machines, etc. and thorough enforcement of safe traveling

(iv) Welfare benefits for workers and encouragement to take vacation days

(2) General Relationship concerning Project Implementation

Figure 2-2-4-4.1 shows relations of the parties involved in project implementation including construction supervision.



Note: *JICA's authentication is required for consultancy and vendor contracts.
Source: Preparatory Survey Team

Figure 2-2-4-4.1 Relations of Parties Involved in the Project Implementation

(3) Construction Supervisor

The contractor shall conduct procurement and installation of the substation facilities for existing substations as well as foundation works (civil engineering works) for such works. The contractor will enter into a contract with local subcontractors in Nigeria, and local workers will carry out the works. As the contractor needs to ensure that local subcontractors will fully understand the requirements concerning the construction schedule, quality, output and safety measures specified in the contract, the contractor shall dispatch engineers with experience in similar overseas projects to provide guidance and advice to local subcontractors.

Considering the scale and contents of the substation facilities of the Project, it is preferable

that engineers from the contractor will be present and engage in works at the site on a full-time basis, as shown in Table 2-2-4-4.1.

Table 2-2-4-4.1 Organization of the Contractor

Engineer to be dispatched	No. of personnel	Duties	Period of dispatch
Local procurement management personnel	1	Overall management of the works, consultation and coordination with relevant organizations and obtainment of approval, OJT implementation, equipment procurement management, customs clearance, labor management, and accounting, and management of equipment installation works at Apo Substation	Entire construction period
Local procurement management personnel (Keffi Substation)	1	Management of equipment installation works at Keffi Substation	Period of equipment installation works at Keffi Substation
Inspector-1 (equipment)	1	Confirmation and verification of equipment manufacture drawings, observation of testing, etc. for transforming equipment	Periods for drawing approval and equipment testing
Inspector-2 (equipment foundation)	1	Development, confirmation and verification of equipment foundation drawings	Period for drawing approval
Office boy (locally hired)	2	Miscellaneous duties	Entire construction period
Guard	About 3	Security for procured equipment, construction equipment, vehicles, etc.	From arrival of procured equipment to the completion of installation

Source: Preparatory Survey Team

2-2-4-5 Quality Control Plan

Construction supervisors dispatched from the consulting company shall conduct the following supervision and verification work to see whether the contractor meets the requirements specified in the contract documents (technical specifications, execution drawings, etc.) in terms of quality of the procured equipment and output of construction and installation works. In case required quality or output is not likely to be achieved, the consultant shall immediately request the contractor to make corrections, changes or adjustments.

(1) Examination of shop drawings and specifications of equipment

(2) Observation of equipment factory inspection or examination of the result of factory inspection

(3) Examination of packaging, transportation and on-site temporary storage methods

(4) Examination of execution drawings and installation instructions for equipment

(5) Examination of commissioning, adjustment, testing and inspection instructions for equipment

(6) Supervision of equipment installation works at site and observation of commissioning, adjustment, testing and inspection

(7) Cross-check of finished work quality with equipment installation drawings, manufacture drawings

(8) Cross-check of finished work quality with construction execution drawings and manufacture drawings

2-2-4-6 Procurement Plan

As the equipment for substation facilities to be procured and installed in the Project is not produced in Nigeria, major units for the Project shall be Japanese products pursuant to the Grant Aid scheme. Such Japanese products shall be selected with due considerations to operability and maintainability of the equipment for Nigerian engineers and the availability of after-the-sale services such as procurement of spare items and response to failures.

Based on the above, the equipment to be used in the Project shall be procured as below.

(1) Items to Be Locally Procured

Construction equipment and materials including cement, fine/coarse concrete aggregates, reinforcing steel rods, wood materials, gasoline, diesel oil, construction vehicles, cranes, trailers, computers for operation management and other temporary equipment and materials

(2) Items to Be Procured from Japan

Major items for transformation including power capacitors, breakers and disconnecting switches

(3) Items to Be Procured from Third Countries

None

2-2-4-7 Operational Guidance Plan

As a basic rule, instructors from manufacturers shall give instructions before completion of works for initial operation of the procured equipment as well as regular operation and maintenance methods, using operation and maintenance manuals. For smooth implementation of such instructions, TCN shall have close communication and consultation with the consultant and subcontractors and appoint full-time engineers who will participate in the OJT. Appointed TCN engineers shall spread acquired skills to other members to cooperate for the improvement of TCN’s maintenance skills. Use of local vendors for operation and adjustment and testing before and after installation would be difficult because such works will require specialists from the manufacturers with a certain level of expertise. Therefore, engineers shall be dispatched from Japan for quality control, technical guidance and process management.

2-2-4-8 Soft Component (Technical Assistance) Plan

(1) Background

While having experience in operation of the power capacitors, TCN has shortage in engineers who can properly manage operation and maintenance including operation records. Therefore,

they cannot compensate reactive power with efficient facility operation and it contributes to the lack of power transmission capacity. Against such a background, TCN management requested technical assistance for their operation and maintenance staff during the outline design study conducted from November to December 2014.

Through the implementation of this soft component, technological transfer will be conducted for improvement of operation and management skills and daily check skills for power capacitors and extra-high voltage switchgears that will be procured for the Project.

(2) Objectives

The objectives of the soft component are as below.

- Basic knowledge for sustainable operation and daily inspection of the equipment is transferred.
- Basic skills for sustainable maintenance of the equipment are transferred.
- Management skills for proper operation and daily inspection of the equipment are transferred and such skills are summarized in a manual.

(3) Outputs

Table 2-2-4-8.1 shows the outputs to be produced by the soft component.

Table 2-2-4-8.1 Outputs of the Soft Component

Objective	Output of soft component	Department in charge
(1) Basic knowledge for sustainable operation and daily inspection of the equipment is transferred.	1) Overview and characteristics of power capacitors and switching gears are understood.	· Maintenance and Field Service, TSP[1], TCN[2]
	2) Theories about stable power supply are understood.	· System Operator, SO[3], TCN
(2) Basic skills for sustainable maintenance of the equipment are transferred.	1) Necessity of items listed on a checklist is understood.	· Maintenance and Field Service, TSP, TCN · System Operator, SO, TCN
	2) Computerized data management methods are understood.	· System Operator, SO, TCN · Maintenance and Field Service, TSP, TCN
(3) Management skills for proper operation and daily inspection of the equipment are transferred and such skills are summarized in a manual.	1) Daily equipment inspection manual (draft) is created.	· Maintenance and Field Service, TSP, TCN
	2) Operation manual (draft) is created.	· System Operator, SO, TCN

Source: Preparatory Survey Team

[1] TSP: Transmission Service Provider
[2] TCN: Transmission Company of Nigeria
[3] SO: System Operation

(4) Soft Component Activities (Input Implementation Plan)

As shown in Table 2-2-4-8.2, activities of the soft component will include technical transfer covering everything from the basics of power capacitors and extra-high voltage switchgears to operation management and daily checks. The technical transfer shall be conducted through classroom lectures, exercise (development of a manual by trainees) and practical training using equipment.

Table 2-2-4-8.2 Activities of the Soft Component and Methods for Technical Transfer

Objective	Output of soft component	Activity	Method for technical transfer	Main target
(1) Basic knowledge for sustainable operation and daily inspection of the equipment is transferred.	1) Overview and characteristics of power capacitors and switchgears are understood.	· Learn the principles and basic knowledge of circuit breaking of power capacitors and switchgears. · Understand characteristics and protection functions of current transformers and instrument transformers.	· Classroom lecture · Group exercise	· Maintenance and Field Service, TSP and TCN
	2) Theories about stable power supply are understood.	· Learn basic theory of power transmission (stable use of reactive power and system, causes for voltage rise, etc.)	· Classroom lecture · Group exercise	· System Operator, SO and TCN
(2) Basic skills for sustainable maintenance of the equipment are transferred.	1) Necessity of items listed on a checklist is understood.	· Deepen understanding of the importance of daily inspection through discussion on each item on the daily checklist.	· Classroom lecture · Practical training (equipment test operation using actual equipment)	· Maintenance and Field Service, TSP and TCN
	2) Computerized data management methods are understood.	· Understand operation management methods. · Create equipment ledgers and understand how to update.	· Classroom lecture · Practical training (recording and evaluation of operation data, and equipment monitoring)	· System Operator, SO and TCN · Maintenance and Field Service, TSP and TCN
(3) Management skills for proper operation and daily inspection of the equipment are transferred and such skills are summarized in a manual.	1) Daily equipment inspection manual (draft) is created.	· Develop daily inspection manuals for power capacitors and switchgears.	· Classroom lecture and exercise (development of manuals)	· Maintenance and Field Service, TSP and TCN
	2) Operation manual (draft) is created.	· Update existing operation management manuals.	· Classroom lecture and exercise (development of manuals)	· System Operator, SO and TCN

Source: Preparatory Survey Team

(5) Implementation Structure

TCN has staff called System Operators (SOs) on a 24-hour basis at each 132/33 kV substation and transmits power in collaboration with Osogbo National Control Center and Katampe Substation, which is the major facility in Abuja sub-region (TCN's transmission area, covering the Federal Capital Territory and surrounding areas). Engineers in charge of maintenance are stationed at Apo Substation and make short trips to each substation for maintenance work. Table 2-2-4-8.3 shows the implementation structure for the soft component of the Project.

Table 2-2-4-8.3 Soft Component Implementation Structure

	Japanese consultant	Maintenance and Field Service[4]	System Operator[5]
Engineers	2	5-10[6]	3-5[7]
Operation method	Overall progress management	Maintenance of procured equipment	System maintenance for procured equipment and existing equipment
Orientation about the contents of the soft component	Explanation	Participation	Participation
Development of a manual	Advice	Development of a daily inspection manual	Update of operation manuals
Maintenance follow-up	Guidance on maintenance	Maintenance report	Operation management report
Report to	- JICA Headquarters - JICA Nigeria Office - TCN	- Consultant - Head of Maintenance and Field Service	- Consultant - Head of each substation

Source: Preparatory Survey Team

(6) Implementation Schedule

Figure 2-2-4-8.1 shows the implementation schedule for soft components.

Engineers dispatched from Japan shall carry out soft components in each category according to the implementation schedule shown in Figure 2-2-4-8.1. Timing of implementation and points of concern for each category are as shown below.

1) Transfer of Basic Knowledge for Operation and Maintenance Management

Such basic knowledge shall be transferred before Japanese engineers provide guidance on initial and regular operations so that basic knowledge of operation and maintenance management as well as understanding of daily inspection will be deepened.

The target groups of the soft components of the Project are the Maintenance and Field Service

[4] Maintenance and Field Service, TSP, TCN
[5] System Operator, SO, TCN
[6] Number of maintenance engineers stationed at Apo Substation
[7] Number of engineers stationed at Apo Substation and Keffi Substation respectively

Department and the System Operator Department, who should carry out duties with understanding of each other's activities to ensure smooth operation. For this reason, the training course of "Transfer of Basic Techniques" shall be conducted for the two groups together.

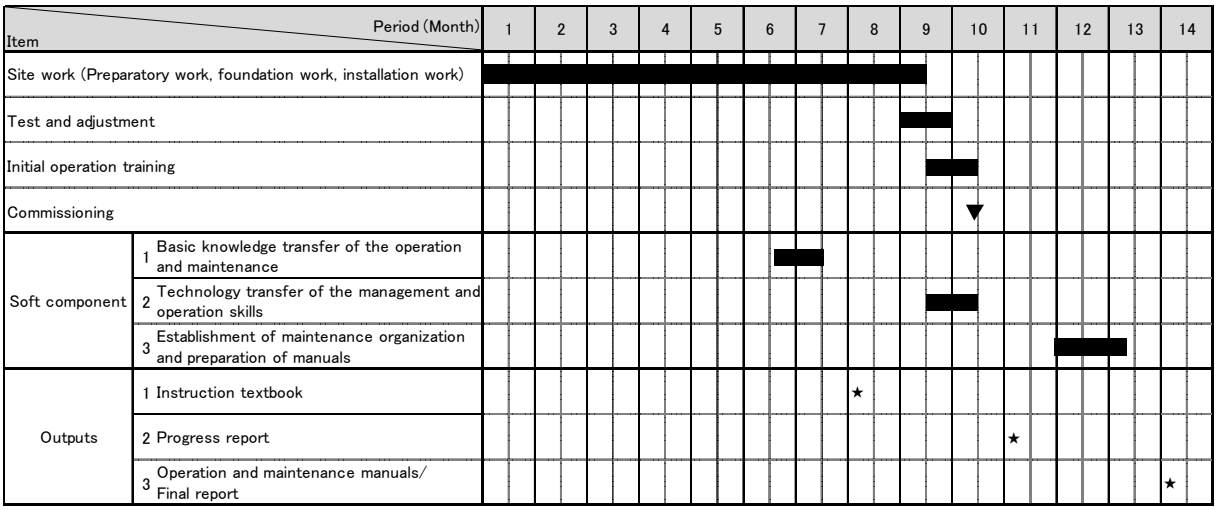
2) Transfer of Management and Operation Techniques

This technical transfer will be conducted at the same time as guidance on initial and regular operations by Japanese engineers to deepen understanding of daily inspection with a checklist.

3) Maintenance Structure and Development of Manuals

After guidance on initial and regular operations, transferred techniques for daily inspection and other information defined through the implementation of the soft component such as the structure and roles shall be compiled into manuals.

Each group will develop a manual for their own group, but two groups will work together and study each other's operations. This collaboration work is expected to promote information sharing for operations between groups and contribute to building information bases for the development of SCADA system in the future.



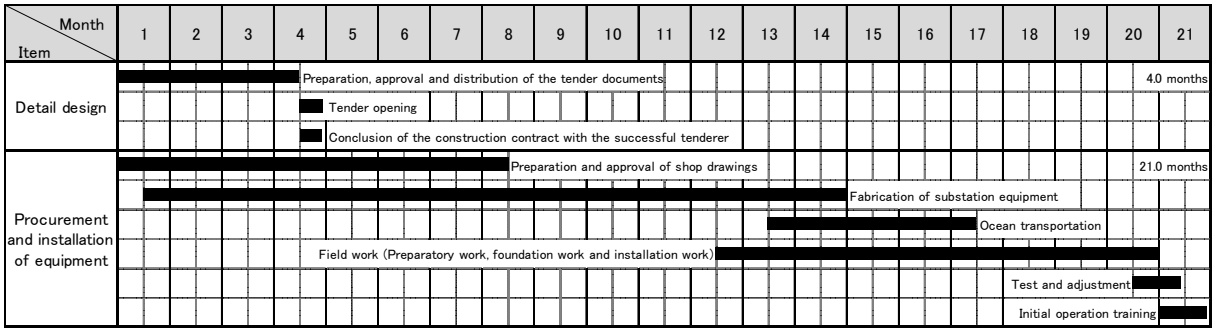
Source: Preparatory Survey Team

Figure 2-2-4-8.1 Soft Component Implementation Schedule

During the soft component, one personnel from the Maintenance and Field Services will be appointed as the soft component leader. Also one personnel from each group shall be assigned as the sub leader to realize the smooth communication and coordination during the soft component implementation period.

2-2-4-9 Implementation Schedule

Pursuant to Japan's Grant Aid system, the implementation schedule has been developed as shown in Figure 2-2-4-9.1.



Source: Preparatory Survey Team

Figure 2-2-4-9.1 Project Implementation Schedule

2-3 Project Operation Plan

2-3-1 Basic Policy

With experience in operation and maintenance management of power capacitors for stable transmission, TCN has a minimum knowledge and techniques concerning operation and maintenance management of the facilities. Therefore, the basic policy of the Project is to review checklist items for operation and maintenance management and reconfirm implementation schedule in order to ensure smooth and quick transition from guidance on initial and regular operations to the implementation of operation and maintenance management by TCN.

2-3-2 Items for Daily and Periodic Inspection of Substation Facilities

Daily maintenance and inspection is crucial to sustainable operation of substation equipment including power capacitors, auxiliary facilities and protection control equipment to be installed in the Project. The following are the three major categories of inspection to be conducted by operation management personnel.

- Examination and inspection at the time of completion of the substation equipment before start of operation
- Daily inspection after commencement of operation
- Periodic inspection after a certain period of operation

(1) Items to be Checked for the Inspection at the Completion of Substation Facilities and for Periodic Inspection

Items to be checked for the inspection at the completion of substation facilities installation and those for periodic inspection are almost the same. Table 2-3-2.1 shows the items to be checked and measured. For examination and inspection at the completion of substation facilities installation, see 2-2-4-7 “Operation Guidance Plan”.

(2) Daily Inspection

The substation facilities will require such operations as activation and release, like other substation facilities.

After it is confirmed that 132kV system voltage has dropped and lagging reactive power has increased, the substation facilities shall be manually activated to stabilize such state. The substation facilities shall be manually released after it is confirmed that the system voltage has risen and delayed reactive power has lowered enough. As breakers and line switches with moving parts may have trouble during initial operation, operation status should be checked daily. Operation management personnel shall check all substation devices with a Japanese engineer who installed the equipment and learn about check points and keys to successful inspection.

Although the substation facilities can be remotely operated, daily inspection at the site is useful in detecting malfunctions immediately.

Daily inspection shall be conducted as visual inspection every day for a month after commencement of operation. After that, inspection shall be conducted about once a week. Table 2-3-2.1 shows the items to be checked.

Table 2-3-2.1 Items for Daily Inspection

Device for Inspection	Items to Be Checked
Power Capacitor (visual check only when in operation)	・Dirt and breakage on surface ・Corrosion and rusting of mounting ・Damage on external wiring ・Oil leakage
Gas Circuit Breaker and Line Switch	・Dirt and breakage on surface ・Corrosion and rusting of casing ・Damage on external wiring ・On/off display ・Gas pressure
Current Transformer and Condenser Type Voltage Transformer	・Dirt and breakage on surface ・Corrosion and rusting of casing ・Damage on external wiring ・Oil leakage
Lightning Arrestor	・Dirt and breakage on surface ・Corrosion and rusting of casing ・Damage on external wiring ・Number of times of operation

Device for Inspection	Items to Be Checked
Capacitor Bank Protection Panel and Control Panel	・Corrosion and rusting of casing ・Cleaning of vent filters ・Indicating instruments and display ・Installation environment (temperature)
Power cable and termination	・Dirt and breakage on surface
DC Supply System	・Corrosion and rusting of surface ・Battery fluid leakage ・Indicating instruments and display
Substation Earthing Device	・Damage on wiring

Source: Preparatory Survey Team

Operation management personnel shall keep daily inspection records whenever they conduct daily inspection.

After checking the daily inspection items listed in Table 2-3-2.1, operation management personnel shall describe inspection results in the book and keep it. Recording the results will help detect abnormal changes.

(3) Periodic Inspection

Tables 2-3-2.2 to 2-3-2.8 show the general items for periodic inspection and measurement. For periodic inspection, systems shall be shut down after a certain period of operation and inspection and measurements shall be conducted for the items listed in the table. Periodic inspection shall be conducted 1, 3, 6 and 12 years after the commencement of operation (and in another 6 and 12 years).

Examination and inspection results shall be recorded and kept without fail.

Table 2-3-2.2 Items for Periodic Inspection of Power Capacitors

Device for inspection	Check item	Regular inspection A	Regular inspection B	Detailed inspection A	Detailed inspection B
		1 year	3 years	6 years	12 years
Power Capacitor	• Visual inspection of external structure (oil leakage, etc.) • Measurement of insulation resistance • Check of tightening of connecting parts of main circuits	○	○	○	○
	• Measurement of capacitor capacitance	○	○	○	○
	• Inspection of earthing conductors and connecting parts		○	○	○

Source: Preparatory Survey Team

Table 2-3-2.3 Items for Periodic Inspection of Gas Circuit Breakers

Device for inspection	Check item	Regular inspection A	Regular inspection B	Detailed inspection A	Detailed inspection B
		1 year	3 years	6 years	12 years
Gas Circuit Breaker	• Inspection of structure and cleaning • Opening and closing operation test • Measurement of insulation resistance	○	○	○	○
	• Inspection and maintenance of attachment parts • Inspection and cleaning of blocking parts and support insulators • Inspection and lubrication of mechanism parts • Measurement of minimum operating voltage		○	○	○
	• Measurement of operating pressure of gas density switches • Measurement of operating pressure of air pressure switches • Measurement of switching time • Measurement of resistance of main circuits			○	○

Source: Preparatory Survey Team

Table 2-3-2.4 Items for Periodic Inspection of Line Switches

Device for inspection	Check item	Regular inspection A	Regular inspection B	Detailed inspection A	Detailed inspection B
		1 year	3 years	6 years	12 years
Line Switch	• Measurement of resistance of main circuits	○	○	○	○
	• Inspection of structure and cleaning • Opening and closing operation test • Measurement of insulation resistance	○	○	○	○
	• Inspection and maintenance of attachment parts • Inspection and deterioration check of arcing horns • Inspection and lubrication of active parts • Inspection of earthing wires and connecting parts		○	○	○

Source: Preparatory Survey Team

Table 2-3-2.5 Items for Periodic Inspection of Current Transformers and Condenser type Voltage Transformer

Device for inspection	Check item	Regular inspection A	Regular inspection B	Detailed inspection A	Detailed inspection B
		1 year	3 years	6 years	12 years
Current Transformer and Condenser Type Voltage Transformer	• Inspection, maintenance and cleaning of tanks, FT covers and oil level	○	○	○	○
	• Inspection and cleaning of bushing and terminals • Measurement of insulation resistance	○	○	○	○
	• Inspection of earthing wires and connecting parts		○	○	○
	• Inspection of secondary and tertiary circuits • Inspection of coated parts		○	○	○

Source: Preparatory Survey Team

Table 2-3-2.6 Items for Periodic Inspection of Lightning Arrestors

Device for inspection	Check item	Regular inspection A	Regular inspection B	Detailed inspection A	Detailed inspection B
		1 year	3 years	6 years	12 years
Lightning Arrestor	• Inspection of external appearance and structure, and cleaning • Inspection and cleaning of connecting parts of major circuits • Measurement of insulation resistance	○	○	○	○
	• Inspection and cleaning of fastening parts of control circuits • Measurement of leakage currents			○ ○	○ ○

Source: Preparatory Survey Team

Table 2-3-2.7 Items for Periodic Inspection of Protection and Control Panels

Device for inspection	Check item	Regular inspection A	Regular inspection B	Detailed inspection A	Detailed inspection B
		1 year	3 years	6 years	12 years
Capacitor Bank Protection Panel and Control Panel	• External and internal inspection and cleaning of housing	○	○	○	○
	• Inspection and cleaning of fan filters	○		○	○
	• Inspection and cleaning of fastening parts of control circuits • Inspection and maintenance of earthing conductors • Inspection of coated parts		○	○	○
	• Replacement of fan filters			○	○
	• Replacement of fuses *EF.f, etc.)				○

Source: Preparatory Survey Team

Table 2-3-2.8 Items for Periodic Inspection of DC Supply System

Device for inspection	Check item	Regular inspection A	Regular inspection B	Detailed inspection A	Detailed inspection B
		1 year	3 years	6 years	12 years
DC Supply System (Chargers)	• Cleaning of fouling with dust • Check of various set values • Measurement of input/output voltage values and current values • Measurement of insulation resistance • Sequence test • Ventilation of housings	○	○	○	○
	• Operation check of no-load voltage compensation circuits • Measurement of DC output current characteristics • Operation check of charge switching units and timers • Observation of output waveforms of rectifiers • Operation test at the time of automatic equalization and power return after power failure		○	○	○
	• Characteristic verification test of silicon symmetrical switchers • Observation of voltage and waveforms of controlling circuits • Measurement of adjustable range of various charging voltages • Precise measurement of automatic constant voltage characteristics • Calibration of instruments			○	○
	• Detailed inspection of parts and operation of each circuit and replacement of parts				○
DC Supply System (Batteries)	• Measurement of voltage of all cells • Measurement of temperature and specific gravity of electrolyte of all cells	○	○	○	○
	• Check of cracks and liquid leakage • Check of corrosion of terminals and connecting parts • Check of damage on low liquid alarm, sensors, etc. • Check of deformation, cracks and loss of inner electrodes • Check of quantity, turbidity and discoloration of electrolytic solution	○	○	○	○

Device for inspection	Check item	Regular inspection A	Regular inspection B	Detailed inspection A	Detailed inspection B
		1 year	3 years	6 years	12 years
	• Check of damage of hydrometers and thermometers in liquid • Check and retightening of terminals and connecting parts • Check of deposition volume of active materials • Check of charging voltage at the time of floating charge • Execution of equalized charge				
	• Capacity test • Adjustment of specific gravity of electrolytic solution (if necessary) • Activation of liquid replacement (if necessary)			Expected standard life duration (control valve type stationary lead batteries) MSE type: 7-9 years	Same as on the left

Source: Preparatory Survey Team

2-3-3 Spare Item Purchase Plan

The power capacitor that is the major equipment of the Project is a stationary device with no moving parts. However, as the gas circuit breaker and the line switch have moving parts and require periodic maintenance, materials required for maintenance shall be procured as spare items. Also, as semiconducting materials are used for protection control panels and they may have a failure, spare items, especially protection relays, shall be procured.

Equipment will deteriorate as they age and eventually lose its functions. For many equipment, it is difficult to assess the state of deterioration. One way to maintain system reliability based on the concept of preventive maintenance is to replace parts before failures occur. Table 2-3-3.1 shows recommended replacement cycles and inspection contents for major equipment.

Table 2-3-3.1 Replacement Cycles and Inspection Contents for Target Devices (Recommendation)

Device	Recommended replacement cycle	Inspection contents
Power capacitor	20-30 years	Measurement of external appearance, insulation and electric capacity
Gas circuit breaker	20 years	Operation test
Line switch	20 years	Operation test
Current transformer and condenser type Voltage transformer	20 years	Measurement of external appearance and insulation
Lightning arrestor	20 years	Measurement of operation characteristics
Protection control panel	15 years	Measurement of operation characteristics

Device	Recommended replacement cycle	Inspection contents
Battery for DC supply system	7-9 years	Measurement of operation characteristics and battery performance

Source: JEMA "Have you had your power receiving/transforming facilities diagnosed? (Recommendation of facility diagnosis, inspection and maintenance)" 2012, et al.

1) Storage of spare parts

Breakage or failure of equipment for substation equipment often directly leads to shutdown of the equipment. It is desirable to repair or replace devices immediately when there is trouble. If spare parts are stored at or near the site, facilities can be quickly recovered. However, as storage of expensive parts or a large quantity of parts would increase the cost, the number of spare parts and the storage place shall be determined with due consideration to such factors as characteristics of the equipment, economical efficiency and time required for equipment recovery. Spare parts to be procured by the Project as indicated in Table 2-2-2-4.5 to Table 2-2-2-4.11 are designed to be stored until 2020 (during the period of three years after the commissioning). After this period, TCN will be required to procure the same number of spare parts and keep them in a proper manner.

2) Spare Item Purchase Plan

Table 2-3-3.1 shows recommended replacement cycles for the target substation equipment. As the major devices have a long life, the Project will prepare spare items. Table 2-3-3.2 shows the replacement cycle for batteries necessary for DC supply system. Battery replacement cost has to be included in TCN's budget about 9 years after the completion of the work.

Table 2-3-3.2 Battery Replacement Cycle

Item	Replacement cycle	Volume
Battery	7-9 years	1 set

Source: Preparatory Survey Team

2-4 Project Cost Estimation

2-4-1 Initial Cost Estimation

(1) Cost to Be Borne by the Nigerian Side 27,000 USD (about 3,000,000 JPN)

Undertakings and cost amounts to be borne by the Nigerian side are as shown below.

1) Land preparation in the project sites: 10,000 USD (about 1,100,000 JPN)

2) Removal of obstacles from the project sites: 5,000 USD (about 600,000 JPN)

3) Fees based on banking agreement: 12,000 USD (about 1,300,000 JPN)

(2) Conditions for Cost Estimation

1) Time of estimation: December 2014

2) Exchange rate: 1 USD = 111.15 JPN (average TTS from September to November 2014)

3) Construction and procurement period: The period for detailed design, equipment procurement and installation is as shown in the construction schedule.

4) Other: The Project will be implemented according to Japan's Grant Aid scheme.

2-4-2 Operation and Maintenance Cost

After the commencement of service, TCN, under the supervision of FMP, shall be responsible for the operation and maintenance of the equipment procured and installed in the Project. As the target substations of the Project are existing ones that TCN has been operating and maintaining, it will not be necessary to hire new personnel for operation or maintenance.

For the sound operation of the substations improved in the Project, prompt response to troubles and more stable and continuous power supply, the spare parts listed in "Spare Item Purchase Plan" in Section 2-3-3 concerning spare parts purchase planning should always be stored and TCN shall include cost for such items in its budget as necessary. As labor cost will be consolidated with other substations as with the operation, there will be no increase in labor cost and additional maintenance cost will mainly be for the purchase of spare parts. As the cost required for the purchase of spare parts will be about 0.04 million USD (about 4.3 million JPN/year), which is only 0.07% of TCN's budget for transforming facilities (6.2 billion NGN (about 4.3 billion JPN) in 2015), it is expected that such cost can easily be included in the budget.

CHAPTER 3 PROJECT EVALUATION

Chapter 3 Project Evaluation

3-1 Preconditions

As a prerequisite, land has to be obtained for the installation of the equipment procured in the Project. TCN, the implementing agency of the Project, has already obtained land for this purpose and there are no environmental or social issues.

3-2 Necessary Inputs by Recipient Country

Followings are the inputs from the Nigerian sides that will be required to achieve the overall plan of the Project, including power flows.

(1) Before Commencement of Construction

- Land preparation and leveling in the planned sites for equipment installation should be conducted before the start of installation works by the Japanese side.
- Existing lights should be relocated from the sites for equipment installation before the start of installation works by the Japanese side.
- Temporary storage space should be secured for procured equipment.
- It should be ensured that the ground resistance value is 1Ω or below in existing grounding equipment.
- Transformers, switchgears, frames, lightning arrestors, etc. that cannot be used or are damaged by lightning at Apo Substation should be replaced.
- Damaged control panels and related equipment in the control building of Apo Substation should be replaced or repaired.
- Power meters and reactive power meters embedded in 132 kV control panels in the existing control building of Keffi Substation should be calibrated.
- Power capacitors (330kV, 50MVar × 2 sets) and transformer (330/132kV, 150MVA) at Katampe Substation should be connected to the system.
- Shunt reactors (330kV, 75MVar) at Gwagwalada Substation should be connected to the system.

(2) During the Construction Period

- Relevant organizations should be consulted and necessary measures should be taken for necessary planned outage.
- Space should be reserved in existing cable pits to store low voltage cables and control wires.
- Space should be reserved in existing control buildings for the installation of control and protection panels.

- AC and DC power should be supplied for the control panels to be installed.
- Existing bus bar communication lines should temporarily be removed for the transportation of heavy machinery required for the works by the Japanese side.

(3) Other

- Necessary human resources and cooperation should be provided to achieve the objectives of the soft components.
- Necessary expenses for the operation and maintenance after the commencement of service should be included in budget.

3-3 Important Assumptions

The external conditions to generate and maintain impacts of the Project are:

(1) For the Overall Goal

- There should be no change in power development policies.
- There should be political and economic stability.

(2) For the Project Purposes

- TCN should conduct operation and maintenance management in a sustainable manner.
- Security should be ensured for the facilities.

(3) For Expected Outputs

- Superordinate power generation facilities and subordinate distribution facilities should be fully utilized.
- The operation and maintenance management plan for the facilities should be carried out.

3-4 Project Evaluation

3-4-1 Relevance

As shown below, the Project will contribute to the realization of Nigerian development plan and energy policies and bring benefits to the general public. Therefore, the relevance of the Project is considered high.

(1) Urgency

Backed up by ongoing strong economic growth, Nigerian government has set an ambitious national development plan, “Nigeria Vision 20: 2020”, aiming at being one of the 20 largest economies in the world by 2020.

While further economic growth will be required to achieve the goal of target, weak power supply is a major adverse factor to such economic growth. Early restoration of reliability in power supply is the key to implement the development plan and has become an urgent task in

its national policy.

Under these circumstances, TCN established a transmission network extension plan for 2020 introducing phase modifying equipment to increase supply facility capacity and reduce reactive power.

The components of the Project are included in the extension plan and consistent with the afore-mentioned national development plan. The Project is also expected to contribute to the earliest improvement of the power supply situation in the capital city of Abuja and surrounding areas, where planned power outage occurs on a daily basis. Therefore, the urgency of the Project is considered high.

(2) Benefits

Apo Substation, one of the target substations of the Project, is located in the south part of the capital city of Abuja and distributes power to a large area including Asokoro District, which has many residents, and the Abuja International Airport. Keffi Substation is located in the suburbs next to the capital city of Abuja, which has many residents commuting to the capital region during the day.

According to Abuja Electricity Distribution Company (Disco), the number of consumers in the distribution area of Apo Substation is as shown in Table 3-4-1.1. The area has schools, hospitals and important international organizations including ECOWAS.

Table 3-4-1.1 Numbers of Households and Consumers Receiving Power from the Target Substations

Apo Substation Distribution Area		Keffi Substation Distribution Area	
No. of households	No. of consumers (4.5 persons/household)	No. of households	No. of consumers (5.5 persons/household)
About 160,000	About 720,000	About 42,000	About 231,000

Note: The household size of FCT is used for Apo Substation and that of Nasarawa State is used for Keffi Substation. The information about household size is provided by NBS (National Bureau of Statistics).
Source: Table created by the Preparatory Survey Team based on information from DISCO and Social-Economic Survey on Nigeria2010, NBS.

(3) Operation and Maintenance Management Capabilities

With experience in operation of the equipment and facilities to be procured and installed in the Project, TCN is considered to have sufficient technical capabilities for such operation and maintenance management. However, due to a lack of engineers with such experience and a significant lack of maintenance management capabilities, technical transfer from the Japanese consultant is expected to help acquisition of sustainable skills for maintenance management and spread of such skills to other engineers and other substations.

3-4-2 Effectiveness

(1) Quantitative Effects

Technical quantitative effects to be provided by the Project is described in Table 3-4-2.1

Table 3-4-2.1 Quantitative Impacts of the Project

Indicator		Base Value (2014)	Target Value (2020 年) (3years from operation)
1. Voltage improvement at receiving end (%)*[1]	Apo Substation 132kV incoming side	N/A	2.90%
	Apo Substation 33kV outgoing side	N/A	3.01%
	Keffi Substation 132kV incoming side	N/A	6.19%
	Keffi Substation 33kV outgoing side	N/A	6.84%
2. Transmission power loss on 132kV line (MW)*[1]	Shiroro area (Target power system area of the Project) (%): Loss rate	N/A	101.4MW (6.85%)
3. Reducing of greenhouse gas (t/year)*[1]		N/A	6,404t/year
4. Additional number of household that will receive the power (household/day)*[2]	Apo Substation	N/A	5,400 household/day
	Keffi Substation	N/A	1,700 household/day
5. Additional number of consumer that will receive the power (person/day)*[2]	Apo Substation (4.5 person/household)	N/A	24,300 person/day
	Keffi Substation (5.5 person/household)	N/A	9,350 person/day

Note: *[1] Every indicator was calculated based on power system model as of 2017 at the commencement of operation
*[2]Additional number of households and consumers were calculated based on power system model targeted in 2020

◆ **Additional number of households that will receive the power**

Through the effect of the improvement of power factor, these substations to be targeted by the Project will receive more active power than what it is now. As a result, it will enable to provide powers to more consumers than what it is before the Project implementation. Now, the number of additional households to benefit the additional power supply will be calculated in line with the following procedure based on the peak period recorded from June 1, 2014 to May 31, 2015. Also, parameters which are utilized for the calculation are shown in the Table 3-4-2.2 with parameters shown in the Table 3-4-2.3 for the calculation.

i. Apparent power (MVA) will be calculated based on the peak demand (MW)

ii. The present reactive power (before the implementation of the Project) will be calculated (MVar).

iii. The compensated reactive power after the Project will be calculated (MVar).

iv. The compensated active power after the Project will be calculated (MW).

v. The additional active power will be calculated (MW).

vi. Through the division of the additional active power (MW) by the average number of power consumption by household (kW/household), the additional number of household will be calculated.

Table 3-4-2.2 Calculation of Additional number of households that will receive the power by the Project

Step		Apo Substation	Keffi and Akwanda Substations
1	Apparent Power	$\frac{217.0\text{MW}}{0.95} = 228.4\text{MVA}$	$\frac{37.4\text{MW}}{0.87} = 42.9\text{MVA (Keffi)}$ $\frac{53.7\text{MW}}{0.93} = 57.7\text{MVA (Akwanga)}$ $42.9\text{MVA} + 57.7\text{MVA} = 100.6\text{MVA}$
2	Reactive Power	$228.4\text{MVA} \times \sqrt{1^2 - 0.95^2} = 71.3\text{MVar}$	$42.9\text{MVA} \times \sqrt{1^2 - 0.87^2} = 21.1\text{MVar (Keffi)}$ $57.7\text{MVA} \times \sqrt{1^2 - 0.93^2} = 21.2\text{MVar (Akwanga)}$ $21.1\text{MVar} + 21.2\text{MVar} = 42.3\text{MVar}$
3	Reactive Power after operation of capacitor banks	$60\text{MVar} - 71.3\text{MVar} = -11.3\text{MVar}$	$25\text{MVar} - 42.3\text{MVar} = -17.3\text{MVar}$
4	Active Power after operation of capacitor banks	$\sqrt{228.4^2\text{MVA} - 11.3^2\text{MVar}} = 228.1\text{MW}$	$\sqrt{100.6^2\text{MVA} - 17.3^2\text{MVar}} = 99.1\text{MW}$
5	Addition of Active Power	$228.1\text{MW} - 217.0\text{MW} = 11.1\text{MW}$	$99.1\text{MW} - (37.4 + 53.7)\text{MW} = 8.0\text{MW}$ $8.0\text{MW} \times \left\{\frac{37.4MW}{(37.4+53.7)MW}\right\} = 3.3\text{MW}$*[1]
6	Additional number of households	$\frac{11.1\text{MW}}{2.03\text{kW/household}} \cong 5{,}400$ household	$\frac{3.3\text{MW}}{1.89\text{kW/household}} \cong 1{,}700$ household

Note: *[1] Additional active power at Keffi and Akwanga substations is divided proportionately to specify additional number of households for Keffi substation.
Source: Preparatory Survey Team

Table 3-4-2.3 Parameters used for the calculation

Item		Amount
Power Factor*[1]	Apo Substation	0.95
	Keffi Substation	0.87
	Akwanga Substation	0.93
Peak Demand (Assumption of 2020) *[1]	Apo Substation	217.0MW
	Keffi Substation	37.4MW
	Akwanga Substation	53.7MW
Average of power demand per household	Apo Substation (Actual value in 2014)	0.93kW/household
	Apo Substation (Assumption in 2020)*[2]	2.03kW/household

Item		Amount
	Keffi Substation (Actual value in 2014)	0.86kW/household
	Keffi Substation (Assumption in 2020)*2	1.89kW/household
Capacitor Bank	Apo Substation	60 MVar
	Keffi Substation	25 MVar

Note: *1 Power factor and peak demand assumption were set up from average of power factor in Shiroro area in TCN's power system model, and average of demand per household was set up with reference to the data from Disco. Load at Keffi substation was taken load of neighboring Akwanga area into consideration.

*2 Average of power demand per household in 2020 was taken increasing rate of population by WB and load data from Disco into consideration.

◆ Calculation of Greenhouse Gas Reduction

Greenhouse gas reduction effect of the expected power loss on a transmission network after installation of power capacitors was calculated by using the emission factor for each fuel type shown in Table 3-4-2.4.

1) Calculate reduction of power loss (MWh/year).

2) Calculate offset calorific power (GJ/year): Generated power (MWh/year) x 3,600 (GJ/1000MWh) / heat efficiency of power generation facilities

3) Calculate CO_2 emission reduction (t): Reduction of calorific power (GJ/year) x emission factor (tC/GJ) x 44/12

Table 3-4-2.4 Examples of Emission Factor by Fuel Type

Fuel type	Unit calorific value	Emission factor
Steam coal	25.7 GJ/t	0.0247 tC/GJ
Crude oil (excluding condensate (NGL))	38.2 GJ/kl	0.0187 tC/GJ
Light oil	37.7 GJ/kl	0.0187 tC/GJ
Heavy oil	39.1 GJ/kl	0.0189 tC/GJ
Natural gas (excluding liquid natural gas (LNG))	43.5 GJ/10^3Nm^3	0.0139 tC/GJ

Source: Manual for the Calculation and Report of Greenhouse Gas Emissions, Ministry of Environment and Ministry of Economy, Trade and Industry (May 2013)

(2) Qualitative Impacts

Current state and issues	Introduction of power capacitors to the target substations of the Project (Apo and Keffi Substations) (Cooperation project)	Level of effect and improvement
There is significant voltage drop at customers' receiving ends in the target area of the Project. Customers' electric appliances can easily break down.	Introduce power capacitors.	Voltage at customers' receiving ends is determined by the distribution voltage of the distribution company. Operation voltage of the distribution company is low because it is at the demarcation point with the transmitter. Introduction of power capacitors will improve the transmission operation voltage and is also expected to improve the voltage of power supply to the distributor. Supply of higher-quality power from the distribution company that almost achieves the rated voltage will contribute to extending the service life of customers' fluorescent lamps, PC batteries and other electric appliances.
Frequent power outage caused by low-quality power supply to customers makes the entire power supply unstable and hinders social and economic development.	Introduce power capacitors.	Introduction of power capacitors is expected to improve the state of planned outage and contribute to the promotion of social and economic development of the target area of the Project. It is also expected to improve the operation of the power supply through the enhancement of the reliability of the transmission system operation.
Significant voltage drop creates problems in the operation of hospitals, schools and other public facilities.	Introduce power capacitors.	High-quality power supply is necessary for the stable use of medical instruments at hospitals, where precision instruments are often used. Moreover, use of stable lighting at school is expected to contribute to the improvement of learning efficiency of the students.
Night-time outage worsens the security situation because street lamps and security lamps cannot be used.	Introduce power capacitors.	Reduction of outage time will increase the number of hours when street lamps and security lamps can be used and is expected to help maintain security in the target area of the Project.

APPENDICES

A-1 Member List of the Study Team

A-1 Member List of the Study Team

(1) First Field Survey

Name	Assignment	Organization
Kazunari OSHIMA	Team Leader	Japan International Corporation Agency
Yuki MASUYA	Planning Management	Japan International Corporation Agency
Masatsugu KOMIYA	Chief Consultant / Power Development Planning	Yachiyo Engineering Co., Ltd.
Makoto ABE	Deputy Chief Consultant/ Power Development Planning/ Substation Facilities-1	Yachiyo Engineering Co., Ltd.
Hiroto SATO	Substation Facilities-2	Yachiyo Engineering Co., Ltd.
Masahiko TAKEMURA *1)	Power System Analysis	Yachiyo Engineering Co., Ltd.
Uyu TANAKA	Facility Planning	Yachiyo Engineering Co., Ltd.
Kazuaki KONDO	Procurement Planning/ Cost Estimation	Yachiyo Engineering Co., Ltd.

(2) Second Field Survey

Name	Assignment	Organization
Kazunari OSHIMA	Team Leader	Japan International Corporation Agency
Yuki MASUYA	Planning Management	Japan International Corporation Agency
Makoto ABE	Deputy Chief Consultant/ Power Development Planning/ Substation Facilities-1	Yachiyo Engineering Co., Ltd.
Kazuaki KONDO	Procurement Planning/ Cost Estimation	Yachiyo Engineering Co., Ltd.

A-2 Study Schedule

A-2 Study Schedule

(1) First Field Study

No.	Month	Date	Day	Survey contents						Stay at
				Official member	Consultant member					
				Mr. Oshima Ms. Masuya	Mr. Komiya	Mr. Abe	Mr. Sato	Mr. Tanaka	Mr. Kondo	
1	Nov.	2	Sun				・Trip {Tokyo 10:50 → Paris(France) 15:40 (JL045)}			Paris
2	Nov.	3	Mon				・Trip {Paris (France) 11:00 → Abuja (Nigeria) 17:00 (AF514)}			Abuja
3	Nov.	4	Tue	・Discussion(8:00 JICA Nigeria Office)			・Discussion(8:00 JICA Nigeria Office) ・Courtesy call and explanation of the survey(9:00 JICA Nigeria Office) ・Courtesy call and explanation of the survey(10:00 Transmission Company of Nigeria (TCN)) ・Site survey(13:30 Apo Substation: Confirmation of the current situation and equipment) ・Courtesy call and explanation of the survey (16:00 TCN)			Abuja
4	Nov.	5	Wed				・Site survey(9:30 Keffi Substation : Confirmation of the current situation and equipment) ・Technical discussion(16:00 TCN: Questionnaire)			Abuja
5	Nov.	6	Thu				・Site survey(9:00 Katampe Substation : Confirmation of present equipment) ・Internal meeting(15:00)			Abuja
6	Nov.	7	Fri				・Site survey(9:00 Apo Substation : Confirmation of present equipment) ・Internal meeting(15:00)			Abuja
7	Nov.	8	Sat				・Site survey(9:00 Gwagwalada Substation : Confirmation of present equipment) ・Internal meeting(17:00)			Abuja
8	Nov.	9	Sun				・Internal meeting(9:00) ・Trip {Abuja (Nigeria) 23:55 → Paris (France)06:05+1 (AF513)}	・Internal meeting(9:00) ・Data analysis(13:00)		Abuja
9	Nov.	10	Mon				・Trip {Paris (France) 18:55 → Tokyo 14:55+1 (JL046)}	・Internal meeting(9:00) ・Technical discussion(14:00 TCN : Questionnaire)		Abuja
10	Nov.	11	Tue		・Trip {Tokyo 10:50 → Paris(France) 15:40 (JL045)}		Trip {→ Tokyo 14:55 (JL046)}	・Internal meeting(9:00) ・Technical discussion(14:00 Apo Substation : Transmission network)		Abuja
11	Nov.	12	Wed		・Trip {Paris (France) 11:00 → Abuja (Nigeria) 17:00 (AF514)} ・Internal meeting(18:30 Project component)			・Data analysis ・Technical discussion(15:00 TCN : Project priority) ・Internal meeting(18:30 Project component)		Abuja
12	Nov.	13	Thu		・Same as Mr. Tanaka and Mr. Kondo			・Courtesy call(8:00 JICA Nigeria Office) ・Courtesy call(11:00 Federal Ministry of Power) ・Site survey(12:30 Katampe Substation) ・Courtesy call(14:30 TCN) ・Courtesy call(16:00 NPC)		Abuja
13	Nov.	14	Fri		・Same as Mr. Tanaka and Mr. Kondo			・Site survey(10:00 Apo Substation : Confirmation of current situation) ・Technical discussion(14:00 TCN : Priority of project components) ・Internal meeting(17:00)		Abuja
14	Nov.	15	Sat	・Trip{Tokyo → Paris}	・Same as Mr. Tanaka and Mr. Kondo			・Site survey(8:00 Keffi Substation) ・Site survey(12:00 Gwagwalada Substation) ・Internal meeting(17:00)		Abuja
15	Nov.	16	Sun	・Trip	・Internal meeting and Data analysis			・Internal meeting and Data analysis		Abuja

No.	Month	Date	Day	Survey contents						Stay at
				Official member	Consultant member					
				Mr. Oshima Ms. Masuya	Mr. Komiya	Mr. Abe	Mr. Sato	Mr. Tanaka	Mr. Kondo	
16	Nov.	17	Mon	・Trip{Paris→ Abuja} ・Internal meeting(19:00)	・Same as Mr. Tanaka and Mr. Kondo			・Discussion (8:00 JICA Nigeria Office) ・Courtesy call(9:30 NPC) ・Courtesy call(11:00 Federal Ministry of Power) ・Courtesy call(14:00 TCN) ・Internal meeting(19:00)		Abuja
17	Nov.	18	Tue	・Discussion (8:00 JICA Nigeria Office) ・Discussion on the Minutes(11:00 Federal Ministry of Power) ・Site visit(14:00 Apo Substation) ・Site visit(16:00 Gwagwalada Substation)				・Same as Mr. Komiya		Abuja
18	Nov.	19	Wed	・Site visit(9:00 Keffi Substation) ・Conclusion of the Minutes(15:00 Federal Ministry of Power) ・Conclusion of the Minutes(16:00 TCN) ・Conclusion of the Minutes(17:00 NPC)				・Same as Mr. Komiya		Abuja
19	Nov.	20	Thu	・Site visit(9:00 Katample Substation) ・Report(10:30 Federal Ministry of Power) ・Report(11:00 JICA Nigeria Office) ・Report(15:00 Embassy of Japan) ・Trip{Abuja→Paris}				・Same as Mr. Komiya		Abuja
20	Nov.	21	Fri	・Trip {Paris(France) → Tokyo}	・Trip {Paris(France) 18:55 → Tokyo 14:55+1 (JL046)}			・Data analysis(9:00) ・Site visit(13:00 Apo Substation) ・Market survey (15:00)		Abuja
21	Nov.	22	Sat	・Trip {→ Tokyo}	・Trip {→ Tokyo 14:55 (JL046)}			・Internal meeting		Abuja
22	Nov.	23	Sun			・Trip {Tokyo 10:50 → Paris(France) 15:40 (JL045)}		・Internal meetingとData analysis		Abuja
23	Nov.	24	Mon			・Trip {Paris (France) 18:20 → London (UK) 18:30 (BA323)} ・Trip {London (UK)22:40→ Abuja (Nigeria)6:00 (BA83)}		・Internal meeting(9:00) ・Technical discussion(14:00 TCN : Distribution area)		Abuja
24	Nov.	25	Tue			・Trip {→ Abuja (Nigeria) 6:00} [Mr. Abe and Mr. Sato] ・Internal meeting(10:00) ・Site survey(13:00 Keffi Substation)				Abuja
25	Nov.	26	Wed			・Courtesy call(9:00 JICANigeriaOffice) ・Site visit(10:00 Gwagwalada Substation) ・Site visit(15:00 Apo Substation) ・Internal meeting(17:00)				Abuja
26	Nov.	27	Thu			・Data analysis(9:00) ・Technical discussion(14:00 TCN)				Abuja
27	Nov.	28	Fri			・Site visit(Keffi Substation ・Internal meeting	・Discussion (Survey company)	・Same as Mr. Abe and Mr. Sato		Abuja
28	Nov.	29	Sat			・Data analysis				Abuja
29	Nov.	30	Sun			・Internal meetingとData analysis				Abuja
30	Dec.	1	Mon			・Technical discussion(10:00 TCN) ・Technical discussion(15:00 AFD)	・Site visit, site survey supervision (9:00 Keffi Substation)		・Same as Mr. Abe	Abuja
31	Dec.	2	Tue			・Technical discussion(11:00 TCN) ・Site survey(14:00 Apo Substation) ・Market survey(16:00)	・Site visit、site survey supervision (9:00 Apo Substation) ・Market survey(16:00)		・Site survey(10:00 Apo Substation)	Abuja
32	Dec.	3	Wed			・Data analysis(9:00) ・Technical discussion(13:00 TCN)	・Internal meeting(10:00)	・Data analysis(9:00) ・Market survey(13:00)	・Internal meeting(10:00)	Abuja
33	Dec.	4	Thu			・Technical discussion(TCN:Field report) ・Preparation of survey outline report				Abuja
34	Dec.	5	Fri			・Technical discussion(TCN: Sign on the Field report) ・Preparation of survey outline report				Abuja

No.	Month	Date	Day	Survey contents						Stay at
				Official member	Consultant member					
				Mr. Oshima Ms. Masuya	Mr. Komiya	Mr. Abe	Mr. Sato	Mr. Tanaka	Mr. Kondo	
35	Dec.	6	Sat			・Preparation of survey outline report				Abuja
36	Dec.	7	Sun			・Internal meeting and Data analysis				Abuja
37	Dec.	8	Mon			・Technical discussion(TCN: Field report) ・Preparation of survey outline report				Abuja
38	Dec.	9	Tue			・Technical discussion(TCN: Field report) ・Technical discussion(14:30 Abuja Disco) ・Preparation of survey outline report				Abuja
39	Dec.	10	Wed			・Preparation of survey outline report				Abuja
40	Dec.	11	Thu			・Preparation of survey outline report				Abuja
41	Dec.	12	Fri			・Internal meeting(10:00) ・Sign on the Field report (12:00 TCN) ・Discussion and sign on the Field report (15:00 Federal Ministry of Power)				Abuja
42	Dec.	13	Sat			・Preparation of survey outline report				Abuja
43	Dec.	14	Sun			・Preparation of survey outline report				Abuja
44	Dec.	15	Mon			・Report(9:00 JICA Nigeria Office) ・Trip {Abuja (Nigeria) 23:55 → Paris (France) 06:05+1 (AF513)}				On board
45	Dec.	16	Tue			・Trip {Paris (France) 18:55 → Tokyo 14:55+1 (JL046)}				On board
46	Dec.	17	Wed			・Trip {→ Tokyo 14:55 (JL046)}				

(2) Second Field Study

No.	Month	Date	Day	Contents of Field Survey		Stay at
				Official members Mr. Oshima Ms. Masuya	Consultant members Mr. Abe Mr. Kondo	
1	Jun.	18	Thu		・Trip [Tokyo 11:20 → London (UK) 15:50 (JL043)] ・Trip[London (UK) 22:40 → Abuja 04:40+1 (BA083)]	On board
2	Jun.	19	Fri		・09:00～10:00 Courtesy call and explanation of the survey (JICA Nigeria Office) ・10:00～11:00 Courtesy call and explanation of the survey (FMP) ・11:00～12:00 Courtesy call and explanation of the survey (TCN) ・12:30～16:00 Site survey (Apo Substation)	Abuja
3	Jun.	20	Sat	・Trip	・09:00～12:00 Site survey (Keffi Substation) ・13:00～18:00 Site survey and data collection (Katampe Substation)	Abuja
4	Jun.	21	Sun	・Trip	・Data analysis and internal meeting	Abuja
5	Jun.	22	Mon	・09:00～10:00 Internal meeting (JICA Nigeria Office) ・10:00～11:00 Courtesy call and explanation of DFR, minutes of discussions (NPC) ・14:00～16:00 Discussion on the Minutes of Discussion (MD) (FMP, NPC, TCN)		Abuja
6	Jun.	23	Tue	・09:00～12:00 Supplementary explanation of DFR (TCN) ・12:00～16:00 Discussion and sign on the minutes of discussions (FMP, NPC, TCN)		Abuja
7	Jun.	24	Wed	・09:00～12:00 Data analysis ・13:30 Report (JICA Nigeria Office) ・15:00 Report (Embassy of Japan in Nigeria)		Abuja
8	Jun.	25	Thu	・Trip	・Trip [Abuja 08:00 → London (UK) 14:30 (BA082)] ・Trip [London (UK) 19:15 → Haneda (Tokyo) 15:00+1 (JL044)]	On board
9	Jun.	26	Fri	・Trip	・Trip	-

A-3 List of Parties Concerned in the Recipient Country

A-3 List of Parties Concerned in the Recipient country

Name	Position
National Planning Commission (NPC)	
Mr. Oladimeji Tajudeen Shogbuyi	Director (IC)
Mr. Ibraheem Rafiu Oyegbade	Director (EG)
MR. Ileuma S. A.	AD (BEC)
Mr. M. Y. Abdulraheem	AD (BEC)
Mr. N. A. Lawal	Acting Director (Infrastructure)
Mr. Adeosun David	Assistant Director
Mr. Nwozuzu U. S	Chief Planning Officer, Commission Secretariat
Mr. Adeosun David T.	Macroeconomist (Infrastructure)
Dr. Chika Nwodo	PPO
Mrs. Eweioie Binbo	Senior Legal Officer (Asia Region)
Mr. Alfa Muhammad	SPO
Mr. Anyadiegwu Emmanuel	PO II
Mr. Oluwakemi Ogunjabi	PO I
Federal Ministry of Power (FMP)	
Amb. Godknows Boladei Igali	Permanent Secretary
Mr. Genjamin Neuge	Special Assistant, PS Office
Engr. A. Adebisi	Director, Renewable Energy and Rural Access Department
Mr. Afolabi John Oladele	Acting Director (TSD)
Engr. Ibhugora O. E.	Deputy Director (TS)
Engr. O. E. Ibhugom	Deputy Director
Mr. S. I. Anekwe	Deputy Director (INV) ISO
Engr. Briskilla Sapke	Deputy Director (Power)
Engr. A. E. Uwueiyen	Assistant Director
Engr. Faruk Yusuf Yabo	Assistant Director
Engr. A. D. Abubakar	Assistant Director
Engr. Philip Okpanafe	ACEE (Power)
Engr. D. B. Madu	Chief Engineer
Mr.Enang Moses	SEE(Power)
Mr. Nasira Muhammad Dange	SEE
Mr. Onwuama Victor C.	SEE
Mrs. Nwanus Theresa A.	PCS (TSD)
Mr. Abel Philip	RRP

Engr. Ominiyi A.	Electrical Engineer I
Mr. Arinze M. Osbuso	Electrical Engineer I
Mr. Abimbola Ominiyi	Electrical Engineer I
Engr. Onu Ogbonnaya Moutell	Mechanical Engineer 1 (Power)
Mr. Umoru S. Solomon	Higher Technical Officer
Mr Audi Bitrus Simon	Assistant Technical Officer

Transmission Company of Nigeria

Mr. Shahid Mohammad	Executive Director (TSP)
Mr. Tom Uwah	Director (TSP)
Engr. Musa M. Gumel	Director (System Operations)
Engr. F. K. Oluwafemi Zaccheaus	General Manager (PSP+R&D)
Engr. M. J. Lawal	General Manager (SO)
Engr. M. C. Ezeudenna	General Manager (D&C)
Engr. Olisa M. Okoli	General Manager (Chem, Resset and Environ)
Mr. Afolabi F. Ademora	General Manager (DS and Spec)
Engr. Aribaba Peter Adebisi	Assistant General Manager (Generation Planning & Data Control)
Engr. Shehu Abba Aliyu	Assistant General Manager (PSP)
Engr. L. C. Okalla	Assistant General Manager (T)
Engr. M. A. O. Dada	Assistant General Manager (Regulation)
Mr. E. O. Efiong	Assistant General Manager (Civil Substation)
Engr. Mohammad M. Sheik	Assistant General Manager (Substation Designs)
Engr. Abdulkadir Nazif	Senior Manager (PSPD)
Engr. M. K. Abdullahi	Senior Manager (Planning)
Engr. M. A. Ajibade	Senior Manager (PSP+R&D)
Mr. L.C. Ogwu	Senior Manager (Lines)
Engr. O. Osarenren	Senior Manager(Civil)
Mr. Umar Faruk Tahayc	Senior Manager (Substation Designs)
Engr. Dahiru A. I.	Principal Manager (Substation Designs)
Engr. Sulaiman Mahmud	Principal Manager (Transmission)
Mr. G. O. Aliyu	Principal Manager (Project)
Engr. Bassay I. H.	Principal Manager (SE)
Engr. Bukan Musa Tzab	Principal Manager (DS and IPP)
Engr. Ikeli Ndubuisi H.	Manager (PSP)
Mr. Vincent A. Chukwi	AM (Projects)
Engr. Nongo V. T.	Electrical Engineer (PC&M)

Mr. Ashipa James	Senior Manager (SO), Gwagwalada Substation
Mr. Akamagwuna George	Manager (SO), Gwagwalada Substation
Mr. Obasi Kingsley	Contract Operator (SO), Gwagwalada Substation
Ms. Nina Ikwan	Assistant Manager (SO), KACC[1]
Engr. Emmanuel Osikwemhe	Senior Manager (SO), KACC
Mr. Alhaji Yusuf Sanusi	Assistant Manager (Electrical SO)
Engr. RespectA. Aluya	Assistant Manager (SO), Shift head, KACC
Mr. Davies Kolawole N.	Principal Manager
Mr. John Newton	Station Manager, Keffi Substation
Mr. B. A. S. Umar	Assistant Manager (SO), Keffi Substation
Mr. Maduga Musa Sammuel	System Operator, Keffi Substation

Niger Delta Power Holding Company Limited

Engr. C. A. Ogunrinde	DGM (Civil Field Operations)

Abuja Electricity Distribution Company

Mr. Joe Chiyassa	Executive Director (Technical Services)
Mr. A. Bello	Principal Manager (O&M)
Mr. M. S. Dauda	Principal Manager (Planning & Construction)

French Development Agency

Mr.Adesoji Ademola	Senior Program Officer

Embassy of Japan in Nigeria

Mr. Sadanobu Kusaoke	Ambassador Extraordinary and Plenipotentiary
Mr. Ryuichi Shoji	Ambassador Extraordinary and Plenipotentiary
Mr. Chikara Yoshimura	First Secretary
Mr. Kazuhito Kibana	First Secretary

JICA Nigeria Office

Mr. Hirotaka Nakamura	Chief Representative
Mr. Tetsuo Seki	Chief Representative
Mr. Kensuke Ohishi	Representative
Mr. Masaaki Shikano	Project Formulation Advisor
Mr. Agidani Gabriel O.	Consultant

[1] KACC: Katampe Area Control Center

A-4 Minutes of Discussions

Minutes of Discussions
on the Preparatory Survey
for the Project for Emergency Improvement of Electricity Supply Facilities in Abuja
in the Federal Republic of Nigeria
(First Field Survey)

In response to the request from the Government of the Federal Republic of Nigeria (hereinafter referred to as "Nigeria"), the Japan International Cooperation Agency (hereinafter referred to as "JICA"), in consultation with the Government of Japan, decided to conduct a Preparatory Survey (hereinafter referred to as "the Survey") on the Project for Emergency Improvement of Electricity Supply Facilities in Abuja (hereinafter referred to as "the Project")

JICA sent to Nigeria the Preparatory Survey Team (hereinafter referred to as "the Team") headed by Mr. Kazunari Oshima, the Senior Advisor in the field of Energy and Mining, JICA, to conduct the first field survey and the Team is scheduled to stay in the country from 3rd November to 15th December, 2014.

The Team held discussions with the concerned officials of Nigeria; Federal Ministry of Power (FMP), Transmission Company of Nigeria (TCN), and National Planning Commission (NPC); and conducted a field survey in Nigeria.

In the series of the discussions, all parties have confirmed the main items described in the attached sheets hereto. Both sides have also noted that at the stage of the Survey no commitment is made from the Japanese side concerning the realization of the Project. The Team will proceed with further study and prepare the preparatory survey report.

Abuja, Nigeria
19th November, 2014

Mr. Kazunari Oshima
Leader, Preparatory Survey Team
Japan International Cooperation Agency
(JICA)

Engr. Afolabi John Oladele
Ag. Director, Transmission Services
Federal Ministry of Power (FMP)

Mr. Shahid Mohammad
Executive Director, TSP
Transmission Company of Nigeria (TCN)

19/11/2014

Witness

Mr. Oladimeji Tajudeen Shogbuyi
Ag. Director, International Cooperation
National Planning Commission (NPC)

19/11/14

ATTACHMENT

1. Objective of the Project

The objective of the Project is to improve and reinforce the power supply in Federal Capital Territory (FCT) in Nigeria.

2. Project Site

The Project sites are located as shown in Annex-1.

3. Responsible and Implementing Organizations

(1) The responsible sector ministry is the Federal Ministry of Power (FMP)
(2) The implementing agency is Transmission Company of Nigeria (TCN)
(3) The witness agency is National Planning Commission (NPC)
(4) The organization structures of FMP and TCN are shown in Annex-2 and 3.

4. Items Targeted in the Project

(1) The Nigerian side and the Team discussed the final requested components of the Project and their priority. The rating of the priority shown in the following table is higher in the following manner; A, B and C.

Table Final requested components of the Project and their priority

Component	Location	Specification	Priority
Installation of capacitor bank	Apo 132/33 kV Substation	60MVar, 132kV	A
Installation of capacitor bank	Keffi 132/33 kV Substation	25MVar, 132kV	A
Installation of Static Var Compensator (SVC)	Katampe 330/132/33kV Substation	50MVar, 330kV	C
Installation of shunt reactor	Gwagwalada 330/132/33kV Substation	75MVar	B

(2) The Team will study further the appropriateness of each component and technical specifications from the viewpoint of necessity and relevance as Japan's Grant Aid scheme, and will compile the findings into the preparatory survey report for the project appraisal process of the Government of Japan.

5. Japan's Grant Aid Scheme

(1) The Nigerian side has understood Japan's Grant Aid Scheme explained by the Team as described in Annex-4 and Annex-5.
(2) The Nigerian side will take the necessary measures, as described in Annex-6, for smooth implementation of the Project.

7. Schedule of the Study

(1) The Team will continue the first field survey in Nigeria until 15th December, 2014.
(2) The Team will prepare the draft report of the Preparatory Survey and dispatch a team to Nigeria in order to explain its contents to the Nigerian side in April 2015.

8. Other Relevant Issues

(1) The Nigerian side should submit answers to the terms to be confirmed, including as-built drawings especially layout drawings, TCN financial statements and data from Abuja Electricity Distribution Company, which the Team handed to the Nigerian side, by the beginning of December 2014.
(2) The Team informed that topographic and geological surveys at the Project sites will be

started from the week of 24 November, 2014 and requested to secure the sites.

(3) Nigerian side explained that, in Apo 132/33 kV substation, the damaged equipment by lightning such as transformer, switchgears, gantry structure, lightning rod, etc., will be replaced with new ones by Nigerian side. Also Nigeria side informed that the damaged parts of control building will be repaired by Nigerian side not to disturb the installation of equipment in the room before December, 2015.

(4) Nigerian side explained that, in Keffi 132/33 kV substation, proper maintenance works such as the repairing of the existing cooling fan of transformer, calibration of MW and MVar meters of 132kV control panel, etc. will be made by Nigerian side before December, 2015.

(5) Nigerian side explained that, in Katampe 330/132/33 kV substation, TCN has been installing Capacitor Banks (330 kV, 50 MVar x 2 sets) and a transformer (330/132 kV, 150 MVA) and they will be commissioned in 2015.

(6) Nigerian side explained that, in Gwagwalada 330/132/33 kV substation, the existing Shunt Reactor (330 kV, 75 MVar) placed at the site will be installed by TCN, however JICA should include Gwagwalada substation in the study.

(7) Nigerian side requested to carry out the capacity building in the field of substation management for the Project.

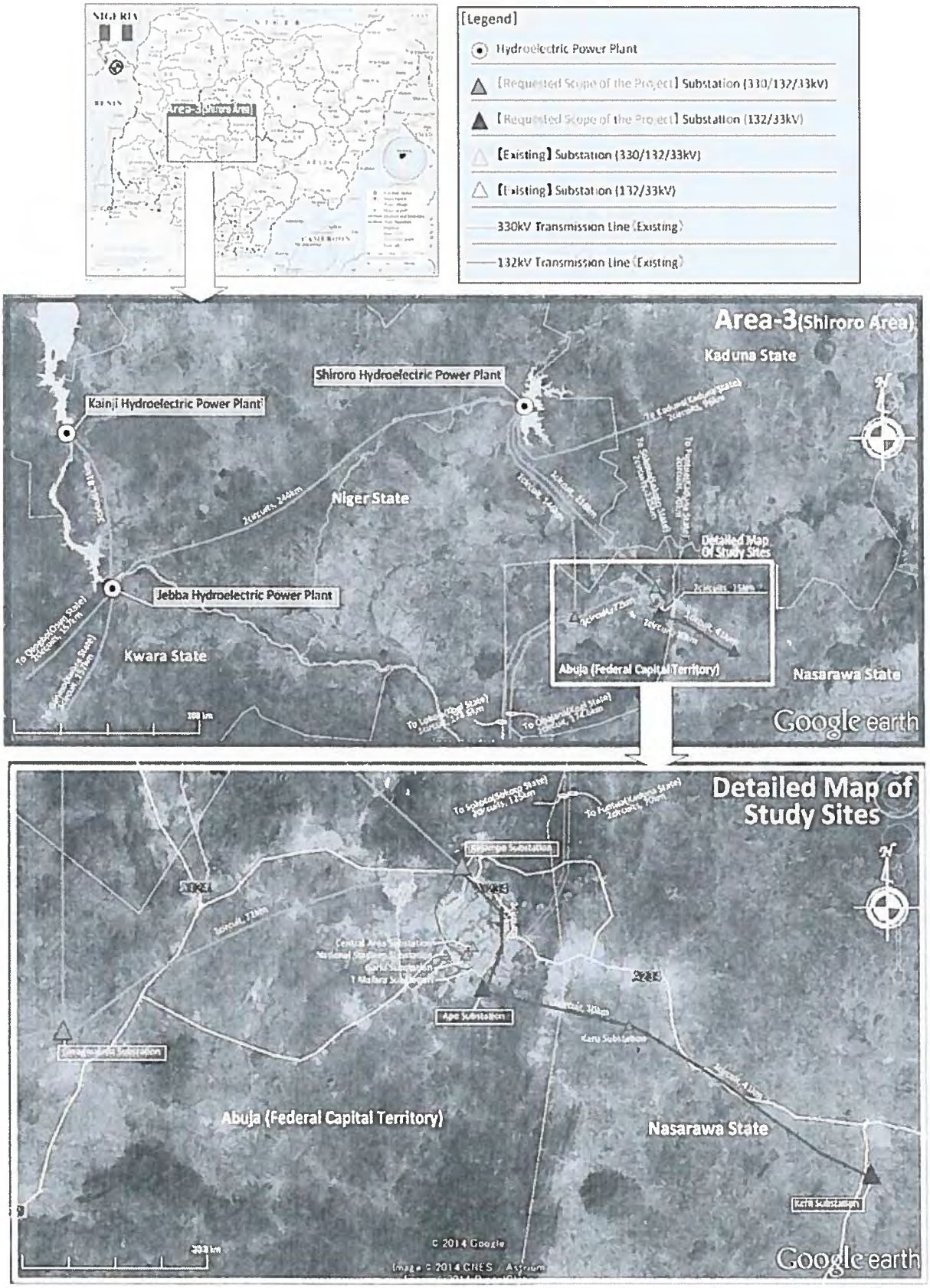
(End)

<List of Annex>

Annex-1	Location of the Project Sites
Annex-2	Organization Structure of Federal Ministry of Power (FMP)
Annex-3	Organization Structure of Transmission Company of Nigeria (TCN)
Annex-4	Japan's Grant Aid
Annex-5	Flow Chart of Japan's Grant Aid Procedures
Annex-6	Major Undertakings to be taken by Each Government

Annex - 1

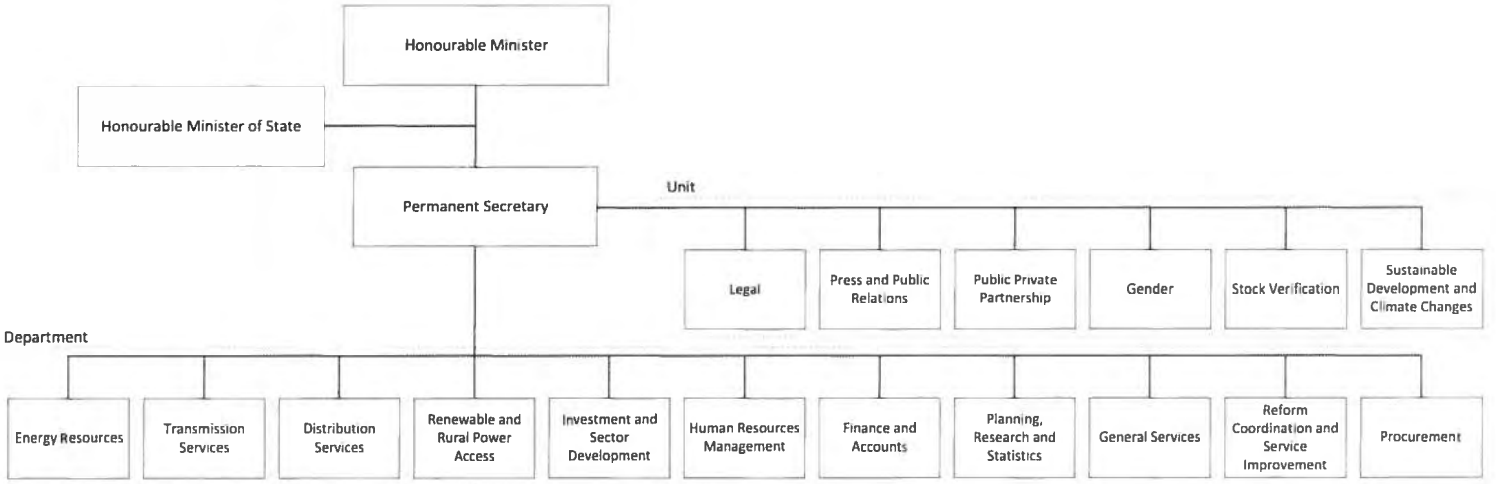
LOCATION OF THE PROJECT SITES



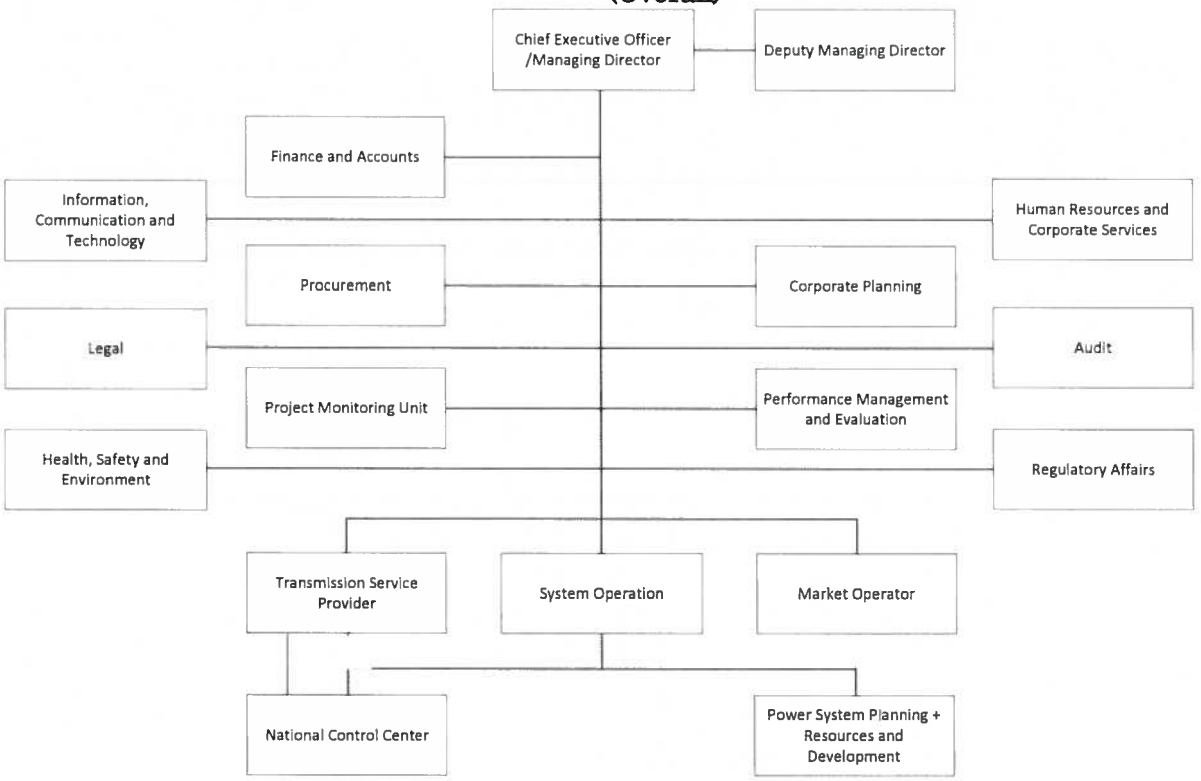
Location of the Study Sites (Federal Capital Territory and the surrounding area)

Annex - 2

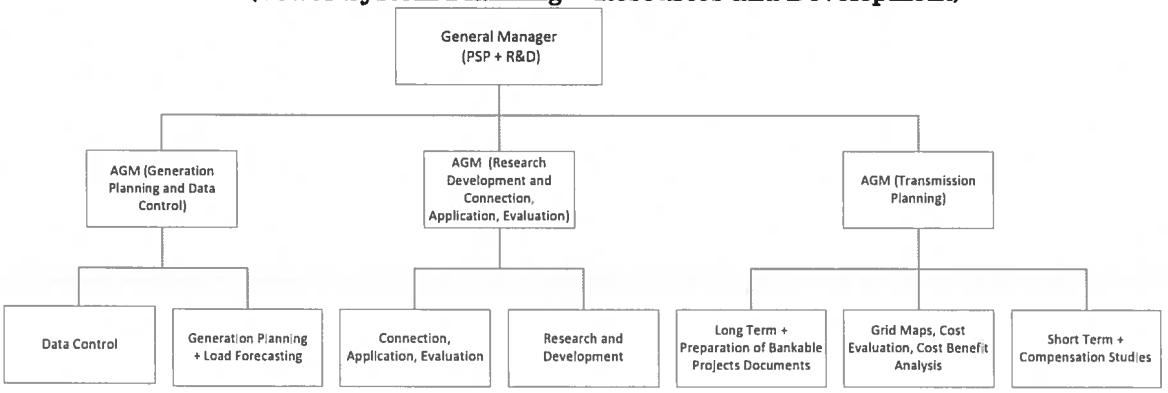
ORGANIZATION STRUCTURE OF FEDERAL MINISTRY OF POWER (FMP)



Organization Chart of TCN
(Overall)



Organization Chart of TCN
(Power System Planning + Resources and Development)



JAPAN'S GRANT AID

Based on the new JICA law entered into effect on October 1, 2008, JICA is designated as the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and 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. The Grant Aid is not supplied through the donation of materials as such.

1.Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures :

・Preparatory Survey
- The Survey conducted by JICA

・Appraisal &Approval
- Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet

・Authority for Determining Implementation
- The Notes exchanged between the GOJ and a recipient country

・Grant Agreement (hereinafter referred to as "the G/A")
- Agreement concluded between JICA and a recipient country

・Implementation
- Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of 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 country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme 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 a outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever 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 organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered 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 appropriateness of the Project.

3. Japan's Grant Aid Scheme

(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 country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) 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 country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex-7.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

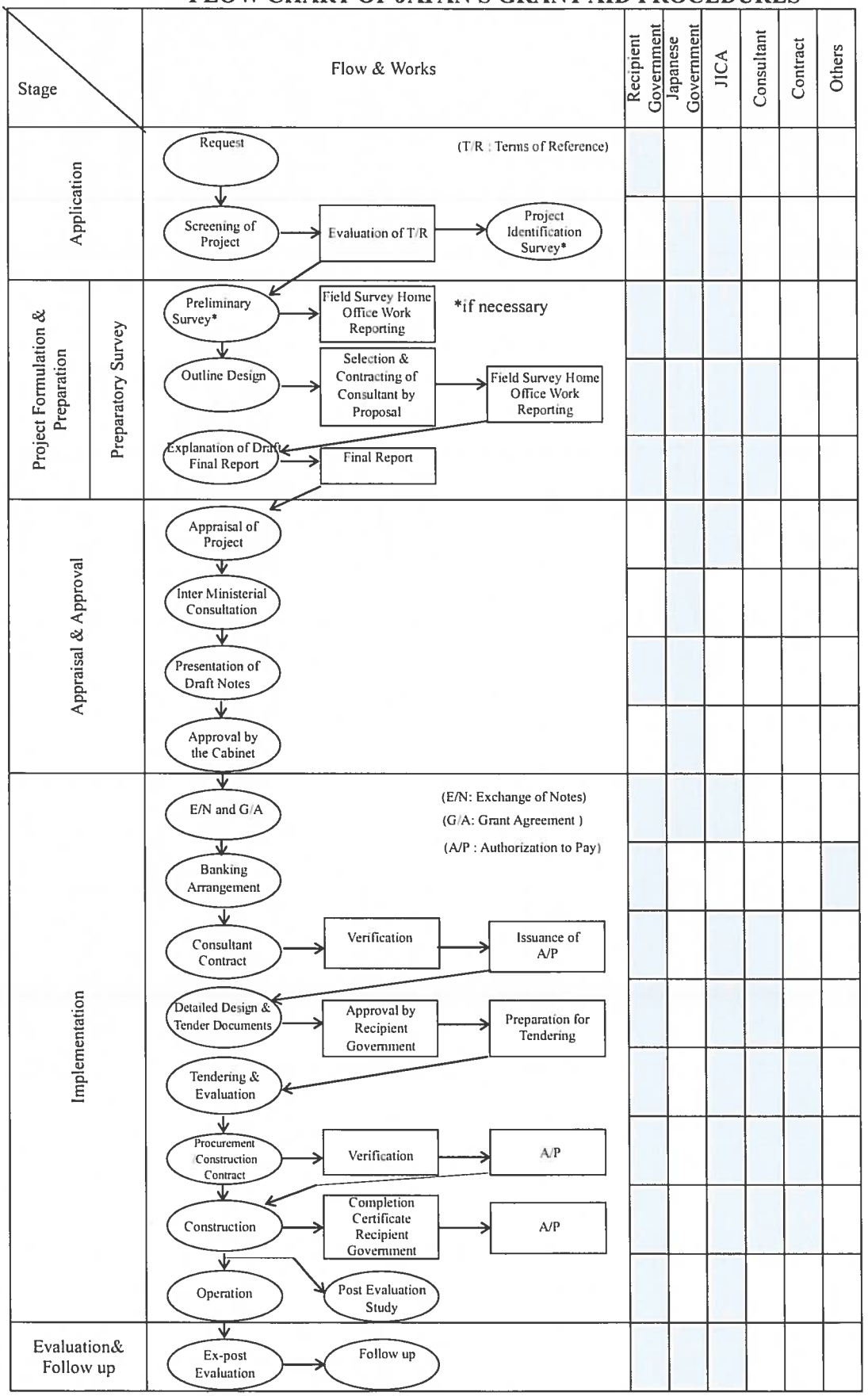
(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

(End)

Annex-5

FLOW CHART OF JAPAN'S GRANT AID PROCEDURES



Annex-6

Major Undertakings to be taken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	to secure lots of land necessary for the implementation of the Project and to clear the sites;		●
2	To construct the following facilities		
	1) The building	●	
	2) The gates and fences in and around the site		●
	3) The parking lot	●	
	4) The road within the site	●	
	5) The road outside the site (including Access road)		●
3	To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the sites		
	1)Electricity		
	a. The distributing power line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for storm sewer and others to the site)		●
	b. The drainage system (for toilet sewer, common waste, storm drainage and others) within the site	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
4	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the Products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services be exempted		●
6	To accord Japanese nationals 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 recipient country and stay therein for the performance of their work		●
7	To ensure that the Facilities and the products be maintained and used properly and effectively for the implementation of the Project		●
8	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project		●
9	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
10	To give due environmental and social consideration in the implementation of the Project.		●

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

(2) Minutes of Discussions (Second Preparatory Survey)

Minutes of Discussions
on the Preparatory Survey
on the Project for Emergency Improvement of
Electricity Supply Facilities in Abuja
in the Federal Republic of Nigeria

In response to the request from the Government of the Federal Republic of Nigeria (hereinafter referred to as "Nigeria"), the Japan International Cooperation Agency (hereinafter referred to as "JICA"), in consultation with the Government of Japan, decided to conduct a Preparatory Survey (hereinafter referred to as "the Survey") on the Project for Emergency Improvement of Electricity Supply Facilities in Abuja (hereinafter referred to as "the Project") .

JICA sent to Nigeria the Preparatory Survey Team (hereinafter referred to as "the Team") headed by Mr. Kazunari Oshima, a Senior Advisor, Energy and Mining Group, Industrial Development and Public Policy Department, JICA. The Team is scheduled to stay in the country from 19th to 25th June, 2015.

The Team held discussions with the concerned officials of Nigeria (hereinafter referred to as "the Nigerian side"). In the course of the discussions, the Nigerian side agreed and accepted the contents of the Draft Final Report and the Draft Technical Specifications, both sides have confirmed the main items described in the sheets attached hereto.

Abuja, 24th June, 2015

Mr. Kazunari Oshima
Leader, Preparatory Survey Team
Japan International Cooperation Agency
(JICA)

Engr. Afolabi John Oladele
Ag. Director, Transmission Services
Federal Ministry of Power (FMP)

Mr. Shahid Mohammad
Executive Director, Transmission Service Provider (TSP)
Transmission Company of Nigeria (TCN)

Witness

Mr. Oladimeji Tajudeen Shogbuyi
Ag. Director, International Cooperation
National Planning Commission (NPC)

ATTACHMENT

1. Contents of the Draft Final Report

The Nigerian side agreed and accepted in principle the contents of the Draft Final Report explained by the Team. The Team emphasized that the scope, the schedule and the cost for the Project are tentative and subject to change due to the domestic circumstances in Japan and in Nigeria. The Nigerian side understood it.

2. Objective of the Project

The objective of the Project is to improve and reinforce power supply by installing power capacitor and other associated equipment at Apo and Keffi substations in Nigeria.

3. Project Site

The Project sites are located as shown in Annex-1.

4. Responsible and Implementing Organizations

(1) The responsible organization is Federal Ministy of Power (FMP).
(2) The implementing organization is Transmission Company of Nigeria (TCN).
(3) The witness agency is National Planning Commission (NPC).
The organization structures of FMP and TCN are shown in Annex-4 and Annex-5, respectively.

5. Components of the Project

The components of the project are shown in Table below.

Site	132/33 kV Apo Substation		132/33 kV Keffi Substation	
Equipment Procurement and Installation	1. Power capacitor banks (132kV、60MVar)	1 set	1. Power capacitor banks (132kV、25MVar)	1 set
	2. Extra-high voltage switchgear	1 set	2. Switchgear for special high voltage	1 set
	3. Protection and control panel	1 set	3. Protection and control panel	1 set
	4. Substation earthing equipment	1 set	4. Substation earthing equipment	1 set
	5. Low voltage equipment	1 set	5. Low voltage equipment	1 set
	6. Foundation for equipment	1 set	6. 132 kV power cable (underground)	1 set
			7. DC supply system	1 set
			8. Foundation for equipment	1 set
Procurement	1. Spare parts		1 set	
	2. Test equipment and maintenance tools		1 set	

6. Japan's Grant Aid Scheme

(1) The Nigerian side has understood Japan's Grant Aid Scheme explained by the Team as described in Annex-6 and Annex-7.
(2) The Nigerian side will take the necessary measures, as described in Annex-8, for smooth implementation of the Project.

7. Project Cost

The Nigerian side agreed that the cost for the Project should not exceed the amount agreed on Exchange of Notes (E/N). The Nigerian side also agreed that the cost for the Project contains

procurement cost of equipment, transportation cost up to the Project site, construction cost and the Consultant fees.

8. Confidentiality of the project

(1) Detailed specifications of the Facilities and Equipment

Both sides agreed that all the information related to the Project including detailed drawings and specifications of the facilities and equipment and other technical information shall not be disclosed to any outside parties (i.e. outside of JICA and the Nigerian side) before the finalization of all contract(s) for the Project.

(2) Confidentiality of the Cost Estimation

The Team explained the estimated cost of the Project as described in Annex 9. Both sides agreed that the estimated cost for the Project should never be duplicated or disclosed to any outside parties (i.e. outside of JICA and the Nigerian side) before tender for the Project. The Nigerian side also understood that the estimated cost for the Project in Annex 9 is not the final and is subject to change as a result of examination through revision of the Outline Design Study.

9. Possibility of Change in Scope, Schedule and Cost of the Project

The Nigerian side and the Team confirmed that the scope, the schedule, and the cost for the Project are tentative and subject to change due to the domestic circumstances in Japan and in Nigeria.

10. Other Relevant Issues

(1) Undertakings to be taken by the Nigerian Side

The Nigerian side agreed to complete the items listed in Annex 10 by responsible organization(s) in accordance with the suggested timeline. In particular, the Nigerian side agreed to complete the following items by the date mentioned below.

1) Replacement or repair of damaged transformer, switchgear, gantry, control panel and lightning arrester at Apo Substation **by the end of November 2017.**
2) Calibration or replacement of power meter on the existing 132kV Control Panel at Keffi substation **by the end of June 2017.**
3) Installation and Commissioning of 2 × 50MVar capacitor banks and 1 × 150MVA transformer at Katampe substation **by the end of December 2015.**
4) Installation and commissioning of 1 × 75MVar Shunt Reactor at Gwagwalada substation **by the end of June 2016.**

The following items were agreed by the Nigerian side to be completed **by the end of October 2016.**

5) Land preparation for the project sites (Apo and Keffi) including storage yard for equipment and materials.
6) Site clearance & leveling (Apo and Keffi) including relocation or removal of existing lighting poles.
7) Securing Space for control and protection panel installed by JICA (Apo and Keffi).

The Nigerian Side also agreed the following item to be completed and paid by FMP.

8) Banking Arrangement (B/A), Authorization to Pay (A/P) and Bank Commission.

(2) Project Cost to be borne by the Nigerian side

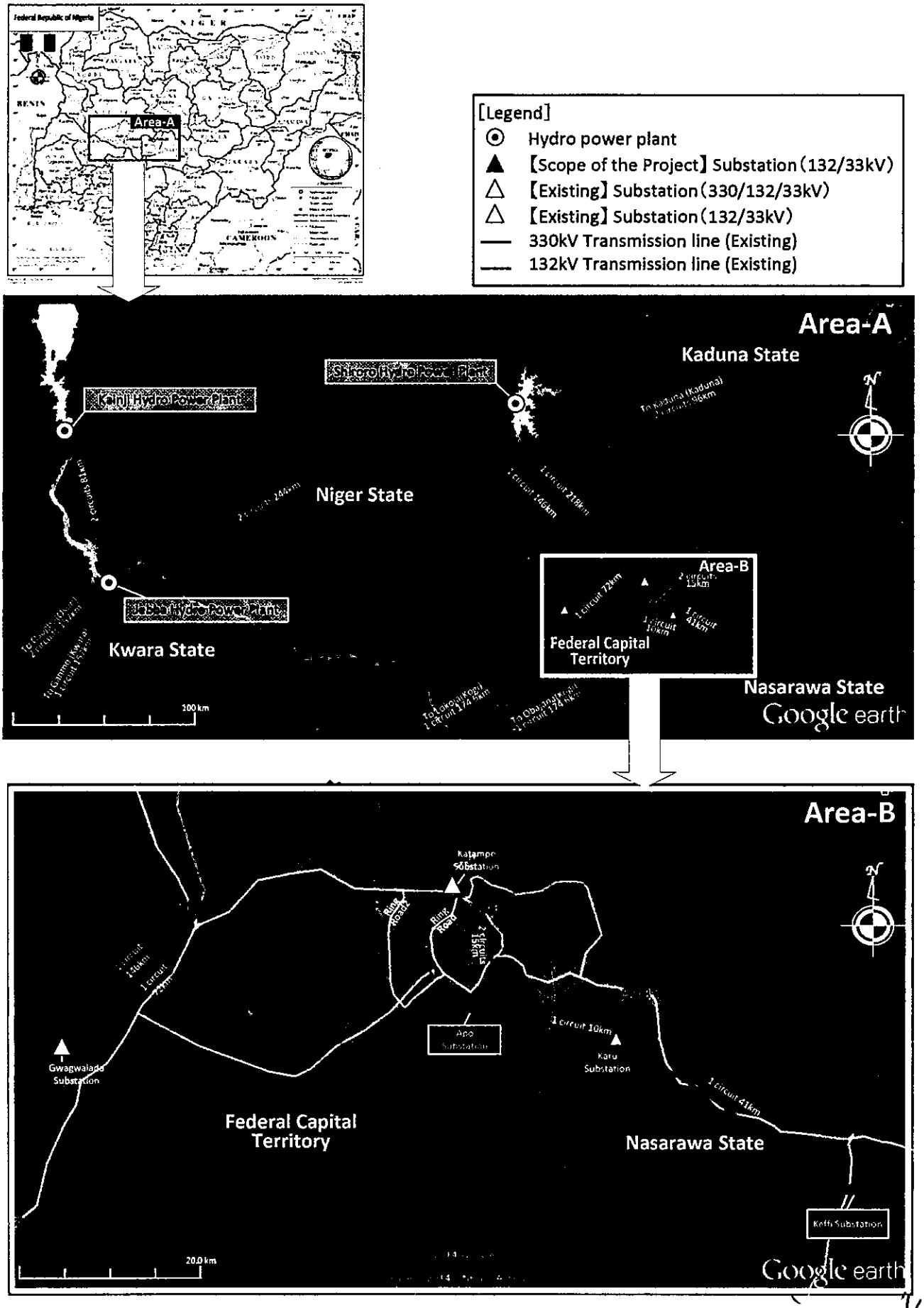
The Nigerian side assured the Team that the Project cost to be borne by the Nigerian side, mentioned in Annex-9, shall be timely allocated from its own fund.

(End)

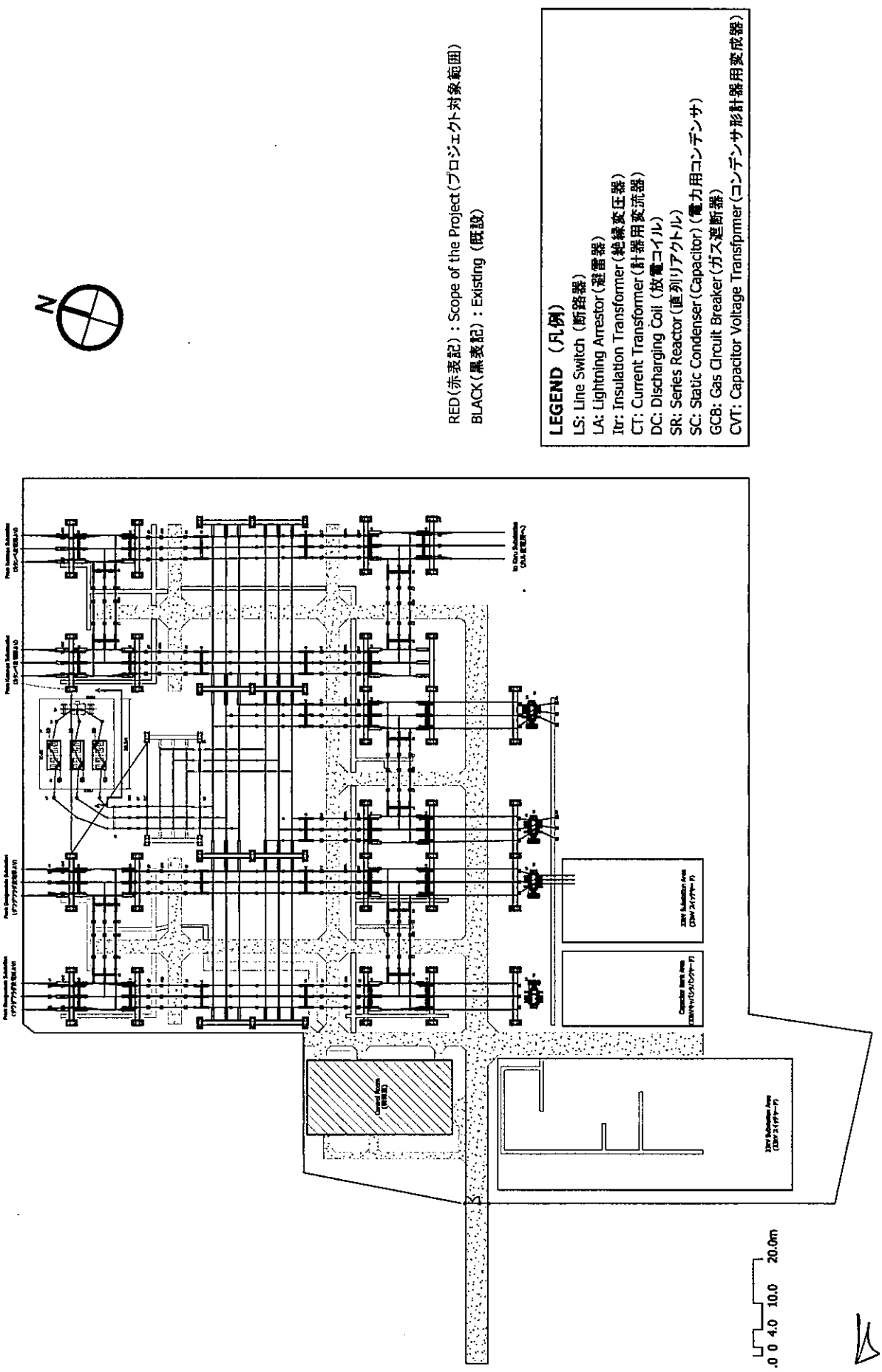
<List of Annex>

Annex-1	Location of the Project Sites
Annex-2	Layout of Apo Substation
Annex-3	Layout of Keffi Substation
Annex-4	Organization Structure of Federal Ministry of Power (FMP)
Annex-5	Organization Structure of Transmission Company of Nigeria (TCN)
Annex-6	Japan's Grant Aid
Annex-7	Flow Chart of Japan's Grant Aid Procedures
Annex-8	Major Undertakings to be taken by Each Government
Annex-9	Estimated Project Cost
Annex-10	Tentative Implementation Schedule of the Project and Undertakings by the Nigerian Side

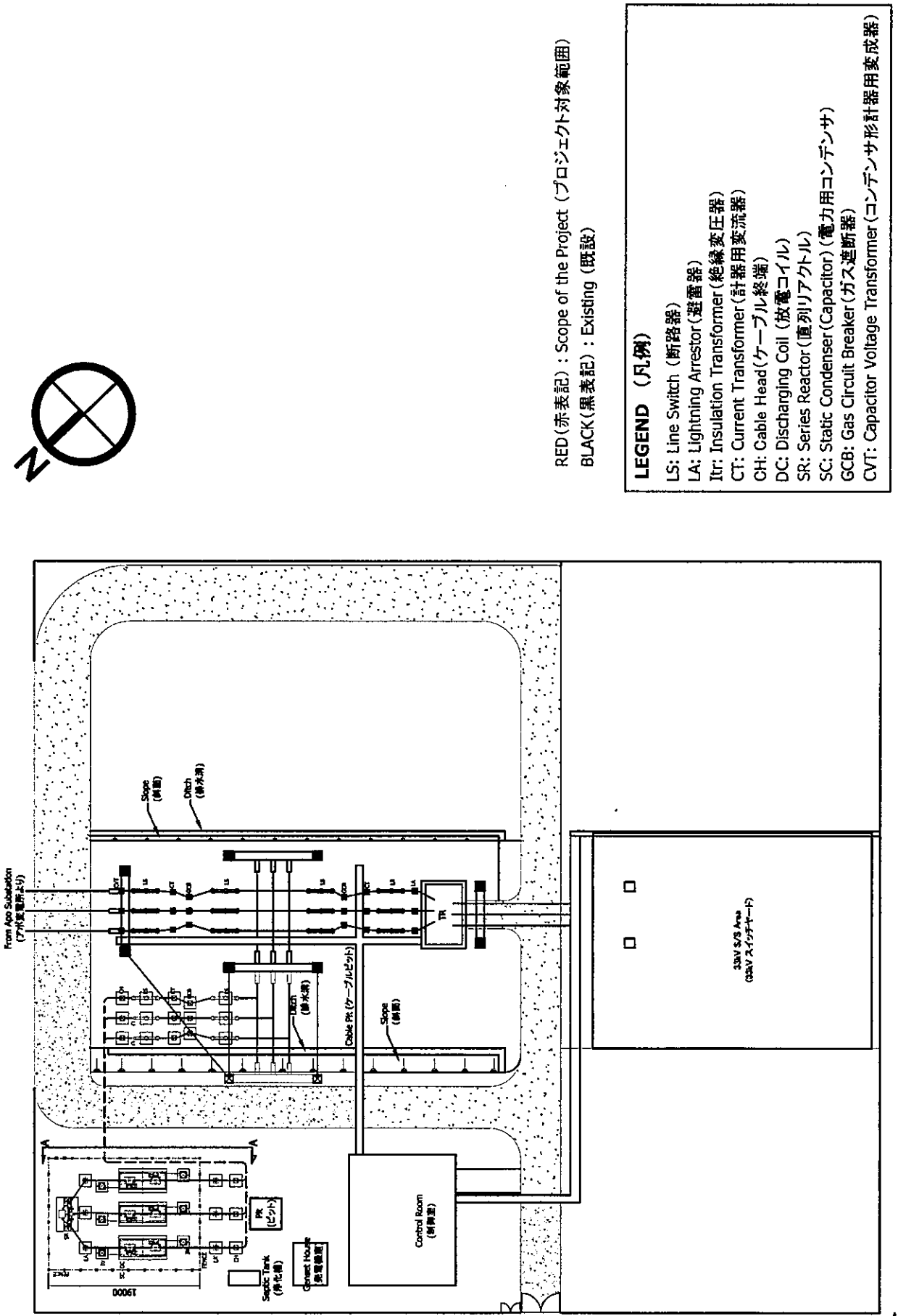
LOCATION OF THE PROJECT SITES



LAYOUT OF APO SUBSTATION

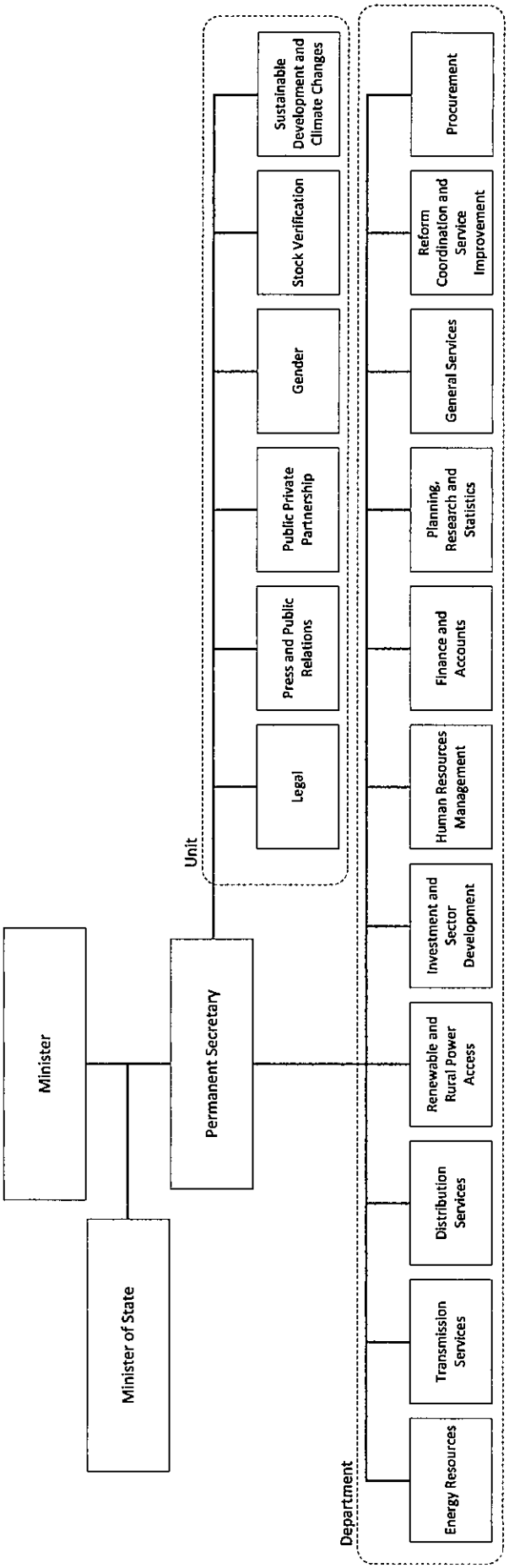


LAYOUT OF KEFFI SUBSTATION

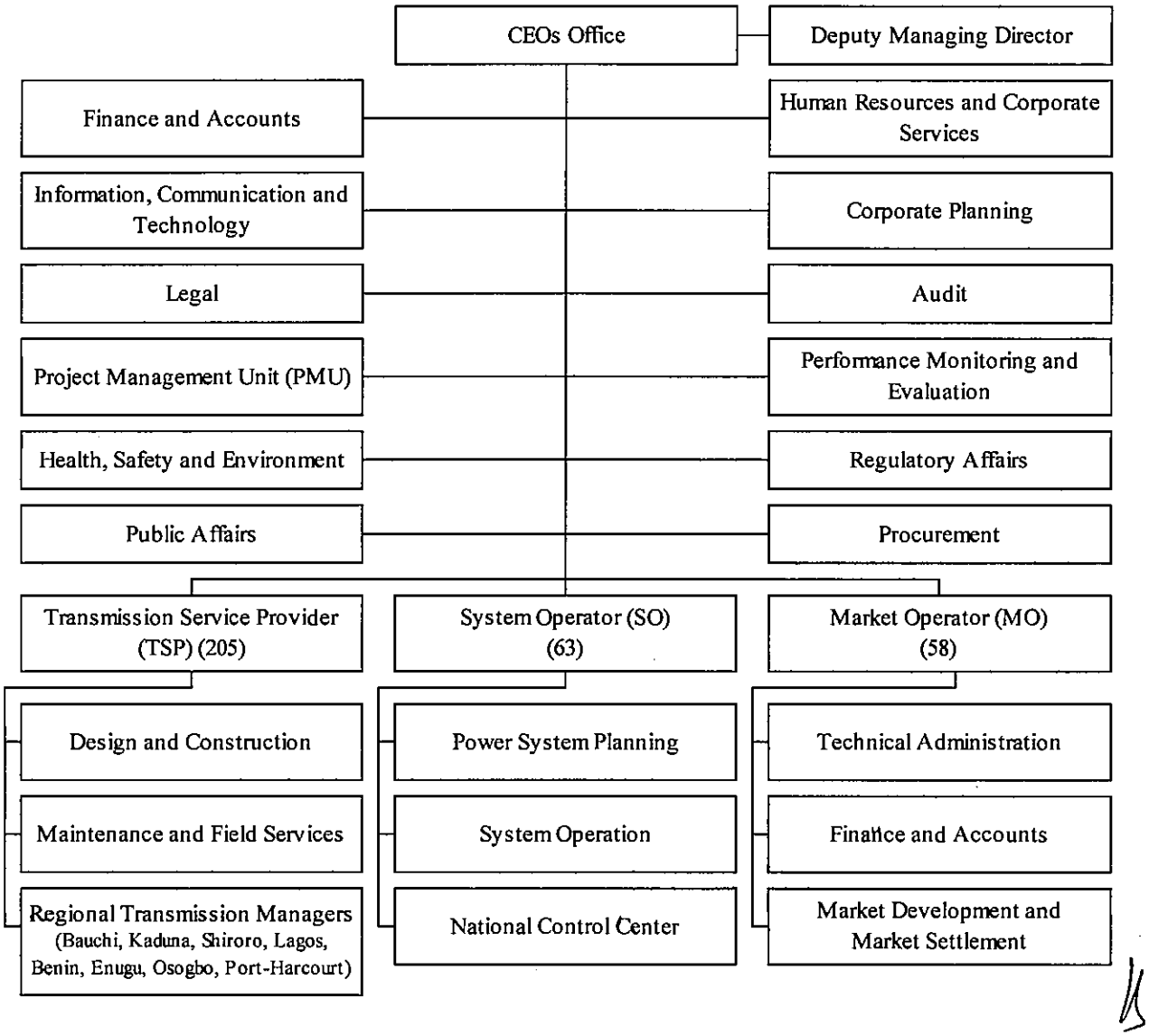


Annex-4

ORGANIZATION STRUCTURE OF FEDERAL MINISTY OF POWER (FMP)



ORGANIZATION STRUCTURE OF TRANSMISSION COMPANY OF NIGERIA (TCN)



JAPAN'S GRANT AID

Based on the new JICA law entered into effect on October 1, 2008, JICA is designated as the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and 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. The Grant Aid is not supplied through the donation of materials as such.

1.Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures :

・Preparatory Survey
- The Survey conducted by JICA

・Appraisal &Approval
- Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet

・Authority for Determining Implementation
- The Notes exchanged between the GOJ and a recipient country

・Grant Agreement (hereinafter referred to as "the G/A")
- Agreement concluded between JICA and a recipient country

・Implementation
- Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of 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 country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme 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 a outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever 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 organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered 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 appropriateness of the Project.

3. Japan's Grant Aid Scheme

(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 country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) 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 country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex-8.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

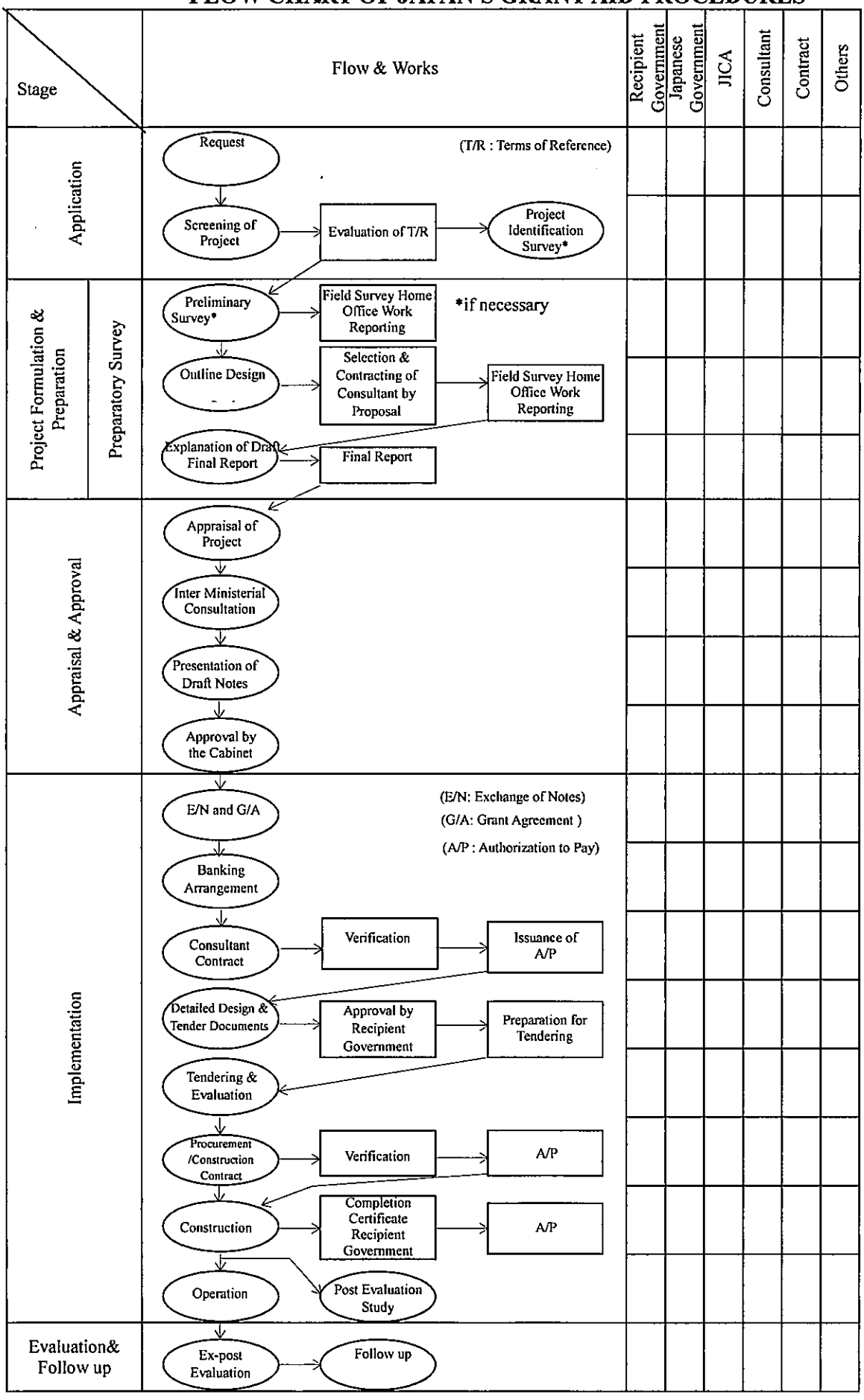
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

(End)

FLOW CHART OF JAPAN'S GRANT AID PROCEDURES



Major Undertakings to be taken by Each Government

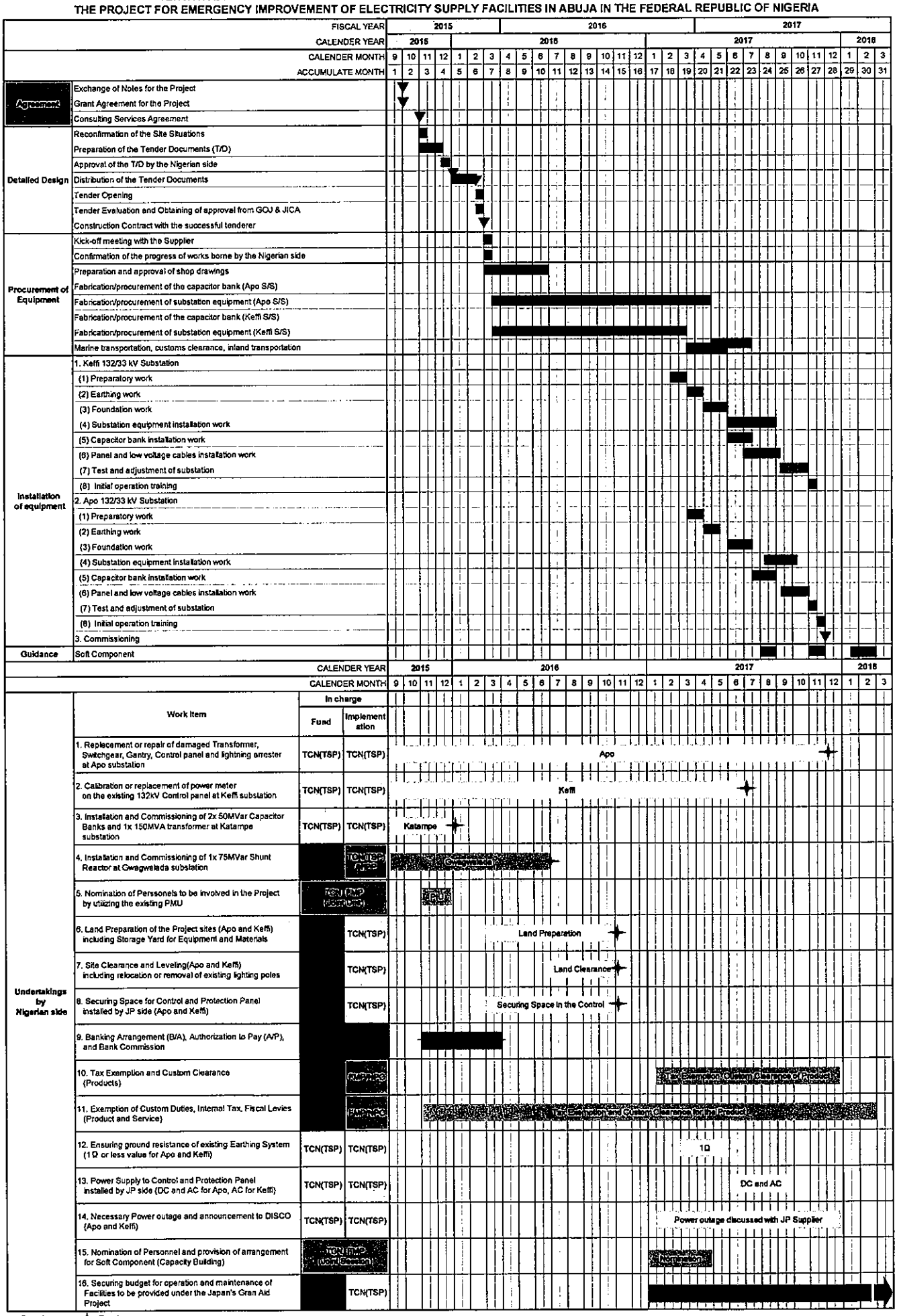
No.	Undertaking	To be covered by		Note
		Japanese side	Nigerian side	
1	(1) Acquisition of the Project sites for the installation of equipment		o	
	(2) Project site clearance		o	
2	To construct the following facilities			
	(1) Foundation for substation facilities	o		
	(2) Safety fences for power capacitors	o		
	(3) Access roads to the project sites		o	
3	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products			
	(1) Marine transportation of the Products from Japan to Nigeria	o		
	(2) Tax exemption and custom clearance of the Products at the port of disembarkation		o	
	(3) Internal transportation from the port of disembarkation to the project site	o		
4	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services be exempted		o	
5	To accord Japanese nationals 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 Nigeria and stay therein for the performance of their work		o	
6	To ensure that the facilities and the products be maintained and used properly and effectively for the implementation of the Project		o	
7	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project		o	
8	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A			
	(1) Advising commission of A/P		o	
	(2) Payment commission		o	
9	Measures necessary to obtain the following permits: - Permits for installation work - Permits to access to restricted areas		o	To be obtained as necessary before the implementation of the Project
10	Construction of gates and fences for temporary storeyard		o	
11	Securing of parking during the work		o	
12	Office for construction work	o		For the Japanese contractor
13	Appropriate storage and safety control for materials and equipment at temporary storage	o		
14	Provision of places to dispose of surplus soil and waste water		o	
15	Manufacturing and procurement of materials and equipment	o		
16	Installation, adjustment and tests of materials and equipment	o		
17	Temporary dead-line work during the work		o	
18	Confirmation and ensuring of ground resistance value (1Ω or below) for existing grounding devices		o	Apo Substation and Keffi Substation
19	Removal of a light between existing double bus arrangements		o	Apo Substation
20	Removal of an existing light		o	Keffi Substation
21	Securement of place for control and protection panels in existing control buildings		o	Apo Substation and Keffi Substation

No.	Undertaking	To be covered by		Note
		Japanese side	Nigerian side	
22	Power supply (DC and AC) for control and protection panels to be procured		o	Apo Substation
23	Power supply (AC) for control and protective boards to be procured		o	Keffi Substation
24	Installation of lights for procured equipment	o		Keffi Substation
25	Initial operation guidance and operational guidance for maintenance and management of equipment procured	o		
26	Securing of the safety of persons concerned with the project at the project sites		o	
27	Response to and compensation for users of electricity in relation to outages inevitable for the work		o	
28	Announcement of outage plans to users of electricity during the work		o	

(Confidential)
Estimated Project Cost

This page is closed due to the confidentiality.

TENTATIVE IMPLEMENTATION SCHEDULE OF THE PROJECT AND UNDERTAKINGS BY THE NIGERIAN SIDE
THE PROJECT FOR EMERGENCY IMPROVEMENT OF ELECTRICITY SUPPLY FACILITIES IN ABUJA IN THE FEDERAL REPUBLIC OF NIGERIA



Remarks: ✦: Target
Schedule is subject to change

A-5 Soft Component Plan

PREPARATORY SURVEY
FOR
THE PROJECT FOR
EMERGENCY IMPROVEMENT OF
ELECTRICITY SUPPLY FACILITIES IN ABUJA
IN
THE FEDERAL REPUBLIC OF NIGERIA

Soft Component Plan

October 2015

YACHIYO ENGINEERING CO., LTD.

CONTENTS

1. Background to Planning the Soft Component

The Project for Emergency Improvement of Electricity Supply Facilities in Abuja in the Federal Republic of Nigeria (hereinafter called 'the Project') shall procure and install 132 kV power capacitor to 132/33 kV Apo Substation, which is located within Federal Capital Territory (FCT) and 132 kV Keffi Substation, which is located in Nasawara State neighboring State of FCT. The Project aims to provide more stable power by supplying the reactive power as a countermeasure against problems such as voltage drops and power loss which Transmission Company of Nigeria (TCN), the Implementing Agency of the Project, has been facing.

While having experience in operation of the power capacitors, TCN has shortage in engineers who can properly manage operation and maintenance including operation records. Therefore, they cannot compensate reactive power with efficient facility operation and it contributes to the lack of power transmission capacity. Against such a background, TCN management requested technical assistance for their operation and maintenance staff during the outline design study conducted from November to December 2014.

Through the implementation of this soft component, technological transfer will be conducted for improvement of operation and management skills and daily check skills for power capacitors and extra-high voltage switchgears that will be procured for the Project.

2. Objectives of the Soft Component

The objectives of the soft component are as below:

(1) Basic knowledge for sustainable operation and daily inspection of the equipment is transferred..
(2) Basic skills for sustainable maintenance of the equipment are transferred..
(3) Management skills for proper operation and daily inspection of the equipment are transferred and such skills are summarized in a manual. .

3. Outputs of the Soft Component

The output shall be achieved by the soft component is shown in Table 3-1.

Table 3-1 Outputs of the Soft Component

Goal	Output	Targeted trainee
(1) Basic knowledge for sustainable operation and daily inspection of the equipment is transferred..	1) Overview and characteristics of power capacitors and switching gears are understood.	- Maintenance and Field Service), TSP[1], TCN[2]
	2) Theories about stable power supply are understood.	- System Operator, SO[3] , TCN
(2) Basic skills for sustainable maintenance of the equipment	1) Necessity of items listed on a checklist is understood.	- Maintenance and Field Service, TSP, TCN

[1] TSP: Transmission Service Provider
[2] TCN: Transmission Company of Nigeria
[3] SO: System Operation

Goal	Output	Targeted trainee
are transferred..		- System Operator, SO, TCN
	2) Computerized data management methods are understood.	- System Operator, SO, TCN - Maintenance and Field Service, TSP, TCN
(3) Management skills for proper operation and daily inspection of the equipment are transferred and such skills are summarized in a manual. .	1) Daily equipment inspection manual (draft) is created.	- Maintenance and Field Service, TSP, TCN
	2) Operation manual (draft) is created.	- System Operator, SO, TCN

Japanese supervisor of the contractor will carry out the initial operation training during the Project implementation. This training shall include the following training contents:

- Inspection, test and measurement method with the test equipment
- Operation method of substation facilities
- Daily inspection method

The initial operation training shall instruct how to operate and maintain the substation equipment procured by the Project based on their specifications. On the other hand, this soft component aims the technology transfer on the basic knowledge (including the explanation of the inspection checklist items) required for the management skill of overall facilities such as switchgear and phase modifying equipment (including equipment procured by the Project).

After the technology transfer by the consultant, the Japanese supervisor will instruct how to inspect facilities with the inspection checklist. As a result, theory and practice are able to be simultaneously understood. The work demarcation between Japanese supervisor and consultant are indicated in the drawing 3-1.

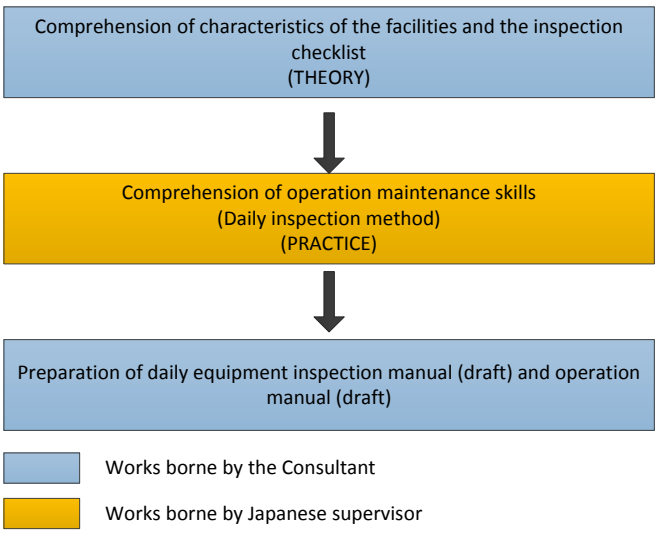


Figure 3-1　Work demarcation and work flow of the consultant and Japanese supervisor

This soft component shall compile the draft daily inspection manual of equipment and draft operation manual to indicate the inspection methods and the organization structure evidently. Accordingly, the outputs of this soft component will be efficiently delivered to other substations through the use of these manuals.

4. Method for Confirming the Degree of Attainment of Outputs

The outputs of this soft component shall be evaluated through the draft daily inspection manual of equipment and draft operation manual to be prepared and the submission of training reports from the participants. Table 4-1 shows the expected outputs and methods to confirm the attainment by each output. The draft daily inspection manual of equipment and draft operation manual shall be evaluated that these manuals shall cover the following without technical errors: the organization structure and their roles, daily management, periodical inspection and urgent countermeasures. During the classroom training, participants will be required to prepare the reports to evaluate their understanding of the technical contents. If the understanding of participants are not sufficient, supplementary lectures shall be organized.

Table 4-1　Outputs of the soft component and the methods of confirmation

Participants	Outputs	Confirmation of the attainment
Maintenance and Field Service, TSP, TCN	• Outline and characteristics of power capacitors and substation facilities shall be comprehended. • Necessity of each check item of the checklist shall be comprehended.	Report
	• Draft daily inspection manual of facilities shall be prepared.	Manual
System Operator, SO, TCN	• Basic theory on the stable power supply shall be comprehended.	Report
	• Data management skill with personal computers shall be acquired.	Report
	• Draft operation manual shall be prepared.	Manual

5. Soft Component Activities (Input Implementation Plan)

5-1 Contents and Activities of the Soft Component

As the activities of the soft component is shown in Table 5-1, activities of the soft component will include technical transfer covering everything from the basics of power capacitors and extra-high voltage switchgears to operation management and daily checks. The technical transfer shall be conducted through classroom lectures, exercise (development of a manual by trainees) and practical training using equipment.

Table 5-1 Activities of the Soft Component and Methods for Technical Transfer

Objective	Output of soft component	Activity	Method for technical transfer	Main target
(1) Basic knowledge for sustainable operation and daily inspection of the equipment is transferred.	1) Overview and characteristics of power capacitors and switchgears are understood.	· Learn the principles and basic knowledge of circuit breaking of power capacitors and switchgears. · Understand characteristics and protection functions of current transformers and instrument transformers.	· Classroom lecture · Group exercise	· Maintenance and Field Service, TSP and TCN
	2) Theories about stable power supply are understood.	· Learn basic theory of power transmission (stable use of reactive power and system, causes for voltage rise, etc.)	· Classroom lecture · Group exercise	· System Operator, SO and TCN
(2) Basic skills for sustainable maintenance of the equipment are transferred.	1) Necessity of items listed on a checklist is understood.	· Deepen understanding of the importance of daily inspection through discussion on each item on the daily checklist.	· Classroom lecture · Practical training (equipment test operation using actual equipment)	· Maintenance and Field Service, TSP and TCN
	2) Computerized data management methods are understood.	· Understand operation management methods. · Create equipment ledgers and understand how to update.	· Classroom lecture · Practical training (recording and evaluation of operation data, and equipment monitoring)	· System Operator, SO and TCN · Maintenance and Field Service, TSP and TCN
(3) Management skills for proper operation and daily inspection of the equipment are transferred and such skills are summarized in a manual.	1) Daily equipment inspection manual (draft) is created.	· Develop daily inspection manuals for power capacitors and switchgears.	· Classroom lecture and exercise (development of manuals)	· Maintenance and Field Service, TSP and TCN
	2) Operation manual (draft) is created.	· Update existing operation management manuals.	· Classroom lecture and exercise (development of manuals)	· System Operator, SO and TCN

5-2 Input Implementation Plan

(1) Input plan by the Japanese size

This soft component shall implement the activities on the Table 5-1 to transfer the necessary skills to carry out the operation and daily maintenance of facilities such as power capacitors. The consultant will dispatch Instruction Engineer 1 and Instruction Engineer 2 to Nigeria during periods shown in Table 5-2.

Table 5-2 Input plan for the Soft Component

Item		Rank	Period (Days)	Trip	Contents
1.	Transfer of basic knowledge				
	Instruction Engineer 1	3	1.00 month (30 days)	1	・ Technology transfer on the outline and characteristics of power capacitor and switchgears. ・ Confirmation of maintenance system and roles of each actor.
	Instruction Engineer 2	3	1.00 month (30 days)	1	・ Technology transfer on the outline and characteristics of transmission system. ・ Confirmation of maintenance system and roles of each actor.
2.	Transfer of management and operation skills				
	Instruction Engineer 1	3	1.00 month (30 days)	1	・ Technology transfer on the evaluation and handling of facilities.
	Instruction Engineer 2	3	1.00 month (30 days)	1	・ Technology transfer on the operation management. ・ Technical transfer on the monitoring facilities and preparation of facilities inspection checklist.
3.	Establishment of maintenance organization and manuals				
	Instruction Engineer 1	3	1.50 month (45 days)	1	・ Preparation of the draft operation manual. ・ Instruction on TCN's preparation of the draft maintenance manuals.
	Instruction Engineer 2	3	1.50 month (45 days)	1	・ Preparation of draft operation maintenance manual. ・ Revision of operation manual.

(2) Input plan by the Nigerian side

TCN has staff called System Operators (SOs) on a 24-hour basis at each 132/33 kV substation and transmits power in collaboration with Osogbo National Control Center and Katampe Substation, which is the major facility in Abuja sub-region (TCN's transmission area, covering the Federal Capital Region and surrounding areas). Engineers in charge of maintenance are stationed at Apo Substation and make short trips each substation for maintenance work. Figure 5-1 and Table 5-3 shows the implementation framework of the soft component.

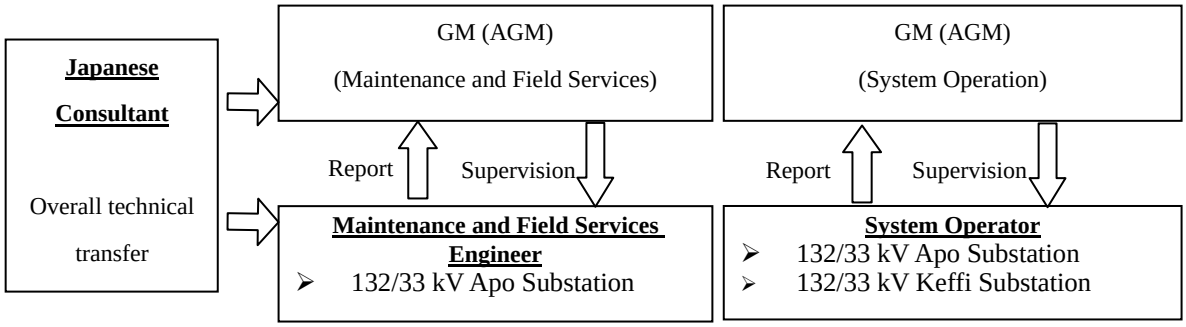


Figure 5-1 Operation and maintenance organization of substation facilities (Draft)

Table 5-3 Soft Component Implementation System (Draft)

	Japanese consultant	Maintenance and Field Service[4]	System Operator[5]
Engineers	2	5-10[6]	3-5[7]
Operation method	Overall progress management	Maintenance of procured equipment	System maintenance for procured equipment and existing equipment
Orientation about the contents of the soft component	Explanation	Participation	Participation
Development of a manual	Advice	Development of a daily inspection manual	Update of operation manuals
Maintenance follow-up	Guidance on maintenance	Maintenance report	Operation management report
Report to	- JICA Headquarters - JICA Nigeria Office	- Consultant - Head of Maintenance and Field Service	- Consultant - Head of each substation

6. Procurement of Implementation Resources for the Soft Component

Instruction Engineers to be dispatched for the soft component are required to be familiar with power capacitors and switchgears made in Japan, since key equipment to be procured by the Project is assumed to be made in Japan. Therefore, the consultants who are familiar with the equipment manufactured in Japan with deep knowledge of these characteristics will be utilized.

Personal computers for the operation shall be provided to the System Operation to be used for the data management and equipment ledgers. This equipment is expected to contribute not only to attain the technology transfer on the sustainable operation skills at substations but also to provide the basic skills on the command of computer for the smooth utilization of SCADA (System Control And Data Acquisition)

[4] Maintenance and Field Service, TSP, TCN
[5] System Operator, SO, TCN
[6] Number of maintenance engineers stationed at Apo Substation
[7] Number of engineers stationed at Apo Substation and Keffi Substation respectively

system, which is scheduled to be installed in the future, when this system will be installed.

One set of personal computer shall be procured to 132/33 kV Apo Substation and 132/33 kV Keffi Substation (2 sets in total). The specification of the PC is shown in Table 6-1.

Table 6-1 Specification of PC for the operation

Item	Specification
Number of units	2
Type	Desk top / Lap top
Operation system	Windows 7
Memory	2 GB or later
Bit	64
Application	Microsoft Word, Excel

7. Soft Component Implementation Schedule

Soft component implementation schedule is shown in Figure 7-1.

Engineers dispatched from Japan shall carry out soft components in each category according to the implementation schedule shown in Figure 7-1. Timing of implementation and points of concern for each category are as shown below.

1) Transfer of Basic Knowledge for Operation and Maintenance Management

Such basic knowledge shall be transferred before Japanese engineers provide guidance on initial and regular operations so that basic knowledge of operation and maintenance management as well as understanding of daily inspection will be deepened.

The target groups of the soft components of the Project are the Maintenance and Field Service Department and the System Operator Department, who should carry out duties with understanding of each other's activities to ensure smooth operation. For this reason, the training course of "Transfer of Basic Techniques" shall be conducted for the two groups together.

2) Transfer of Management and Operation Techniques

This technical transfer will be conducted at the same time as guidance on initial and regular operations by Japanese engineers to deepen understanding of daily inspection with a checklist.

3) Maintenance Structure and Development of Manuals

After guidance on initial and regular operations, transferred techniques for daily inspection and other information defined through the implementation of the soft component such as the structure and roles shall be compiled into manuals.

Each group will develop a manual for their own group, but two groups will work together and study each other's operations. This collaboration work is expected to promote information sharing for operations between groups and contribute to building information bases for the development of

SCADA system in the future.

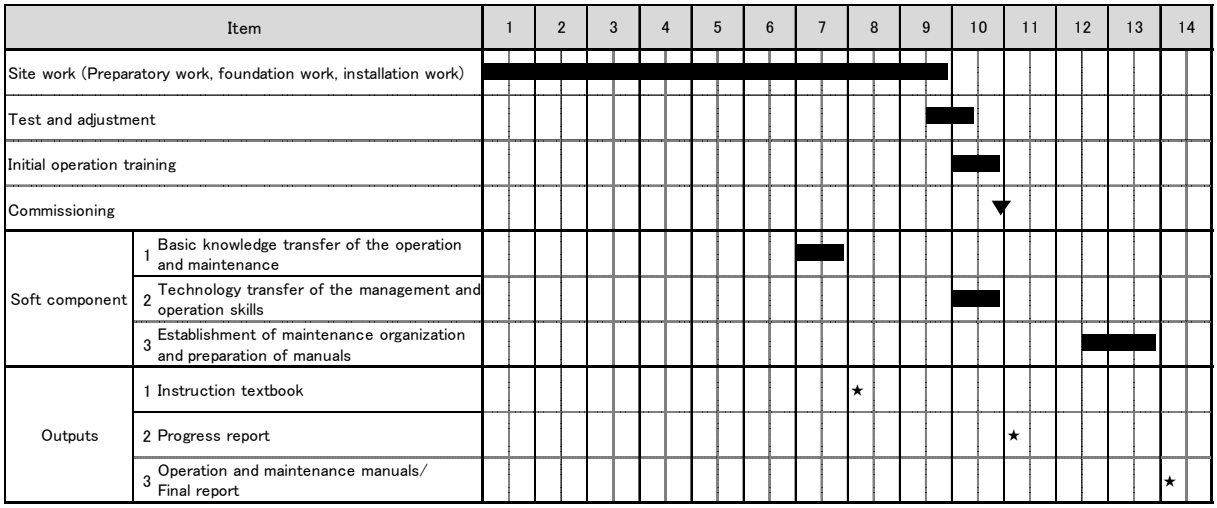


Figure 7-1 Implementation schedule of the soft component

During the soft component, one personnel from the Maintenance and Field Services will be appointed as the soft component leader. Also one personnel from each group shall be assigned as the sub leader to realize the smooth communication and coordination during the soft component period.

8. Outputs

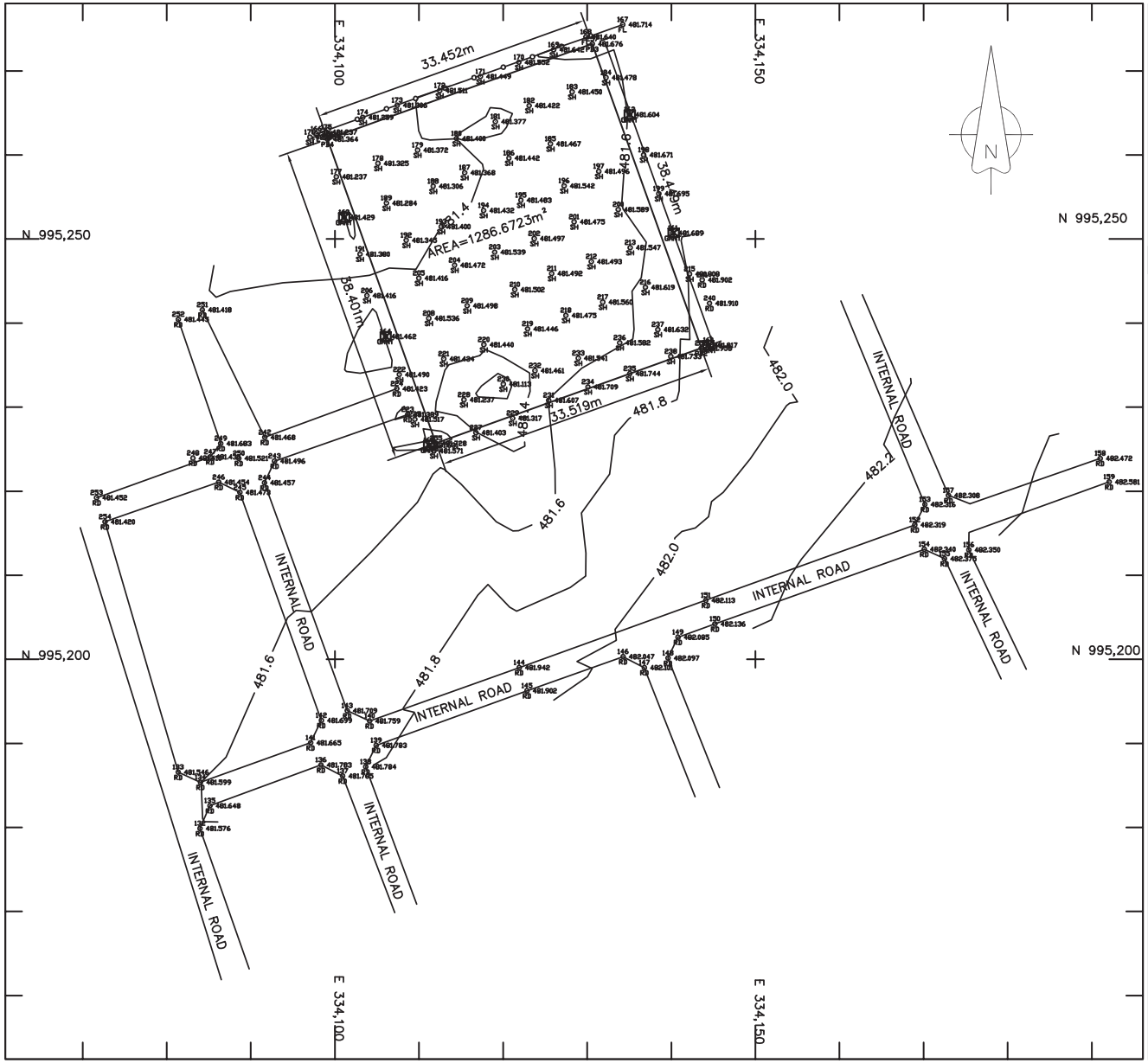
Outputs of the soft component include operation manual, maintenance manual, progress report and final report.

9. Obligations of the Implementing Agencies in Nigeria

The followings are responsibilities on the Nigerian side related to the soft component:

- TCN will provide the conference rooms, etc. needed for implementing the soft component.
- TCN will provide necessary personnel to participate in the soft component.
- Participants will be highly motivated to prepare the draft operation manual and draft maintenance manual under the supervision of the instruction engineers (consultants).
- TCN will report the actual accomplishment delivered by the manuals periodically.

A-6 Topographical Survey Report



LEGEND

- GANTRY LOCATION
- EXISTING WALL
- AREA OF INTEREST

Reference Drawings

Drawing No:	Title

☐ Approved ☐ Approved with comments ☐ Not Approved ☐ For information

Date ---------- Signature/Stamp ----------

IPP DEVELOPER — C:\YACHIYO ENG CO LTD\YEC LOGO.jpg — YACHIYO ENGINEERING CO., LTD

PROJECT CONSULTANT — EPC CONTRACTOR — Best & Crompton Engineering Projects Ltd

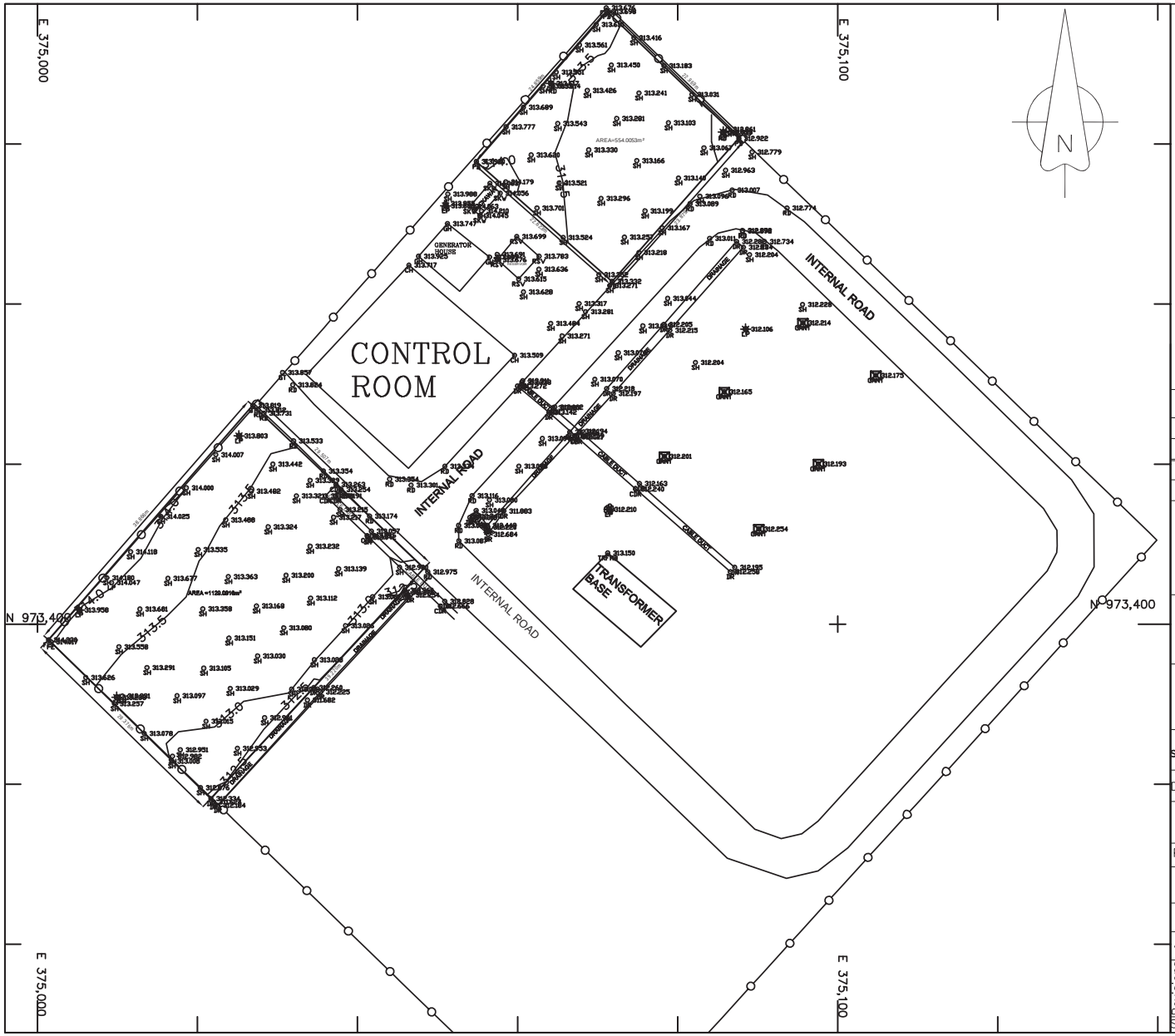
SURVEYED BY: — PENGATE

Drawing No.

Project	Name	Date	Drawing Detail
Prepared:	J.A.	12/14	COORDINATE SYSTEM: UTM ZONE 32 MINNA DATUM
Drawn:	J.A.	12/14	Project:
Checked:	S.O.I	12/14	Title: TOPOGRAPHIC SURVEY OF EXTENSIONS BAYS AT APO SUBSTATION, FCT ABUJA
Approved:			

Revisions No:	Name	Date
B	J.A.	19/12/14
A	J.A.	03/12/14

Scale: 1:500 — Contractor's Drawing No: — Rev:1.0



LEGEND

- GANTRY LOCATION
- DRAINAGE DUCT
- EXISTING WIRE FENCE
- LAMP POST
- AREA OF INTEREST

Reference Drawings

Drawing No:	Title

☐ Approved ☐ Approved with comments ☐ Not Approved ☐ For information

Date ---------- Signature/Stamp ----------

IPP DEVELOPER: C:\YACHIYO ENG CO LTD\YEC LOGO.jpg YACHIYO ENGINEERING CO., LTD

PROJECT CONSULTANT:

EPC CONTRACTOR: Best & Crompton Engineering Projects Ltd

SURVEYED BY: PENGATE

Drawing No.

Project	Name	Date
Prepared:	J.A.	12/14
Drawn:	J.A.	12/14
Checked:	S.O.I	12/14
Approved:		

Drawing Detail

COORDINATE SYSTEM: UTM ZONE 32 MINNA DATUM

Project:

Title: TOPOGRAPHIC SURVEY OF EXTENSIONS BAYS AT KEFFI SUBSTATION, NASSARAWA STATE

Revisions	No:	Name	Date
	B	J.A.	19/12/14
	A	J.A.	03/12/14

Scale: 1:500 Contractor's Drawing No: Rev:1.0

A-6-2

A-7 Geological Survey Report

PROPOSED DEVELOPMENT AT APO SUB STATION, FCT, ABUJA

GEOTECHNICAL INVESTIGATION

PREPARED BY:

BEST&CROMPTON ENGINEERING AFRICA LTD.,

December, 2014

CLIENT: YACHIYO ENGINEERING CO. LTD.,

TABLE OF CONTENT

1.0 INTRODUCTION

The Client, **Yachiyo Engineering Co. Ltd**., commissioned Best & Crompton Engineering Africa Ltd., to proceed with subsoil investigations at the proposed development at **Apo Sub station, FCT Abuja.** This report is a consequence of the soil investigation and analyses, which is presented in an objective and professional manner.

The purpose of the subsoil investigation and attendant report is as follows:

- Determine the subsoil and surface/groundwater conditions of the designated location.
- Evaluation of the subsoil stratigraphic sequence geotechnical/engineering properties of the soil and the subsequent effects on foundation design and construction.
- Analysis of the data/results of tests carried out on the soil samples obtained and provide recommendations on the fit-for-purpose type of foundation for the proposed structure.

A-7-2

2.0 SITE ACCESSIBILITY

The sites are accessible through **Abuja road** to mention but a few.

3.0 DESCRIPTION OF WORK

The soil investigation comprised of and carried out in three parts;

- Field Work: Test (2Nos. DCPTs) and collation of the test results.

3.1 FIELD WORK

The site works were carried out on November, 2014.

The Scope of Work executed involved the performance of 2Nos. 2.5tons Dutch Cone Penetrometer Tests (DCPTs) to a depth of refusal.

DUTCH CONE PENETROMETER

The apparatus consists of a cylindrical probe, of 1000mm^2 cross sectional area, and a conic head of apex angle of 60^o. The probe is forced down through the soil at a steady rate of about 20mm/s in the closed position by exerting pressure force on outer sounding tube. If desired the point resistance and the resistance to side friction can be measured separately.

2Nos. static cone penetration tests were carried out using a 2.5tons capacity testing equipment (machine) on each site. The test involves advancing the cone into the ground slowly at a constant rate and the resistant to penetration measured at predetermined intervals of 0.25m depth. The tests were terminated at depths where the machine anchor legs lifted.

These tests were taken from the existing ground level down to depths refusal at each location.

The cone penetration test results are presented in a graphical form respectively in the Appendix to this Report.

3.2 ANALYSIS OF TEST RESULTS

3.2.1 Geological Description

Available geological record reveals that the investigated area is within the basement complex of Nigeria; it is characterized by crystalline rocks of Precambrian age. Rocks of granitic origin later intruded these rocks.

The sedimentary deposits found on top of the basement rock are product of the parent rocks that have undergone weathering and decomposition.

3.2.2 Subsoil Condition

The subsoil condition of the site, based on the DCP test carried out reveals predominantly cohesive soil as observed from the DCP Plot.

Details of the subsoil characteristics encountered during the Penetrometer tests are stated below:

Subsoil Condition based on the field work.

Dutch Cone Penetrometer Test

Address: Apo power station, FCT, Abuja.

Depth (m)	Description of Stratum
0.00 to –.1.00	Firm cohesive soil.
1.00 to –2.50	Firm becoming Stiff to hard cohesive soil.

Geotechnical Properties

Depth (m)	Geotechnical Properties
0.00 to –.1.00	Moderate geotechnical properties, moderate shear strength and moderate compressibility potential.
1.00 to –2.50	Moderate becoming good to very good geotechnical properties, moderate becoming high shear strength and low compressibility potential.

A-7-3

Geotechnical Engineering Parameters

Depth (m)	*P1(Kgf/cm^3)*	*P2(Kgf/cm^3)*
0.00 – 1.00m	***10 – 20***	***15 – 32***
1.00 – 2.50m	***9 – 55***	***10 – 62***

3.2.4 Site description and condition

The project site is an open piece of land within existing power substation. Structures around site show no sign of distress at the time of our investigation.

3.2.5 Topography.

The topography of the project site is nearly even topography.

3.2.6 Vegetation.

No vegetation was observed on the project site during our subsoil investigation.

4.1 FOUNDATION DISCUSSION AND RECOMMENDATION

4.1.1 Proposed Development

No structural detail of the proposed development was made available to us prior to the subsoil investigation, thus our recommendations are based on the DCP test carried out.

The geotechnical issues considered relevant to the proposed development include

- Soil bearing pressure
- Level of groundwater
- Recommendation of a suitable foundation type
- Excavation

4.1.2 RECOMMENDATION

The foundation type to be chosen for a particular structure depends largely on the followings;

- Loads to be transmitted
- Receiving soil strata
- Factor of safety against shear failure of the supporting soil must be adequate.
- Settlement should neither cause any unacceptable damage nor interfere with the function of the structure.

Foundations can be classified as shallow foundation or as deep foundation.

The choice between shallow foundation and deep foundation can be arrived at after careful consideration of the following elements.

1. The magnitude of the transmitted loads from the stratum,
2. The soil nature,

3. The economic aspects of the elements of the foundation work,
4. Problems concerning foundation construction.

4.1.3 Allowable bearing pressure and foundation recommendation

Allowable bearing pressure calculated in accordance with theoretical soil mechanics principle for depths are indicated below:

Differential Depth (m)	Allowable bearing Capacity (KN/m^2)
0.00 – 0.50	107
0.50 – 1.00	134
1.00 – 1.50	134
1.50 – 2.00	222

FOUNDATION RECOMMENDATION

Shallow Foundation

Shallow Foundation (Spread footing or Reinforced Raft Foundation) is considered adequate for the proposed development on the project site.

Groundwater

Groundwater was not encountered during the subsoil investigation work

METHOD OF CALCULATING ALLOWABLE BEARING PRESSURE IN COHESIVE SOIL IS GIVEN BY:

Empirical Method for calculating in Cohesive Soil is given by:

q_{ult} = 5.14Cu + ϫD (Prandtl method of estimating allowable bearing pressure)

$q_a = q_{ult}$/F.S (3) – For Shallow foundation

Or

If the Clay is very Sandy

Correlation between q_c and SPT (N – Values)

$N = q_C / 2$

q_a = 10N, or 5.0N (If Submerged)

Correlation between q_c and Cu

$Cu = q_c / 20$ (KN/m^2)

4.2.2 Settlement

Settlement for this allowable bearing pressure for each location stated above would not exceed ***25mm***.

Our analysis on settlement is based on the method stated below

S = 1.1Mv x 0.55qn x h

Where S = Total settlement

Mv = Volume of compressibility potential

qn = net foundation base pressure

h = depth of foundation

The table below shows the permissible settlement as per I.S Code.

Soil type	Permissible total settlement		Permissible differential settlement	
	For isolated footings	For raft footings	For isolated footings	For raft footings
Sandy	4.0cm	4.cm to 6.5cm	2.5cm	2.5cm
Clays	6.5cm	6.5 to 10.0cm	4.0cm	4.0cm

4.2.3 Factor of Safety

Factor of safety of 3 was adopted for our estimation of allowable bearing pressure.

4.2.4 Excavation

- Excavation could be achieved using conventional excavating equipment.
- Excavation support would not be required

4.2.5 General Precaution for Shallow Foundation Construction

It is recommended that the following general guidelines that govern the construction of shallow foundation should be observed when work starts on the site:

- Over excavation beyond the depths stated should not be done.
- Ingress of water into the excavated foundation trench should be prevented if the stated bearing value at the founding depth is to be achieved. A layer of concrete blinding should therefore be provided within a trench once it has been excavated.
- Adequate cover to the concrete should be allowed for the reinforcement bars to protect them from possible effect of corrosion.
- The sides of foundation should be backfilled up to existing ground level as soon as they are cast.

5.0 CONCLUSION

Shallow Foundation (Spread footing or Reinforced Raft foundation) is considered adequate for the proposed development on the project site.

Despite an objective soil investigation and reporting, a poorly designed and/or constructed foundation may lead to structural failure if all other environmental conditions remain constant.

BEST&CROMPTON ENGINEERING AFRICA LIMITED therefore recommends that the design and construction of all foundation and earthwork be carried out by a competent company in accordance with good and strict engineering practice expected of a professional. The construction contractor shall be guided by reference Code of Practices such as; British Institution CP 2004, 1973: Code of Practice for Foundation and BS 6031: Code of Practice for Earth Works.

M.Nageswara Rao

For Best & Crompton Engineering Africa Ltd.,

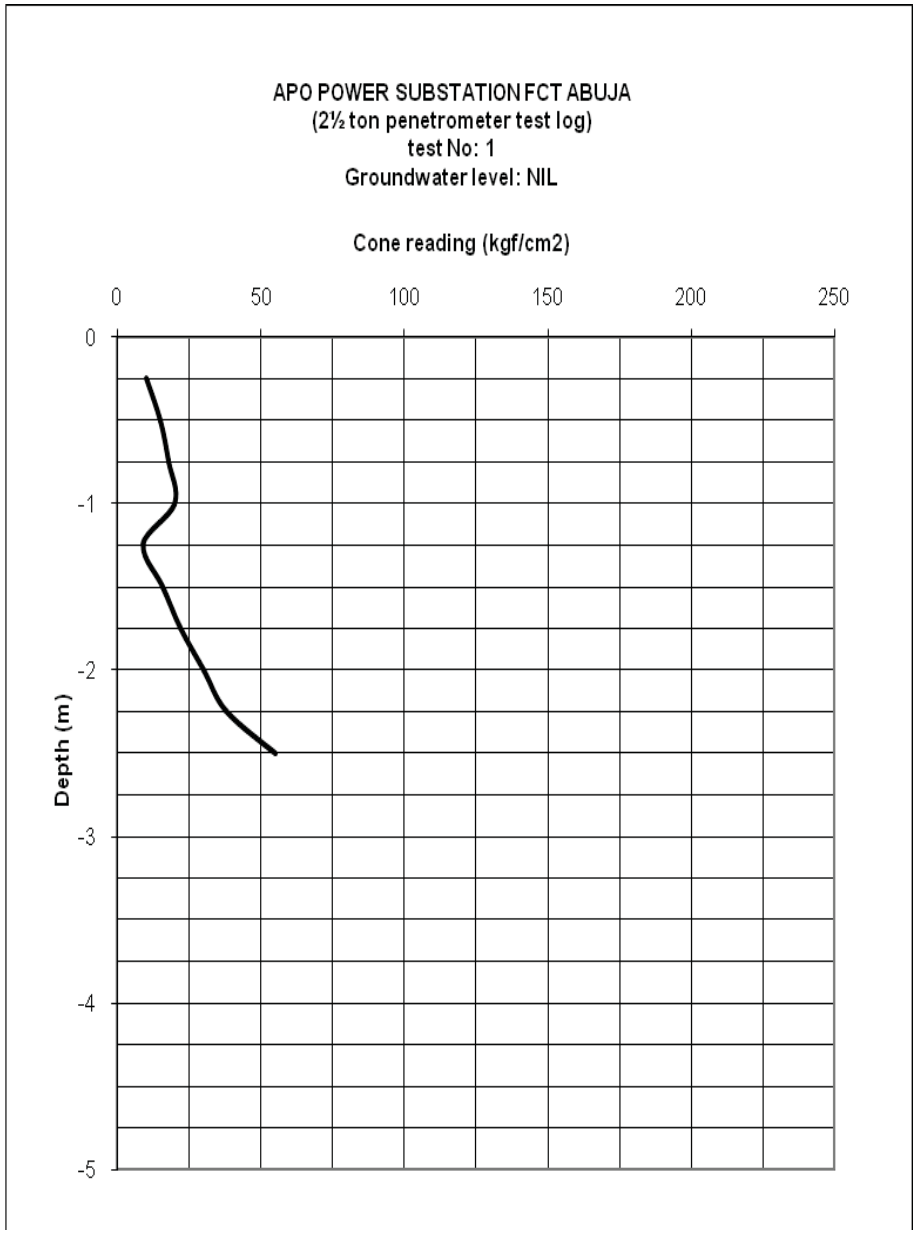
A-7-6

APPENDIX

FIELD LOGS

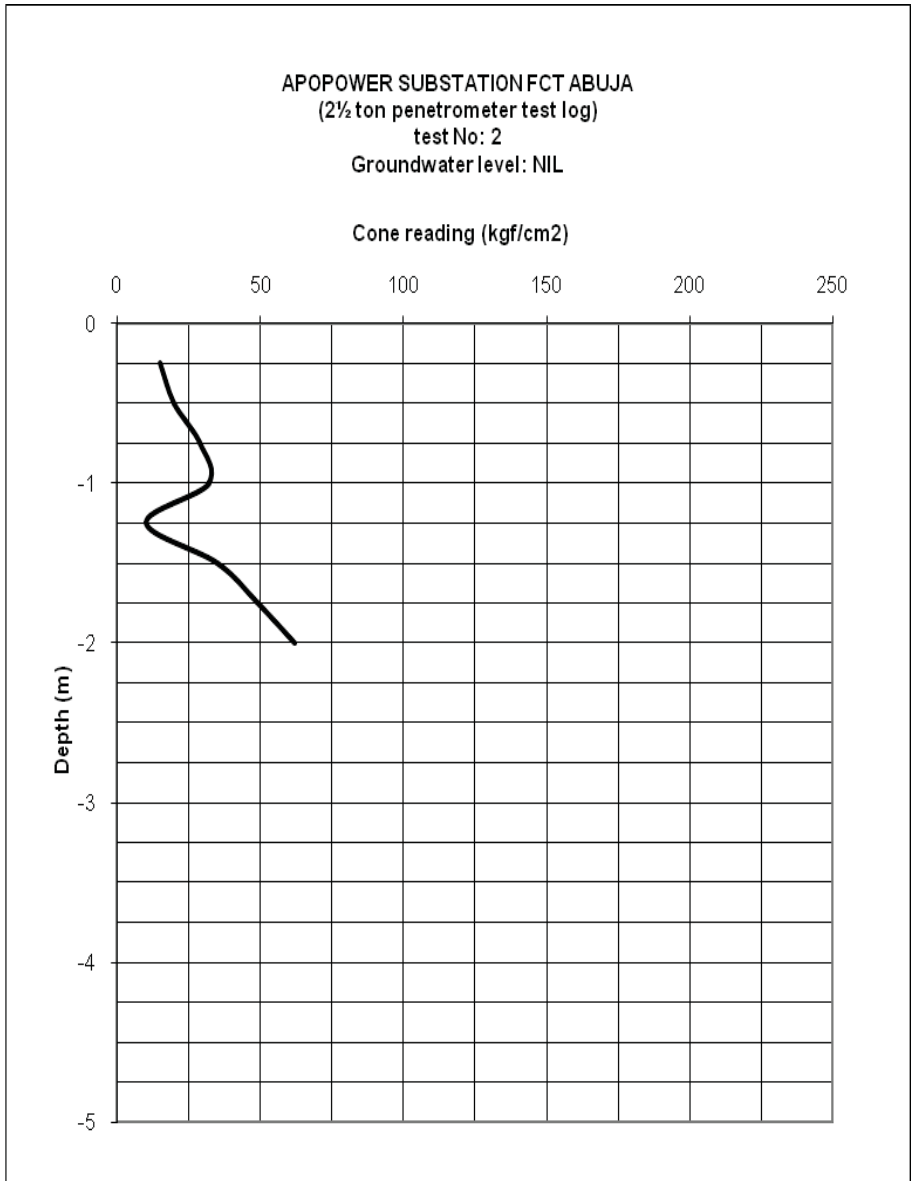
PENETROMETER 1

Qc	Depth
0	0
10	-0.25
15	-0.5
18	-0.75
20	-1
9	-1.25
16	-1.5
22	-1.75
30	-2
38	-2.25
55	-2.5
	-2.75



PENETROMETER 2

Qc	Depth
0	0
15	-0.25
20	-0.5
29	-0.75
32	-1
10	-1.25
35	-1.5
49	-1.75
62	-2
	-2.25



PICTURES OF WORK ON THE PROJECT SITE

NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience.

For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone Penetrometer tests (CPT) as below:

Relative Density	CPT Cone Value (qc — MPa)
Very loose	less than 2
Loose	2—5
Medium dense	5—15
Dense	15—25
Very dense	greater than 25

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

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• In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open. Attention is drawn to the document

"Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers,

• A localised perched water table may lead to an erroneous indication of the true water table.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

PROPOSED DEVELOPMENT AT KEFFI SUB STATION, NASSARAWA ROAD, KEFFI, NASSARAWA STATE.

GEOTECHNICAL INVESTIGATION

A-7-10

PREPARED BY:

BEST & CROMPTON ENGINEERING AFRICA LTD.,

December, 2014

CLIENT: YACHIYO ENGINEERING CO. LTD.,

TABLE OF CONTENT

1.0 INTRODUCTION

The Client, **Yachiyo Engineering Co.Ltd: commissioned Best & Crompton Engineering Africa Ltd.,** to proceed with subsoil investigations at the proposed development at **Keffi Sub station, Nassarawa road, Keffi, Nassarawa State.** This report is a consequence of the soil investigation and analyses, which is presented in an objective and professional manner.

The purpose of the subsoil investigation and attendant report is as follows:

- Determine the subsoil and surface/groundwater conditions of the designated location.
- Evaluation of the subsoil stratigraphic sequence geotechnical/engineering properties of the soil and the subsequent effects on foundation design and construction.
- Analysis of the data/results of tests carried out on the soil samples obtained and provide recommendations on the fit-for-purpose type of foundation for the proposed structure.

A-7-11

2.0 SITE ACCESSIBILITY

The sites are accessible through **Nassarawa Road** to mention but a few.

3.0 DESCRIPTION OF WORK

The soil investigation comprised of and carried out in three parts;

- Field Work: Test (2Nos. DCPTs) and collation of the test results.

3.1 FIELD WORK

The site works were carried out on November, 2014.

The Scope of Work executed involved the performance of 2Nos. 2.5tons Dutch Cone Penetrometer Tests (DCPTs) to a depth of refusal.

DUTCH CONE PENETROMETER

The apparatus consists of a cylindrical probe, of 1000mm^2 cross sectional area, and a conic head of apex angle of 60^o. The probe is forced down through the soil at a steady rate of about 20mm/s in the closed position by exerting pressure force on outer sounding tube. If desired the point resistance and the resistance to side friction can be measured separately.

2Nos. static cone penetration tests were carried out using a 2.5tons capacity testing equipment (machine) on each site. The test involves advancing the cone into the ground slowly at a constant rate and the resistant to penetration measured at predetermined intervals of 0.25m depth. The tests were terminated at depths where the machine anchor legs lifted.

These tests were taken from the existing ground level down to depths refusal at each location.

The cone penetration test results are presented in a graphical form respectively in the Appendix to this Report.

3.2 ANALYSIS OF TEST RESULTS

3.2.1 Geological Description

Available geological record reveals that the investigated area is within the basement complex of Nigeria; it is characterized by crystalline rocks of Precambrian age. Rocks of granitic origin later intruded these rocks.

The sedimentary deposits found on top of the basement rock are product of the parent rocks that have undergone weathering and decomposition.

3.2.2 Subsoil Condition

The subsoil condition of the site, based on the DCP test carried out reveals predominantly cohesive soil as observed from the DCP Plot.

Details of the subsoil characteristics encountered during the Penetrometer tests are stated below:

Subsoil Condition based on the field work.

Dutch Cone Penetrometer Test

Address: Keffi power station, Nassarawa road, Keffi, Nassarawa State

Depth (m)	Description of Stratum
0.00 to –.0.50	Filling.
0.50 to –1.00	Stiff to very stiff cohesive soil with gravels.
1.00 to –2.00	Firm becoming Stiff to hard cohesive soil with gravels and pebbles.

Geotechnical Properties

Depth (m)	Geotechnical Properties
0.00 to –.0.50	Moderate geotechnical properties, moderate shear strength and moderate compressibility potential.
0.50 to –1.00	Good geotechnical properties, high shear strength and low compressibility potential.
1.00 to –2.00	Moderate becoming good to very good geotechnical properties, moderate becoming high shear strength and low compressibility potential.

Geotechnical Engineering Parameters

Depth (m)	*P1(kgf/cm^3)*	*P2(kgf/cm^3)*
0.00 – 0.50m	***10 – 25***	***5 – 15***
0.50 – 1.00m	***40 – 53***	***25 – 33***
1.00 – 2.00m	***–***	***15 – 62***

A-7-12

3.2.4 Site description and condition

The project site is an open piece of land within existing power substation. Structures around site show no sign of distress at the time of our investigation.

3.2.5 Topography.

The topography of the project site is undulating topography.

3.2.6 Vegetation.

Vegetation around the project site area is mainly grasses and weeds.

4.1 FOUNDATION DISCUSSION AND RECOMMENDATION

4.1.1 Proposed Development

No structural detail of the proposed development was made available to us prior to the subsoil investigation, thus our recommendations are based on the DCP test carried out.

The geotechnical issues considered relevant to the proposed development include

- Soil bearing pressure
- Level of groundwater
- Recommendation of a suitable foundation type
- Excavation

4.1.2 RECOMMENDATION

The foundation type to be chosen for a particular structure depends largely on the followings;

- Loads to be transmitted
- Receiving soil strata
- Factor of safety against shear failure of the supporting soil must be adequate.
- Settlement should neither cause any unacceptable damage nor interfere with the function of the structure.

Foundations can be classified as shallow foundation or as deep foundation.

The choice between shallow foundation and deep foundation can be arrived at after careful consideration of the following elements.

1. The magnitude of the transmitted loads from the stratum,
2. The soil nature,
3. The economic aspects of the elements of the foundation work,
4. Problems concerning foundation construction.

4.1.3 Allowable bearing pressure and foundation recommendation

Allowable bearing pressure calculated in accordance with theoretical soil mechanics principle for depths are indicated below:

Differential Depth (m)	Allowable bearing Capacity (KN/m^2)
0.00 – 0.50	**85**
0.50 – 1.00	**208**
1.00 – 1.50	**257**
1.50 – 2.00	**505**

FOUNDATION RECOMMENDATION

Shallow Foundation

Shallow Foundation (Spread footing) is considered adequate for the proposed development on the project site.

Groundwater

Groundwater was not encountered during the subsoil investigation work

METHOD OF CALCULATING ALLOWABLE BEARING PRESSURE IN COHESIVE SOIL IS GIVEN BY:

Empirical Method for calculating in Cohesive Soil is given by:

q_{ult} = 5.14Cu + ϫD (Prandtl method of estimating allowable bearing pressure)

$q_a = q_{ult}$/F.S (3) – For Shallow foundation

Or

If the Clay is very Sandy

Correlation between q_c and SPT (N – Values)

$N = q_C / 2$

q_a = 10N, or 5.0N (If Submerged)

Correlation between q_c and Cu

$Cu = q_c / 20$ (KN/m^2)

4.2.2 Settlement

Settlement for this allowable bearing pressure for each location stated above would not exceed ***25mm***.

Our analysis on settlement is based on the method stated below

S = 1.1Mv x 0.55qn x h

Where S = Total settlement

Mv = Volume of compressibility potential

qn = net foundation base pressure

h = depth of foundation

The table below shows the permissible settlement as per I.S Code.

Soil type	Permissible total settlement		Permissible differential settlement	
	For isolated footings	For raft footings	For isolated footings	For raft footings
Sandy	4.0cm	4.cm to 6.5cm	2.5cm	2.5cm
Clays	6.5cm	6.5 to 10.0cm	4.0cm	4.0cm

4.2.3 Factor of Safety

Factor of safety of 3 was adopted for our estimation of allowable bearing pressure.

4.2.4 Excavation

- Excavation could be achieved using conventional excavating equipment.
- Excavation support would not be required

4.2.5 General Precaution for Shallow Foundation Construction

It is recommended that the following general guidelines that govern the construction of shallow foundation should be observed when work starts on the site:

- Over excavation beyond the depths stated should not be done.
- Ingress of water into the excavated foundation trench should be prevented if the stated bearing value at the founding depth is to be achieved. A layer of concrete blinding should therefore be provided within a trench once it has been excavated.
- Adequate cover to the concrete should be allowed for the reinforcement bars to protect them from possible effect of corrosion.
- The sides of foundation should be backfilled up to existing ground level as soon as they are cast.

5.0 CONCLUSION

Shallow Foundation (Spread footing) is considered adequate for the proposed development on the project site.

Despite an objective soil investigation and reporting, a poorly designed and/or constructed foundation may lead to structural failure if all other environmental conditions remain constant.

BEST&CROMPTON ENGINEERING AFRICA LIMITED therefore recommends that the design and construction of all foundation and earthwork be carried out by a competent company in accordance with good and strict engineering practice expected of a professional. The construction contractor shall be guided by reference Code of Practices such as; British Institution CP 2004, 1973: Code of Practice for Foundation and BS 6031: Code of Practice for Earth Works.

A-7-15

M.Nageswara Rao

For Best & Crompton Engineering Africa Ltd.,

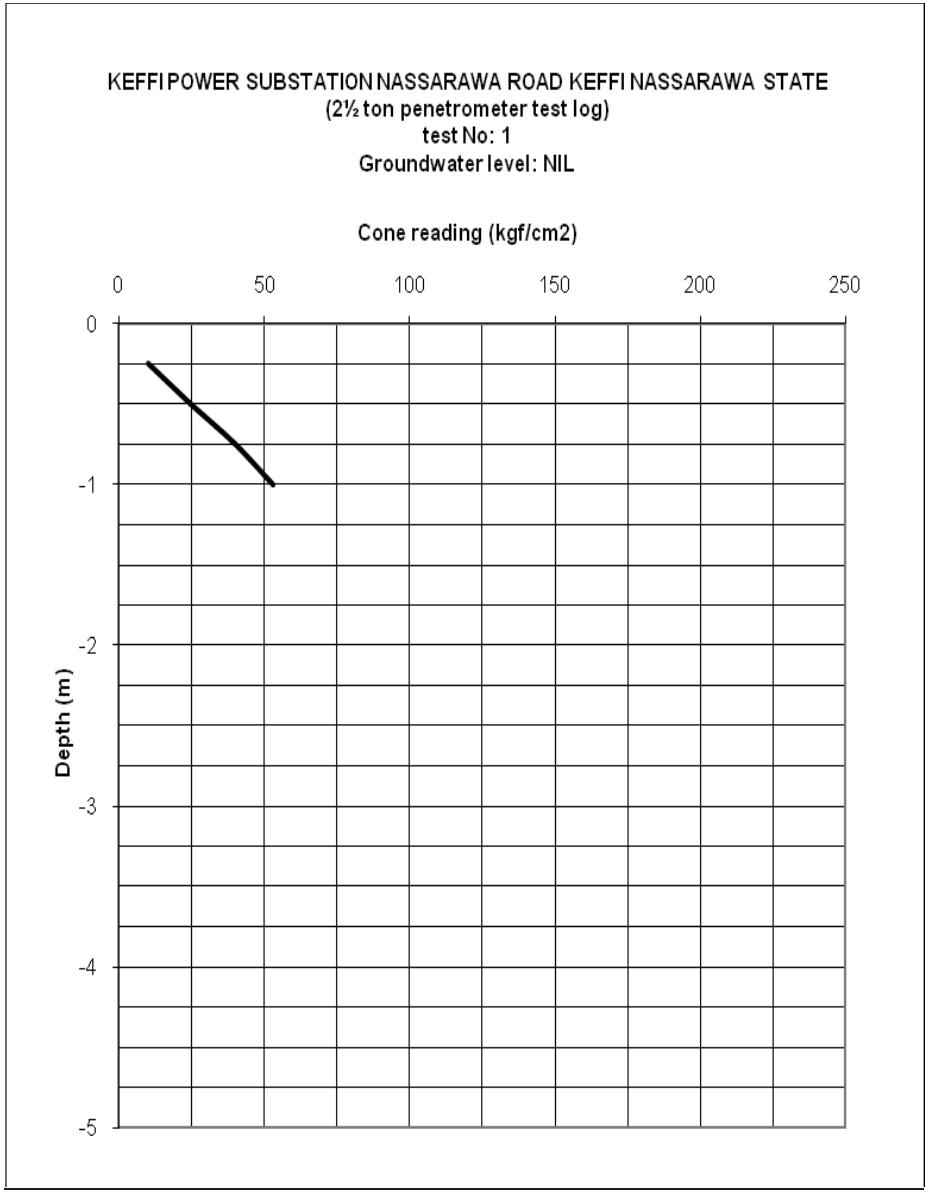
APPENDIX

FIELD LOGS

PENETROMETER 1

Qc	Depth
0	0
10	-0.25
25	-0.5
40	-0.75
53	-1
	-1.25

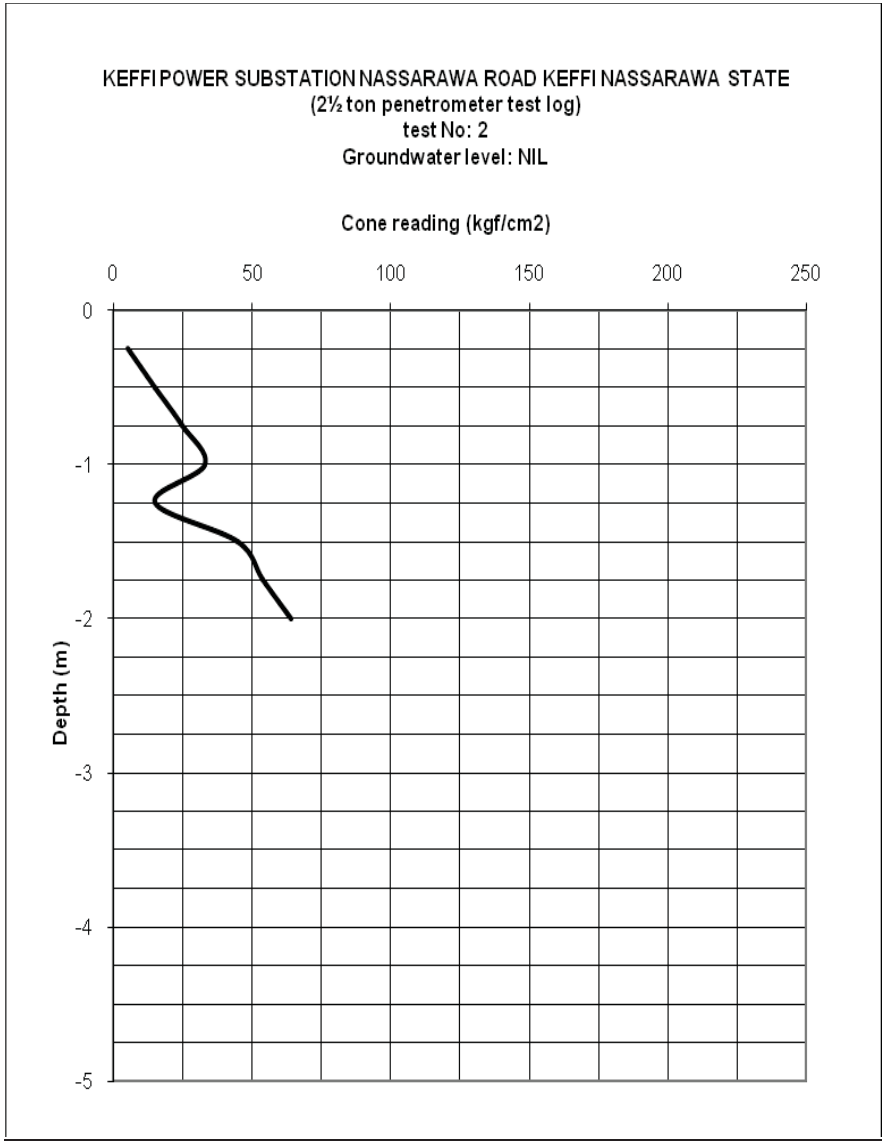
A-7-16



PENETROMETER 2

Qc	Depth
0	0
5	-0.25
15	-0.5
25	-0.75
33	-1
15	-1.25
45	-1.5
54	-1.75
64	-2
	-2.25

A-7-17



PICTURES SHOWING FIELD OPERATION ON THE PROJECT SITE

NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience.

For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone Penetrometer tests (CPT) as below:

Relative Density	CPT Cone Value (qc — MPa)
Very loose	less than 2
Loose	2—5
Medium dense	5—15
Dense	15—25
Very dense	greater than 25

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

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• In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open. Attention is drawn to the document

"Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers,

• A localised perched water table may lead to an erroneous indication of the true water table.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

A-8 Field Report

PREPARATORY SURVEY
FOR
THE PROJECT
FOR
EMERGENCY IMPROVEMENT
OF
ELECTRICITY SUPPLY FACILITIES IN ABUJA
IN
THE FEDERAL REPUBLIC OF NIGERIA

FIELD REPORT

12th DECEMBER 2014

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Federal Ministry of Power (FMP)

JICA PREPARATORY SURVEY TEAM
Yachiyo Engineering Co.,Ltd.

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1. Outline of the Project

1.1 Background of the Project

In response to the request from the Government of the Federal Republic of Nigeria (Nigeria), the Japan International Cooperation Agency (JICA), in consultation with the Government of Japan, decided to conduct a Preparatory Survey (the Survey) for the Project for Emergency Improvement of Electricity Supply Facilities in Abuja (the Project).

JICA sent to Nigeria the Preparatory Survey Team (the Team) headed by Mr. Kazunari Oshima, Visiting Senior Advisor, JICA, to conduct the first field survey and the Team is scheduled to stay in the country from 3rd November to 15th December, 2014.

The Team continued discussions with the concerned officials of Nigeria and the field survey in Nigeria in consideration of mutual understandings made on the Minuets of Discussions signed among Japan International Cooperation Agency (JICA), the Federal Ministry of Power (FMP) and Transmission Company of Nigeria (TCN) on 19th November, 2014.

TCN and the Team had series of technical discussions to form mutual understandings about the contents, scope, preconditions for the Outline Design, basic specifications, general layouts, and so on of the Project in the First Field Survey. FMP, TCN and the Team agreed to record the following issues described on this Field Report as a conclusion of the First Field Survey and discussions.

Components of the Project and their priority will be further examined and may be modified through the consultation with the Japanese Ministry of Foreign Affairs and JICA headquarters. It is important for the Nigerian side to understand that the Preparatory Survey is not a commitment for the future implementation of the Project.

Particularly, in consideration of the schedule and procedures of Japan's Grant Aid projects, the Team explained that the outline design, planning of the implementation schedule, the cost estimation and so on of the Project will be carried out in accordance with the mutual understandings made on this Field Report.

FMP and TCN expressed understanding about the schedule and procedures of Japan's Grant Aid project and agreed with the Team to progress the further study, the outline design, planning of the implementation schedule, the cost estimation and so on of the Project in accordance with the mutual understandings made on this Field Report after the First Field Survey.

1.2 Framework for the Project

The framework for the Project is shown as follows.

(1) The responsible ministry is the Federal Ministry of Power (FMP).
(2) The implementing agency is Transmission Company of Nigeria (TCN).

1.3 Components of the Project on Minutes of Discussions on 19th November, 2014

The Components and their priority for the Project on Minutes of Discussions (M/D) concluded on 19th November, 2014 are shown in Table 1.3-1 and the locations are shown in the drawing G-01.

The Nigerian side and the Team discussed the final requested components of the Project and their priority. The rating of the priority shown in the following table is higher in the following manner: A, B and C.

Table 1.3-1 Final requested components of the Project and their priority

Component	Location	Specification	Priority
Installation of capacitor bank	Apo 132/33 kV Substation	60 MVar, 132 kV	A
Installation of capacitor bank	Keffi 132/33 kV Substation	25 MVar, 132 kV	A
Installation of Static Var Compensator (SVC)	Katampe 330/132/33 kV Substation	50 MVar, 330 kV	C
Installation of shunt reactor	Gwagwalada 330/132/33 kV Substation	75 MVar	B

<Note>

This report is mainly focused on the components for Apo 132/33 kV Substation and Keffi 132/33 kV Substation as they are prioritized with A.

In case of the components for Katmpe 330/132/33 kV Substation and Gwagwalada 330/132/33 kV Substation with priority C and B, the Team shall determine the voltage violation on the power flow analysis and study the appropriateness as Japan's Grant Aid Scheme in consultation with JICA and the Ministry of Foreign Affairs in Japan.

1.4 Obligations / Undertakings of the Nigerian side for the Project

(1) Preconditions

- TCN agreed to secure, clear and level the land space of the proposed substations for the Project as shown in the drawing L-01 and L-03 in accordance with agreement on M/D signed on 19th November, 2014.
- TCN agreed to obtain permission or consent from related authorities for power outage during the period of necessary construction work by the Japanese side.
- TCN agreed to ensure the earth resistance value with less than 1(one) ohm in case of the value with over 1(one) ohm on the existing earthing system.

(2) Necessary Inputs by the Nigerian side

1) Prior to the Commencement of the Construction Work

- For Apo 132/33 kV Substation (Refer to the drawing L-01 and L-02):
  - TCN agreed to secure the space for the installation of LV and control cables for the

Project in the existing cable pit.

- ✧ TCN agreed to relocate the existing outdoor lighting pole between busbars before commencement of the installation work by the Japanese side.
- ✧ TCN agreed to secure the place in the control building where the panels will be installed.
- ✧ TCN agreed to provide the power supply (DC110 V and AC415-240 V (3-phase)) to the panel which will be installed by the Project.
- ✧ TCN agreed to secure sites for temporary storage yard for the Project inside the Substation.

➢ For Keffi 132/33 kV Substation (Refer to the drawing L-03 and L-04):

- ✧ TCN agreed that the Japanese side shall install 132kV underground cable from existing 132kV switchyard to the yard for capacitor bank.
- ✧ TCN agreed to relocate the existing outdoor lighting pole before commencement of the installation work by the Japanese side.
- ✧ TCN agreed to secure places in the control building where the panels and batteries will be installed.
- ✧ TCN agreed to provide the power supply (AC415-240 V (3-phase)) from the existing LV panel to the panel which will be installed by the Project.
- ✧ TCN agreed to secure sites for temporary storage yard for the Project inside the Substation.

2) During the Construction Work

➢ For Apo 132/33 kV Substation

- ✧ TCN agreed that Japanese side shall install the overhead grounding wire between the existing one gantry and the other existing gantry above the capacitor bank.
- ✧ TCN agreed to temporarily remove the 132 kV overhead connecting line between Transformer No.1 bay and Transformer No.2 bay when the heavy vehicle will transport equipment enter into the site, if necessary.

➢ For Keffi 132/33 kV Substation:

- ✧ TCN agreed that Japanese side shall install the overhead grounding wire between the existing gantries and the new gantry.

➢ TCN agreed to schedule power outages required for installation work for the Project and carry out them in timely manner. TCN shall also manage any issue concerning the power

outages, including related procedures, and compensation to and grievances from customers (DISCO).

3) After the Commencement of Operation

➢ TCN agreed to operate and maintain the equipment properly.

2. Technical requirements confirmed in the First Field Survey

2.1 Technical requirements for the equipment of the substation for the Project

(1) Applicable Codes and Standards

The equipment of Substation Facilities of the Project shall be designed in accordance with IEC, JIS, JEC, JEM standards and/or equivalent.

(2) Design Condition for the equipment of the substations

Table 2.-1-1 indicates the electrical systems and design conditions applied to the Project.

Table 2.1-1 Electrical Systems and Design Conditions

Item		Substation system
Frequency		50 Hz
Phase		3-phase
Maximum voltage		145 kV
Nominal voltage		132 kV
Lightning impulse withstand voltage		650 kV
Power-frequency withstand voltage		275 kV
Grounding system		Direct
Phase to Earth wire (minimum distance)[1]		1,200 mm
Phase to Phase (minimum distance)[2]		2,400 mm
System voltage		
Voltage level [kV]	Minimum voltage [kV] (pu)	Maximum Voltage [kV] (pu)
132	118.8 (0.90)	145.0 (1.098)
System frequency		
Nominal frequency [Hz]	Minimum frequency [Hz] (pu)	Maximum frequency [Hz] (pu)
50	48.75 (0.975)	51.25 (1.025)

(3) Requirements for the equipment of the substations

The items and their specifications of the equipment procured by the Japanese side are shown in Table 2.1-2 and Table 2.1-3. Single Line Diagram for the equipment is shown in the drawing E-01 and E-02.

[1] Refer to P.64(NERC Regulation 2014)

[2] Refer to P.64(NERC Regulation 2014)

Table 2.1-2 Items and Specification of Equipment to be supplied for Apo 132/33 kV Substation

No.	Description	Specifications	Q'ty
AP-1	**132 kV Gas Circuit Breaker**		**1 set**
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Three-pole, outdoor use porcelain (creepage distance shall be designed as Equivalent Salt Deposit Density(ESDD) is 0.03 mg/cm^2)	
	➢ Rated voltage	145 kV or higher	
	➢ Rated current	1,250 A or higher	
	➢ Rated breaking current	31.5 kA or higher	
	➢ CB operating sequence	O - 0.3 sec. – CO – 3 min. CO	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
	➢ Control voltage	DC110 V, AC415 (3-phase) –AC240V (Single-phase)	
AP-2	**132 kV Line Switch**		**2 sets**
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Three-pole, single-throw, outdoor use, horizontal double break rotating and insulator type (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	➢ Rated voltage	145 kV or higher	
	➢ Rated current	1,250 A or higher	
	➢ Short-time withstand current	31.5 kA or higher	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
	➢ Control voltage	DC110 V	
AP-3	**132 kV Line Switch with earthing devise**		**1 set**
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Three-pole, single-throw, outdoor use, horizontal double break rotating and insulator type (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	➢ Rated voltage	145 kV or higher	
	➢ Rated current	1,250 A or higher	
	➢ Short-time withstand current	31.5 kA or higher	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
	➢ Control voltage	DC110 V	
	➢ Mechanical earthing device	Available	
AP-4	**132 kV Current Transformer**		**3 sets**
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Outdoor use, single phase, oil-filled porcelain type or bushing type (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	➢ Highest system voltage	145 kV	
	➢ Core number	3 cores/phase	
	➢ Rated primary current	600 A	
	➢ Rated secondary current	1/1/1 A	
	➢ Tolerances	Core 1: Class 1.0 Core 2, 3: 5P20	
	➢ Rated burden	30 VA or higher	
	➢ Rated short-time current	25 kA (2 sec.) or higher	
	➢ Lightning impulse withstand voltage	650 kV or higher	

No.	Description	Specifications	Q'ty
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
AP-5	**132 kV Condenser type voltage transformer**		**3 sets**
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Outdoor use, single phase, oil-filled porcelain type or bushing type (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	➢ Highest system voltage	145 kV	
	➢ Secondary circuits number	2 (Circuit 1: Metering, Circuit 2: Protection)	
	➢ Rated primary voltage	132/$\sqrt{3}$ kV	
	➢ Rated secondary current	110/$\sqrt{3}$ V (Both of 2 circuits)	
	➢ Tolerances	Core 1: Class 0.5 Core 2, 3: 3P	
	➢ Rated burden	100 VA or higher (Both of 2 circuits)	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
AP-6	**132 kV Lighting arrester**		**3 sets**
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Outdoor use, Metal oxide without gap type, single phase (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	➢ Rated voltage	120 kV	
	➢ Rated discharge current	10 kA	
AP-7	**132 kV Capacitor bank**		**1 lot**
	➢ Standard	JEC, JIS, IEC or equivalent	
	➢ Type	Outdoor use (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	➢ Rated equipment	3-phase, 50 Hz, 132 kV	
	➢ Rated capacity	60 MVar (1 group)	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
	(1) Power capacitor		
	➢ Rated phase voltage	81.2 kV (Single phase)	
	➢ Rated total capacity	63.8 MVar	
	(2) Series reactor		
	➢ Rated voltage	4860*/$\sqrt{3}$ V (3-phase)	
	➢ Reactance	6% of the power capacitor reactance	
	➢ Lightning impulse withstand voltage	400 kV or higher(reduced by lightning arrester)	
	➢ Power frequency withstand voltage (1 min.)	160 kV or higher(reduced by lightning arrester)	
	(3) Discharging coil		
	➢ Rated voltage	To be specified	
	➢ Total discharge capacity	63.8 MVar or higher	
	➢ Secondary voltage	110 V	
	➢ Secondary capacity	100 VA	
	➢ Allowable transformer ratio error	+/-1.0%	
	(4) Insulation transformer		
	➢ Primary voltage	110 V (Single phase)	
	➢ Secondary voltage	To be specified	
	➢ Secondary capacity	600 VA (100 VA x 6 units)	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
	➢ Allowable transformer ratio error	+/-1.0%	
	(5) Lighting arrester		

No.	Description	Specifications	Q'ty
	➢ Type	Metal oxide without gap type	
	➢ Rated voltage	98 kV	
	(6) Insulated mounting structure		
	➢ Rated voltage	132 kV	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
AP-8	**132 kV Busbar, steel structures for busbars, insulators and other materials**		**1 lot**
	(1) 132 kV busbar		
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Conductor	Hard drawn standard wire (HDCC)	
	(2) Steel structures for busbars		
	➢ Standard	JIS or equivalent	
	➢ Size	Width: 14 m, height: 10 m	
	➢ Material	Galvanized steel	
	(3) Strain insulators for 132 kV busbars		
	➢ Standard	JIS or equivalent	
	➢ Type	Porcelain (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	(4) 132 kV Overhead conductors		
	➢ Standard	JIS or equivalent	
	➢ Material	ACSR	
	(5) Post insulators for 132 kV busbars		
	➢ Standard	JIS or equivalent	
	➢ Type	Porcelain (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	(6) Grounding wire		
	➢ Standard	JIS or equivalent	
	➢ Material	Galvanized iron-wire	
	(7) Other materials		
AP-9	**Substation earthing**		**1 lot**
	➢ Materials	Earthing conductors (copper wire) and terminals	
	➢ Earthing resistance	Less than 1 ohm	
AP-10	**Protection panel for 132 kV capacitor bank**		**1 panel**
	(1) Protection function		
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Indoor use, metal enclosed self–standing type	
	➢ Control voltage	DC110 V, AC 240 V (Single phase)	
	➢ Relay	- Under voltage relay - Over voltage relay - Voltage balance relay	
	➢ Alarming system	- Static temperature switch - Static internal faulty detecting device	
AP-11	**Control panel for 132 kV line**		**1 panel**
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Indoor use, metal enclosed self–standing type	
	➢ Control voltage	DC110 V, AC415 (3-phase) –AC240V (Single-phase)	
	➢ Relay	- Overcurrent relay (Instant, time lagging)	
	➢ Metering indication	- Current, voltage and reactive power	
AP-12	**LV cable and materials**		**1 lot**
	➢ Low voltage cables	600 V power cables and control cables	
	➢ Cabling materials	Conduits, cable racks and others	
	➢ Fire-protection kit	Prevent the building from outdoor fire through cable pits	

Table 2.1-3 Items and Specification of Equipment to be supplied for Keffi 132/33 kV Substation

No.	Description	Specifications	Q'ty
KF-1	**132 kV Gas Circuit breaker**		**1 set**
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Three-pole, outdoor use porcelain (creepage distance shall be designed as Equivalent Salt Deposit Density(ESDD) is 0.03 mg/cm^2)	
	➢ Rated voltage	145 kV or higher	
	➢ Rated current	1,250 A or higher	
	➢ Rated breaking current	31.5 kA or higher	
	➢ CB operating sequence	O - 0.3 sec. – CO – 3 min. CO	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
	➢ Control voltage	DC110 V, AC415 (3-phase) –AC240V (Single-phase)	
KF-2	**132 kV Line Switch**		**1 set**
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Three-pole, single-throw, outdoor use, horizontal double break rotating and insulator type (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	➢ Rated voltage	145 kV or higher	
	➢ Rated current	1,250 A or higher	
	➢ Short-time withstand current	31.5 kA or higher	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
	➢ Control voltage	DC110 V	
KF-3	**132 kV Line Switch with earthing devise**		**1 set**
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Three-pole, single-throw, outdoor use, horizontal double break rotating and insulator type (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	➢ Rated voltage	145 kV or higher	
	➢ Rated current	1,250 A or higher	
	➢ Short-time withstand current	31.5 kA or higher	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
	➢ Control voltage	DC110 V	
	➢ Mechanical earthing device	Available	
KF-4	**132 kV Current Transformer**		**3 sets**
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Outdoor use, single phase, oil-filled porcelain type or bushing type (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	➢ Highest system voltage	145 kV	
	➢ Core number	3 cores/phase	
	➢ Rated primary current	300 A	
	➢ Rated secondary current	1/1/1 A	
	➢ Tolerances	Core 1: Class 1.0 Core 2, 3: 5P20	
	➢ Rated burden	30 VA or higher	
	➢ Rated short-time current	25 kA (2 sec.) or higher	
	➢ Lightning impulse withstand voltage	650 kV or higher	

No.	Description	Specifications	Q'ty
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
KF-5	**132 kV Lighting arrester**		3 sets
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Outdoor use, Metal oxide without gap type, single phase (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	➢ Rated voltage	120 kV	
	➢ Rated discharge current	10 kA	
KF-6	**132 kV Capacitor bank**		1 lot
	➢ Standard	JEC, JIS, IEC or equivalent	
	➢ Type	Outdoor use (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	➢ Rated equipment	3-phase, 50 Hz, 132 kV	
	➢ Rated capacity	25 MVar (1 group)	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
	(1) Power capacitor		
	➢ Rated phase voltage	81.2 kV (Single phase)	
	➢ Rated total capacity	26.6 MVar	
	(2) Series reactor		
	➢ Rated voltage	4860*$\sqrt{3}$ V (3-phase)	
	➢ Reactance	6% of the power capacitor reactance	
	➢ Lightning impulse withstand voltage	400 kV or higher(reduced by lightning arrester)	
	➢ Power frequency withstand voltage (1 min.)	160 kV or higher(reduced by lightning arrester)	
	(3) Discharging coil		
	➢ Rated voltage	To be specified	
	➢ Total discharge capacity	26.6 MVar or higher	
	➢ Secondary voltage	110 V	
	➢ Secondary capacity	100 VA	
	➢ Allowable transformer ratio error	+/-1.0%	
	(4) Insulation transformer		
	➢ Primary voltage	110 V (Single phase)	
	➢ Secondary voltage	To be specified	
	➢ Secondary capacity	600 VA (100 VA x 6 units)	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
	➢ Allowable transformer ratio error	+/-1.0%	
	(5) Lighting arrester		
	➢ Type	Metal oxide without gap type	
	➢ Rated voltage	98 kV	
	(6) Insulated mounting structure		
	➢ Rated voltage	132 kV	
	➢ Lightning impulse withstand voltage	650 kV or higher	
	➢ Power frequency withstand voltage (1 min.)	275 kV or higher	
KF-7	**132 kV Busbar, steel structures for busbars, insulators and other materials**		1 lot
	(1) 132 kV busbar		
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Conductor	Hard drawn standard wire (HDCC)	
	(2) Steel structures for busbars		
	➢ Standard	JIS or equivalent	
	➢ Size	Width: 14 m, height: 10 m	
	➢ Material	Galvanized steel	

No.	Description	Specifications	Q'ty
	(3) Post insulators for 132 kV busbars		
	➢ Standard	JIS or equivalent	
	➢ Type	Porcelain (Creepage distance shall be designed as ESDD is 0.03 mg/cm^2)	
	(4) 132 kV Overhead conductors		
	➢ Standard	JIS or equivalent	
	➢ Material	ACSR or equivalent	
	(5) 132 kV Cable termination		
	➢ Type	Outdoor termination	
	(6) 132 kV Underground cable		
	➢ Type	XLPE	
	➢ Conductor	Copper	
	➢ Core	Single	
	➢ Seethe type	Ant-proof PVC	
	➢ Seethe color	Black	
	➢ Armor	Aluminum for direct burial or lead seethe	
	(7) Grounding wire		
	➢ Standard	JIS or equivalent	
	➢ Material	Galvanized iron-wire	
	(8) Other materials		
KF-8	**Substation earthing**		1 lot
	➢ Materials	Earthing conductors (copper wire) and terminals	
	➢ Earthing resistance	Less than 1 ohm	
KF-9	**Protection panel for 132 kV capacitor bank**		1 panel
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Indoor use, metal enclosed self –standing type	
	➢ Control voltage	DC110 V, AC 240 V (Single phase)	
	➢ Relay	- Under voltage relay - Over voltage relay - Voltage balance relay	
	➢ Alarming system	- Static temperature switch - Static internal faulty detecting device	
KF-10	**Control panel for 132 kV line**		1 panel
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Indoor use, metal enclosed self –standing type	
	➢ Control voltage	DC110 V, AC415 (3-phase) –AC240V (Single-phase)	
	➢ Relay	- Overcurrent relay (Instant, time lagging)	
	➢ Metering indication	- Current, voltage and reactive power	
KF-11	**DC power supply system**		1 lot
	➢ Standard	IEC, JEC, JIS, JEM or equivalent	
	➢ Type	Indoor use, metal enclosed thyristor type	
	➢ System	One charger	
	➢ Input	AC240 V (Single-phase)/AC415 V (three-phase) +/-10%	
	➢ Output	110V (+/-3%)	
	➢ Rated current	80 A	
	➢ Batteries	Lead-acid battery with control valves or equivalent, 450 Ah/10 hrs, 54 cells	
	➢ DC output circuits number	3 or higher	
KF-12	**LV cable and materials**		1 lot
	➢ Low voltage cables	600 V power cables and control cables	
	➢ Cabling materials	Conduits, cable racks and others	
	➢ Fire-protection kit	Prevent the building from outdoor fire through cable pits	

2.2 Technical requirements for the facilities of the substation of the Project

(1) Design Conditions for the Substation Facilities

The design conditions for the substation facilities are shown in the following Table 2.1.2-1.

Table 2.2-1 Basic Conditions for the Facility Design of the Project

Items		Values in Apo Substation	Values in Keffi Substation
Altitude		483 m	314 m
Ambient Temperature (Daily)	Maximum	36.0 Degree Celsius	
	Minimum	19.1 Degree Celsius	
	Mean	27.0 Degree Celsius	
Maximum Wind Velocity	(Sustained)	33.5 m/sec	
Annual Rain Fall		1,221 mm	
Seismic Force		Not Applicable	

(2) Requirements for the Substation Facilities

1) Foundation of Capacitor Bank

The Outline for the Foundation of Capacitor Bank is shown in Table 2.2-2. Foundations shall be placed in two (2) places.

Ground floor level should be +0.5 m from the design ground level.

Table 2.2-2 Outline for the Foundations of Capacitor Bank

Items	Contents	Details
Structure	Reinforced Concrete Mat Foundation	-
Height of story	1 story	GF:Space for 1 unit Reactor, 3 units of Lighting Arrestors, 6 units of Insulating Transformers, and 3 units of Capacitors [Note] For the equipment to avoid submerging to water on heavy rainy days, the floor level of the foundations shall be 0.5 m raised from the design ground level. Anchor Bolt and insert base: In order to fix each equipment anchor bolt and insert base must put in position Earthing Wire (36) 22mm² - 100 mm² earthing wire for each equipment must in place Control Cable Outlet (7) the control cables to 6 Insulating Transformers, and 1 Reactor must go through the foundation and bundled in one place
Total Floor Area	Approx. 300 m² (20m x 15m) in Apo Substation and 187 m² (17m x 11m) in Keffi Substation	At installation point (Anchor Bolt and insert base) foundation must bear load from each equipment
Building Area	Approx. 300 m² and 187 m²	The foundation must bear following weight 133,000 kg in Apo substation, 97,000 kg in Keffi substation.

2) Cable Pipe

The Outline of the Cable Pipe is shown in Table 2.2-3.

Table 2.2.3 Outline of the Cable Pipes

Items	Contents
Cable Pipe (1) from Capacitor Bank in Apo Substation to Existing Cable pit	D 100 mm, Length Approx. 55.5m (Depth =0.5m) material to be confirmed
Cable Pipe (2) from Capacitor Bank in Keffi Substation to Existing Cable pit	D 100 mm, Length Approx. 50.7m (Depth =0.5m) material to be confirmed
Cable Pipe (3) from Capacitor Bank in Keffi Substation to Switch Yard	Length Approx. 48.1m (Depth =0.5m) Diameter and material to be confirmed

The function of each pipe is as follows. Cable Pipe (1) and Cable Pipe (2) are for connection to Control Room. Cable Pipe (3) is for smooth cabling from switch yard to the capacitor bank.

2.3 Procurement Plan of Spare Parts and Test Equipment

Capability of sustainable operation and maintenance for the equipment of the Project by the recipient is one of conditions for the Japan's Grant Aid Project. The Nigerian side shall keep operation and maintenance for the equipment of the Project properly by himself, including procurement of spare parts. On the other hand, the warranty period for the Project is one (1) year after issuance of the completion certificate in case of the Japan's Grant Aid Project. To secure operation and maintenance for the equipment of the Project for the warranty period, the spare parts required for the period shall be provided as the scope of the Japanese side.

Possession of maintenance tools for proper operation and maintenance for the equipment of the Project by the Recipient is one of conditions for the Japan's Grant Aid Project. However, the special tools required for operation and maintenance of the equipment of the Project shall be provided as the scope of the Japanese side.

Outline of the spare parts and test equipment of the Project is shown in Table 2.3-1 and Table 2.3-2. More detailed parts, tools, test equipment and the quantity will be explained with the Draft Final Report.

Table 2.3-1 Spare Parts List

No.	Item	Q'ty
AP-1	**132 kV Gas Circuit Breaker**	
(1)	Trip coil	1
(2)	Closing coil	1
(3)	MCCB (each type)	1
(4)	Auxiliary relay (each type)	1
AP-2	**132 kV Line Switch**	
(1)	MCCB (each type)	1
(2)	Magnetic contactor (each type)	1

No.	Item	Q'ty
(3)	Auxiliary relay (each type)	1
AP-3	**132 kV Line Switch with earthing devise**	
(1)	MCCB (each type)	1
(2)	Magnetic contactor (each type)	1
(3)	Auxiliary relay (each type)	1
AP-10	**Protection panel for 132 kV capacitor bank**	
(1)	Protection relay (each type)	1
(2)	Switch (each type)	1
(3)	Lamp (each type)	1
(4)	MCCB (each type)	1
(5)	Auxiliary relay (each type)	1
(6)	Magnetic contactor (each type)	1
AP-11	**Control panel for 132 kV line**	
(1)	Protection relay (each type)	1
(2)	Switch (each type)	1
(3)	Lamp (each type)	1
(4)	MCCB (each type)	1
(5)	Auxiliary relay (each type)	1
(6)	Magnetic contactor (each type)	1
AP-12	**LV cable and materials**	
(1)	Fire protection kit	1
KF-1	**132 kV Gas Circuit Breaker**	
(1)	Trip coil	1
(2)	Closing coil	1
(3)	MCCB (each type)	1
(4)	Auxiliary relay (each type)	1
KF-2	**132 kV Line Switch**	
(1)	MCCB (each type)	1
(2)	Magnetic contactor (each type)	1
(3)	Auxiliary relay (each type)	1
KF-3	**132 kV Line Switch with earthing devise**	
(1)	MCCB (each type)	1
(2)	Magnetic contactor (each type)	1
(3)	Auxiliary relay (each type)	1
KF-9	**Protection panel for 132 kV capacitor bank**	
(1)	Protection relay (each type)	1
(2)	Switch (each type)	1
(3)	Lamp (each type)	1
(4)	MCCB (each type)	1

No.	Item	Q'ty
(5)	Auxiliary relay (each type)	1
(6)	Magnetic contactor (each type)	1
KF-10	**Control panel for 132 kV line**	
(1)	Protection relay (each type)	1
(2)	Switch (each type)	1
(3)	Lamp (each type)	1
(4)	MCCB (each type)	1
(5)	Auxiliary relay (each type)	1
(6)	Magnetic contactor (each type)	1
KF-11	**DC power supply system**	
(1)	Protection relay (each type)	1
(2)	Switch (each type)	1
(3)	Lamp (each type)	1
(4)	MCCB (each type)	1
(5)	Auxiliary relay (each type)	1
(6)	Magnetic contactor (each type)	1
KF-12	**LV cable and materials**	
(1)	Fire protection kit	1

Table 2.3-2 Test Equipment List

No.	Item	Q'ty
MT-1	Megger	1
MT-2	Capacitance measuring device	1
MT-3	Earthing resistance tester	1
MT-4	Switchgear testing device	1

2.4 On-the-Job Training (OJT)

On-the-job training (OJT) will be carried out during the construction period. Through the OJT, maintenance and operation for the equipment of the Project will be carried out by Japanese skilled engineers from the manufacturers of the equipment for the Project at the project sites.

3. Tentative Implementation Schedule of the Project

The tentative implementation schedule is shown in Table-3.-1. In case that the Project is adapted by the Japanese Government, the Project will proceed as follows in the earliest scenario. It is important for both sides to understand that the tentative implementation schedule does not assume a commitment for the future implementation of the Project.

4. Drawings

The outline drawings are followed after the Table-3.-1 Tentative Implementation Schedule.

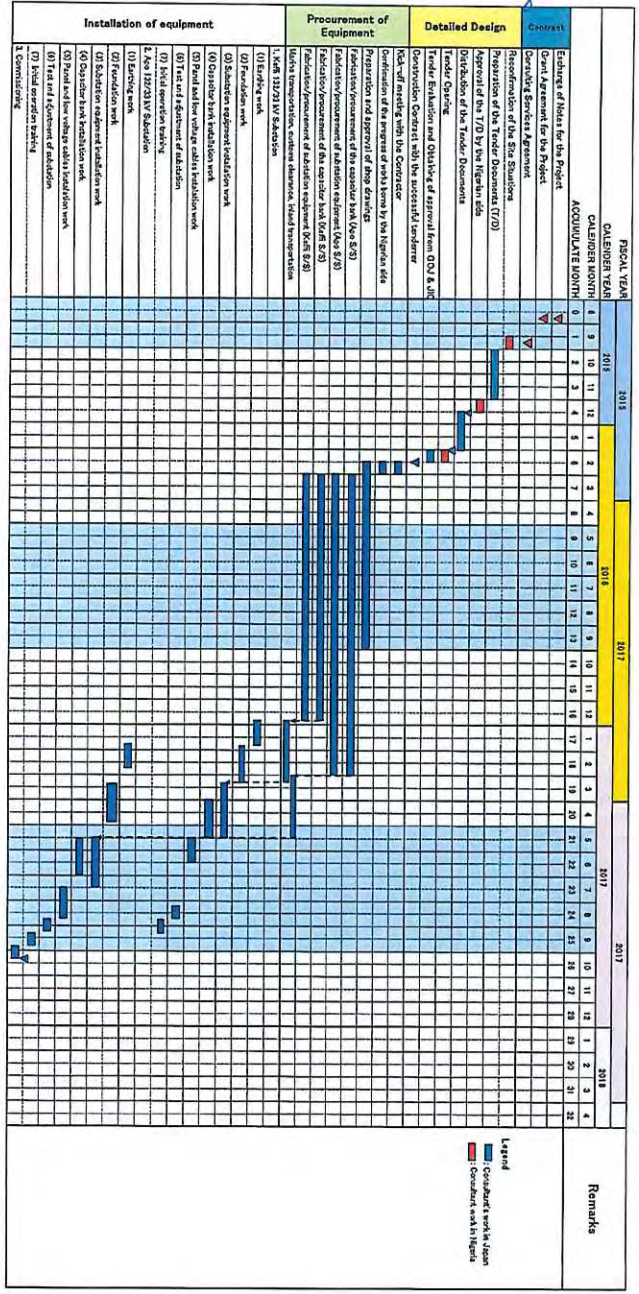
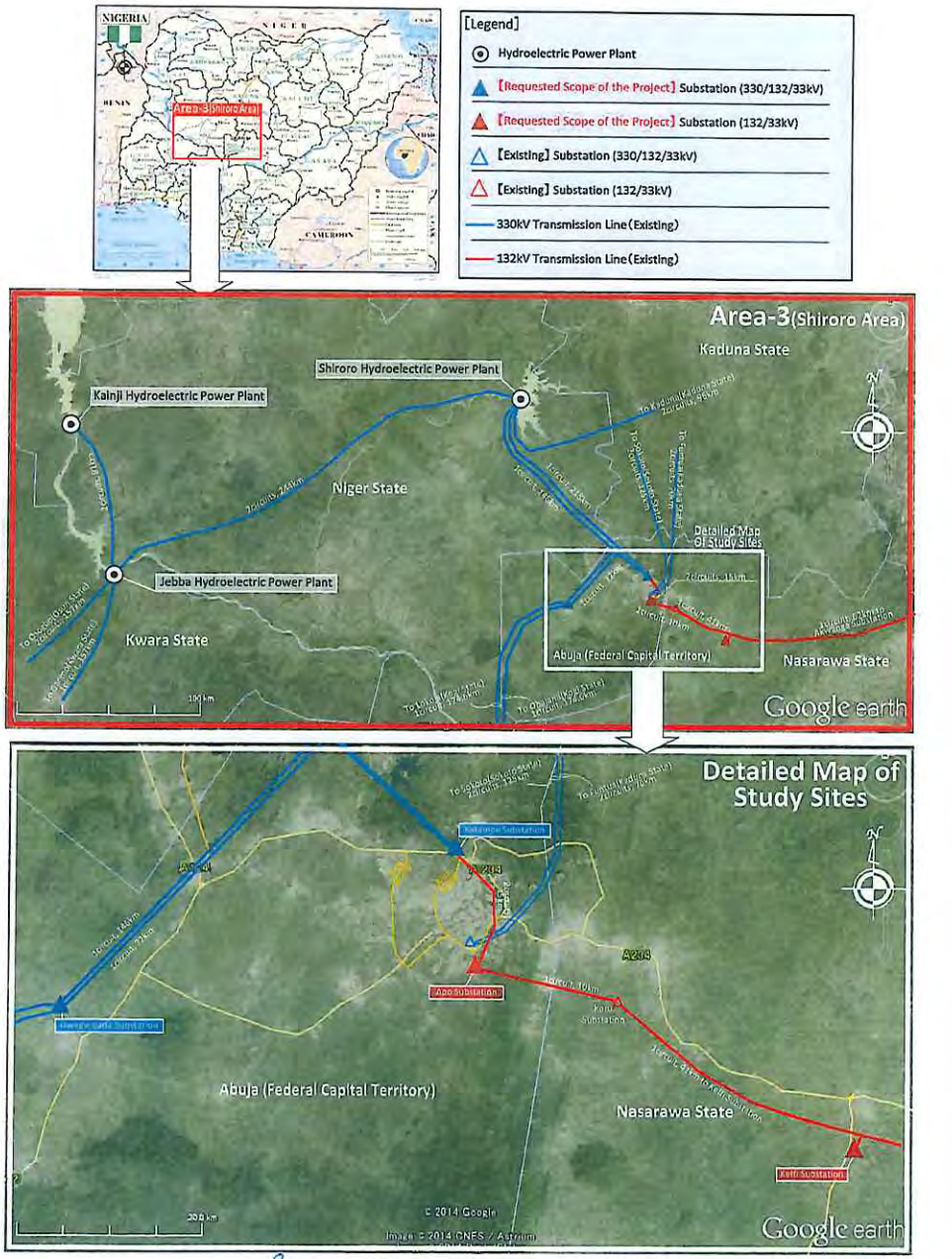
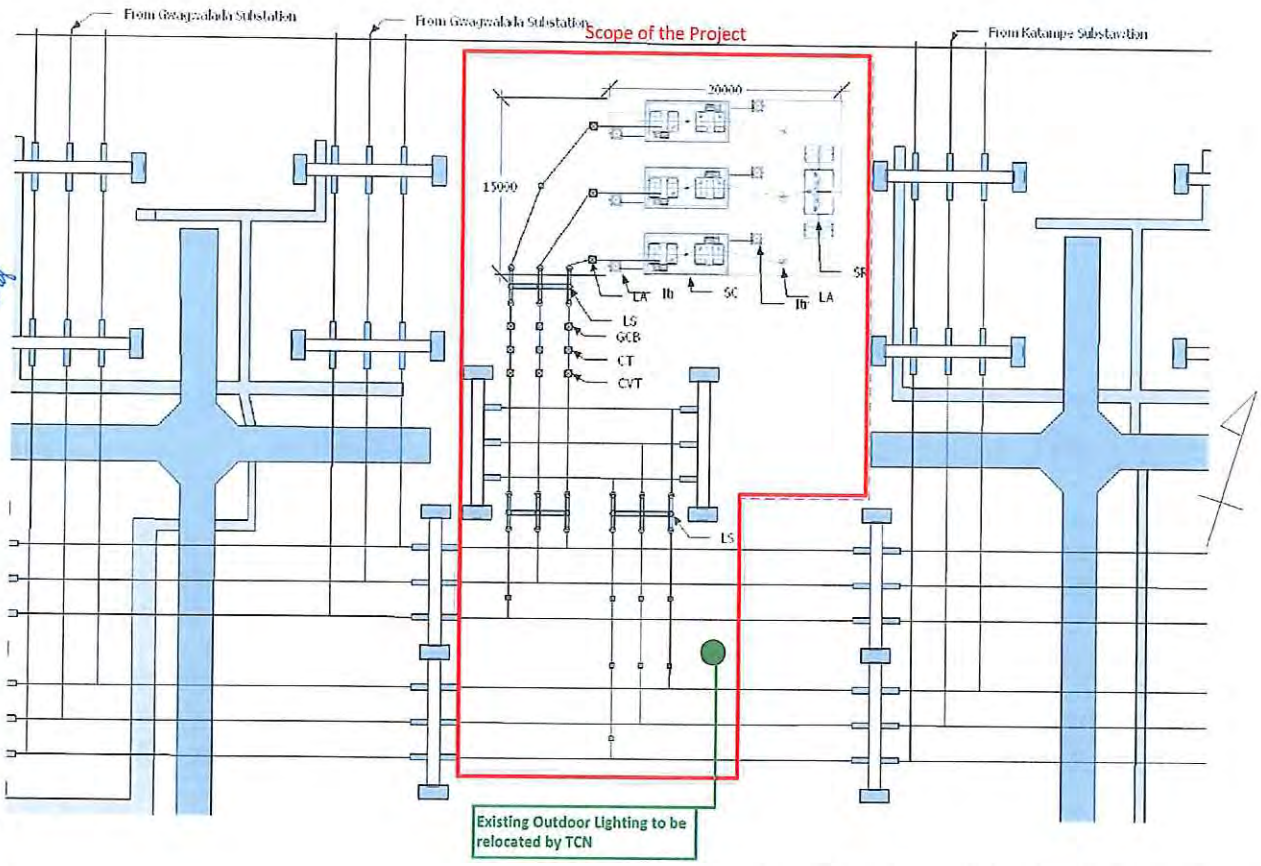


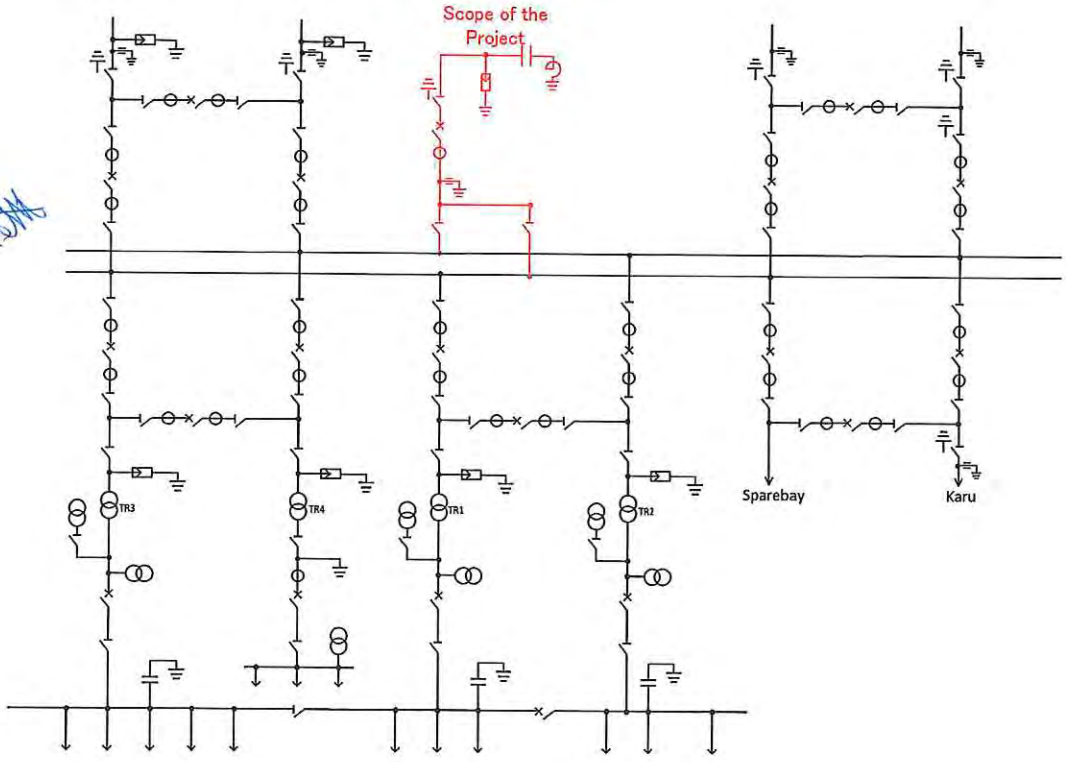
Table 3-1 Tentative Implementation Schedule



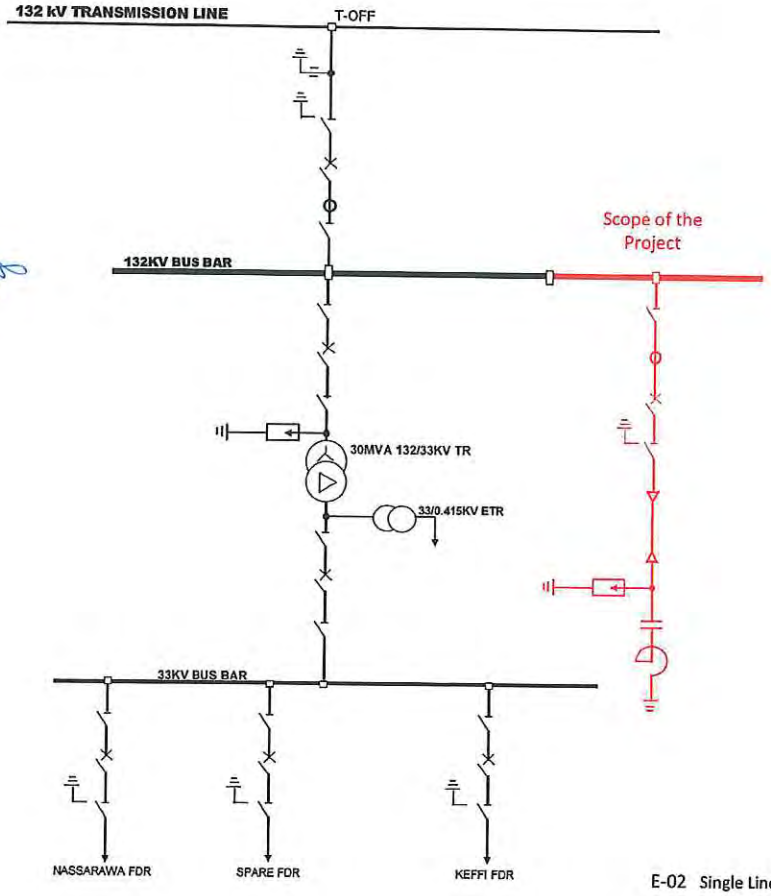
G-01 Location of the Proposed Substations for the Project



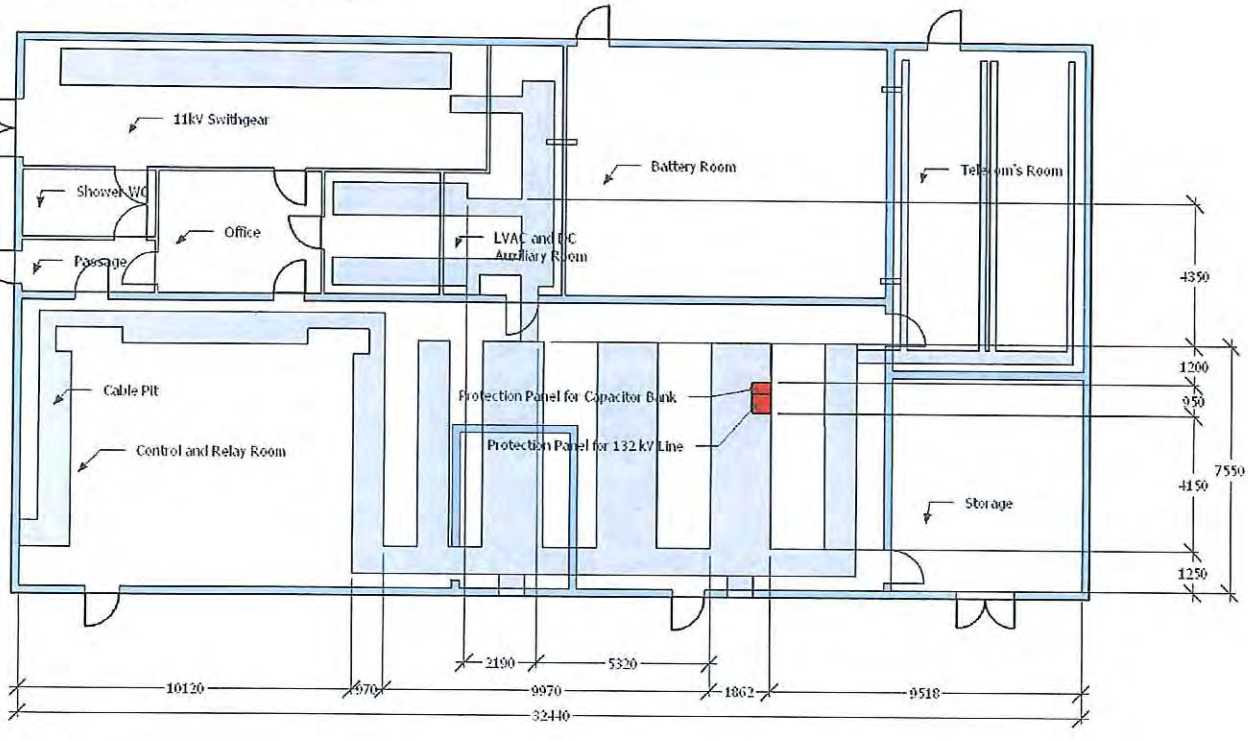
L-01 Layout Plan for Apo 132kV Switchyard (Apo Substation)



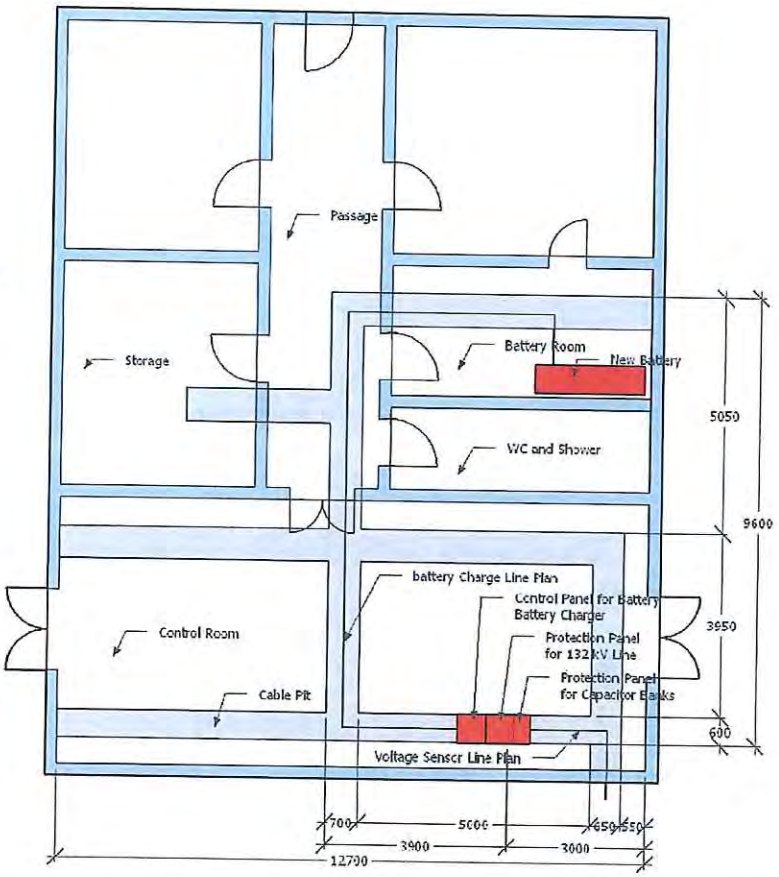
E-01 Single Line Diagram of Apo 132/33kV Substation



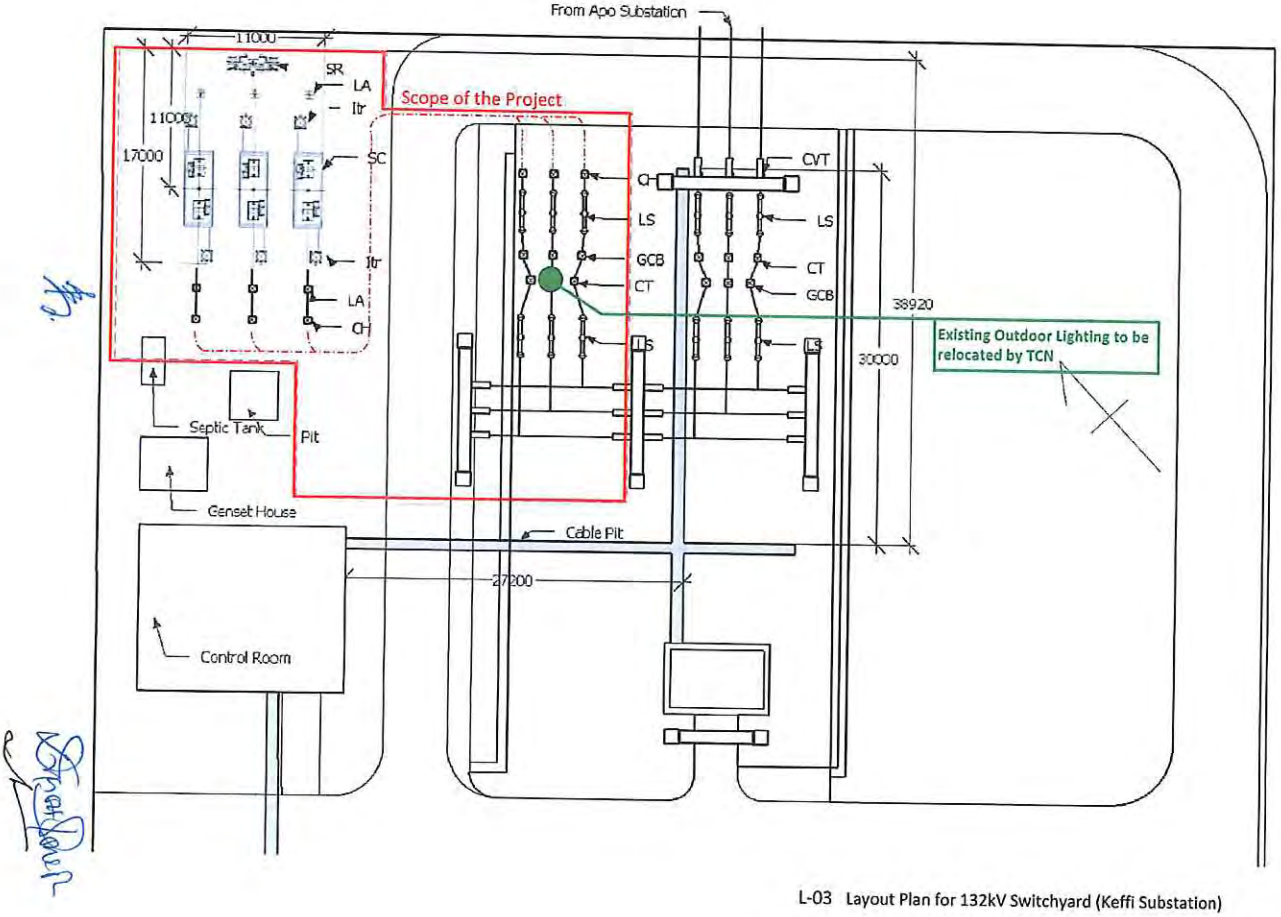
E-02 Single Line Diagram of Keffi 132/33kV Substation



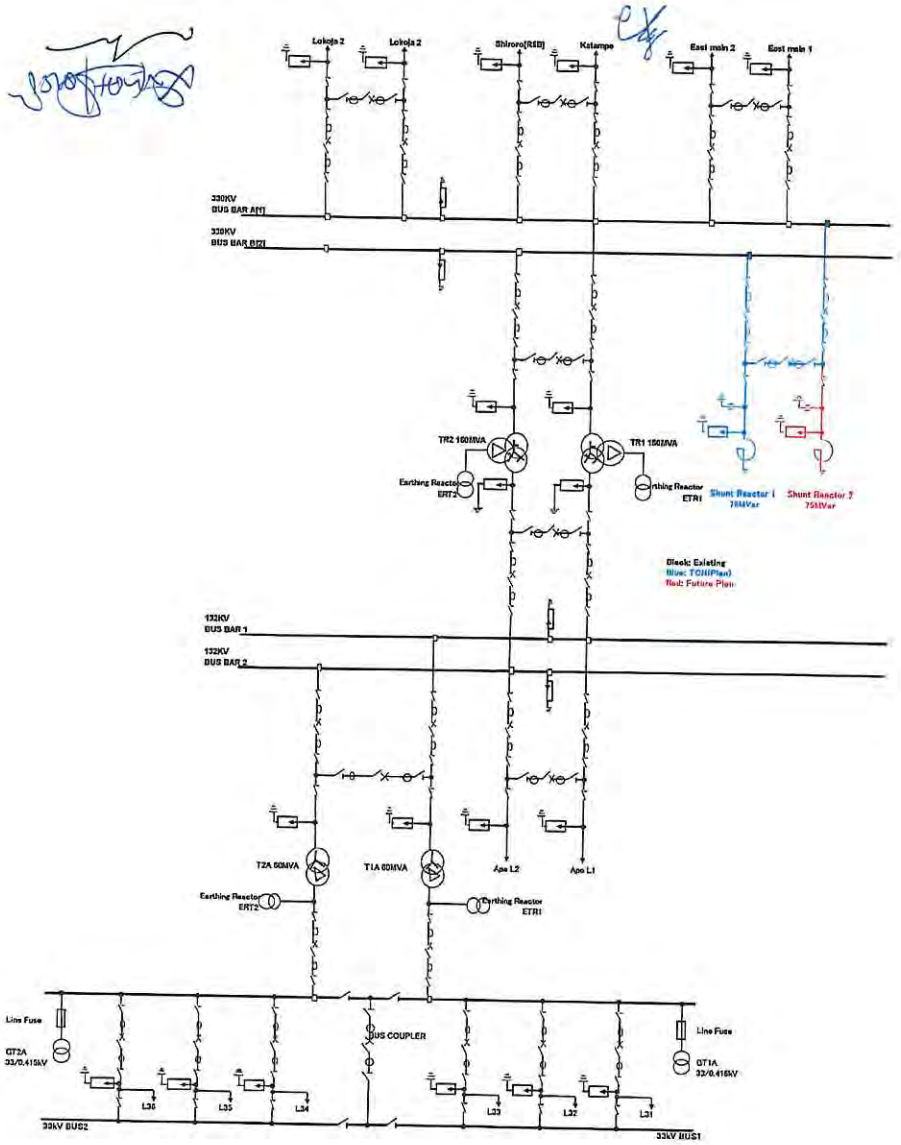
L-02 Layout Plan for Control Room (Apo Substation)



L-04 Layout Plan for Control Room (Keffi Substation)



L-03 Layout Plan for 132kV Switchyard (Keffi Substation)



E-03 Single Line Diagram of Gwagwalada 330/132/33kV Substation (For Reference)