PREPARATORY SURVEY
ON
THE PROJECT FOR REINFORCEMENT OF POWER SUPPLY
TO ACCRA CENTRAL
IN
THE REPUBLIC OF GHANA

FIELD REPORT

11th FEBUARY 2014

Prepared and Submitted by:

Mr. Kazunari Nogami
Chief Consultant
Preparatory Survey Team, JICA

Confirmed and Agreed by:

Ing. William Amuna
Chief Executive
Ghana Grid Company Limited
Implementing Agency for the Project

Confirmed and Agreed by:

Ing. William Hutton-Mensah
Managing Director
Electricity Company of Ghana Limited
Relevant Organazation for the Project

JICA PREPARATORY SURVEY TEAM

Yachiyo Engineering Co.,Ltd.
West Japan Engineering Consultants, Inc.

Contents

1. Outline of the Project

1.1 Background of the Project

In response to the request from the Government of the Republic of Ghana (Ghana), the Japan International Cooperation Agency (JICA), in consultation with the Government of Japan, decided to conduct a Preparatory Survey (the Survey) on the Project for Reinforcement of Power Supply to Accra Central (the Project).

JICA sent to Ghana the Preparatory Survey Team (the Team) headed by Mr. Fuyuki Sagara, Advisor, Energy and Mining Division 1, Industrial Development and Public Policy Department, JICA, to conduct the first field survey and the Team is scheduled to stay in the country from 12th January to 17th February, 2014.

The Team continued discussions with the concerned officials of Ghana and the field survey in Ghana in consideration of mutual understandings made on the minuets of discussions signed between the Ministry of Energy and Petroleum (MoEP), Ministry of Finance (MoF), Ghana Grid Company Limited (GRIDCo), Electricity Company of Ghana (ECG) on 23rd January, 2014.

GRIDCo, ECG 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. GRIDCo, ECG and the Team agreed to record the following issues described on this Field Report as a conclusion of the discussions.

Components of the Project 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 Ghana 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 immediately after the first field survey. GRIDCo and ECG expressed understanding about the schedule and procedures of Japan's Grant Aid projects. GRIDCo and ECG agreed for 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 immediately 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 Ministry of Energy and Petroleum (MoEP).
(2) The implementing agency is Ghana Grid Company Limited (GRIDCo).
(3) The relevant organization is Electricity Company of Ghana Limited (ECG).

1.3 The Scope of the Japanese side on Minutes of Discussions on 23rd January, 2014

The Scope of the Japanese side on Minutes of Discussions on 23rd January, 2014 is shown in Table 1.3-1 and Figure 1.3-1.

Three (3) sets of 161/34.5 kV transformers (125 MVA, Outdoor type) shall be installed as the scope of the Japanese side. The fourth units of a transformer and the GISs for the transformer will be procured and installed by the Ghana side in the future.

Table 1.3-1 Outline of the Final Components

Components		Capacity
Procurement and Installation Work		
1. Accra Central BSP		
(1) 161 / 34.5 kV Transformers (ODAF, Outdoor, Metal Enclosure Type)		125 MVA × 3units
(2) 161 kV Gas Insulated Switchgears (GIS)		
1) Incoming Feeders	(Outdoor Type)	2 sets
2) Transformers Feeders	(Outdoor Type)	3 sets
3) Bus Coupler	(Outdoor Type)	1 set
4) Bus System (Double Bus Type)	(Outdoor Type)	1 set
5) Voltage Transformers	(Outdoor Type)	2 set
(3) 33 kV GISs (Double Bus Type)		
1) 125 MVA Transformer bays	(Indoor Type)	3 sets
2) 33/11 kV Transformer bays	(Indoor Type)	3 sets
3) 33 kV Feeder bays	(Indoor Type)	14 sets
4) Bus Coupler bay	(Indoor Type)	2 sets
5) Bus Section bays	(Indoor Type)	1 set
6) Station Transformer bays	(Indoor Type)	3 sets
7) Earthing Transformer bays	(Indoor Type)	2 sets
(4) SCADA Interface Panel		1 set
2. 161kV Transmission Line from the Avenor Branch Point to Accra Central BSP (1 Circuit for Achimota Line and 1 circuit for Mallam Line)		
(1) 161 kV Overhead Line (ACSR, TERN, twin bundle or equivalent)		Approx. 3 km
(2) 161 kV Underground Cable (XLPE Cable, Copper, 1,600 mm^2)		Approx. 0.4 km
Procurement Work		
3. Underground cable for 33 kV Sub transmission Line between Station D and Station E for the decommissioning part (XLPE, Al, 630 mm^2, 3 cores or equivalent)		Approx. 6 km × 2 Circuits
4. Maintenance Tools for the Equipment of the Project		1 lot
5. Spare Parts for the Equipment of the Project		1 lot
Construction Work		
6. Foundation for the Equipment of the Project (Gas Insulated Switchgears, Transformers, Towers for 161 kV Transmission Line)		1 lot
7. Building for a control room of Accra Central BSP		1 building

[Remark] Quantities shall be examined in the outline design.

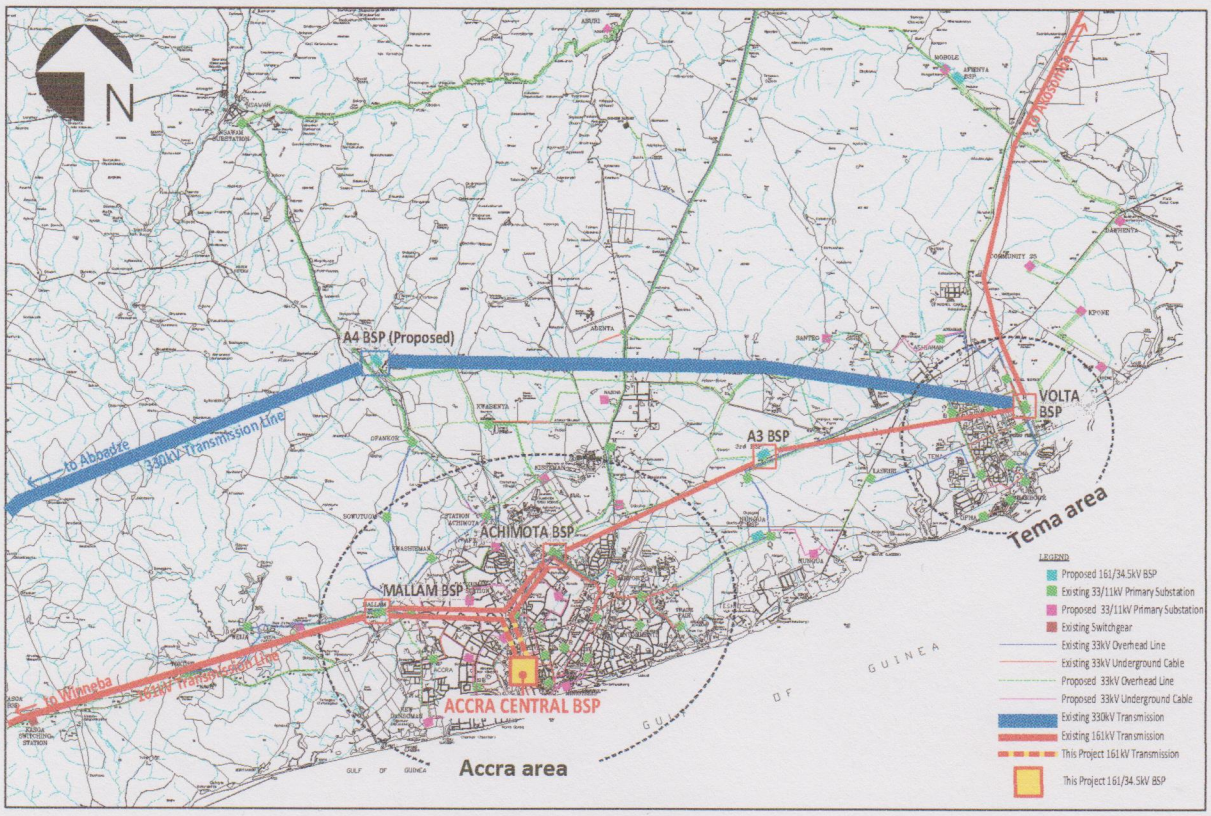


Figure 1.3-1 Location of the Requested Components

1.4 Obligations/Undertakings of the Ghana side for the Project

(1) Preconditions

- GRIDCo shall obtain an Environmental Permit (EP) from the Environmental Protection Agency (EPA) by July, 2014 after implementation of Environmental and Social Impact Assessment (ESIA) and submitting Environmental Impact Statement (EIS) in timely manner.
- GRIDCo (ECG) shall secure the land for the Project on entire 161 kV transmission line route, and show the evidences, especially for the 15 meters ROW that ECG owns on the existing 33 kV line between Avenor branch point and Graphic Road Primary Substation.
- GRIDCo (ECG) shall secure the land for the installation of 33 kV sub-transmission underground cables procured by the Japanese side between Avenor Primary Substation and Graphic Road Primary Substation with using utility space which can minimize any adverse impacts on the occupants and structures on the route, and show the evidences.

(2) Necessary Inputs by the Ghana side

1) Prior to the Commencement of the Construction Work

- GRIDCo (ECG) shall decommission and remove the existing equipment, facilities, materials and so on (cable culvert, Ring Main Unit, capacitor banks, 33 kV terminal poles, and so on) at Graphic Road Primary Substation which obstruct the installation of the

equipment and materials of the Project before commencement of installation work by the Japanese side.

- GRIDCo (ECG) shall decommission and remove the existing towers of 33 kV sub-transmission line between Avenor Primary Substation and Graphic Road Primary Substaion, including their foundations, along the route for 161 kV transmission line of the Project before commencement of the installation work covered by the Japanese side.
- GRIDCo (ECG) shall obtain permission from related authorities for 161 kV transmission lines and 33 kV sub-transmission lines to go across the roads and a railway before commencement of installation work by the Japanese side.
- GRIDCo (ECG) shall procure and supply to the Japanese side total 6 units (3 units for GRIDCo and 3 units for ECG) of energy meters for transaction.
- GRIDCo (ECG) shall resettle occupants in accordance with the resettlement plan prepared at the stage of the survey in smooth manner, if necessary.

2) During the Construction Work

- GRIDCo shall complete upgrading work of 161 kV transmission lines between Achimota BSP and Mallam BSP, which have enough capacity to supply power to Accra Central BSP of the Project, before commencement of installation work of 161 kV transmission lines of the Project by the Japanese side. In addition, GRIDCO shall procure and install a termination pole (Pole Number "N0") for connection with the 161 kV transmission lines provided by the Japanese side. (See DWG No.-T01)
- GRIDCo (ECG) shall schedule power outages required for installation work of the Project and carry out them in timely manner. GRIDCo (ECG) shall also manage any issue concerning the power outages, including related procedures, and compensation to and grievances from customers.
- After arrangement of temporary work by himself, GRIDCo (ECG) shall implement the scheduled power outages and, decommission and remove 6 units in total 14 units of the existing 33 kV switchgears from the western side prior to installation of 15 units in total 28 units of 33 kV switchgears of the Project by the Japanese side at Graphic Road Primary Substation. (See Figure 2.1.1-2)

  GRIDCo (ECG) shall keep the above mentioned temporary conditions until completion of installation of these 33 kV switchgears of the Project by the Japanese side.

  In the same manner, GRIDCo (ECG) shall implement the scheduled power outage and shall decommission and remove remaining 8 units of the existing 33 kV switchgears prior to installation of remaining 13 units of 33 kV switchgears of the Project by the Japanese side.

GRIDCo (ECG) shall also prepare new floor openings for the new 33 kV switchgears. The more detail arrangement shall be discussed between the related parties at the implementation stage.

- GRIDCo (ECG) shall secure a temporary storage yard (Approx. 5,000 m2) for the Project within the lot of ECG Project Office. The Ghana side shall also prepare an access point at ECG Project Office, where construction vehicles go through to the route of 161 kV transmission line of the Project along the railway for their installation.
- GRIDCo (ECG) shall obtain permit for the Japanese side to enter the business establishments where the 161 kV towers of the Project will be located and to carry out installation work of the Project.
- GRIDCo (ECG) shall install 33 kV underground cables to be procured by the Japanese side for the section between Avenor Primary Station and Graphic Road Primary Substation, immediately after the cables are delivered to the Project site.
- GRIDCo (ECG) shall monitor impact to the neighboring people around construction sites of the Project and improve the construction activities, if necessary.

3) After the Commencement of Operation

- With applying the materials for the final connection work procured by the Japanese side, GRIDCo shall carry out the final connection work between the termination pole (Pole Number "N0") procured and installed by GRIDCo in the upgrading work of 161 kV transmission lines between Achimota BSP and Mallam BSP, and the termination pole done by the Japanese side. (See DWG No. T-01)
- GRIDCo (ECG) shall carry out the final connection work between the SCADA interface panel procured and installed by the Japanese side and the existing SCADA network at Accra Central BSP with providing equipment and material by himself. (See Figure 2.1.1-3) Japanese engineers shall be present at the time of commissioning of the SCADA system.
- GRIDCo shall carry out the final connection work of optical fiber cables at the terminal box procured and installed by the Japanese side beside the termination pole (Pole Number "N1") procured and installed by the Japanese with providing equipment and material by himself. (See DWG No. T-01)
- GRIDCo (ECG) shall recover or modify the existing fences and gates at Graphic Road Primary Substation in accordance with the layout and arrangement of the equipment and facilities of the Project.
- GRIDCo (ECG) shall provide the setting list of the protection relays to the Japanese side.

2. Technical requirements confirmed in the first field survey

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

(1) Applicable Codes and Standards

The equipment of Accra Central BSP and Graphic Road Primary Substation shall be designed in accordance with IEC, JEC standards and/or equivalent.

(2) Basic Concept for the Substations

The following basic concept is applied for Accra Central BSP Substation.

1) Noise

The Ghana side explains to the Team that Area around Graphic Road Primary Substation is classified as "Light industrial area" and its noise emission shall be in consistency with the following table.

Table 2.1.1.-1 Noise limitation of light industrial area;

Time	Noise Level
Daytime (06:00 – 22:00)	Less than 65 dB
Nighttime (22:00 – 06:00)	Less than 60 dB

[Note] According to NEMA guideline for reference, the standard noise of this capacity size of transformer is around 85 dB

In order to maintain the severe noise limitation around the substation, the Team proposed introduction of "Steel Enclosure Type" of transformers. GRIDCo agreed to introduce the type to be in consistency with the above mentioned criteria. This steal enclosure equips with a function of firewalls. The Steel Enclosure Rough Dimension is shown as Figure 2.1.1-1.

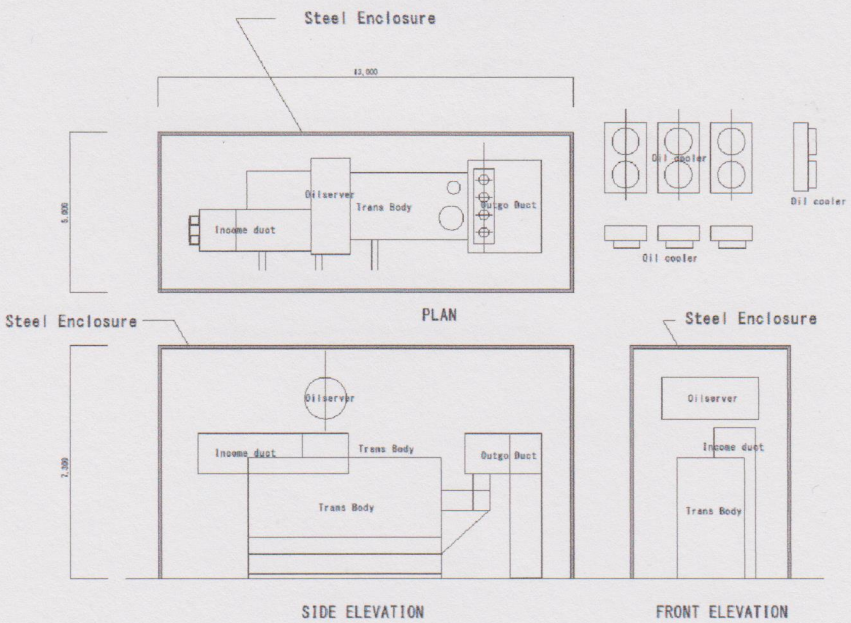


Figure 2.1.1-1: Steel Enclosure Rough Dimension

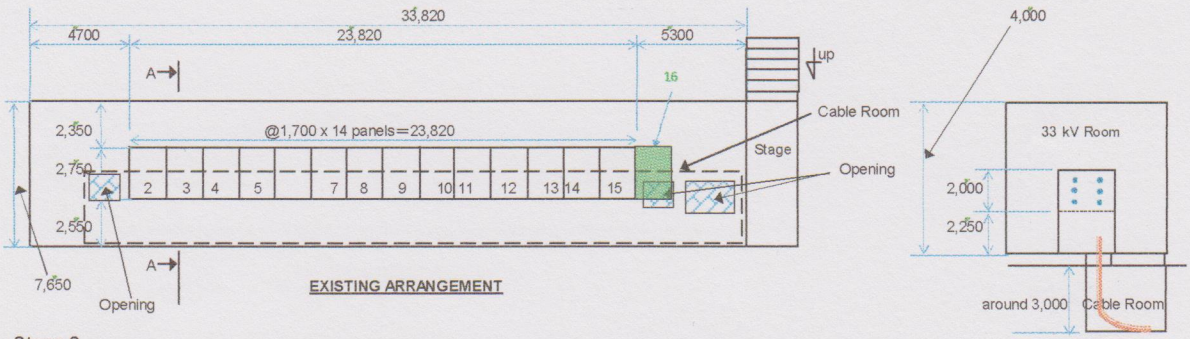
Due to the "Steel Enclosure", air insulated bushing connections cannot be applied. The connection of the transformers shall be made by "Elephant" type connection (cable box type connection).

2) Replacement work for 33 kV switchgears at Graphic Road Primary Substations

33 kV GISs shall be installed at existing 33 kV Switchgear room of Graphic Road Primary Substations. The replacement of the switchgear should be carried out in consideration of minimizing duration of scheduled power outage. Detailed procedure of the replacement of the 33 kV switchgears is shown in the following figure.

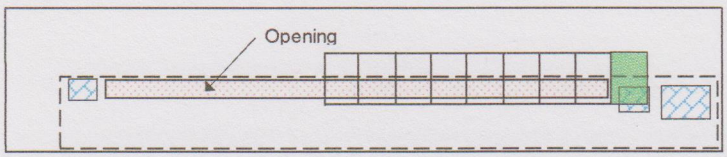
The steel structures under the new switchgears might be installed to raise the switchgear to the level of approx. 1.0 m from the floor level and to secure space for smooth cable connection without cutting the existing beams of the building. The detail design shall be carried out at the implementation stage.

In addition, GRIDCo (ECG) and the Team agreed that the cable to Earthing transformers should be through one of the windows near the Earthing transformer of the existing building. See DWG. No. E-02.



Stage 0
ECG installs "Additional panel (called No.16)" for temporary power supply, before commencement of JICA Project.
ECG requires the three (3) month prior notice before the commencement of JICA Project.

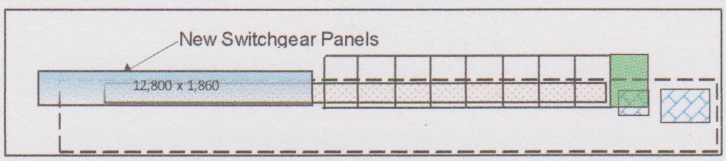
Stage 1
Panel No. 2 to 7 should be removed by ECG. Continuous power supply for removed panels should be done by ECG, using temporary power supply panel, and/or temporary bypass circuit by the other substations.
Additional floor openings are made by ECG, in accordance with information by Japanese side.



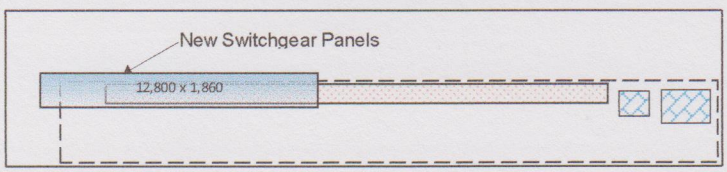
Existing Panel Name

No.	NAME
2	OKASHIE-2
3	OKASHIE-1
4	AVENOR-II
5	(Not in use)
6	(None)
7	Measuring
8	Bus Coupler
9	TR. T31
10	ADABRAKA
11	CATHADRAL
12	TR. T32
13	KOTOBABI
14	AVENOR-II
15	LARTEBIOKOSHIE

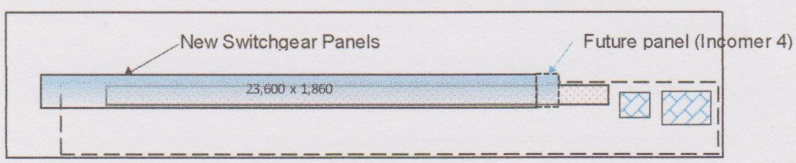
Stage 2
15 panels of New 33 kV Switchgear should be installed by Japanese side, and energized after the installation.
The channel base of the new switchgear might be raised from the floor level, due to the location of the existing floor openings.



Stage 3
Remaining existing Panel No. 8 to 16 should be removed by ECG. Temporary power supply for removed panels are conducted by ECG, as same as Stage 1 above.
Additional floor openings are made by ECG, in accordance with information by Japanese side.



Stage 4
Remaining new switchgears should be installed by Japanese side, then completed.



Note;
1) Since the above work may continue for several months, ECG is required to supply power to his customers during the works.
2) The size of the new 33 kV Switchgear panels may change depending on different manufacturers.
3) The detailed schedule such as duration of the works should be discussed at the stage of the implementation.

[Note] The panel arrangement of 33 kV Switchgear may change due to locations of the floor openings.

Figure 2.1.1-2 Replacement work for 33 kV switchgears

3) Interface of SCADA system

Interface panels (terminal boards) for SCADA system are installed in the new control building for the GRIDCo's system and in the existing control room for the ECG's system.

The connection works at the interface panels should be done by GRIDCo and ECG, respectively. Detailed work demarcation is shown in the following figure.

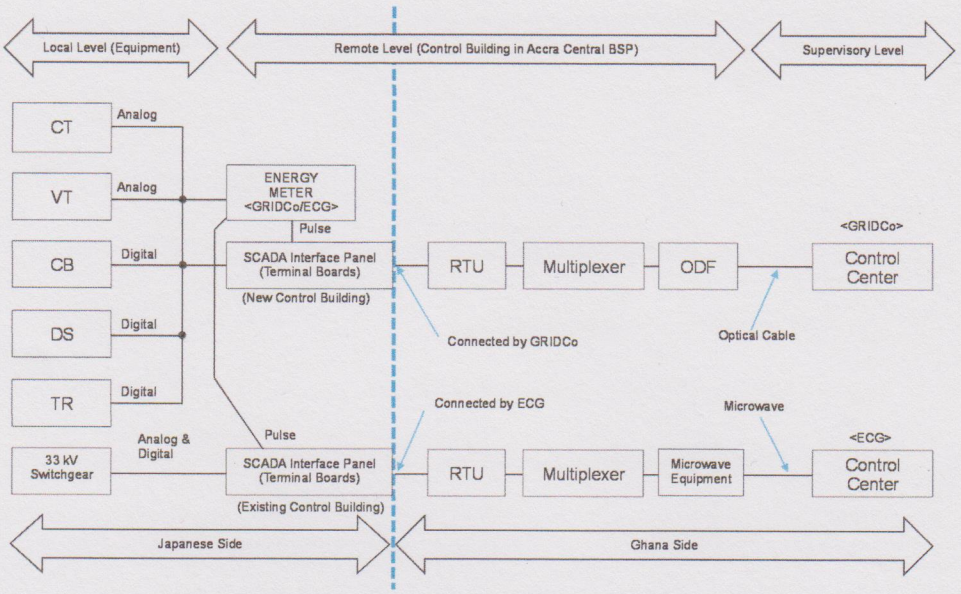


Fig. 2.1.1-3 Interface of SCADA system

(3) Requirements for the equipment of the substations

The specifications of the Equipment procured by the Japanese side are shown in Table 2.1.1-2 and Table 2.1.1-3. Single Line Diagram for the equipment is shown in DWG No. E-01.

Table 2.1.1-2 Equipment to be supplied for Accra Central BSP Substation by the Japanese side

No.	Description	Specifications	Q'ty
AC1	161/34.5 kV Transformer		3 sets
	➢ Capacity	125 MVA	
	➢ Primary voltage	161 kV	
	➢ Voltage regulating range	161 kV +/- 10%	
	➢ Steps (taps)	+/- 8 steps (17 taps)	
	➢ Secondary voltage	34.5 kV	
	➢ Cooling	ODAF	
	➢ Vector group	YNd11	
	➢ % impedance	13%	
	➢ Rated basic impulse withstand voltage	161 kV: 650 kV (Bushings: 750 kV) 34.5 kV: 170 kV	
	➢ Rated power frequency withstand voltage (1 min.)	161 kV: 325 kV 34.5 kV: 70 kV	
	➢ Bushing CT	161 kV line: 3 CTs 161 kV neutral: 1CT 34.5 kV line: 3 CTs	
	➢ Neutral earthing	161 kV : Solidly earthing system 34.5 kV: earthing transformers	
	➢ Connection	161 kV side: Cable connection (1 x 400 mm^2/phase) 34.5 kV side: Cable connection (2 x 800 mm^2/phase)	
	➢ Noise	Special consideration is made on the transformers in order to maintain the noise limitation around the substation.	
	➢ Others	- Fire walls between transformers are not necessary since the transformer is enclosed by "Steel	

No.	Description	Specifications	Q'ty
		Enclosure" and there is no exposed conductors on Transformers. - Future space for No.4 Transformer is considered.	
AC2	161 kV SF_6 Gas Insulated Switchgears		1 lot
	➢ Standards	IEC, JEC or equivalent	
	➢ Busbar configuration	Double Busbar system	
	➢ Quantity	Feeder bays : 2 bays Transformer bays : 3 bays Bus Coupler bay : 1 bay VT bay : 1 bay	
	➢ Rated voltage	170 kV	
	➢ Rated current	Busbar: more than 3,150 A Bus coupler: more than 3,150 A Feeder: more than 2,000 A Transformer: more than 800 A	
	➢ Rated interrupting current	31.5 kA	
	➢ Rated short-time withstand current (short time)	31.5 kA (3 sec.)	
	➢ Rated basic impulse withstand voltage	750 kV	
	➢ Rated power frequency withstand voltage (1 min.)	325 kV	
	➢ Circuit Breaker		
	- Auto-reclosing	Yes	
	- Operating sequence	O-0.3 sec.-CO-3 min.-CO (Three phase)	
	➢ Current Transformer		
	- Feeder bays	4 CTs	
	- Transformer bays	None	
	- Coupler bay	2 CTs	
	- Secondary current	1 A or 5 A, both can be accepted.	
	➢ Voltage Transformer	161/√3 kV/115/√3 V	
	➢ Others		
	-Future bays for 161 kV feeders	- Future space for 1 x spare feeder bay and 1 x spare transformer feeder bay is considered.	
	-Lightning Arresters (LA) for Transformer bays	- LAs are supplied for Transformer bays.	
AC3	161 kV XLPE Cable		*200 m
	➢ Circuit	Primary circuit of 125 MVA Transformer	
	➢ Type	XLPE	
	➢ No. of core	Single core	
	➢ Cross section	*400 mm^2 [*Note] Size and length is subject to change.	
AC4 -1	Control and Protection Control and Protection Panel		1 lot
	➢ Type of Control and Protection panel	Duplex type panel	
	➢ Panel arrangement	Front of panel: 161 kV Switchgear Control and 125 MVA Transformer voltage regulating control with mimic bus, control switches, meters, alarms and other control devices Rear of panel: 161 kV Protection relays	
	➢ Standard Protection system (recommended)		
	- 161 kV Transmission line protection	Main: Directional Phase Comparison Relay Back-up: Distance Relay (Over reach/Under reach) Intertripping scheme should be applied.	
	- 161/34.5 kV Transformer protection	Transformer Differential Relay/Overcurrent Relay	
	- 161 kV Busbar protection	Current Differential Relay	
	- Other 161 kV protection system	Breaker Failure Protection shall be applied.	

No.	Description	Specifications	Q'ty
-2	Energy Meter Panel	A panel with three (3) sets of Energy meters (one (1) set for future space) is provided at Control Room (2) in the new Control building. See DWG. No. E-01.	1 panel
-3	Interface Panel for SCADA System of GRIDCo	Interface terminals for Digital I/O, Analogue I/O and Pulse signals are provided for RTU of SCADA system in the Control building.	1 panel
AC5	Others		
-1	DC Power Supply System		1 lot
	➢ DC Voltage	125 V DC	
	➢ Battery Capacity	To be advised later.	
-2	AC Power Supply System		1 lot
	➢ AC Voltage	415/240 V AC (Three phases and four wires)	
	➢ Station Service Transformer	Capacity: 200 kVA (Tentative) (2 sets) Final capacity will be informed later. AC distribution panel (1 panel) is included.	
-3	Substation Earthing	Earthing conductors, terminals, lightning rods and other necessary materials are provided.	1 lot

Table 2.1.1-3 Equipment to be supplied for Graphic Road Primary Substation by the Japanese side

No.	Description	Specifications	Q'ty
GR1	34.5 kV Switchgears		28 panels
	➢ Standards	IEC	
	➢ Quantity	Following bays are provided. Control, metering and protection relays are mounted on the respective Switchgear. - 3 x 125 MVA Transformer bays - 3 x 33/11 kV Transformer bays - 14 x 33 kV Feeder bays - 2 x Bus Coupler bay - 1 x Bus Section bays - 3 x Station Transformer bays - 2 x Earthing Transformer bays Future space for 1 x 125 MVA Transformer bay is considered.	
	➢ Rated voltage	36 kV	
	➢ Rated current	Busbar: 2,500 A Bus coupler: 2,500 A Bus Section: 2,500 A Feeder: 1,250 A 161/34.5 kV Transformer: 2,500 A 33/11 kV Transformer: 630 A	
	➢ Rated interrupting current	40 kA	
	➢ Rated short-time withstand current (short time)	40 kA (3 sec.)	
	➢ Rated basic impulse withstand voltage	170 kV	
	➢ Rated power frequency withstand voltage (1 min.)	70 kV	
	➢ Circuit Breaker		
	- Auto-reclosing	Yes	
	- Operating sequence	O-0.3 sec.-CO-3 min.-CO (Three phase)	
	➢ Current Transformer		
	- Secondary current	5 A	
	➢ Voltage Transformer	33/√3 kV/110/√3 V	
	➢ Protection relays	Numerical relays should be applied.	
	➢ Standard Protection system (scheme)		
	- 33 kV Incomer (161/34.5 kV Transformer) protection	67/50/51, 67/50/51N	

No.	Description	Specifications	Q'ty
	- 33 kV Feeder Protection	67/50/51, 67/50/51N, 21, 27DC, 79	
	- 33 kV Bus Coupler Protection	50/51, 50/51N, 86, 95	
	- 33 kV Bus Section Protection	50/51, 50/51N	
	- 33/11 kV Transformer Protection	50/51, 50/51N, 87	
GR2	33 kV XLPE Cable		
-1	Secondary circuits of 125 MVA Trans- former		*600 m
	➢ Type	XLPE	
	➢ No. of core	Single core	
	➢ Cross section	*800 mm^2, copper	
	➢ No. per phase	3 cables per phase	
-2	Station Service Transformer		*400 m
	➢ Type	XLPE	
	➢ No. of core	Three core	
	➢ Cross section	*240 mm^2 copper	
-3	Earthing Transformer		*300 m
	➢ Type	XLPE	
	➢ No. of core	Single core	
	➢ Cross section	500 mm^2 copper	
	➢ No. per phase	1 cable per phase	
		[Note] - *Size and length is subject to change. - ECG agreed that the cable route of Earthing transformers is through one of the windows near the Earthing transformer of the existing building. See DWG. No. E-02.	
GR3	Control		
-1	Energy Meter Panel	A panel with three (3) sets of Energy meters (one (1) set for future space) is provided in existing building. See DWG. No. E-01 and E-02.	1 panel
-2	Interface Panel for SCADA System of ECG	Interface panel is provided for SCADA system at the next to existing SCADA panels in existing building.	1 panel
GR4	Others		
-1	DC Supply System	110 V DC Batteries and charger is provided at existing Battery room.	1 lot
	➢ DC Voltage	110 V DC	
	➢ Battery Capacity	500 Ah (Tentative)	
-2	Earthing Transformer		2 sets
	➢ Voltage	33 kV	
	➢ Capacity	19.4 Ω 1060 A per phase	

2.1.2 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 2.1.2-1 Basic Conditions for the Facility Design of the Project

Items		Values
Altitude		Less than 10 m
Ambient Temperature	Maximum	40 Degrees Centigrade
	Minimum	17 Degrees Centigrade
	Mean	31 Degrees Centigrade
Maximum Wind Velocity		34 m/s
Annual Rain Fall		806.8 mm/year
Seismic Force		Horizontal 0.1G
Soil Bearing Capacity		5 t/m^2

(2) Requirements for the Substation Facilities

1) Outline of Control Building

The Outline of Control Building is shown in Table 2.1.2-2.

Table 2.1.2-2 Outline of the Control Building

Items	Contents	Details
Structure	Reinforced Concrete Frame Structure	-
Height of story	4 stories	BF: Cable Maintenance Pit GF: Control Room (1), Control Office (1), Entrance, Toilet 1F: Control Room (2), Battery Room, Shower 2F: Control Room (3), Control Office (2), Toilet RF: 2 units of 200 kVA transformer, Air-conditioning Units with Sound Proofing Wall
Total Floor Area	Approx. 440 m^2	-
Building Area	Approx. 100 m^2	-
Exterior	Wall Finishing	Concrete with Urethane Paint
	Roof Finishing	Concrete Plate t=100 wire-mesh @200 Urethane joint @2000 each Insulation t=100 Asphalt Membrane 3 Layer Water Proofing
Interior	Wall Finishing	Paint on Mortar iron trowel
	Floor Finishing	Free Access Floor h=300mm Ceramic Tile 450*450, 300*300
	Ceiling	System Ceiling with Gypsum Board t=12mm Paint Finishing

2) Foundations of 161/34.5 kV transformers

The Outline of the Foundations of 161/34.5 kV transformers is shown in Table 2.1.2-3.

Table 2.1.2-3 Outline of the Foundations of 161/34.5 kV transformers

Items	Contents	Details
Structure	Reinforced Concrete Wall Structure	-
Height of story	1 story	BF: Cable Culvert (2), (3), Mechanical Pit, Oil Pit 1F: 3 units of 125 MVA transformer (Steel Enclosure) and one Future Space, Oil Cooler Rack for them and future expansion [Note] For the equipment to avoid submerging to water on heavy rainy days, the floor level of the foundations shall be 1.5 m- raised from the ground level.
Total Floor Area	Approx. 370 m^2	-
Building Area	Approx. 430 m^2	-

3) Foundations of GISs

The Outline of the Foundations of GISs is shown in Table 2.1.2-4.

Table 2.1.2-4 Outline of the Foundations of GISs

Items	Contents	Details
Structure	Reinforced Concrete Wall Structure	-
Height of story	1 story	BF: Cable Pit for 161 kV cable (6) and Future Space for (3) cable 1F: GIS and Future Space [Note] For the equipment to avoid submerging to water on heavy rainy days, the floor level of the foundations shall be 1.5 m- raised from the ground level.
Total Floor Area	Approx. 140 m^2	-
Building Area	Approx. 180 m^2	-

4) Cable Culvert

The Outline of the Cable Culvert is shown in Table 2.1.2-5.

Table 2.1.2-5 Outline of the Foundations of GISs

Items	Contents
Cable Culvert (1) from GISs to 125 MVA transformers	Reinforced Concrete Box Culvert Approx. 30 m^2 (W=2.2 m, H=1.4 m with Cable Rack)
Cable Culvert (4): from 125 MVA transformers to Existing ECG Building	Reinforced Concrete Box Culvert Approx. 70 m^2 (W=1.7 m, H=3.0 m with Cable Rack)
Cable Culvert (5): from Gate A to Existing ECG Building	Reinforced Concrete Box Culvert Approx. 35 m^2 (W=1.7 m, H=3.0 m with Cable Rack)

The size of each Cable Culvert is as follows. Cable Culvert (2) is for smooth cable installation to each transformer. Cable Culvert (3) is for smooth cabling from each transformer.

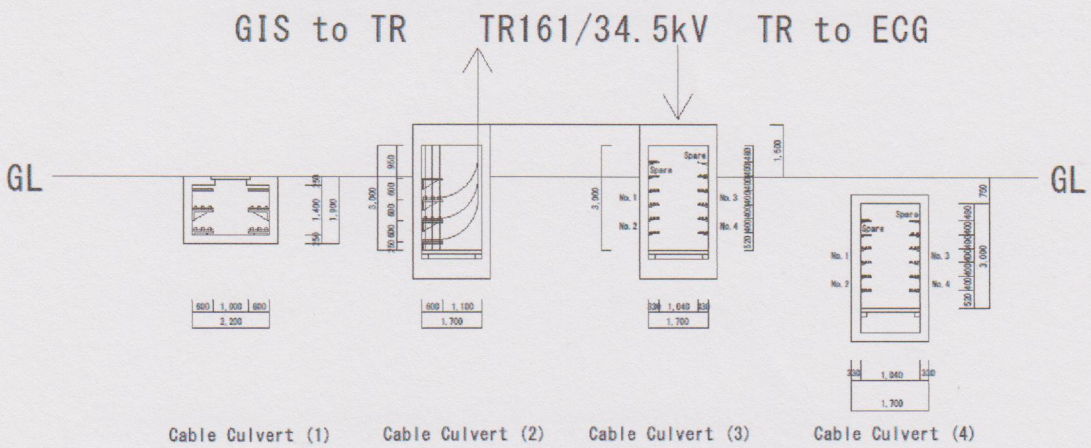


Figure 2.1.1-4 Cable Culvert required Dimension

2.2 Basic Concept for 161 kV Transmission Line and 33 kV Sub-Transmission Line

161 kV transmission line between Avenor Branch Point and Accra Central BSP shall be installed as shown in DWG. No. T-01. Requirements for the transmission lines shall be as follows.

The underground cables for 161 kV transmission lines shall be protected in conduit pipe at the parts across roads and a rail way. The laying depth shall be 1.3 m from the ground level.

(1) Design Conditions for 161 kV Transmission Line

Natural Conditions and Electrical Conditions are shown in Table 2.2-1 and Table 2.2-2, respectively.

Table 2.2-1 Natural Conditions

Items	Design Values
Altitude	Less than 50 m
Conductor temperature	-
Minimum temperature	10 degree C
Everyday temperature	28 degree C
Maximum temperature	80 degree C
Wind speed	31.1 m/s
Seismic force	Not considered
Soil bearing capacity	5 ton/m^2 (depend on boring survey)

Table 2.2-2 Electrical Conditions

Items	Design Values
Minimum clearance of conductor	-
Phase to ground	1,500 mm
Phase to phase	3,000 mm
Height of conductor (See Note 1)	-
General area (m)	7.5 m
Waterway (m)	7.5 m
Road crossing (m)	8.5 m
Shield angle (OPGW and conductor)	15 degree
Minimum creepage distance of insulator (See Note 2)	25 mm/kV
Equivalent salt deposit density	0.25 mg/cm^2

[Notes]

1. The minimum clearance of conductor shall be designed at conductor temperature of 65 degree C.
2. The minimum creepage distance shall be designed "Pollution Level III Heavy" in the following table.

(2) Requirements for 161 kV Transmission Line

Specifications for 161 kV Transmission Line are shown in Table 2.2-3.

Table 2.2-3 Specifications for 161 kV Transmission Line

No.	Items	Specifications		Q'ty
TL1	➢ Tower	Style of tower:	Steel lattice type	
		Configuration of tower:	Narrow base type See DWG. No. T-02	
		Type of tower:	Suspension type (Angle: 0-2 degree), Tension type (Angle: 0-20 degree), Termination tower (Angle: 0-20 degree)	7 towers 10 towers 1 tower

No.	Items	Specifications	Q'ty
		Safety factor: 1.1 for suspension towers 1.2 for tension towers Grounding resistance: less than 10 ohms. [Note] Broken wire condition shall be two ACSR conductors or one conductor and one shield wire.	
TL2	➢ Overhead Line (Conductor)	Type: ACSR Size TERN (Aluminum: 402.8 mm2, total: 430 mm2)	38.0 km
TL3	➢ Insulator	Standards: IEC60383-1 or equivalent Size: 254 mm suspension insulators Creepage distance: 320 mm Material: Porcelain Color: Brown Ball and socket coupling: 16mm Dry lightning impulse withstand voltage: one unit 110 kV Wet power-frequency withstand voltage: one unit 40 kV Electro-mechanical falling load: 120 kN Number of insulators shall be 17 units/phase	1 lot
TL4	➢ Shield Wire and Optical Cable	Type: OPGW Number of Core: 48 cores Type of optical fiber cable: Type G655 or equivalent The shielding angle: less than 15 degree.	6.8 km 1.4 km
TL5	➢ 161 kV Underground Cable	Type: XLPE Size: 1,600 mm^2 Conductor: Copper Number of core: Single Core Type of sheath: PVC with anti-termite protection Color of sheath: Black Armor: Aluminum armor for direct buried in the ground	3.8 km

(3) Basic Concept for 33 kV Sub-Transmission Line

Specifications for 33 kV transmission Line are shown in Table 2.2-4.

Table 2.2-4 Specifications for 33 kV Underground Cables

No.	Items	Specifications	Q'ty
DL1	➢ 33 kV Underground Cable	Type: XLPE Size: 630 mm^2 Conductor: Aluminum Number of core: Single Core Type of sheath: PVC with anti-termite protection Color of sheath: Blue Armor: Aluminum wire armor for direct buried in the ground	48 km (3.6 km x 3 phases x 2 cables / phase x 2 circuits × 110%)

2.3 Procurement Plan of Spare Parts and Maintenance Tools

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. The Ghana 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 1 year after insurance of the completion certificate in case of the Japan's Grant Aid. 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.

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. However, the special tools required for operation and maintenance of the equipment of the Project shall be provided as the scope of the Japanese.

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

2.4 On-the-Job Training (OJT)

An 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 engineer of the manufacturers of the equipment of the Project at the project site.

3. Tentative Implementation Schedule of the Project

The tentative implementation schedule is shown as Attachment-3. In case that the Project is adapted by the Japanese Government, the Project will proceed as follows in the earliest scenario. The installation work of the Project will start in June, 2015. It is important for both sides to understand that the Preparatory Survey is not a commitment for the future implementation of the Project.

- The Exchange of Notes between the Ghana and Japanese Government will be signed in August, 2014.
- The Tender Opening will be held in February 2015.
- Installation work of the Project will start in June, 2015.
- Commissioning of the Project will be in April, 2017.

4. Drawings

Part 1 Substation

E-01: SINGLE LINE DIAGRAM FOR ACCRA CENTRAL BSP SUBSTATION (PRELIMINARY)

E-02: LAYOUT OF PANELS OF THE PROJECT IN THE EXISTING BUILDING AT GRPHIC ROAD PRIMARY SUBSTATION

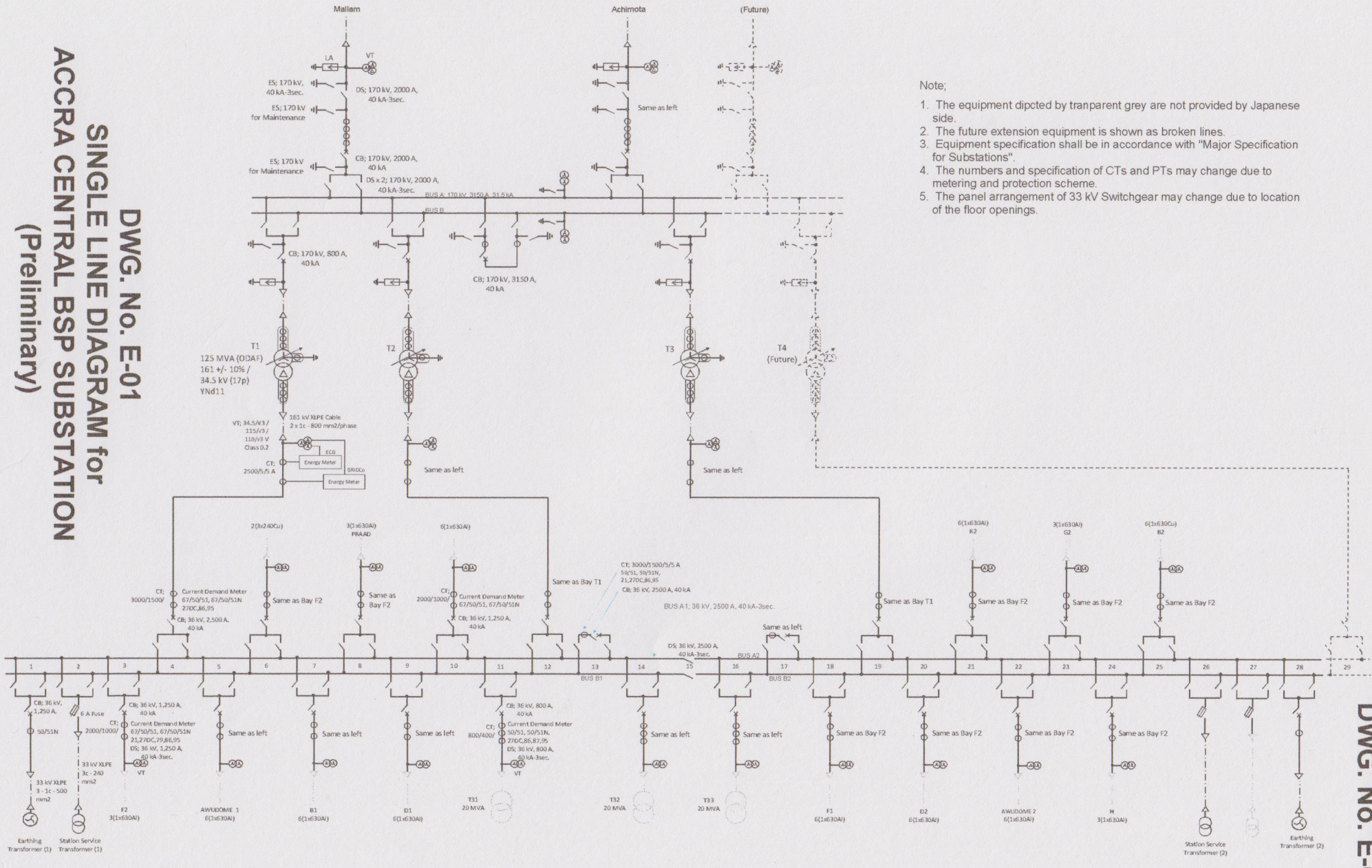
Part 2 Transmission Lines

T-01: 161 kV T/L Route Map
T-02: Outline of Towers (1)-(2)
T-03: 33 kV Underground Cable Route

Part 3 Architectural

A-01: SITE LAYOUT of ACCRA CENTRAL BSP

SINGLE LINE DIAGRAM for ACCRA CENTRAL BSP SUBSTATION (Preliminary)



Note;

1. The equipment dipcted by tranparent grey are not provided by Japanese side.
2. The future extension equipment is shown as broken lines.
3. Equipment specification shall be in accordance with "Major Specification for Substations".
4. The numbers and specification of CTs and PTs may change due to metering and protection scheme.
5. The panel arrangement of 33 kV Switchgear may change due to location of the floor openings.

DWG. No. E-01

SINGLE LINE DIAGRAM for

ACCRA CENTRAL BSP SUBSTATION

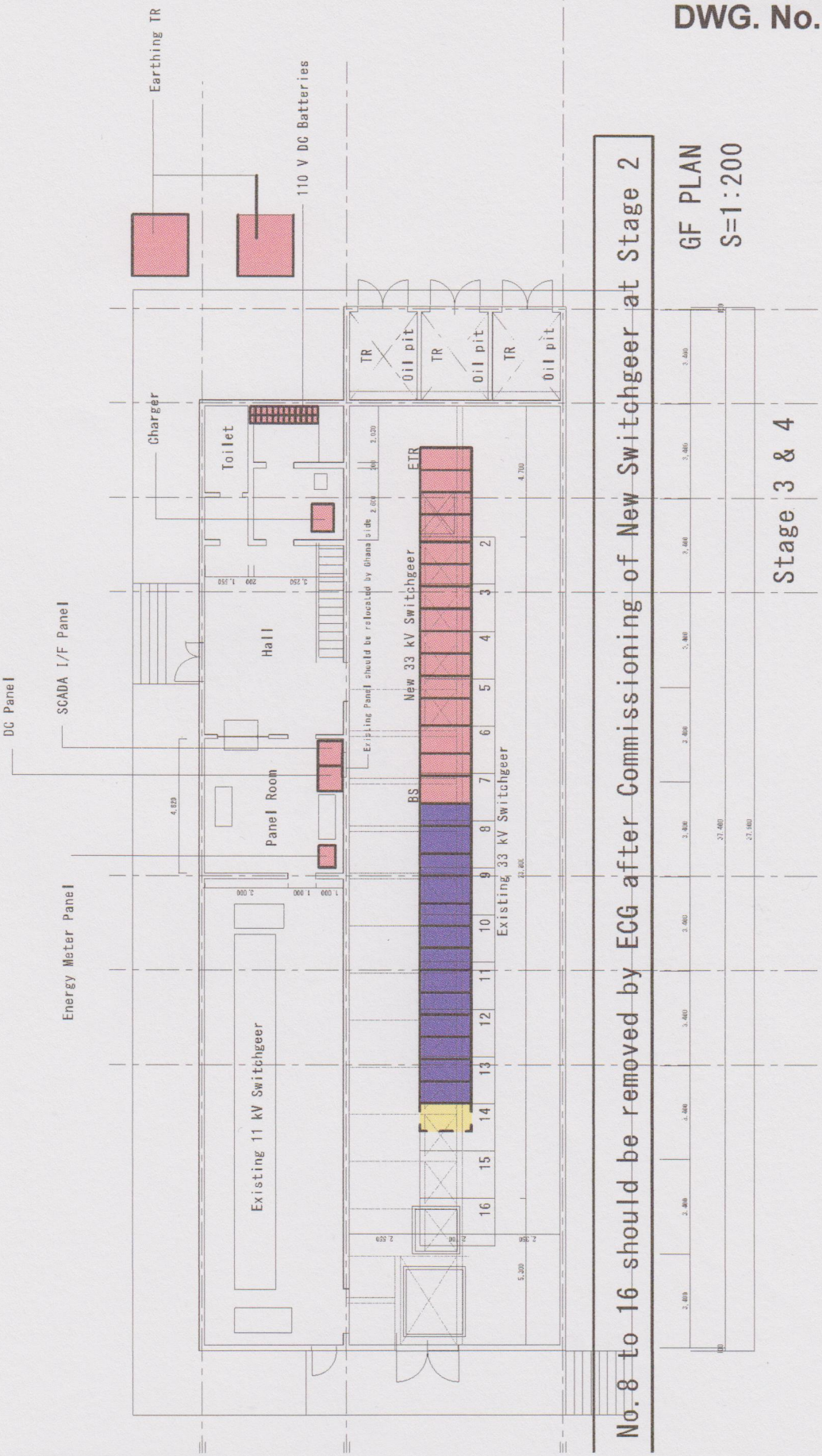
(Preliminary)

A7-21

DWG. No. E-01

A-7

DWG. No. E-02



DWG. No. E-02

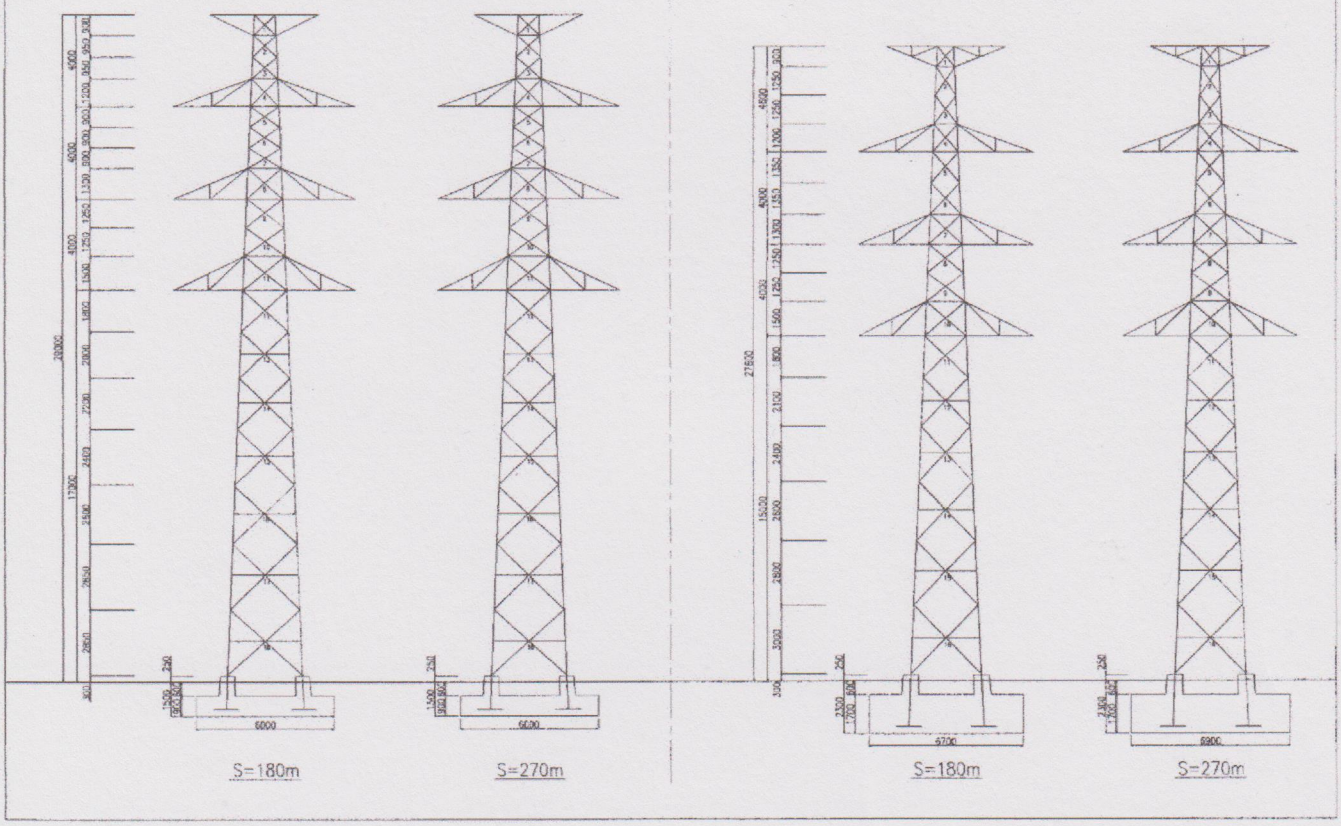
LAYOUT OF PANELS OF THE PROJECT IN THE EXISTING BUILDING AT GRPHIC ROAD PRIMARY SUBSTATION

T-01 161 kV T/L ROUTE MAP(1)

XX 型（懸垂型）
TYPE XX (SUSPENSION TYPE)

YY 型（耐張型）
TYPE YY (TENSION TYPE)

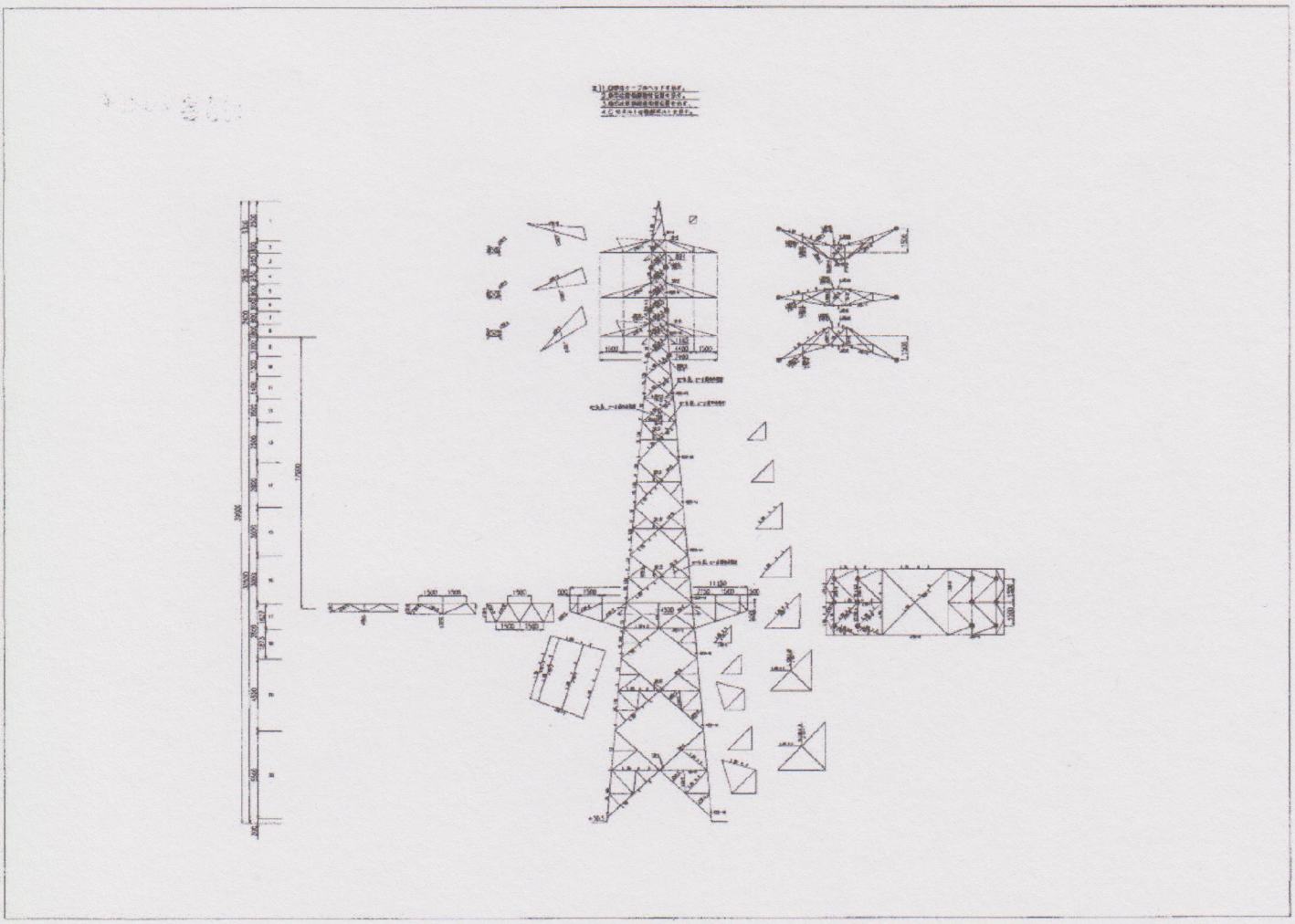
(S=1/150)



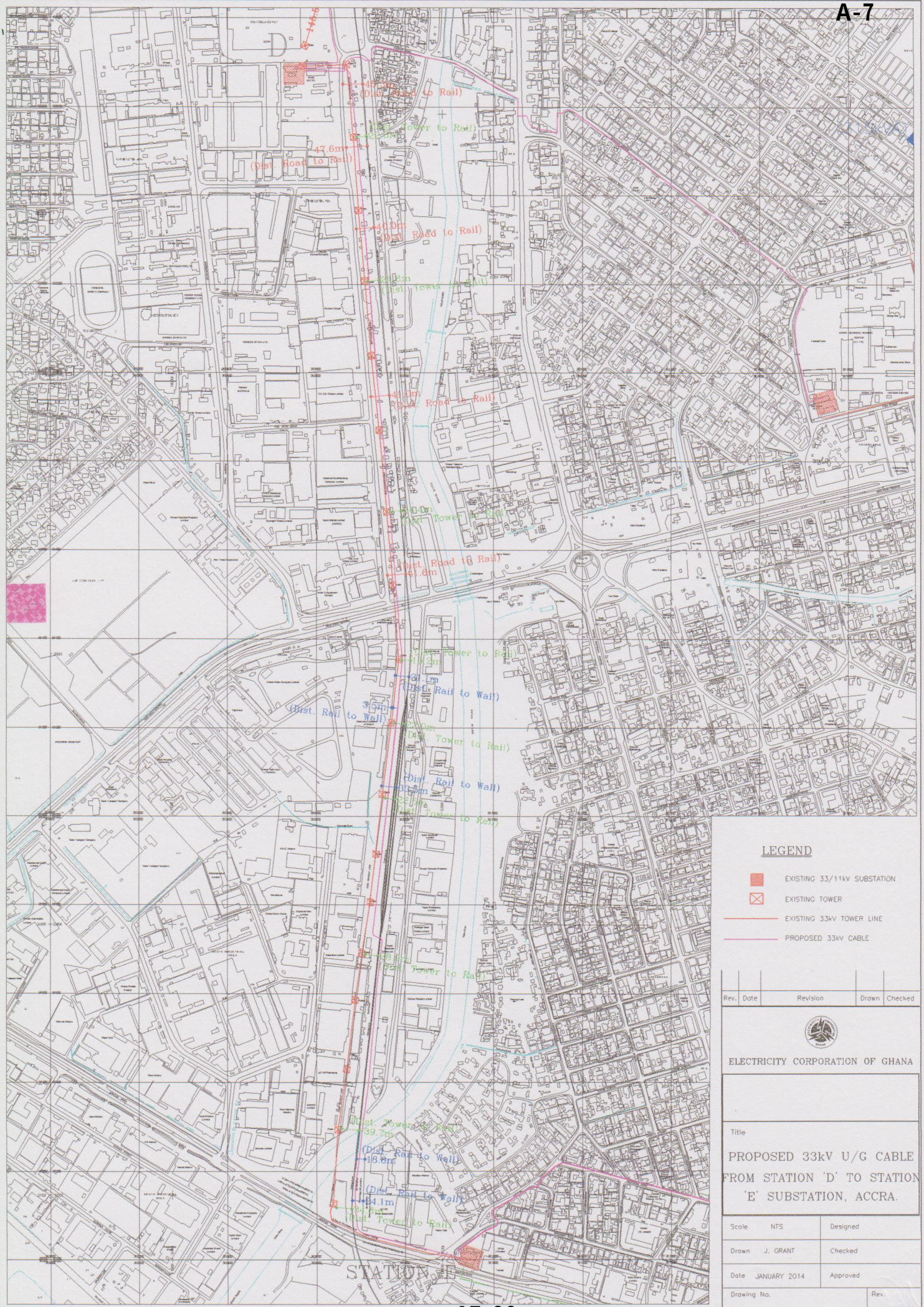
T-02 OUTLINE OF TOWER (1)

ZZ 型（ケーブル引留型）

TYPE ZZ (CABLE TERMINATION TYPE)



T-02 OUTLINE OF TOWER (2)



LEGEND

- EXISTING 33/11kV SUBSTATION
- EXISTING TOWER
- EXISTING 33kV TOWER LINE
- PROPOSED 33kV CABLE

Rev.	Date	Revision	Drawn	Checked

ELECTRICITY CORPORATION OF GHANA

Title

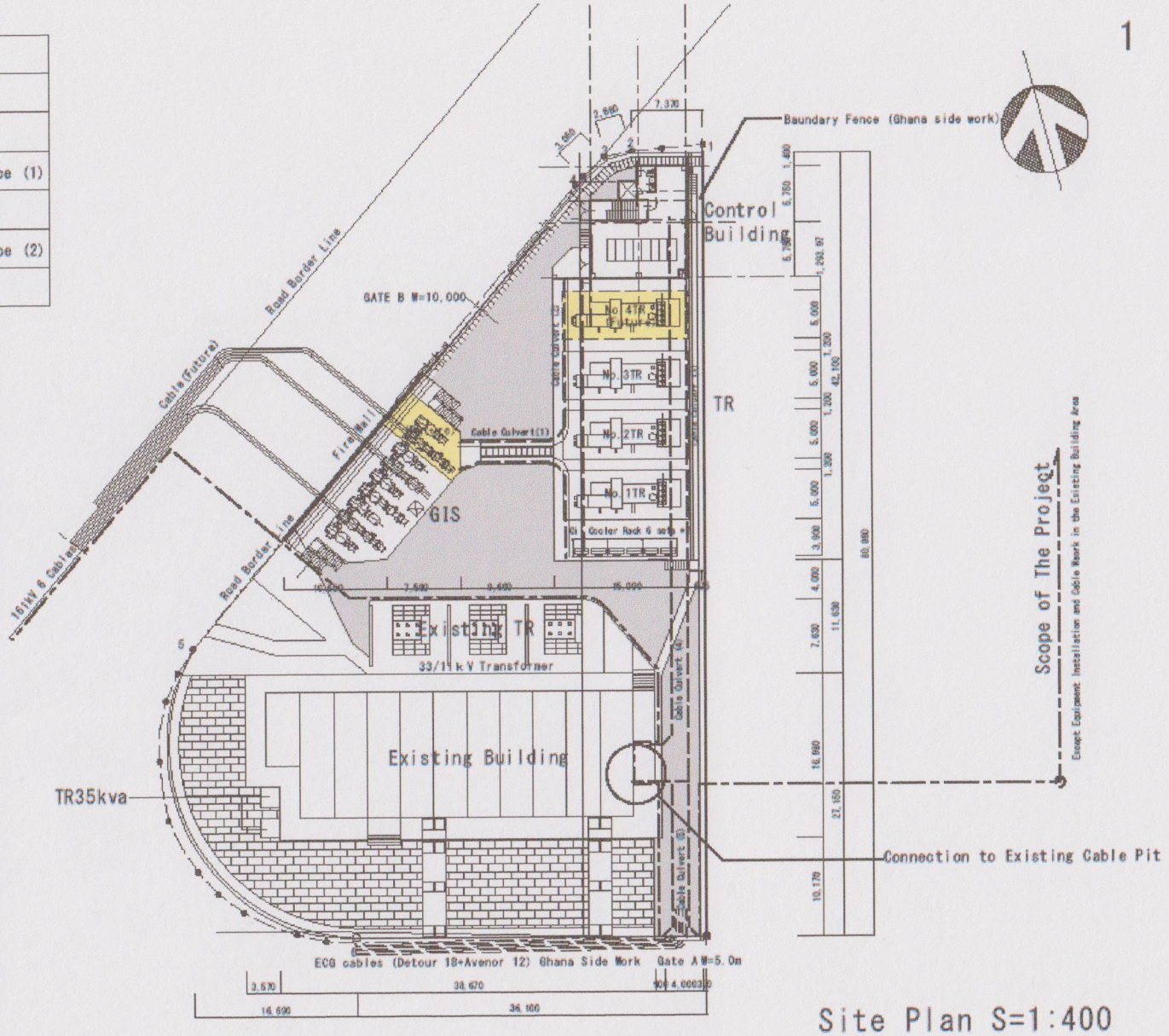
PROPOSED 33kV U/G CABLE FROM STATION 'D' TO STATION 'E' SUBSTATION, ACCRA.

Scale NTS	Designed
Drawn J. GRANT	Checked
Date JANUARY 2014	Approved
Drawing No.	Rev.

T-03 33kV UNDERGROUND CABLE ROUTE MAP

A-01 SITE LAYOUT of ACCRA CENTRAL BSP

Facility List	
1.	Control Building
	BF Cable Pit, Water Tank, Pump
	GF Control Room (1), Control Office (1)
	1F Control Room (2), Battery Room
	2F Control Room (3), Control Office (2)
	RF Trans, Air-con unit
2.	GIS
	BF Cable Pit
	GF GIS 3sets, space for future
3.	Trans
	BF Mechanical Pit,
	BF Cable Culvert (2), (3)
	GF Trans No.1, 2, 3& Space No.4
	Oil cooler Rack (12sets)
4.	Cable Culvert
	Cable Culvert (1) GIS-TR
	Cable Culvert (4) TR-Existing
	Cable Culvert (5) Existing 33kV
5.	Fire Wall
	Fire wall for GIS
6.	Gate B
	W=10m full open gate



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A-7