5. Field Report

PREPARATORY SURVEY
ON
IMPROVEMENT OF SUBSTATIONS AND DISTRIBUTION NETWORK PHASE 3
IN
THE REPUBLIC OF RWANDA

FIELD REPORT

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Prepared and Submitted by:

Mr. Makoto Abe
Chief Consultant
JICA Preparatory Survey Team

Confirmed and Agreed by:

Eng. NSHUTI Yves
Director of Energy Planning
Energy Development Corporation Limited
Rwanda Energy Group
Implementing Agency for the Project

Confirmed and Agreed by:

Eng. GAKWAVU Claver
Director, Planning
Energy Utility Corporation Limited
Rwanda Energy Group
Relevant organization for the Project

JICA PREPARATORY SURVEY TEAM

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

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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 Republic of Rwanda (Rwanda), Japan International Cooperation Agency (JICA), in consultation with the Government of Japan, decided to conduct a Preparatory Survey (the Survey) on the Project for Improvement of Substations and Distribution Network Phase 3 (the Project).

JICA sent to Rwanda the Preparatory Survey Team (the Team) headed by Mr. Tsunenari Soyama, Deputy Director, JICA, to conduct the first field survey and the Team is scheduled to stay in the country from 27th May to 30th June, 2017.

The Team continued discussions with the concerned officials of Rwanda and the field survey in Rwanda.

EDCL, EUCL 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 throughout the first field survey. EDCL, EUCL 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 Rwandan 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, and EDCL and EUCL agreed with the Team to proceed to 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;

- The responsible ministry is Ministry of Infrastructure (MININFRA).
- The implementing agency is Energy Development Corporation Limited (EDCL).
- The relevant organization is Energy Utility Corporation Limited (EUCL).

1.3 The Scope of the Japanese side

The Scope of the Japanese side is shown in Table 1.3-1 and GA-01 Site Location Map in the Drawings.

Table 1.3-1 Outline of the Proposed Components

Components	Capacity
Procurement and Installation Work	
1. New Gasogi Substation	
(a) ~~20 MVA~~ 110 /15 kV transformer 2×15MVA	1 unit
(b) 110 kV switchgear	1 set
(c) 15 kV switchgear	1 set
(d) Control and supervisory facilities	1 set
2. Transmission Line for New Gasogi Substation	
(a) 110 kV transmission line (Single circuit) from the existing line between Birembo (Ndera) and Musha substations to New Gagosi Substation	Approx. 0.2 km
3. Distribution Line	
(a) 15 kV distribution line (Single circuit) from New Gagosi Substation to Masaka connection point	Approx. 8.5 km
(b) 15 kV distribution line (Single circuit) from New Gagosi Substation to Nyagasambu connection point	Approx. 11.5 km
4. Reinforcement of Transmission Line between Birembo and Jabana Substations	
(a) 110 kV transmission line (Single circuit) from Birembo to Jabana Substations	Approx. 7.0 km
Procurement Work	
5. Maintenance Tools for the Equipment to be procured under the Project	1 lot
6. Spare parts for the Equipment to be procured under the Project	1 lot
Construction Work	
7. Installation of Gantries, Towers, etc.	1 lot
8. Construction of Control Building of New Gasogi Substation	1 lot
9. Civil Works	1 building

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

1.4 Obligations/Undertakings of the Rwandan side for the Project

1.4.1 Preconditions

The Rwandan side has agreed to conduct the environmental and social considerations required by JICA Guidelines for Environmental and Social Considerations (2010) as well as laws and regulations in Rwanda. An Abbreviated Resettlement Action Plan (ARAP) must be implemented and the land acquisition should be completed three (3) months after the Approval of the Project by the Japanese Government. An approval on environmental clearance, such as EIA Certificate of Authorization as well as other relevant permits/licenses required for the implementation of the Project must be obtained in a timely manner to meet the Project schedule. An Environmental Management Plan (EMP), monitoring plan and impact mitigation measures must be prepared during an environmental assessment.

1.4.2 Necessary Inputs by the Rwandan side

A Before the Tender announcement

A-1 Completion of Environmental Assessment and Issue of EIA Certificate of Authorization

A-2 Preparation and Implementation of ARAP, Issue of the Land Title, Bush clearing and removal

of obstacles of the land

A-3 Approval of the Layout plan and Line routes from the City of Kigali in the detailed design stage

B Prior to the Commencement of the Construction Work

B-1 Site preparation work such as construction of access road, removing obstacles, tree cutting, etc. necessary for commencement of the construction work for the project components mentioned in Table 1.3-1 above.

B-2 Temporary storage yard for equipment and materials

C During the Construction Work

[New Gasogi Substation]

C-1 Construction of Gate and fence

C-2 Protection Relay setting confirmation and change of the substations where the transmission lines from New Gasogi substation to be interconnected.

C-3 Modification of SCADA System of NECC and Network Management system for accommodation of New Gasogi S/S. This modification includes the additional network connection measures of the Multiplexer/SDH panel in New Gasogi substation for the connection of new optic fiber cable.

[110 kV Transmission line (Switch over to New Gasogi)]

C-4 Gate and Fence

C-5 Power outage

C-6 Removal work of the existing conductor, grounding wire, accessories, steel tower and foundation etc.

[15 kV Distribution Line (D/L)]

C-7 Power outage

C-8 Replacement or reconnection of the existing lines

[110 kV Transmission line (from Jabana substation to Birembo substation)]

C-9 Power outage

C-10 Removal work of the existing conductor, grounding wire, accessories, steel tower and foundation etc.

C-11 Testing of communication network after installation of OPGW on 110kV transmission line between Jabana and Birembo substation

D After Handing Over

D-1 To monitor environmental and social impacts during the operation with an adaptive management approach.

2. Technical requirements confirmed in the first field survey

2.1 Technical requirements for the Substation of the Project

2.1.1 General requirement

(a) General Design Condition

Table 2.1.1-1 Basic Conditions for the Facility Design of the Project

Items		Values
Altitude		2,000 m
Ambient Temperature	Maximum	40 Degrees Centigrade
	Minimum	5 Degrees Centigrade
	Mean	20 Degrees Centigrade
Maximum Wind Velocity		30 m/s
Annual Rain Fall		1,450 mm/year
Seismic Force		Horizontal 0.10 G
Soil Bearing Capacity		Depends on the soil survey result

(b) System voltage

- 110 kV : 110 kV ± 10% (99.0 - 110 - 121.0 kV)
- 15 kV : 15 kV ± 10% (13.5 - 15 - 16.5 kV)

(c) Frequency

50 Hz ± 0.5 Hz (49.5 - 50 - 50.5 Hz)

(d) Short circuit current

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

- 110 kV : 31.5 kA or more
- 15 kV : 25 kA or more

(e) Grounding system

- 110 kV : Solid grounding
- 15 kV : Solid grounding

(f) Pollution level for Insulator

Light (IEC-60815)

(g) Applicable Codes and Standards

As a rule, the transmission and substation system equipment shall be designed in accordance with IEC and IEC compatible standards. (JEC and so on)

2.1.2 Technical requirements for the equipment of New Gasogi Substation

The following equipment shall be installed for New Gasogi Substation.

- One (1) set of 110/15 kV, 20 MVA transformer (2X15MVA)

  Important note;-

  110/15 kV transformer with vector group Yd11 is required by EDCL at this time, since the harmonic frequency could be suppressed by the delta winding. New Gasogi substation will be constructed between existing Ndera and Musha substations. The transformer in Ndera substation is of vector group Yy0, while the vector group Yd11 in Musha substation (30o phase angle difference). Hence, JICA study team agrees with the requirement provided that;-

  "When the source of 15 kV supply is switched over from Ndera to Musha or vice versa, the switchover operation must be done after shutdown of the associated lines."
  EDCL agreed.
- 110 kV outdoor conventional type switchgear shall be installed as follows;-
  - Two (2) bays of transmission lines for Ndera and Musha substations
  - Three (3) bays of transmission lines for future installation
  - One (1) bay of 110/15 kV transformer (T1)
  - One (1) bay of 110/15 kV transformer (T2) for future installation
- Indoor type, 15 kV gas insulated switchgear with single busbar system shall be installed in the new control building.
- Control and protection equipment including Micro SCADA system
- Communication equipment for National Electricity Control Center (NECC) through existing optical fiber cables
- Entire earthing system in the substation shall be considered.
- At the time of cut-in of the 110 kV existing transmission line to New Gasogi substation, approximate 9 days shutdown shall be necessary. See SS-03 "Switchover Procedure for New Gasogi SS", as attached.

Reference drawings;-

SS-01: Single Line Diagram for Gasogi Substation (Preliminary)
SS-02: Control and Protection System for Gasogi Substation
SS-03: Switchover Procedures for New Gasogi Substation (Draft)

Table 2.1.2-1 Equipment to be provided for New Gasogi Substation

No.	Equipment	Q'ty	Unit	Major Specifications
(1)	Transformers			
a.	20 MVA, 110/15 kV Transformer	1	set	- 20 MVA Transformer with On-load tap changer - Primary: 110 kV +/- 13*1.23% (27 taps) - Secondary: 15 kV - Vector group: YNd11 with Earthing transformer - The mounting provisions for fans shall be made on the radiators for future 25 MVA ONAF (oil-immersed, air-forced cooled) cooling in order to increase the transformer capacity. Fan control circuits and associated power supply circuits for ONAF cooling are provided in a local control box from the beginning. - Future parallel operation of the two transformers is considered.
b.	Earthing transformer	1	set	- 160 kVA Earthing transformer - Primary: 15 kV - Short-time duty (5 sec.): 1,050 A - ONAN - Vector group: ZN - CT; 15 kV, 1200/1 A, 5P20, 30 VA
c.	250 kVA, 15/0.4 kV Auxiliary transformer	1	set	- 250 kVA Transformer with No-load tap changer - Primary: 15 kV +/- 2*2.5% (5 taps) - Secondary: 400-230 V, Three phase, four wires - The capacity should be confirmed at the time of implementation stage, considering the auxiliary loads in the substation.
(2)	110 kV Switchgear	1	lot	- 2 sets of 110 kV Feeder bay 145 kV*, 31.5 kA or more 1 set (for three phases) comprising of;- • Disconnecting Switch (DS) • Circuit Breaker (CB) • Current Transformer (CT) • DS with Earthing Switch (ES) • Voltage Transformer (VT) • Lightning Arrester (LA) - 1 set of 110/15 kV Transformer bay 145 kV*, 31.5 kA or more 1 set (for three phases) comprising of;- • Disconnecting Switch (DS) • Circuit Breaker (CB) • Current Transformer (CT) • Lightning Arrester (LA) - 3 phases of 110 kV VT for 110 kV Busbars Note*; Taking into consideration of altitude of the site (approximately 1,500 m), the rated voltage of 110 kV system shall be 145 kV.

No.	Equipment	Q'ty	Unit	Major Specifications
				Common specifications Rated voltage: 145 kV Rated current - Busbar : 1,250 A - Transmission line bay : 1,250 A - Transformer bay : 1,250 A Rated short-time withstand current: 31.5 kA (3 sec.) Rated lightning impulse withstand voltage: 650 kV Rate power frequency withstand voltage (1 min.): 275 kV Creepage distance: 16 mm/kV
(3)	Necessary materials for 110 kV outdoor substation			
a.	110 kV busbar	1	lot	Aluminum tubes for three phase busbars 110 kV busbars are installed for all future bays, i.e., 2 x transformer bays and 5 x transmission line bays Note; The conductor fittings on the busbars for future bays should be provided.
b.	Gantry towers	1	lot	Dead-end gantry towers for 3 circuits of 110 kV transmission line bays
c.	Insulators	1	lot	Support insulators for 110 kV busbar and transmission line wires at gantry towers
d.	110 kV conductors and fittings	1	lot	- 2 sets for 110 kV transmission line bays - 1 set for 110/15 kV transformer bays - 1 set for 110 kV busbars
e.	Other necessary materials	1	lot	Foundations for equipment, Supporting structures and other necessary materials
(4)	15 kV Gas insulated switchgear with single busbar	1	lot	- 1 set of 110/15 kV transformer bay 36 kV*, 1,250 A, 25 kA or more - 7 sets of feeder bays 36 kV*, 1,250 A, 25 kA or more - 1 set of Auxiliary transformer bay 36 kV*, 630 A, 25 kA or more - 2 sets of Busbar connection bays 36 kV*, 1,250 A, 25 kA or more - 1 set of Voltage transformer bay 36 kV*, 25 kA or more Note*; The rated voltage of 15 kV system shall be 36 kV, since the distribution voltage of the whole country is 30 kV, while that in Kigali city is 15 kV. Common specifications Type: Indoor type, SF6 gas insulated metal-clad switchgear (GIS) Rated voltage: 36 kV Rated current Busbar : 2,500 A 20 MVA transformer : 1,250 A 15 kV feeder : 1,250 A Aux. transformer : 630 A Circuit breaker (CB) Type: VCB

No.	Equipment	Q'ty	Unit	Major Specifications
				Rated interrupting current: 25 kA Auto-reclosing: 3 phase reclosing Operating duty: O-3 sec.-CO-3 min.-CO Rated short-time withstand current: 25 kA (3 sec.) Rated lightning impulse withstand voltage: 170 kV Rated power frequency withstand voltage (1 min.): 70 kV
(5) a.	110 kV Control and protection Transmission lines	1	lot	For two (2) circuits - Bay control units (ABB REF 670 or equivalent) - Protection relays (Areva P545 or equivalent)
b.	20 MVA transformer	1	lot	For one (1) transformer - On-load tap change control - Bay control unit (ABB RET 670 or equivalent) - Transformer differential protection relays - Protection relays for neutral circuits
c.	15 kV Control and protection	1	lot	For all 15 kV feeders including 20 MVA and Auxiliary transformers - Bay control unit (ABB REF 670 or equivalent)
(6)	Micro SCADA system	1	lot	- Server and Client (Workstation HMI) with bay control unit (BCU) system for control and supervising of the whole substation - Remote Terminal Unit (RTU) and/or gateway system for communication with the existing National Electricity Control Center (NECC) SCADA system (ABB RTU 560 or equivalent)
(7)	Communication System	1	lot	The communication system includes;- - SDH multiplexer panel (including ECI NPT-1200 or equivalent) - IP PBX equipment with telephone sets - Cables including optical fiber cables for the substation inside
(8)	Substation AC power supply system	1	lot	400/230 V AC distribution panel(s) Molded-case circuit breakers (MCCB) for 400/230 V AC, three phase, four wires, with 10% spare MCCBs
(9) a.	Substation DC power supply system 110 V DC system			
	- Charger	1	lot	Thyristor rectifier system, Dual charger system Input; 400/230 V AC, Output; 110 V DC
	- Battery	1	Lot	Valve regulated lead acid (VRLA) type or equivalent 300 Ah/10 Hr (The capacity shall be confirmed at the time of implementation, using actual auxiliary loads in the substation.)
	- Distribution panel(s)	1	lot	MCCBs for 110 V DC with 10% spare MCCBs
b.	48 V DC system			
	- Charger	1	lot	Thyristor rectifier system, Single charger system Input; 400/230 V AC, Output; 48 V DC Valve regulated lead acid (VRLA) type or equivalent 100 Ah/10 Hr (The capacity shall be confirmed at the time of

No.	Equipment	Q'ty	Unit	Major Specifications
				implementation, using actual auxiliary loads in the substation.)
	- Battery	1	lot	Valve regulated lead acid (VRLA) type or equivalent 100 Ah/10 Hr (The capacity shall be confirmed at the time of implementation, using actual auxiliary loads in the substation.)
	- Distribution panel(s)	1	lot	MCCBs for 48 V DC with 10% spare MCCBs
(10)	Uninterruptible Power Supply (UPS)	1	set	- For Micro SCADA equipment - Input voltage: 400/230 V AC, three or single phase - Output voltage: 230 V AC, single phase - The back-up time is at least 1 hour.
(11)	15 kV power cables	1	lot	15 kV power cables and necessary accessories for connection - 15 kV cables between 110/15 kV transformer and 15 kV switchgear (incoming circuit) - 15 kV cables between 110/15 kV transformer and Earthing transformer - 15 kV cables between 15 kV switchgear panels and first 15 kV distribution tower(s) and/or pole(s)
(12)	Low voltage power and control cables	1	lot	- Necessary low voltage power and control cables and necessary accessories for connection
(13)	Earthing system in the substation	1	lot	- Earthing conductors and accessories - Overhead grounding wires for new 110 kV switchgear and transformer area

2.1.3 Technical requirements for the equipment of existing Jabana Substation

Taking the opportunity of the replacement of 110 kV transmission lines between Jabana and Birembo substations, the basis of the work is described as below.

- Since the associated Circuit breaker (CB)* and busbar side Disconnecting switch (DS)* are made in 1986, the equipment should be replaced with new ones.
- Some part of conductors in this bay (Birembo line) should be replaced with bigger conductors.
- Dead-end tower for Birembo line should also be replaced due to the existing tower distorted.
- The foundations of the equipment and the gantry tower are newly provided.
- The other existing equipment such as CT, VT and line side DS are utilized as they were installed in 2008.
- Since the existing control and protection cables between the equipment and the existing control room should be used, an interconnection marshalling box is installed close to the existing CB and DS, and new control cables are connected to the marshalling box from newly installed CB and DS. The restoring tests of the circuits of CB and DS as listed below should be done at the existing control room after the installation of the equipment.
  - ✓ Control and protection circuits
  - ✓ Interlock circuits
  - ✓ Alarm circuits, and other circuits if any

- AC/DC power for new equipment should be supplied by the existing power supply system.

Reference drawings;

SS-04: Single Line Diagram for Jabana Substation

SS-05: Consideration for modification works of Jabana/Birembo substation

Table 2.1.3-1 Replacement Equipment List at Jabana Substation

No.	Equipment	Q'ty	Unit	Major Specification
(1)	110 kV gas circuit breaker	1	set	Rated voltage : 145 kV Rated current : 2,500 A Rated interrupting current : 40 kA Rated short-time withstand current : 40 kA (3 sec.) Rated impulse withstand voltage : 650 kV Rated power frequency withstand voltage: 275 kV Single auto-reclosing : Yes Operating duty: O-3 sec.-CO-3 min.-CO
(2)	110 kV Disconnecting switch	1	set	Rated voltage : 145 kV Rated current : 1,250 A Rated short-time withstand current : 31.5 kA (3 sec.) Rated impulse withstand voltage : 650 kV Rated power frequency withstand voltage : 275 kV
(3)	Necessary materials for 110 kV substation			
a.	110 kV conductors and fittings	1	lot	Type AAC, 300 mm^2 for 3 phase
b.	Gantry towers	1	set	Dead-end gantry towers for 110 kV Birembo transmission line
c.	Insulators	1	lot	Insulators for 110 kV conductors and transmission line wires at the gantry towers
d.	Supporting structures	1	lot	Supporting structures for CB and DS
e.	Foundations	1	lot	Foundations for CB, DS and Dead-end gantry tower
f.	Other necessary materials	1	lot	Compression terminals, terminals for earthing system and other necessary materials
(4)	All other materials			
a.	Cabling materials	1	lot	Conduits, Cabling materials and other necessary materials
b.	Low voltage cables	1	lot	600 V XLPE cables Control cables with shield Crimp terminals and other necessary materials for cabling

2.2 Technical requirement for Transmission and Distribution Lines

2.2.1 Technical requirement for Transmission and Distribution Lines

(1) Scope of Work

Scope of the work for transmission and distribution lines is shown in GA-01 Site Location Map in the Drawings.

a) 110 kV Transmission Line at Gasogi substation

New Gasogi substation will be energized from existing 110 kV transmission line between Birembo (Ndera) substation and Musha substation. The existing suspension tower No. 217 on the transmission line shall be dismantle and new dead end type towers No.217A and No.217B shall be erected between No.216 and No.218, one is for Birembo (Ndera) line and the other one is for Musha line, refer to attached drawing TL-01.

b) 110 kV Transmission Line between Birembo substation and Jabana substation

Current capacity of existing 110 kV line between Birembo substation and Jabana substation will be upgraded by constructing new 110 kV transmission line within the existing right of way including towers and foundations using new conductor ACSR-240mm^2, refer to attached drawing TL-02. Existing towers and foundations shall be removed by the responsibilities of EUCL.

c) 15 kV Distribution Line: North Route from New Gasogi substation

15 kV distribution line: North route with single circuit from New Gasogi substation to Nyagasambu existing dead end tower as shown in the drawing DL-01 will be constructed, the line length is approx. 11.5 km. Support structure of the 15kV distribution line shall be steel tower and/or steel pole types, refer to the drawing DL-03 with triangle conductor configuration.

d) 15 kV Distribution Line: South Route from New Gasogi substation.

15 kV distribution line: South Route with single circuit from New Gasogi substation to existing 15 kV distribution line at Masaka hospital connection point as shown in the drawing DL-02 shall be constructed. The line length is approx. 8.5 km. Support structure of this line is same as c). This 15 kV Distribution line shall also be used for 30 kV distribution line.

(2) Design Conditions for 110 kV Transmission (T/L) and 15 kV Distribution Lines (D/L)

Natural Conditions and Electrical Conditions are shown in Table 2.2.1-1 and Table 2.2.1-2, respectively.

Table 2.2.1-1 Natural Conditions

Items	Design Values
Altitude	Over 1000m up to 2000m
Conductor temperature	-
Minimum temperature	5 degree Centigrade
Everyday temperature	25 degree Centigrade
Maximum temperature	80 degree Centigrade
Sag calculation to determine steel tower height	50 degree Centigrade
Wind speed	30 m/s
Wind load on conductors	552 Pa
Wind load on steel tower	1,599 Pa
Soil bearing capacity	Depends on the soil survey result

Table 2.2.1-2 Electrical Conditions

Items	Design Value
Standard Span Length	350m to 500m for 110kV T/L, 250m for 15kV D/L
Wind Span	350m to 500m for 110kV T/L, 250m for 15kV D/L
Vertical component of the conductor & G.wire	15% of Max Working Tension
Right of Way (ROW)	- 110kV T/L: 15m width (7.5m +7.5m) - 15kV D/L for double circuits: 10m width (5m +5m) - 15kV D/L for Single circuit: 6m width (3m +3m)
Height of conductor - See Note b) -	
General area (m)	7 m
Waterway (m)	10 m
to Road crossing (m)	8 m
Shield angle for Lightning	30 degree
Minimum nominal specific creepage distance	16 mm/kV
Equivalent salt deposit density	0.063 mg/cm^2

Note:
a) As EUCL's concept, facility for15kV distribution line shall be designed usable for 30kVdistribution line.
b) To decide standard tower height, conductor height of 8 meters shall be employed.

(3) Requirements for 110 kV Transmission and Distribution Lines

Specifications for 110 kV Transmission and Distribution Lines are shown as follows.

Table 2.2.1-3 Specifications for 110kV Transmission Line

No.	Items	Specifications
1)	Line Structure	For New Gasogi sub station Type: Steel lattice type tower Configuration of tower: Single circuits, Horizontal layout (See DWG. TL-03) Type of tower: Dead end type (110D1H: Angle: 90 degree), Safety factor: 1.0 for main body, 1.2 for arms For Jabana substation to Birembo substation Type: Steel lattice type tower Configuration of tower: Single circuits, Triangle layout (See DWG. TL-04) Type of tower: Suspension tower 110-A1, Light angle tower (long span) 110-B1

No.	Items	Specifications	
		Safety factor:	Middle angle tower 110-C1 Dead end tower (Straight) 110-D1-1 Dead end tower (Right angle) 110-D1-2 1.0 for main body 1.2 for arms
2)	Overhead Line (Conductor)	Type: Size	ACSR-240/26/7 φ21.8 mm w =0.976 kg/m Right hand ray
3)	Insulator	Standards: Size: Creepage distance: Material: Color: Ball and socket coupling: Number of insulators:	IEC60383-1 or equivalent 254 mm suspension insulators 292 mm Porcelain Brown 16mm 9 pcs/phase (Double or Single)
4)	Shield Wire and Optical Fiber Cable	Type: Number of Optic Fiber Core: Shielding angle:	OPGW-100mm^2 SM24 x 1 24 cores less than 30 degree.

Table 2.2.1-4 Specifications for 15kV Distribution Line

No.	Items	Specifications	
1)	Line Structure	Type: Configuration of tower:	Steel lattice type tower and/or Steel Pole Single circuit, triangle layout for tower and for steel pole
2)	Overhead Line (Conductor)	Type: Size:	ACSR 120/20, DIN
3)	Insulator for Tower	Specification : Number of insulators:	Same as 110kV Transmission Line but electromechanical Failing Load is 70kN Four (4) units/string :
4)	Insulator for Pole	Type:	Pin type on cross arm
5)	Shield Wire	Type: Number of Optic Fiber Core: Shielding angle:	OPGW-50mm^2 24 cores less than 30 degree.

2.2.2 Technical requirements for the Foundation of Transmission and Distribution Lines

(1) Requirements for the Facilities

Necessary land development including Access Road, Earth wall, Land Leveling, Boundary Fence would be constructed by the Rwanda side.

1) Foundations for Towers of 110 kV Transmission lines

The Outline of the foundations for Towers 110 kV Transmission Lines is shown in Table 2.2.2-1.

Table 2.2.2.1 Outline of the Foundations of 110 kV Transmission Line Tower

Items	Contents	Details
Structure	Reinforced Concrete Foundation (Pad & Chimney Type)	Stability by the result of soil investigation report. Safety factor : 2.0 for stability calculation Reinforcing Bar :Deformed Bar : Mild steel Required strength of concrete : 20N/mm^2

2) Foundations for Towers of 15 kV Distribution lines

The Outline of the foundations for Towers 15 kV Distribution Lines is shown in Table 2.2.2-2.

Table 2.2.2-2 Outline of the Foundations of 15 kV Distribution Line Tower

Items	Contents	Details
Structure	Reinforced Concrete Foundation	Stability by the result of soil investigation report. Safety factor : 2.0 for stability calculation Reinforcing Bar :Deformed Bar : Mild steel Required strength of concrete : 20N/mm^2

(2) Detail procedure of the work

Work shall be performed with maximum care to avoid collapse of existing towers during construction. To apply adequate work procedure is essential.

Some of the preparatory work has to be done with energized condition. Maximum care is deemed to be necessary in order not to make electrical accident.

To minimize the shutdown duration, it is essential to plan and apply parallel works as much as possible.

Followings are the tentative work procedure.

For new Gasogi substation: See drawing SS-03

For Jabana substation to Birembo substation 110 kV line: See drawing TL-05

2.3 Environmental and Social Consideration

The following table shows a schedule for EIA and ARAP, which was agreed upon between EDCL and JICA Preparatory Survey Team. The detail explanation is described in Table 2.3-1 and 2.3-2 below. During all the work of EIA and ARAP, EDCL should work in collaboration with a local consultant hired by JICA Preparatory Survey Team and facilitate them in accessing necessary data and information to carry out their tasks.

Table 2.3-1 Schedule of Environmental Assessment and Preparation of ARAP

Items	Activities	Organizations in charge	2017 Jun.	Jul.	Aug.	Sep.	2018 May
Environmental Assessment	Submission of project brief to RDB for screening	EDCL/JICA/ Local consultant					
	Issue of screening results	RDB					
	Further environmental study (if required)	EDCL/ Local consultant					
	Submission of EIA report to RDB	EDCL/ Local consultant					
	Issue of EIA Certificate of Authorization	RDB					
Preparation of ARAP	ARAP study	EDCL/ Local consultant					
	Submission of ARAP to JICA Study Team	EDCL/ Local consultant					
	Approval of ARAP by EDCL	EDCL					
Implementation of ARAP	Completion of land acquisition/ compensation	EDCL					
Others	Mobilization of a local consultant	JICA/ Local consultant					

Note: Implementation of ARAP should be fully completed within three months after the approval of the Project by the Japanese Government.

2.3.1 Environmental Impact Assessment

In line with the Environmental Impact Assessment (EIA) Guideline (*General Guidelines and Procedure for Environmental Impact Assessment, 2006*), EDCL submitted the Project Brief to Rwanda Development Board (RDB) on 12 June 2017. RDB will determine whether the Project requires a full EIA and issue screening results to EDCL within 2 weeks after the submission. EDCL should keep close communication with RDB, including conducting site inspection, so that RDB can have sufficient information for screening.

In accordance with screening results from RDB, a further environmental study or a full EIA study will be carried out; if required, EDCL should submit an EIA report by 4 August 2017 with the support of a local subcontractor. It is expected that RDB will issue the EIA Certificate of Authorization by the end of August 2017 (Review process of an EIA report by RDB will take 20 days).

2.3.2 Abbreviated Resettlement Action Plan

JICA Preparatory Survey Team conducted the site visit with EDCL, and confirmed that the Project would require land acquisition and resettlement to some extent. Based on the JICA Guideline (2010), EDCL is required to prepare an abbreviated resettlement action plan (ARAP). ARAP should be finalized and authorized by EDCL by 15 September 2017.

According to the Guideline of Right-of-Way (*Guideline No.01/GL/EL-EWS/RURA/2015 on Right-of-way for Power Lines, 2015*), the following principles are applied for newly-constructed 15 kV distribution lines (Gasogi-Nyagasambu/ Gasogi-Masaka):

- Right-of-Way of 15kV electrical lines is **12m width (6m + 6m)**.
- Any permanent building such as houses and shops is not permitted on the Right-of-Way.

Based on the discussion with Rwanda Utilities Regulatory Authority (RURA) on 21 June 2017, EDCL agreed and stated that the following criteria of resettlement and land acquisition are applied for reinforcement of existing 110kV transmission line between Birembo and Jabana Substation:

Table 2.3-2 Rights-of-Ways, Criteria for Land Acquisition and Resettlement

No.	Items	Right-of-Ways, Criteria for land acquisition and resettlement
1.	Right-of Ways	110 kV transmission line: **25m width (12.5m +12.5m)**
2.	Land acquisition	Lands are required **only where towers will be erected.**
3.	Resettlement of structures lived or used by people such as houses , shops etc.	A minimum vertical clearance from the lowest conductor to the top of structures is **5m**. Structures within Right-of-Way that do not meet the above minimum clearance, meaning the distance between the lowest conductor and the top of structures is less than 5m, are subject of resettlement.
4.	Resettlement of trees	All tress within the above Right-of-Way must be removed.
5.	Resettlement of other objects	Other objects within the above Right-of Way not meeting the minimum clearance (5m) will be evaluated based on social impacts and safety.

Once the exact coordinates of towers are finalized, EDCL should conduct site visit with the local sub-contractor. In case involuntary resettlement is predicted due to the Project, EDCL should avoid

or minimize the impacts, exploring all viable alternative routes.

The schedule of land acquisition agreed upon between EDCL and JICA Preparatory Survey Team is shown in the table below. For the smooth implementation of the project, EDCL agreed to complete all the land acquisition as well as compensation process within three months after the approval of the Project by the Japanese Government.

Table 2.3-3 Schedule of Land Acquisition after ARAP Preparation

Stage	Responsible bodies	Actions	Timeframe
6. Submission of the Payment order to MINECOFIN	From EDCL Finance Department to MINECOFIN	From EDCL finance department, the Payment order and the original compensation forms are forwarded to the Ministry of Finance for Payment.	By October 31, 2017
7. Payment process by MINECOFIN	From the MINECOFIN to the National Bank of Rwanda	MINECOFIN submits the Payment Order to the National Bank of Rwanda. The Payment by the National Bank of Rwanda through PAPs' respective Bank accounts.	November to December, 2017
8. Relocation of PAPs	PAPs/ EDCL	The PAPs will be relocated.	January to March, 2018
9. Land title request	EDCL/ Kigali City	EDCL will submit request for transfer of land title to Kigali City	April, 2018 (Within 3 months after the approval of the Project by Japanese Government)

Project site (area to require land acquisition due to the construction of a new Gasogi Substation)

Houses to be affected by the transmission line (Jabana- Birembo)

2.4 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 Rwandan 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.

Spare parts and maintenance tools listed in Table 2.4-1 and Table 2.4-2 are recommended to be procured. More detailed parts, tools, test equipment and the quantity will be explained in the Draft Final Report.

Table 2.4-1 Recommended Spare Part List

Legend; pc: piece, ea.: each, N.A.: Not applicable

Name of Spare Parts	Quantity	
	Gasogi	Jabana
1. 110 kV Switchgear equipment		
1.1 Circuit Breaker		
(1) Closing coil	1 pc	1 pc
(2) Tripping coil	1 pc	1 pc
1.2 Disconnecting Switch (DS)		
(1) Fixed and moving contact (3 phase set for DS)	1 set	1 set
(2) Fixed and moving contact (3 phase set for Earthing switch)	1 set	N.A.
1.3 Transformer		
1.3.1 110/15 kV Transformer		
(1) Gasket (complete set)	1 set	N.A.
(2) Buchholz relay set	1 set	N.A.
(3) Oil temperature indicator (main tank and conservator)	1 pc ea.	N.A.
(4) Oil level indicators (main tank and conservator)	1 pc ea.	N.A.
(5) Silica gel for Breathers	200%	N.A.
1.3.2 15/0.4 kV Transformer		
(1) Oil temperature indicator	1 pc	N.A.
2. 15 kV Switchgear equipment		
(1) Closing coil	1 pc	N.A.
(2) Tripping coil	1 pc	N.A.
(3) Vacuum bulbs complete with necessary accessories for replacement (for three phase)	1 set ea.	N.A.

Name of Spare Parts	Quantity	
	Gasogi	Jabana
(4) Isolating main terminals (completed one pole)	1 set ea.	N.A.
(7) Fuse (each type)	100%	N.A.
(8) Meter (each type)	1 pc ea.	N.A.
(9) Auxiliary relay (each type)	1 pc ea.	N.A.
(10) Necessary accessories for 15 kV cable	1 set	N.A.
3. Control and Protection		
(1) Protection relay (each type)	1 pc ea.	N.A.
(2) Bay control unit	1 pc ea.	N.A.
(3) Fuse (each type)	100%	N.A.
(4) Meter (each type)	1 pc ea.	N.A.
(5) Auxiliary relay (each type)	1 pc ea.	N.A.
(6) Control and selector switch, if any (each type)	1 pc ea.	N.A.
4. Station LV Power Supply Equipment		
4.1 AC Distribution Board		
(1) MCCB (each type)	1 pc ea.	N.A.
(2) Indicating lamp, if any (each type)	100%	N.A.
(3) Fuse (each type)	100%	N.A.
(4) Meter (each type)	1 pc ea.	N.A.
4.2 DC Distribution Board		
(1) MCCB (each type)	1 pc ea.	N.A.
(2) Indicating lamp, if any (each type)	100%	N.A.
(3) Fuse (each type)	100%	N.A.
(4) Meter (each type)	1 pc ea.	N.A.
4.3 Battery and Charger		
(1) Battery	2 cells ea.	N.A.
(2) Electrolyte (20 letter/tank)	1 tank	N.A.
(3) Control Card and diode module	1 pc ea.	N.A.
(4) Indicating lamp, if any (each type)	100%	N.A.
(5) Fuse (each type)	100%	N.A.
(6) Meter (each type)	1 pc ea.	N.A.
4.4 Uninterruptible power supply system		
(1) Battery	2 pc ea.	N.A.
(2) Pulse generator	1 pc ea.	N.A.
(3) Thyristor stack	1 pc ea.	N.A.
(4) MCCB	1 pc ea.	N.A.
(5) Indication lamp (each type)	100%	N.A.
(6) Fuse (each type)	100%	N.A.
(7) Meter (each type)	1 pc.ea.	N.A.

Name of Spare Parts	Quantity	
	Gasogi	Jabana
5. Communication		
(1) RTU card and/or NPT-1200 Communication card	1 pc ea.	N.A.
(2) Cards for IP Media Gateway	1 pc ea.	N.A.

2.5 On-the-Job Training (OJT)

On-the-job training (OJT) shall be carried out during the construction period. Through the OJT, maintenance and operation staff of the Rwandan side will be able to experience practical and advanced skill from Manufacturer's engineers. Contents of OJT are suggested as follows;

- Operation and maintenance on 110 kV and 15 kV substation equipment
- Protection relay setting
- Fault analysis and operation record management

2.6 Power flow analysis

(1) Power demand forecast

Power demand forecast which was conducted in a master plan study titled "Electricity development plan for sustainable geothermal energy development in Rwanda" (November 2014 by JICA) is the basis of the preparatory survey for the project. Table 2.6-1 shows the energy peak demand of each 3 scenario, High middle low case, in the master plan to be applied to the survey. Load allocation to each substation is estimated by the team based on the demand forecast described in the master plan.

Table 2.6-1 Power demand forecast (Rwanda central Area)

Year	Peak demand(MW)			Year	Peak demand(MW)		
	High	Middle	Low		High	Middle	Low
2018	122	105	81	2028	293	257	218
2019	133	114	90	2029	319	280	238
2020	145	125	100	2030	348	305	261
2021	158	137	111	2031	380	333	285
2022	173	150	122	2032	415	362	311
2023	189	165	135	2033	452	394	338
2024	206	180	149				
2025	225	197	164				
2026	246	215	181				
2027	268	235	190				

(1) Power system analysis

The necessity of new Gasogi substation and the necessity of reinforcement for transmission line between Jabana - Birembo substation are evaluated by power system analysis.

This project is aimed to assist enhancement of transmission and distribution facilities in the Kigali area to improve the serious damage to economic activity in the area by insufficient power supply capacity from power transmission/distribution facilities and aging facilities. Therefore power system analysis shall be performed with the range shown figure 2.6-1 as the target.

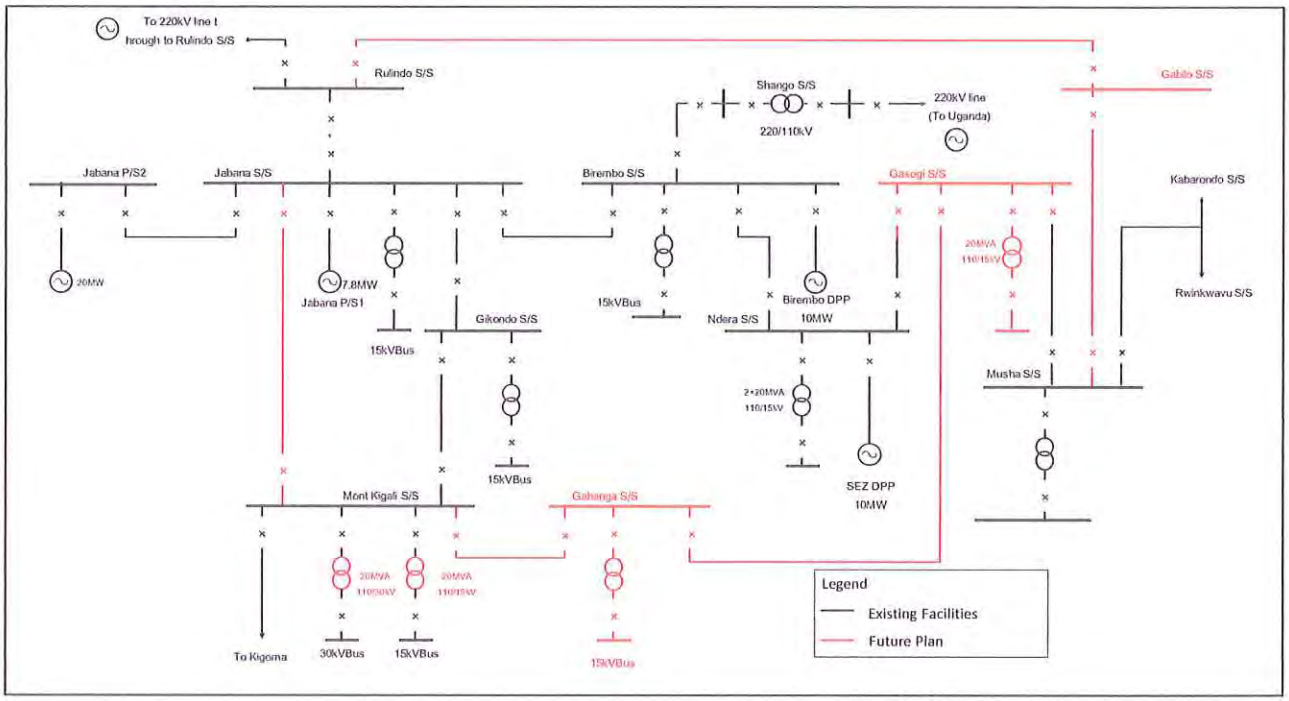


Figure 2.6-1 Range for power flow analysis

3. Tentative Implementation Schedule of the Project

The tentative implementation schedule is shown in Attachment-3. In case that the Project is approved by the Japanese Government, the Project will proceed as below in the earliest scenario. The installation work of the Project will start in October, 2018. 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 Rwanda and Japanese Government shall be signed in March, 2018.
- The Tender Opening will be held in August 2018.
- Installation work of the Project will start in October, 2018.
- Commissioning of the Project will be in March, 2020.

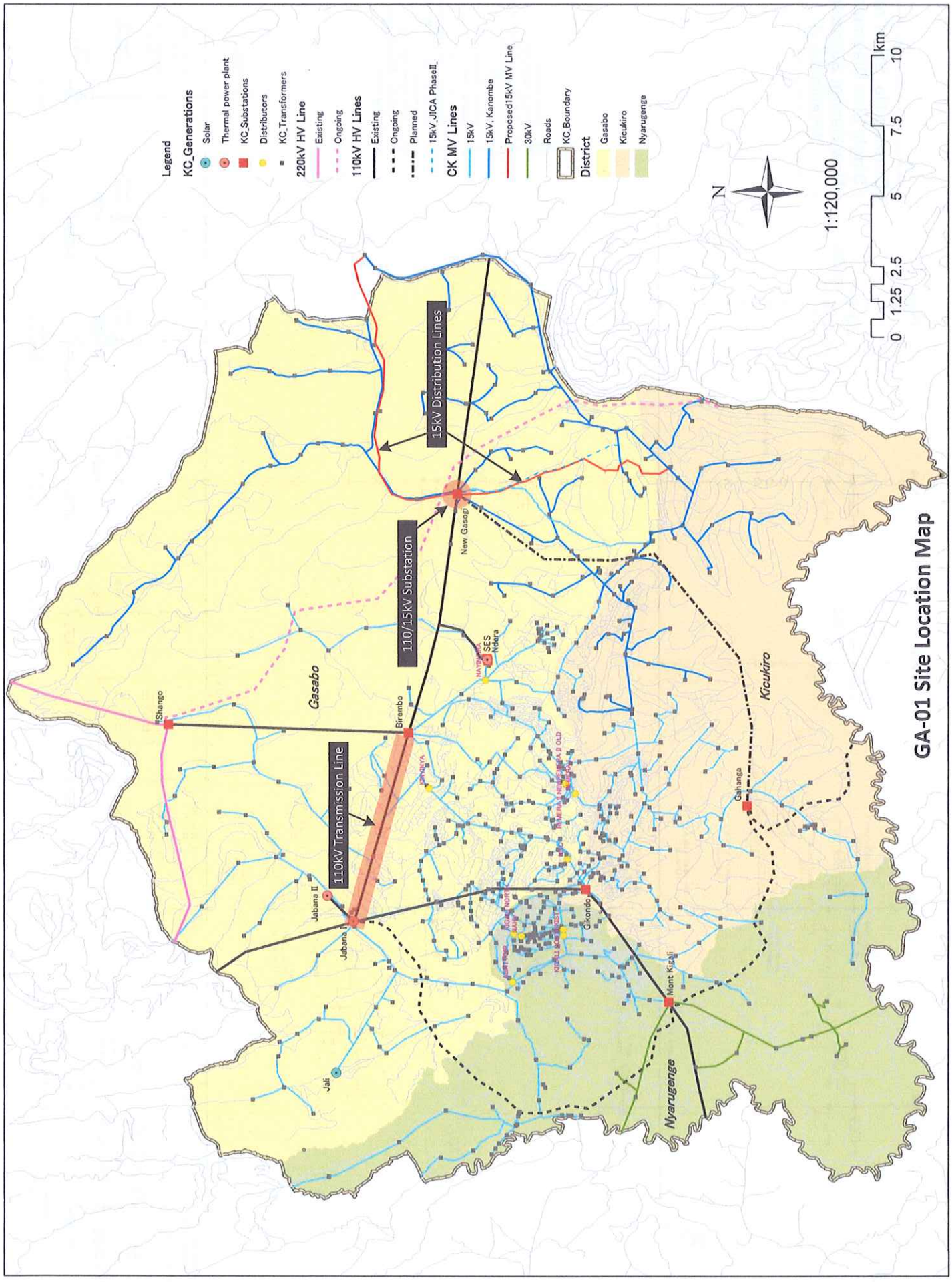
4. Drawings

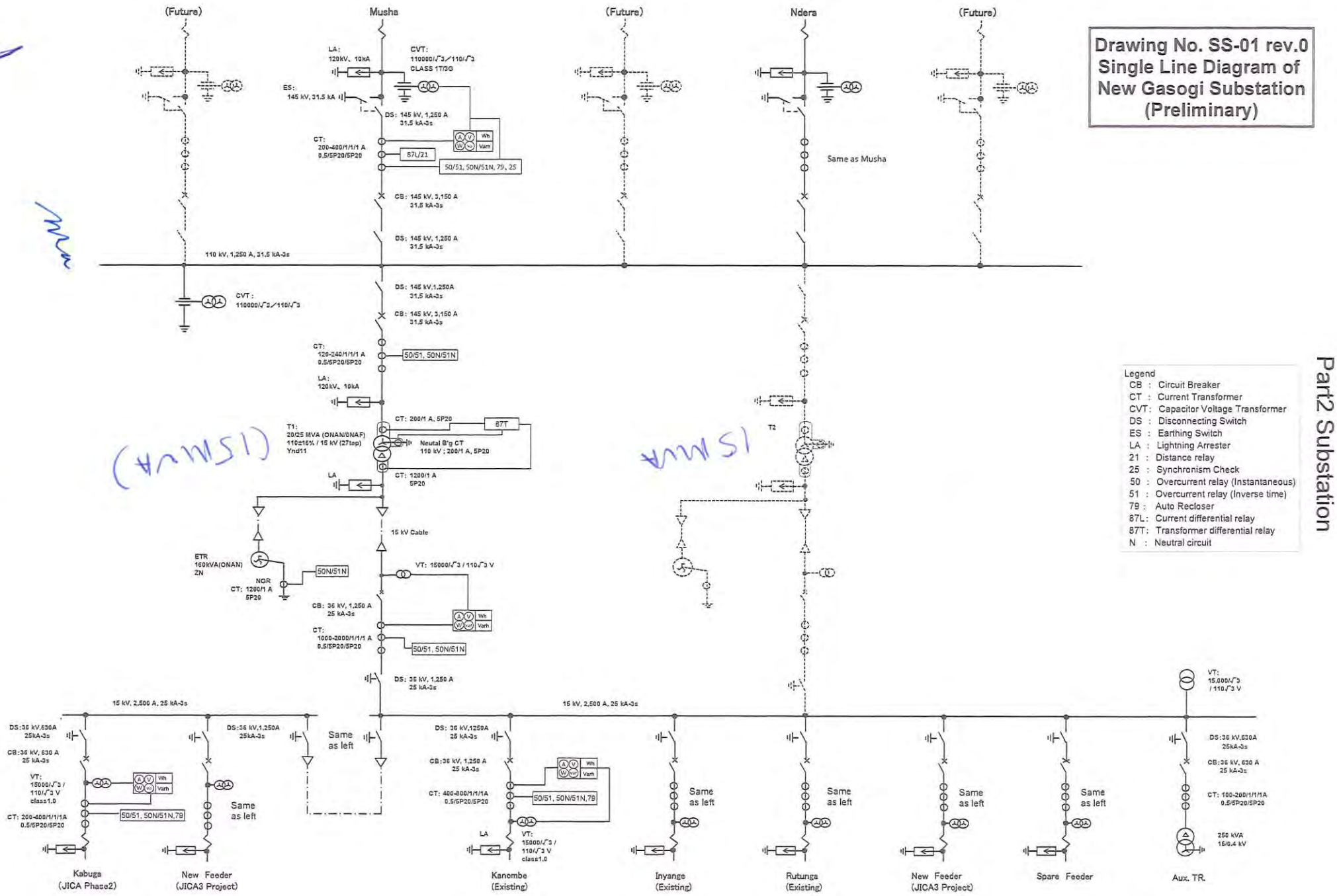
Part 1 General

Part 2 Substation

Part 3 Transmission and Distribution Lines

Part 4 Architectural


Legend
KC_Generations
Solar
Thermal power plant
KC_Substations
Distributors
KC_Transformers
220kV HV Line
Existing
Ongoing
110kV HV Lines
Existing
Ongoing
Planned
15kV_JICA PhaseII_
CK MV Lines
15kV
15kV, Kanombe
Proposed15kV MV Line
30kV
Roads
KC_Boundary
District
Gasabo
Kicukiro
Nyarugenge
N
1:120,000
0 1.25 2.5 5 7.5 10 km
15kV Distribution Lines
110/15kV Substation
110kV Transmission Line
New Gasogi
Shango
Birambo
Jabana II
Jabana I
Jali
SES
Ndera
Gahanga
Gikondo
Mont Kigali
Gasabo
Kicukiro
Nyarugenge
GA-01 Site Location Map

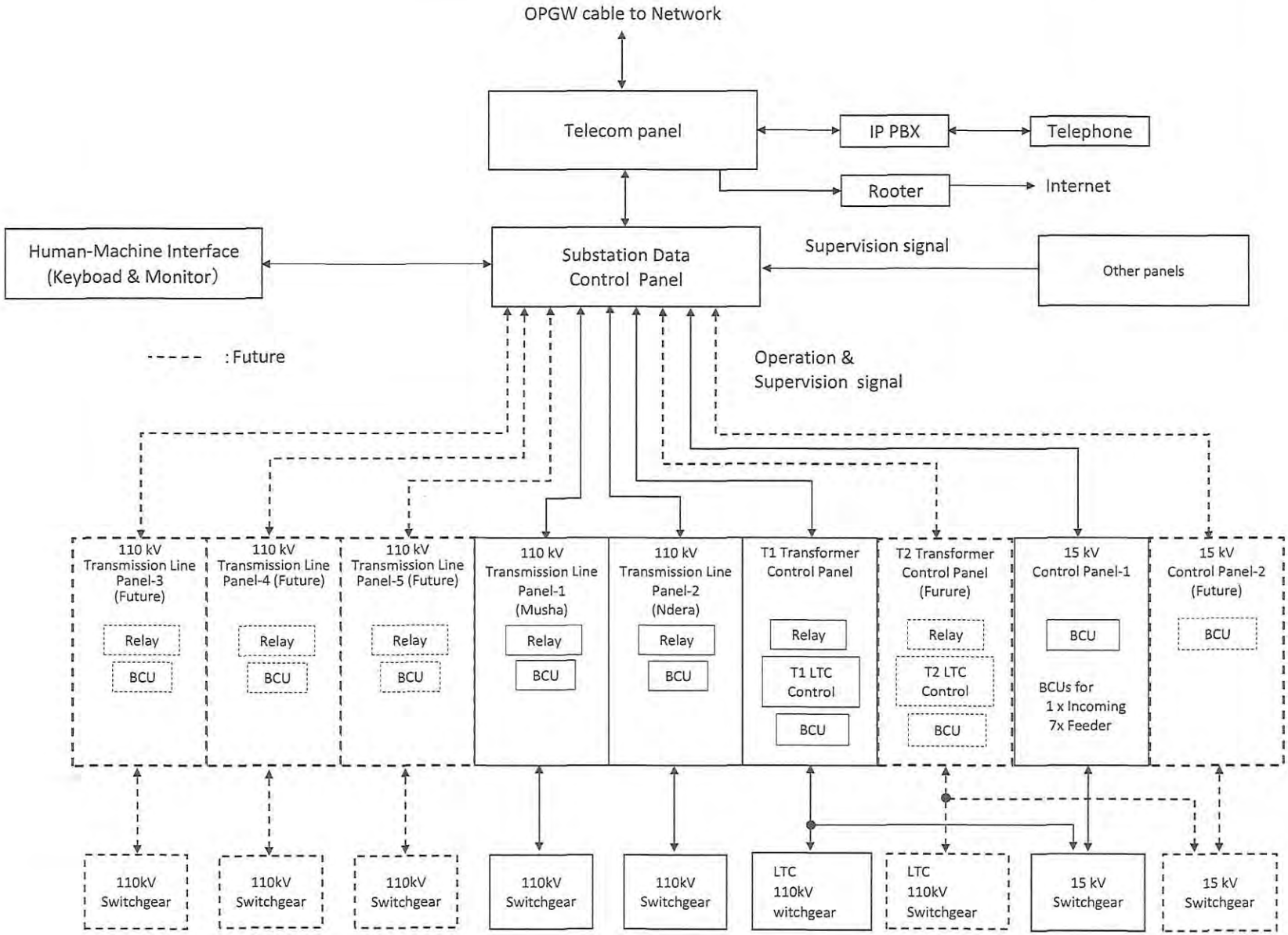


Part2 Substation

A5-24

Drawing No.SS-02 rev.0

Control System Diagram of Gasogi Substation



Drawing No. SS-03

Switchover Procedures for New Gasogi Substation (Draft)

In order to cut-in 110 kV transmission line to New Gasogi SS, 110 kV transmission line between Ndera and Musha substations needs to be shut down. This is to study the duration of shutdown including work items and the schedule for Switchover from existing substation to new substation.

[Duration of Shutdown]

About 9 days

[Procedures]

- O Two additional towers should be constructed within the property of existing Gasogi substation for stringing new 110 kV conductors to new Gasogi substation. In order to minimize the the duration of shutdown of 110 kV transmission line, the foundation work and the assembling works of the lower part of new towers should be conducted even under live condition of the 110 kV transmission line.
- O In order not to postpone the duration of shutdown for transmission line work, all possible works and tests of substation equipment should be done before the shutdown, except the works and tests for communication aspect through OPGW.

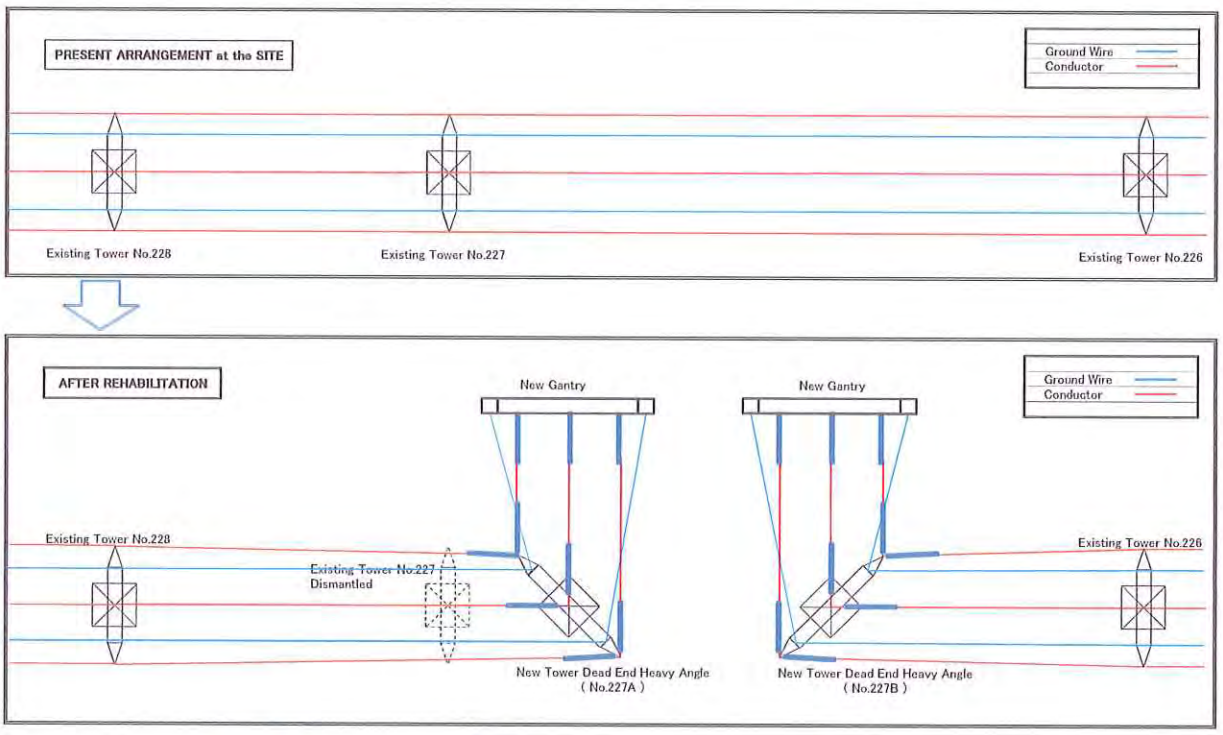
	Pre-works	No. of Shutdown Days on Ndera - Musha line										Remarks
		1	2	3	4	5	6	7	8	9	10	
110 kV Transmission Line	Energized condition	Shutdown ▼				Shutdown				Restored ▼	Energized	
Transmission Line Work	- Foundation works of new Towers - Assembling Works of new Towers (Lower part) (30 days)		- Assembling Works for new Towers (Upper part) - Stringing Main conductors and Grounding wires - Disassembling works for existing tower No. 227									
Substation Work	All possible works and tests of substation equipment to be done.		Cabling and Connection works of 15 kV feeders			Connection works of 110 kV conductors		OPGW connection	- SCADA Tests - 87L Tests	- Energization of 110 kV Bus - Power Transmission to Musha SS - Energization of 110/15 kV Transformer - Power Transmission to 15 kV feeders		

[Attachment]

- O Switchover Procedure for 110 kV Transmission Line
- O Switchover Procedure for Gasogi Substation

EXTENSION and UPDATE PLAN of GASOGI SUB STATION

This plan has been made for the purpose of checking feasibility and budgeting. Therefore, this paper does not bind the contractor's free hand to apply any method as far as it is reasonable.



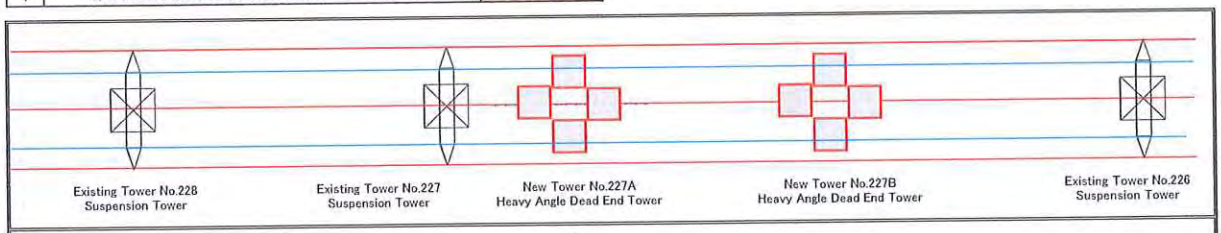
DETAILED WORK STEP

1 Work shall be performed with maximum care to avoid collapse of existing towers during construction. To achieve this, it is essential to apply each and all adequate countermeasure.
2 Some of the preparatory work has to be done with energized condition. Maximum care is deemed to be necessary in order not to make electrical accident.
3 To minimize the shut down duration, it is essential to plan and apply parallel works as much as possible.

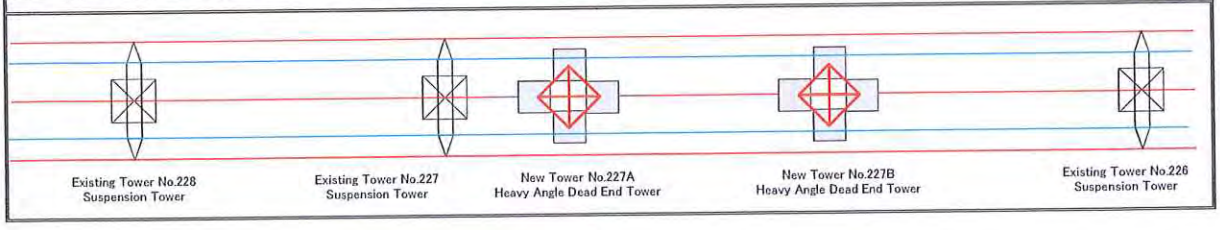
(days)

Step	WORK CONDITION	WORK to be DONE	Remarks		Expected Duration
1	Live Condition	New Foundation for Tower 227A & 227B to be constructed	Work to be done simultaneously.	Foundation shall be newly designed	30.0
2		New Tower 227A & 227B shall be elected up to the bent position		Tower shall be newly designed Keep safety distance from energized conductor	
3		Stay wire foundations to be constructed at tower No.226 & No.228		Need to check the capacity of stay wire foundation	
4	Live to Shut down	Circuit to be shut down		By EDUL	0.5
5	Shut down Condition	Existing Tower No.226 & No.228 shall be tied to the ground by stay wire	Work to be done simultaneously.	Check necessary tension	1.0
6		Ground wire and conductor shall be tied to the arm at tower No.226 & 228		Check necessary tension	
7		Release ground wire & conductor from suspension clamp at tower No.226, No227 & 228		Avoid unbalance tension to towers	
		Cut and unloading ground wire & conductor between tower No.226 & No.228 to the grou		Cutting point shall be at the suspension clamp but maintain extra length in order to utilize for re connection Edge of the ground wire shall be well protected to avoid damage and water immersion	
8				Ground wire & conductors shall be scrapped	
9	Shut down Condition	Erect new tower No.227A & 227B up to the top.	Work to be done simultaneously.	Use Truck Crane if available	3.0
10		Dismantle upper part of existing Tower No.227.			
11	Shut down Condition	String ground wire & conductor between Tower No.226 and tower No.227A	Work to be done at both tower simultaneously.	Ground wire and conductor shall be new and to be connected to the existing by sleeve at tower No.226 and No.228	1.0
12		String ground wire & conductor between Tower No.228 and tower No.227B			
13		String ground wire & conductor between Tower No.227A and Gantry			
14		String ground wire & conductor between Tower No.227B and Gantry			
15	Shut down Condition	Re connect ground wire with connection box at tower No.226 and Gantry & at tower No.228 and Gantry		Work shall be done with care to avoid over tension to ground wire and conductors	1.0
16		Re connect conductor at tower No.226 – Gantry – No.228 with suitable fittings			
17		Release stay wire at Tower No.226 & No.228			
18		Clear unloaded ground wire and conductor from the site			
19	Shut down to live	Energize the circuit		By EDUL	0.5
20	Live Condition	Dismantle existing Tower No.227 below bent Point		By EDUL	2.0
21		Stay wire foundations shall be removed at tower No.226 & No.228			
				Total Expected Working days	39.0
				Required Shutdown days	6.0

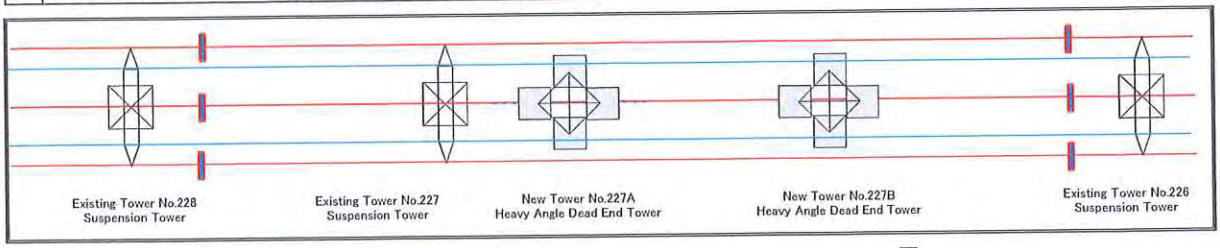
1 **New Foundation for Tower 227A & 227B to be constructed** LIVE CONDITION



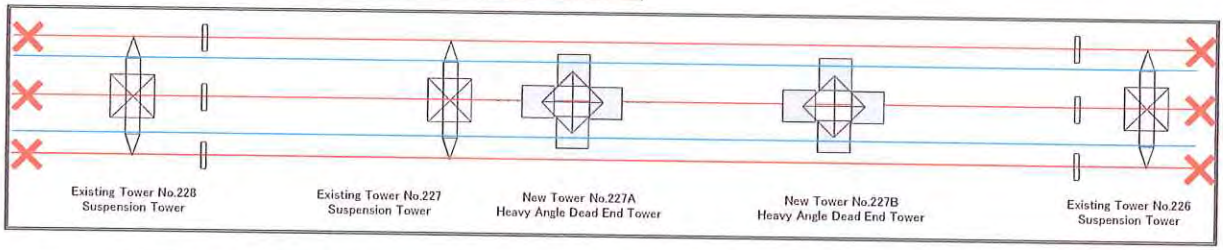
2 **New Tower 227A & 227B shall be elected up to the bent position** LIVE CONDITION



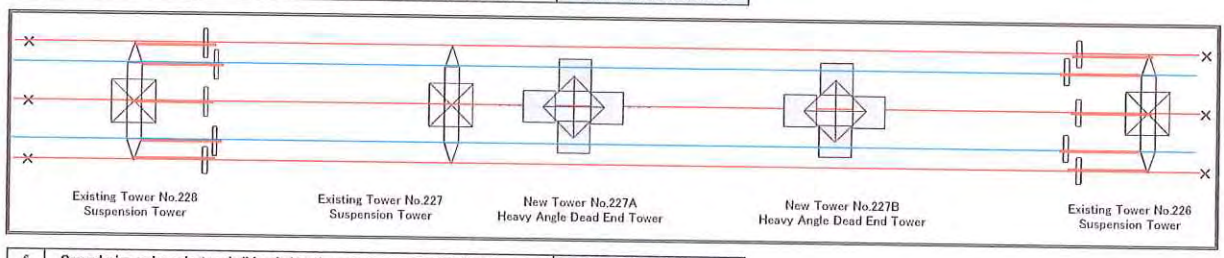
3 **Stay wire foundations to be constructed at tower No.226 & No.228** LIVE CONDITION



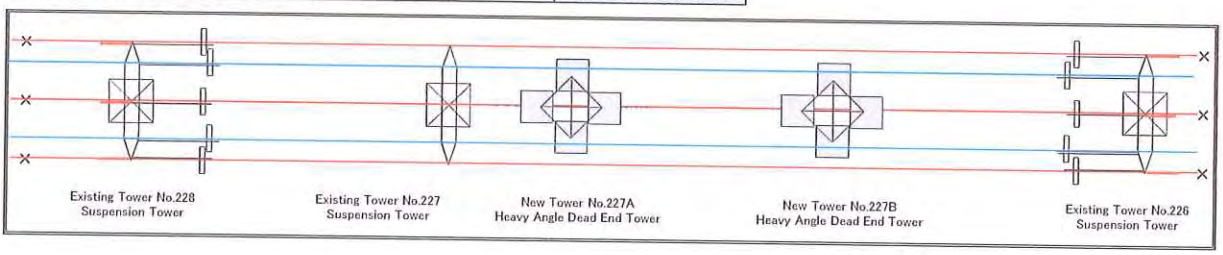
4	Circuit to be shut down	LIVE to SHUT DOWN



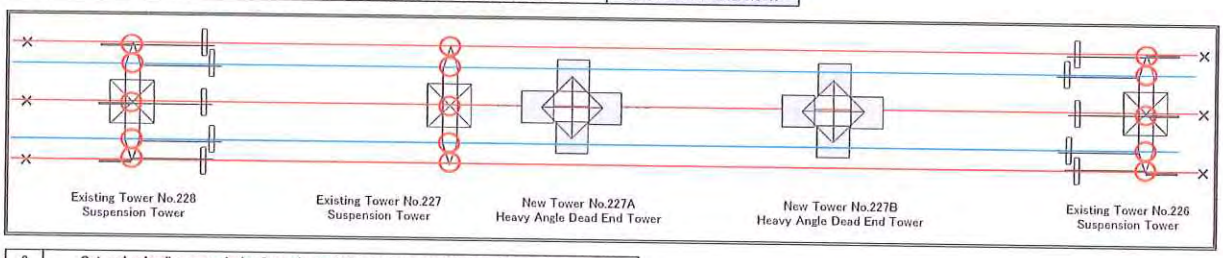
5	Existing Tower No.226 & No.228 shall be tied to the ground by stay wire	SHUT DOWN CONDITION



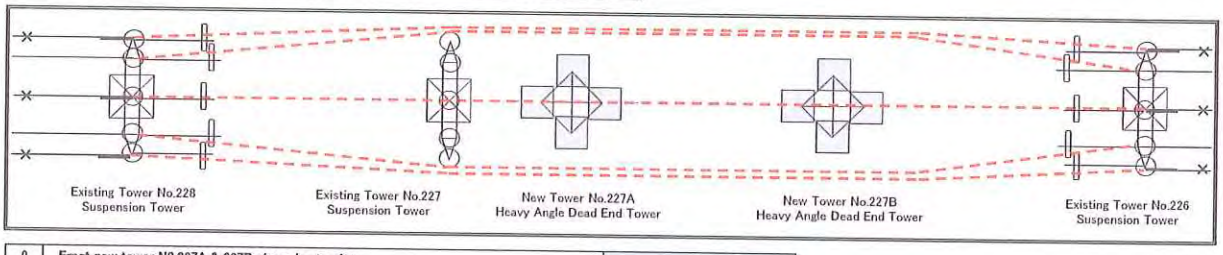
6	Ground wire and conductor shall be tied to the arm at tower No.226 & 228	SHUT DOWN CONDITION



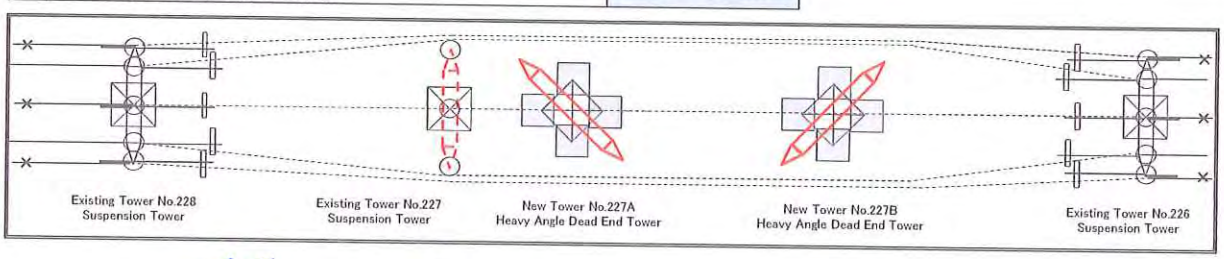
7	Release ground wire & conductor from suspension clamp at tower No.226, No227 & 228	SHUT DOWN CONDITION



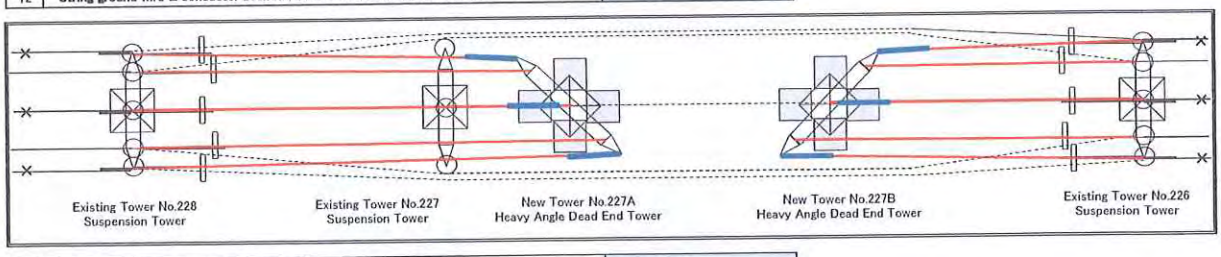
8	Cut and unloading ground wire & conductor between tower No.226 & No.228 to the ground



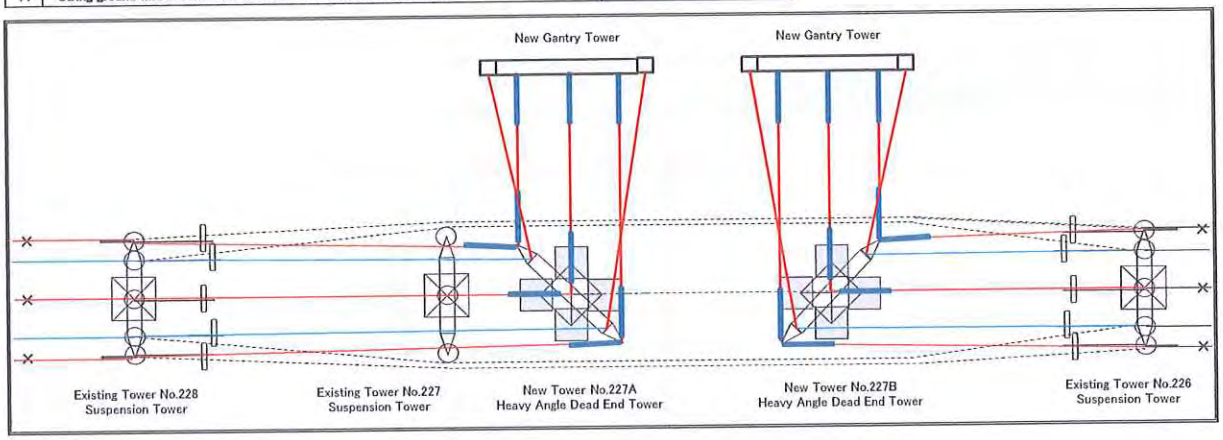
9	Erect new tower N0.227A & 227B above bent point.	SHUT DOWN CONDITION
10	Dismantle upper part of existing Tower No.227.	



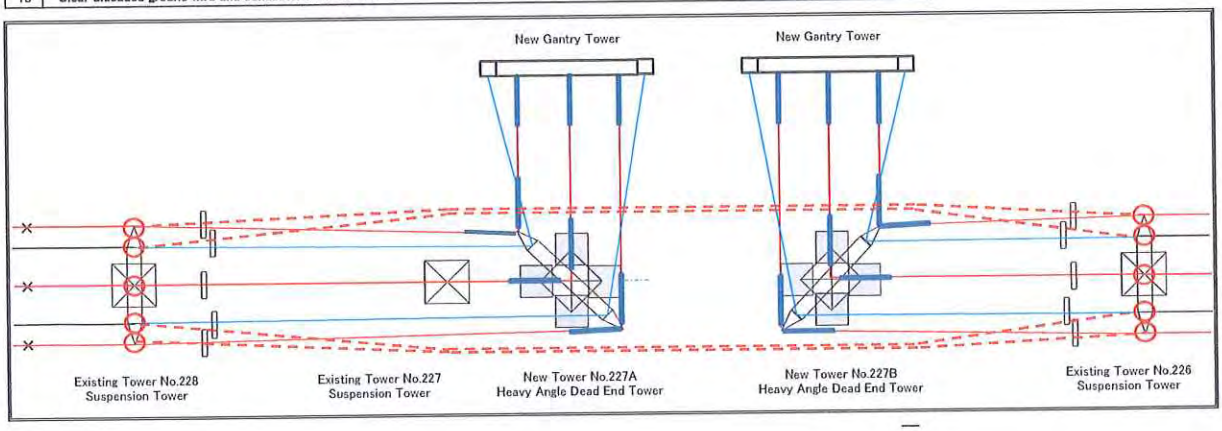
11	String ground wire & conductor between Tower No.226 and tower No.227A	SHUT DOWN CONDITION
12	String ground wire & conductor between Tower No.228 and tower No.227B	



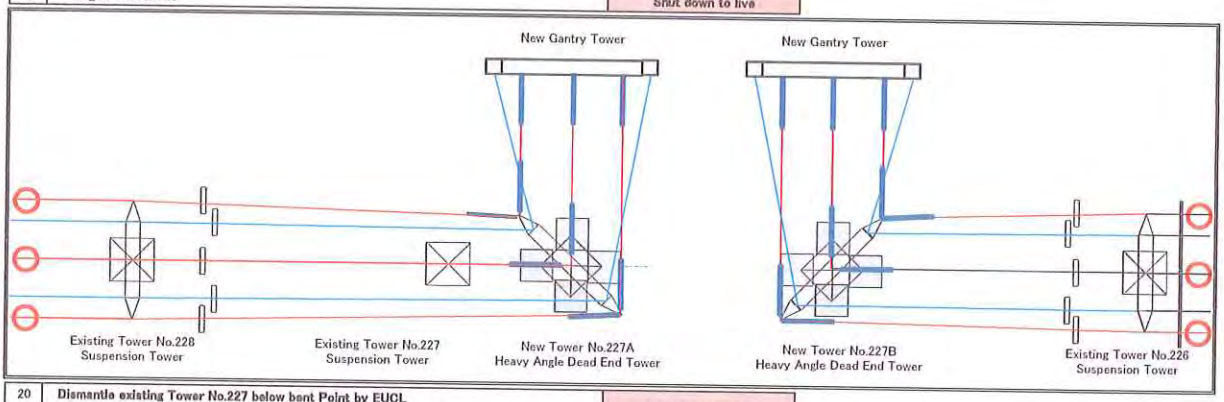
13	String ground wire & conductor between Tower No.227A and Gantry	SHUT DOWN CONDITION
14	String ground wire & conductor between Tower No.227B and Gantry	



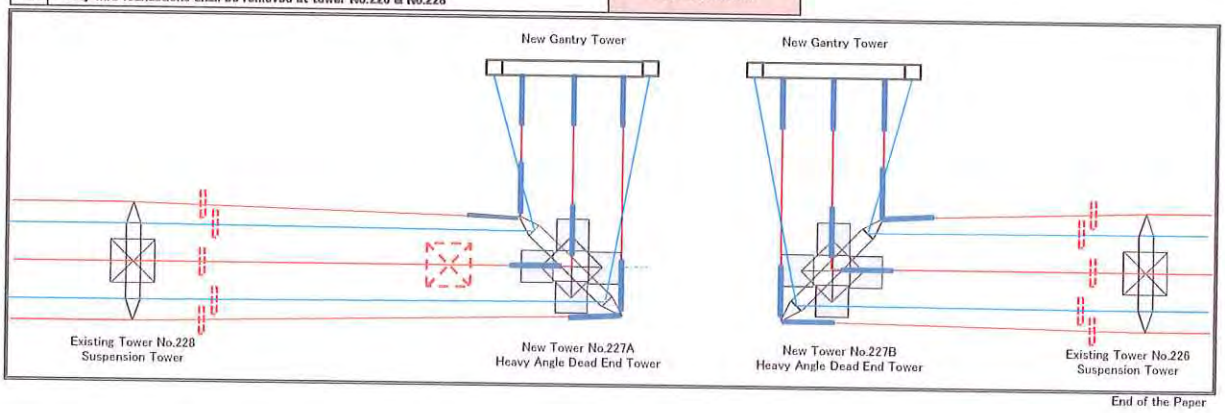
15	Re connect ground wire with connection box at tower No.228 and Gantry & at tower No.228 and Gantry	SHUT DOWN CONDITION
16	Re connect conductor at tower No.226 – Gantry – No.228 with suitable fittings	
17	Release stay wire at Tower No.226 & No.228	
18	Clear unloaded ground wire and conductor from the site	



19	Energize the circuit	Shut down to live

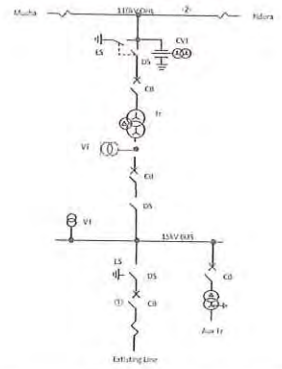
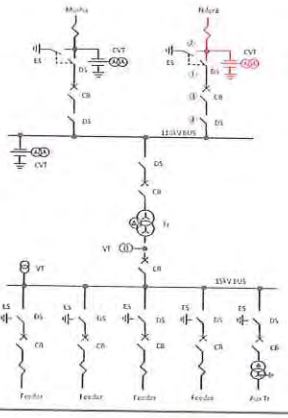


20	Dismantle existing Tower No.227 below bant Point by EUCL	LIVE CONDITION
21	Stay wire foundations shall be removed at tower No.226 & No.228	

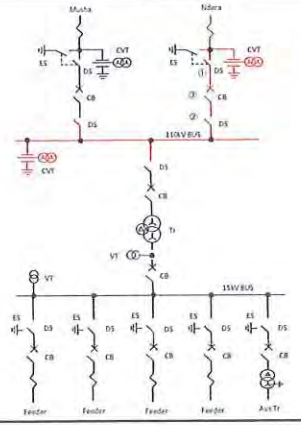
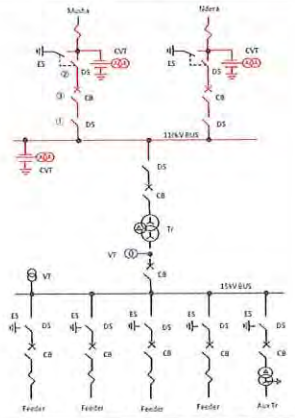


End of the Paper

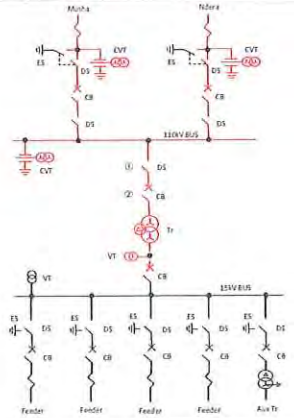
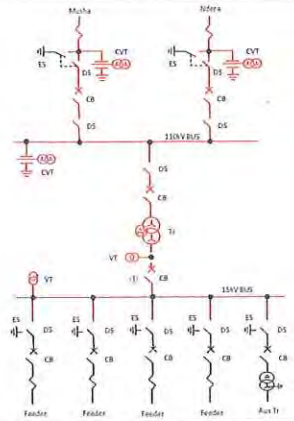
Switchover Procedure for Gasogi Substation (Draft)

Step	Item	Single Line Diagram	Procedure	Necessary Time
1	Preparation Work of Existing Facilities		[Shutdown of Existing Substation (SS)] - To open CB (①) of 15 kV Feeders - To de-energize 110 kV Ndera - Musha Line (②) for Shutdown of Gasogi SS [Connection change to New SS] - To connect OPGW cable to New SS - To install and connect 15 kV Cables for all 15 kV feeders [Test of Feeder Protection Relays (87L)] - To test 87L for Ndera SS and for Musha SS, utilizing OPGW. * All equipment in New Gasogi SS shall be installed and tested as much as possible before Switchover. * AC/DC supplis at this stage are fed from the temporary power supply for construction work.	-
2	Energization by Ndera Feeder		[Preparation work before Energization of New Gasogi SS] - To confirm all CBs, DSs to be open. - To re-confirm 2 x DS (① & ④), ES (②) and CB (③) on Ndera feeder to be open. [Energization from Ndera SS] - Close 110 kV CB at Ndera SS for Gasogi SS. (Energization of Ndera - Gasogi feeder) [Check] - To check the voltages of Ndera feeder and the phase angles	2 hours

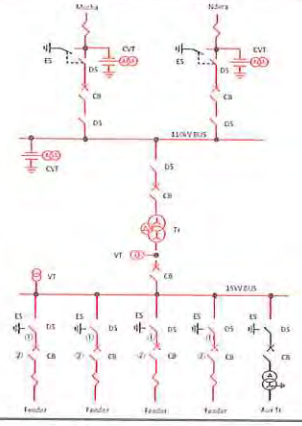
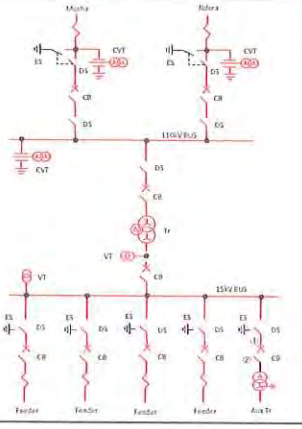
Switchover Procedure for Gasogi Substation (Draft)

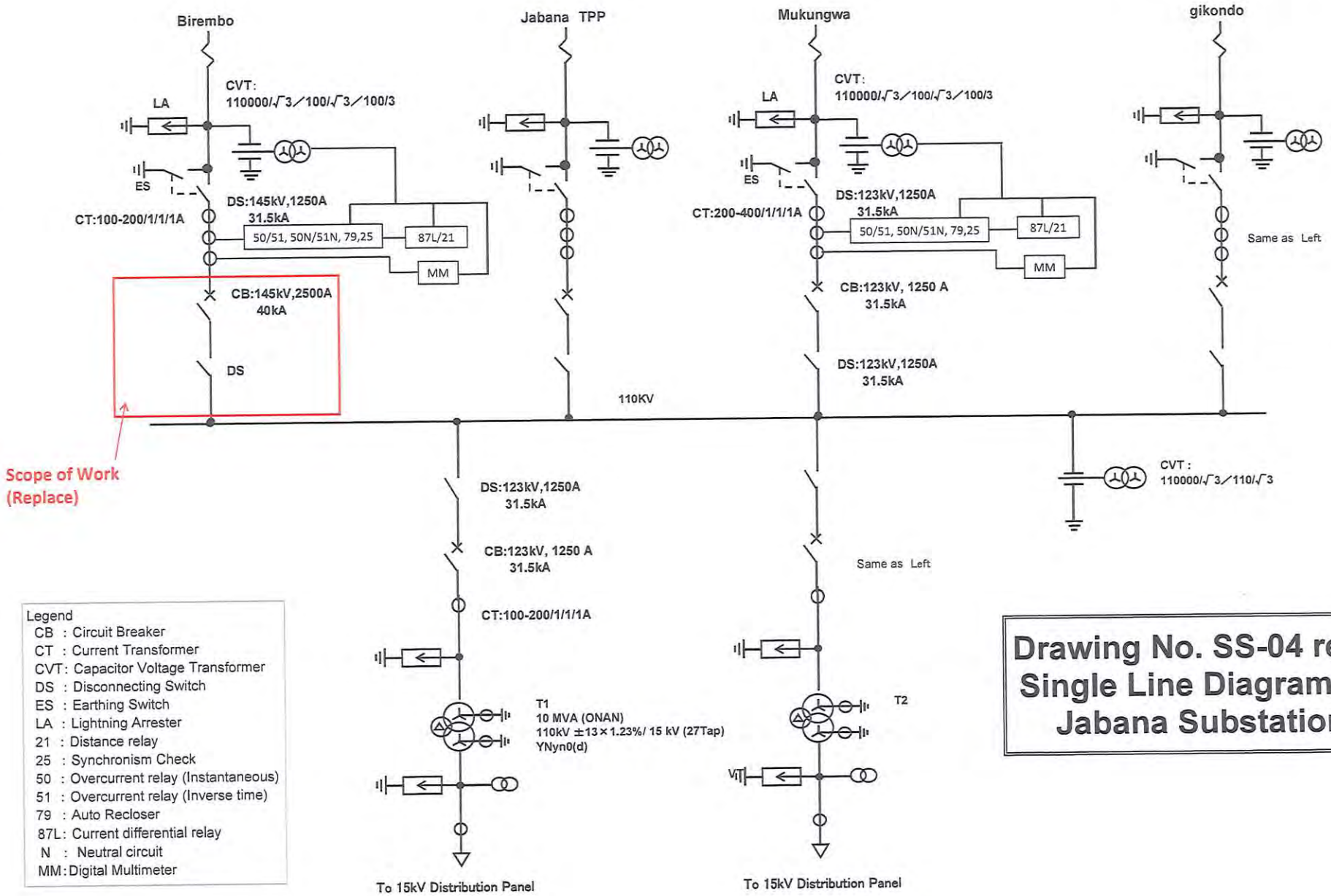
Step	Item	Single Line Diagram	Procedure	Necessary Time
3	Energization of 110 kV Bus		[Operation of Power Receiving] - To close DS (①) on Ndera feeder - To close DS (②) on Ndera feeder - To close CB (③) on Ndera feeder (Energization of 110 kV Bus) [Check] - To check the voltages of 110 kV Bus and the phase angles	1 hour
4	Power Transmission to Musha SS		[Operation of Power Transmitting] - To close DS (①) on Musha feeder - To close DS (②) on Musha feeder - To close CB (③) on Musha feeder (Power transmitting to Musha SS) [Check] - To check the voltages of 110 kV Musha feeder and the phase angles	2 hours

Switchover Procedure for Gasogi Substation (Draft)

Step	Item	Single Line Diagram	Procedure	Necessary Time
5	Energization of 110/15 kV Transformer		[Operation of Transformer Energization] - To close DS (①) on Transformer feeder - To close CB (②) on Transformer feeder (Energization of 110/15 kV Transformer) [Check] - To check the voltages of 15 kV side and the phase angles	1 hour
6	Energization of 15 kV Bus		[Operation of 15 kV Bus Energization] - To close 15 kV side CB (①) on Transformer feeder (Energization of 15 kV Bus) [Check] - To check the voltages of 15 kV Bus and the phase angles	1 hour

Switchover Procedure for Gasogi Substation (Draft)

Step	Item	Single Line Diagram	Procedure	Necessary Time
7	Power Transmission for 15 kV feeders		[Operation of 15 kV feeder Energization] - To close DS (①) on 15 kV Kanombe feeder - To close CB (②) on 15 kV Kanombe feeder (Power transmitting to 15 kV Kanombe feeder) Same operation of the above for other 15 kV feeders. [Check] - To check the voltages of 15 kV feeders and the phase angles	2 hours
8	Energization of 15/0.4 kV Auxiliary Transformer		[Operation of Aux. Transformer Energization] - To close DS (①) on Aux. Transformer feeder - To close CB (②) on Aux. Transformer feeder (Energization of 15/0.4 kV AuxiliaryTransformer) [Check] - To check the voltages of 0.4 kV side and the phase angles	1 hour



Legend
- CB : Circuit Breaker
- CT : Current Transformer
- CVT: Capacitor Voltage Transformer
- DS : Disconnecting Switch
- ES : Earthing Switch
- LA : Lightning Arrester
- 21 : Distance relay
- 25 : Synchronism Check
- 50 : Overcurrent relay (Instantaneous)
- 51 : Overcurrent relay (Inverse time)
- 79 : Auto Recloser
- 87L: Current differential relay
- N : Neutral circuit
- MM: Digital Multimeter

Drawing No. SS-04 rev.0
Single Line Diagram of Jabana Substation

Drawing No.SS-05 rev.0

Consideration for modification works of Jabana/Birembo substation

Based on proposal requested by EDCL (reinforcement of existing T/L among Jabana to Birembo),Team considered of countermeasures for modification works of Jabana, Gasogi Substation.
The detail works shown as following tables.

S/S	Component	current situation	Counter measure	Others
Jabana	Gantry	At connection point between Gantry and T/L conductor,Strain of steel materals was founded (especially Conspicuous phase B) Team decided that reuse of existing gantry is difficult	・To install new gantry near existing ones ・In order to avoid the influence on existing access road, New gantry is installed on the same line as existing LA	
	Electrical Equipment	Circuit breaker and Disconnection switch(bus side) was installed at1986.those reliability seem to low .	Improve reliability by replacement of equipment	Installation works for new foundation is as necessaly
	Conductor	Size of horizontal auxiliary bus conductor between gantry and 110 kV Bus is very thin.	To updated conductor size up to 300mm^2	
Birembo	Gantry	Problematic place in not founded	N/A	
	Electrical Equipment	Circuit breaker and Disconnection switch(bus side) was updated at2008.those reliability seem to high .	N/A	
	Conductor	Size of horizontal auxiliary bus conductor between gantry and 110 kV Bus is 300mm^2.Those size is as right	N/A	After completion of conductor reinforcement, Connection point of trasmission line will be First Transmission tower,

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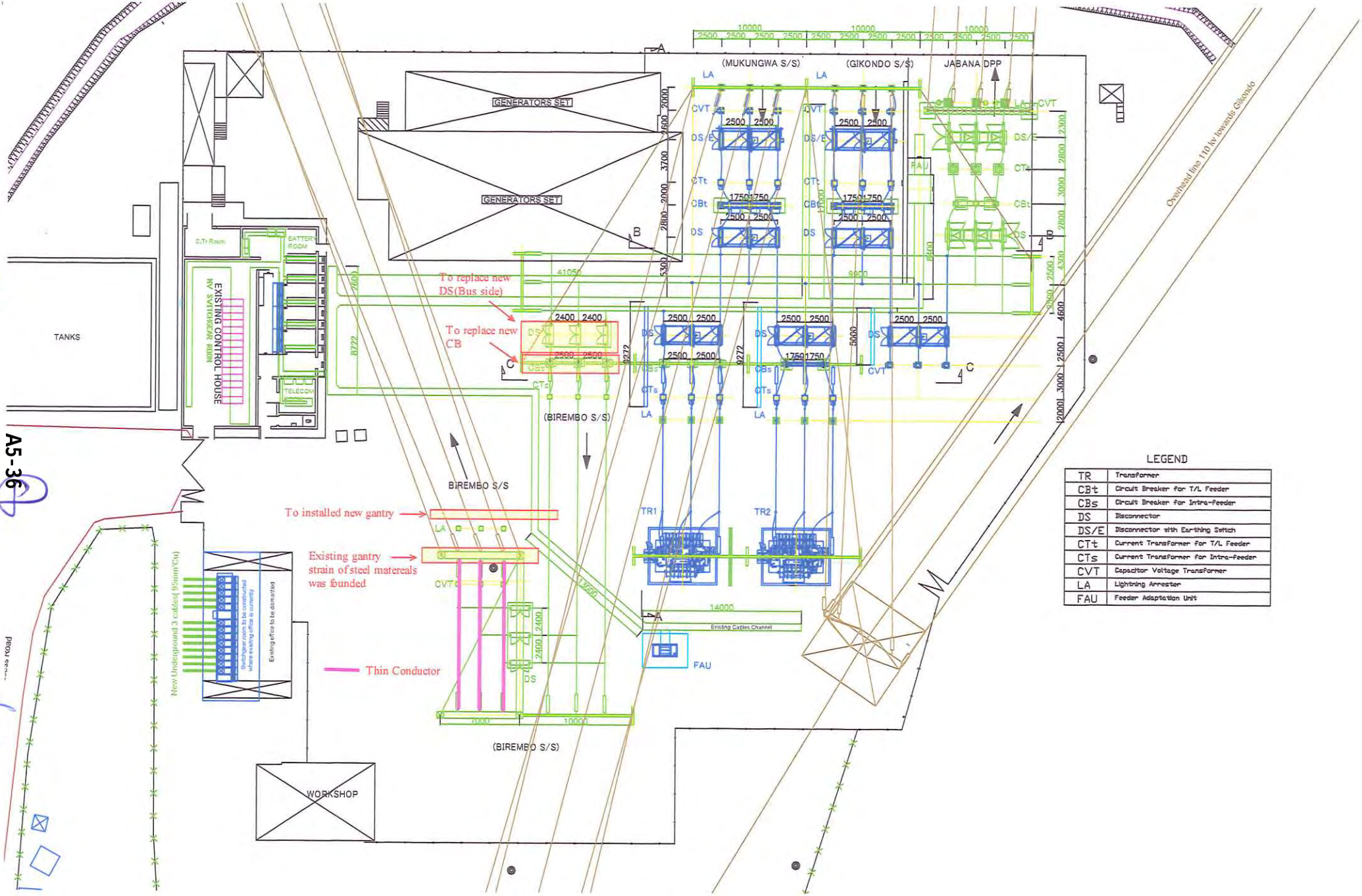
Result of survey for specification of Jabana / Birembo Substation

S/S	Contents	Tension of gantry	Line Conductor	Line Arrestor	VT	DS (Line side)	CT	CB	DS (Bus side)	Bus pipe	備　考
Jabana	Specification	None	300mm$^{2(※1)}$	None	110/√3 ／0.1/√3 ／0.1/3 kV	145kV 1250A 31.5kA(3s)	123kV 100/1A	145kV 2500A 40kA(3s)	None		※1: Size of horizontal auxiliary bus conductor between gantry and 110 kV Bus is very thin.
	Manufacture date	—	-	2008 (9 years)	2008 (9 years)	2007 (10 years)	2007 (10 years)	1986 (31 year)	None$^{(※2)}$		※2: The team made the following consideration based on survey result. ・operation voltage of Birembo line was updated 70kV to 110 kV in 2013 ・By updated works, CT and LA was replaced for oparetion voltage increase. But CB,DS has not necessity of replacement,so that reason orginally equipment still operated.
Birembo	Specification	Max 10kN	300mm$^{2(※3)}$	None	110/√3 ／0.1/√3 ／0.1/3 kV	145kV 1250A 31.5kA(3s)	140kV 200/1A	145kV 3150A 40kA(3s)	145kV 1250A 31.5kA(3s)	D100 t=5	※3: After completion of conductor reinforcement, Connection point of trasmission line will be First Transmission tower.
	Manufacture date	2008 (9 years)	-	2008 (9 years)	2008 (9 years)	2008 (9 years)	2008 (9 years)	2008 (9 years)	2008 (9 years)		


(MUKUNGWA S/S)
(GIKONDO S/S)
JABANA DPP
GENERATORS SET
GENERATORS SET
TANKS
EXISTING CONTROL HOUSE
BATTERY ROOM
TELECOM
To replace new DS(Bus side)
To replace new CB
(BIREMBO S/S)
BIREMBO S/S
To installed new gantry
Existing gantry strain of steel matereals was founded
Thin Conductor
(BIREMBO S/S)
WORKSHOP
TR1
TR2
FAU
Existing Cables Channel
Overhead line 110 kv towards Gikondo
LEGEND
TR Transformer
CBt Circuit Breaker for T/L Feeder
CBs Circuit Breaker for Intra-Feeder
DS Disconnector
DS/E Disconnector with Earthing Switch
CTt Current Transformer for T/L Feeder
CTs Current Transformer for Intra-Feeder
CVT Capacitor Voltage Transformer
LA Lightning Arrester
FAU Feeder Adaptation Unit

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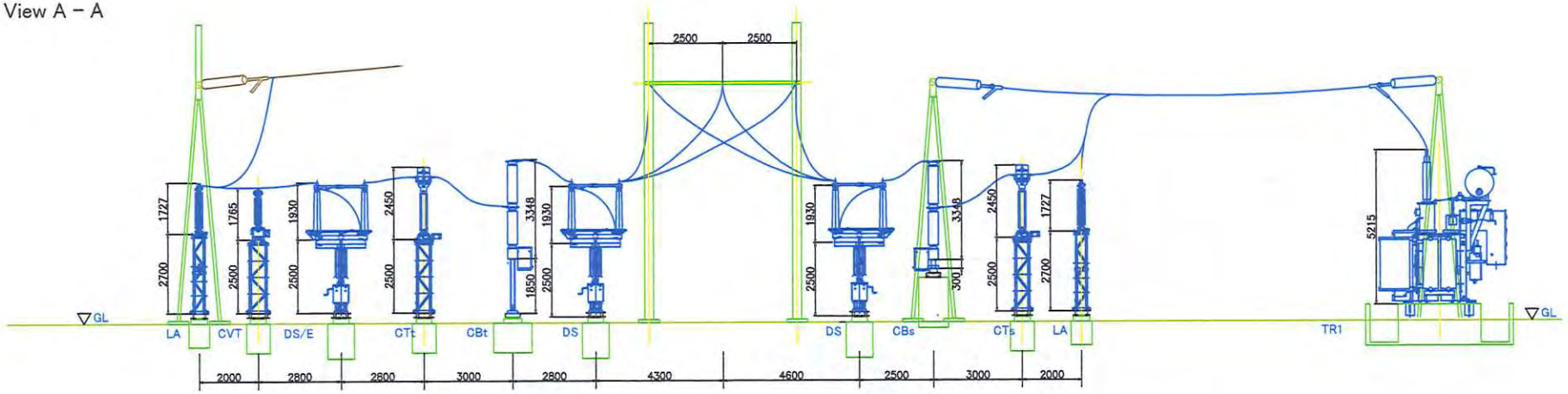
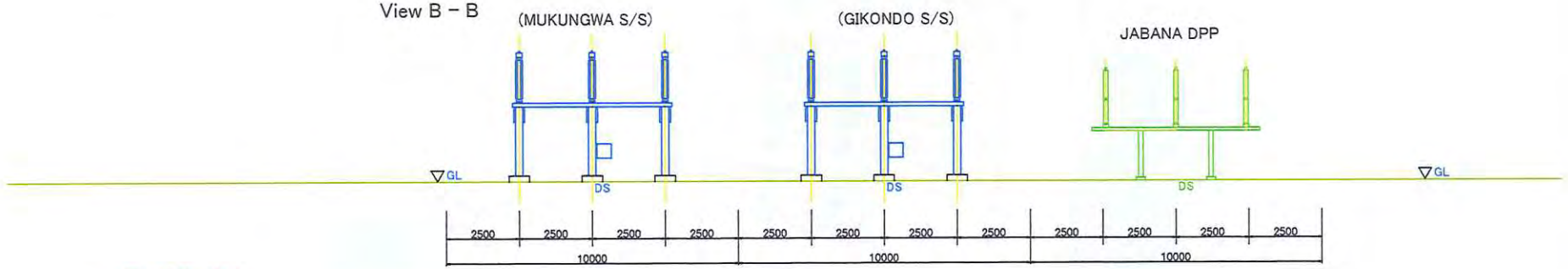
View A – A

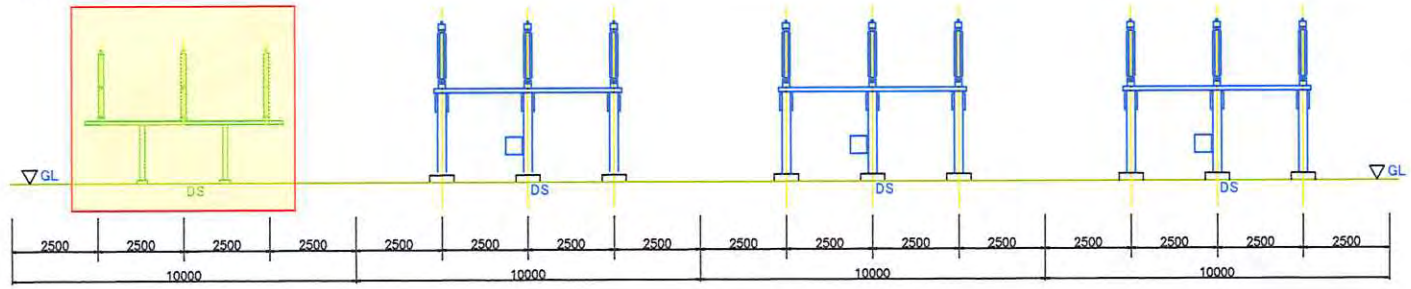


View B – B

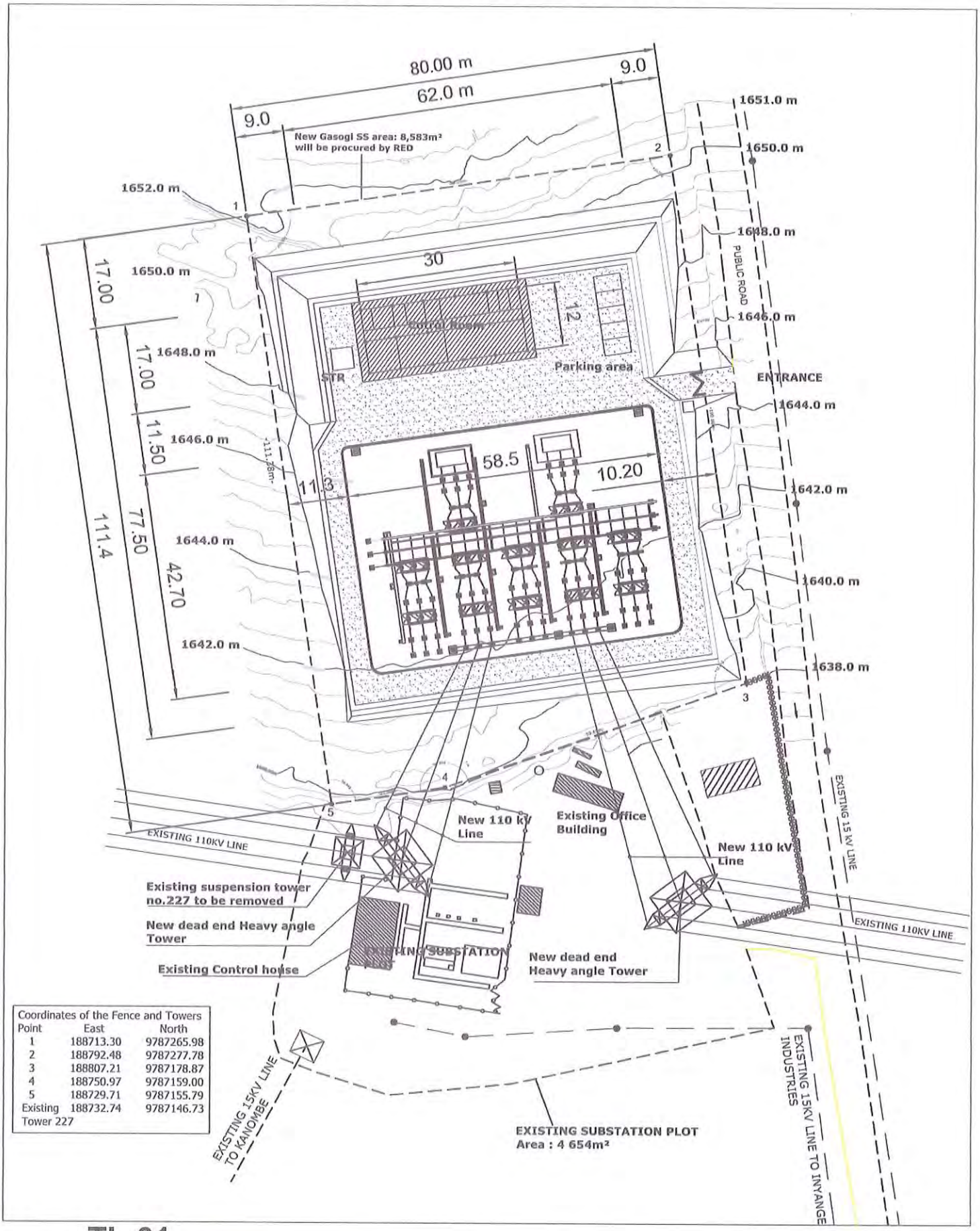


View C – C

Circuit Breaker
(Birembo line)

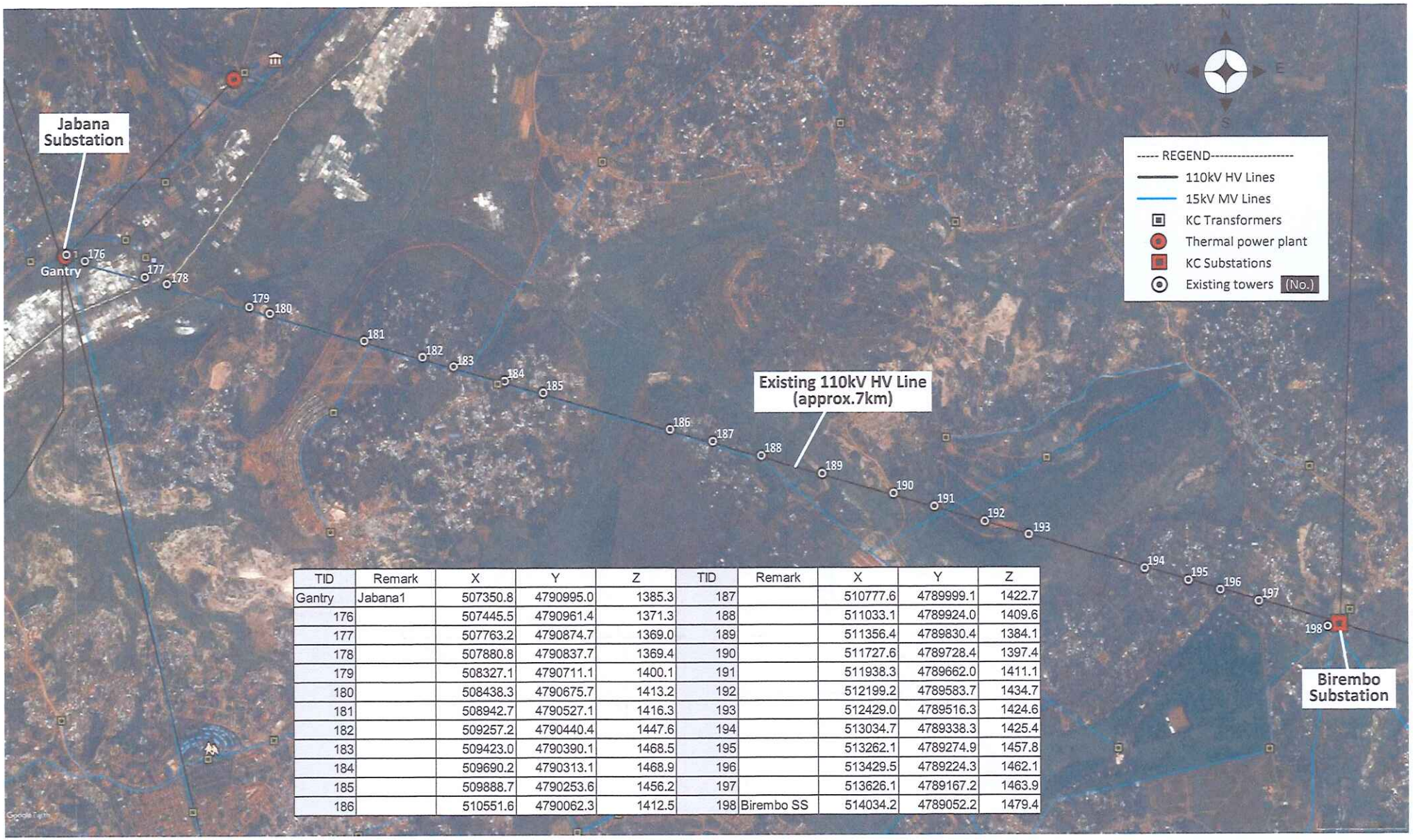


A5-37



Coordinates of the Fence and Towers		
Point	East	North
1	188713.30	9787265.98
2	188792.48	9787277.78
3	188807.21	9787178.87
4	188750.97	9787159.00
5	188729.71	9787155.79
Existing Tower 227	188732.74	9787146.73

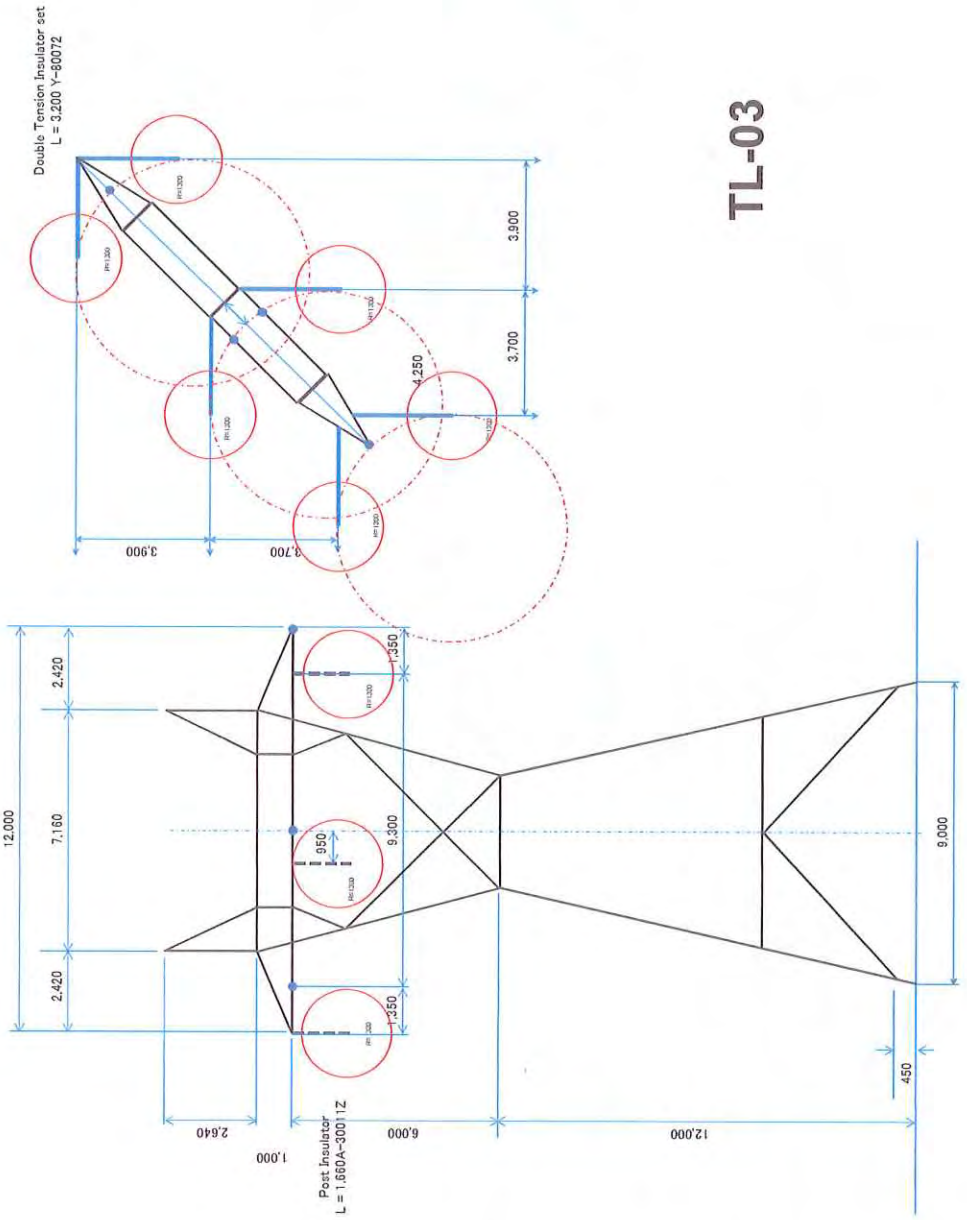
TL-01



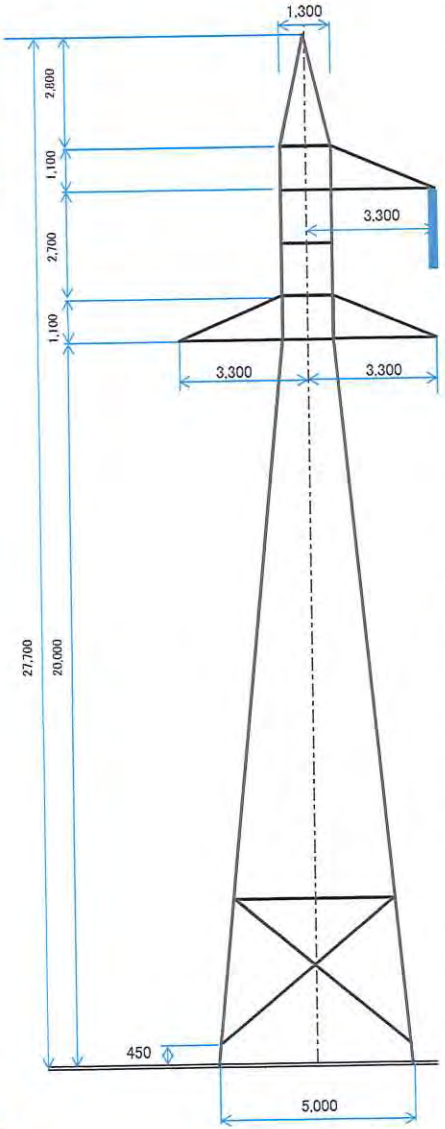
TID	Remark	X	Y	Z	TID	Remark	X	Y	Z
Gantry	Jabana1	507350.8	4790995.0	1385.3	187		510777.6	4789999.1	1422.7
176		507445.5	4790961.4	1371.3	188		511033.1	4789924.0	1409.6
177		507763.2	4790874.7	1369.0	189		511356.4	4789830.4	1384.1
178		507880.8	4790837.7	1369.4	190		511727.6	4789728.4	1397.4
179		508327.1	4790711.1	1400.1	191		511938.3	4789662.0	1411.1
180		508438.3	4790675.7	1413.2	192		512199.2	4789583.7	1434.7
181		508942.7	4790527.1	1416.3	193		512429.0	4789516.3	1424.6
182		509257.2	4790440.4	1447.6	194		513034.7	4789338.3	1425.4
183		509423.0	4790390.1	1468.5	195		513262.1	4789274.9	1457.8
184		509690.2	4790313.1	1468.9	196		513429.5	4789224.3	1462.1
185		509888.7	4790253.6	1456.2	197		513626.1	4789167.2	1463.9
186		510551.6	4790062.3	1412.5	198	Birembo SS	514034.2	4789052.2	1479.4

Existing 110kV Transmission Line from Jabana to Birembo Substation

TL-02


TL-03
Double Tension Insulator set
L = 3,200 Y-80072
3,900
3,700
4,250
3,900
3,700
12,000
2,420
7,160
2,420
1,350
9,300
950
1,350
9,000
450
2,640
1,000
6,000
12,000
Post Insulator
L = 1,660A-30011Z

2017/6/17/R-03



110 kV A1	Suspension

R/03

	Description	Unit	Design Value
	Voltage	kV	110
	Circuit	cct	1
	Tower Type	–	110-A1
	Wind Span	m	350
	Line Angle	deg	0 – 3
	Vertical Angle	Σ tan δ	+0.15
CONDUCTOR	Code	–	ACSR 240/40
	Numbers	–	1
	Diameter	mm	21.8
	Unit Mass	kg/m	0.976
	Unit Tension	N/wire	26,478
GROUND WIRE	Code	–	OPGW-100
	Numbers	–	1
	Diameter	mm	14.0
	Unit Mass	kg/m	0.467
	Unit Tension	N/wire	20,594
Insulator	Kind	–	250mm Suspension
	Numbers	–	9 x 2 Double SUS
	Weight	kg/set	180
	Length	mm	2,000
	Wind	N/set	488
Wind Pressure	Tower	Pa	1,599
	Conductor	Pa	552
	Ground Wire	Pa	552

※ Body Extension +3, +6, +9

※ Safety facter = 1.0 for Body, 1.2 for Arm

TL-04

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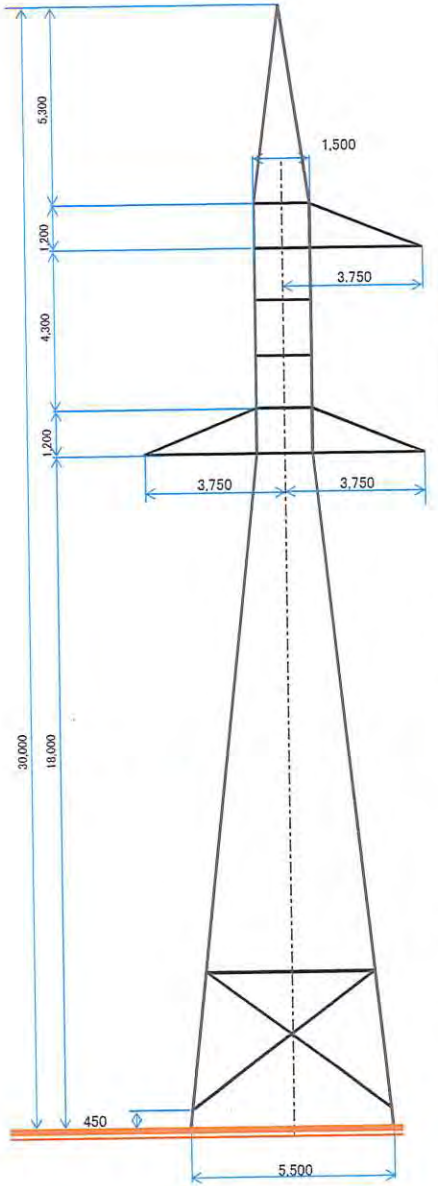
2017/6/17/R-03

Long span Tension



110 kV B1	

R/03

	Description	Unit	Design Value
	Voltage	kV	110
	Circuit	cct	1
	Tower Type	–	110-B1
	Wind Span	m	500
	Line Angle	deg	0 – 15
	Vertical Angle	Σ tan δ	±0.15
CONDUCTOR	Code	–	ACSR 240/40
	Numbers	–	1
	Diameter	mm	21.8
	Unit Mass	kg/m	0.976
	Unit Tension	N/wire	26,478
	Unbalance Tension	N/wire	7,360
GROUND WIRE	Code	–	OPGW-100
	Numbers	–	1
	Diameter	mm	14.0
	Unit Mass	kg/m	0.467
	Unit Tension	N/wire	20,594
	Unbalance Tension	N/wire	5,730
Insulator	Kind	–	250mm Suspension
	Numbers	–	9 x 2 Double TEN
	Weight	kg/set	360
	Length	m	3,200
	Jumper Depth	m	1,600
	Wind	N/set	771
Wind Pressure	Tower	Pa	1,599
	Conductor	Pa	552
	Ground Wire	Pa	552

※ Body Extension +3, +6, +9

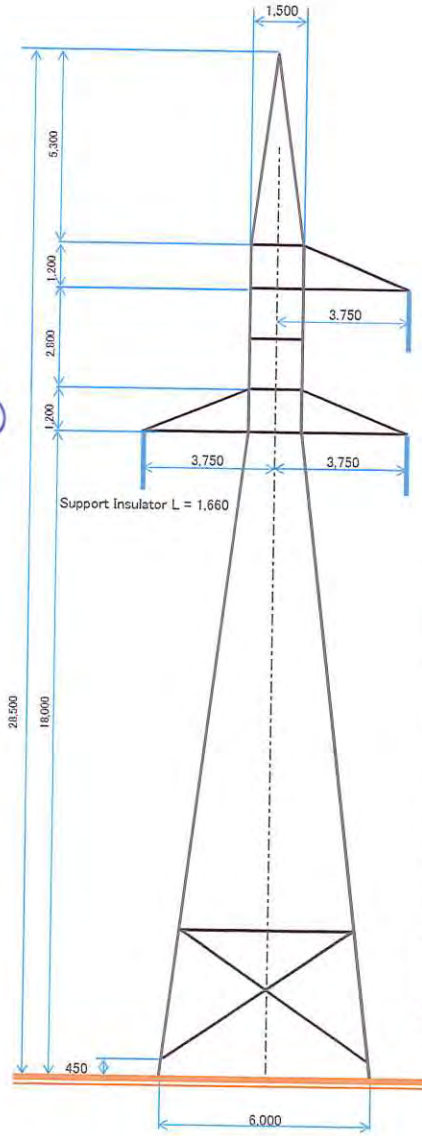
※ Safety facter = 1.0 for Body, 1.2 for Arm

2017/6/17/R-03

Angle Tension

110 kV C1	

R/03



	Description	Unit	Design Value
	Voltage	kV	110
	Circuit	cct	1
	Tower Type	–	110-C1
	Wind Span	m	350
	Line Angle	deg	0 – 30
	Vertical Angle	Σ tan δ	±0.15
CONDUCTOR	Code	–	ACSR 240/40
	Numbers	–	1
	Diameter	mm	21.8
	Unit Mass	kg/m	0.976
	Unit Tension	N/wire	26,478
GROUND WIRE	Code	–	OPGW-100
	Numbers	–	1
	Diameter	mm	14.0
	Unit Mass	kg/m	0.467
	Unit Tension	N/wire	20,594
Insulator	Kind	–	250mm Suspension
	Numbers	–	9 x 2 Double TEN
	Weight	kg/set	360
	Length	m	3,200
	Jumper Depth	m	1,600
	Wind	N/set	771
	Support Insulator	m	1,660
	Weight	kg	55
	Wind	N/set	170
Wind Pressure	Tower	Pa	1,599
	Conductor	Pa	552
	Ground Wire	Pa	552

※ Body Extension +3, +6, +9

※ Safety facter = 1.0 for Body, 1.2 for Arm

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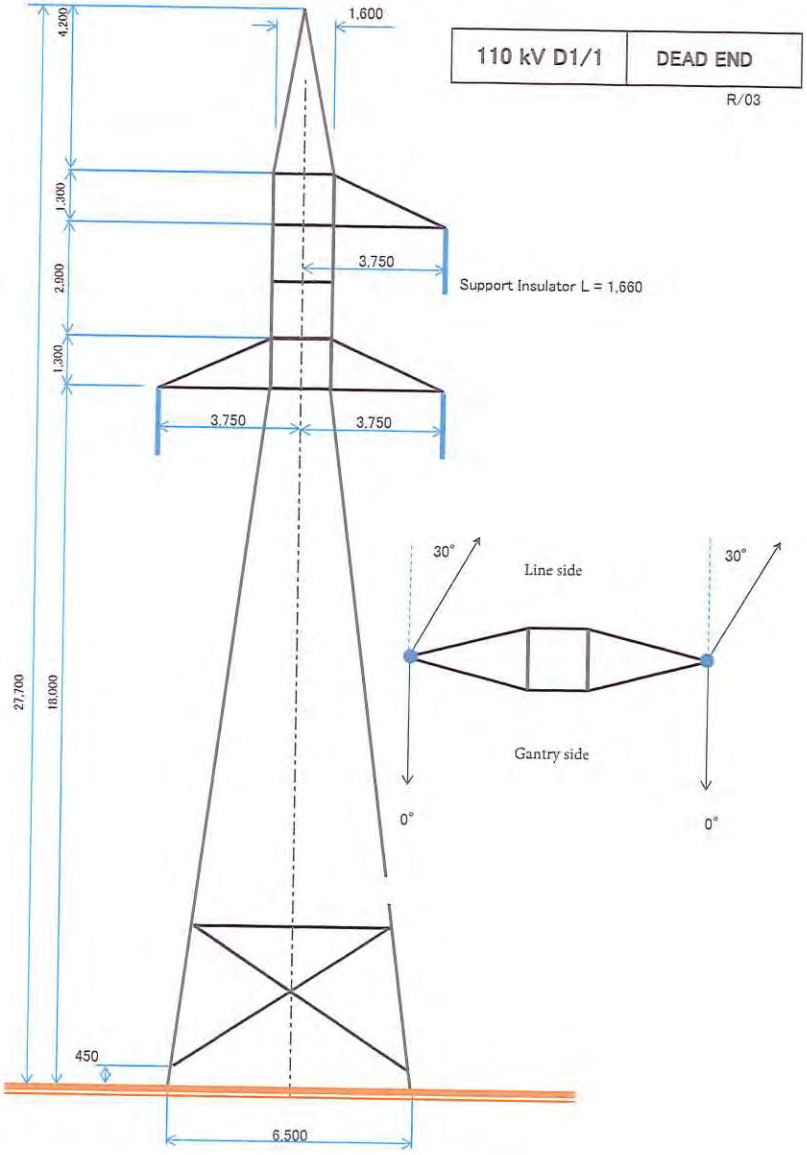
2017/6/17/R-03/1/2

110 kV D1/1	DEAD END

R/03

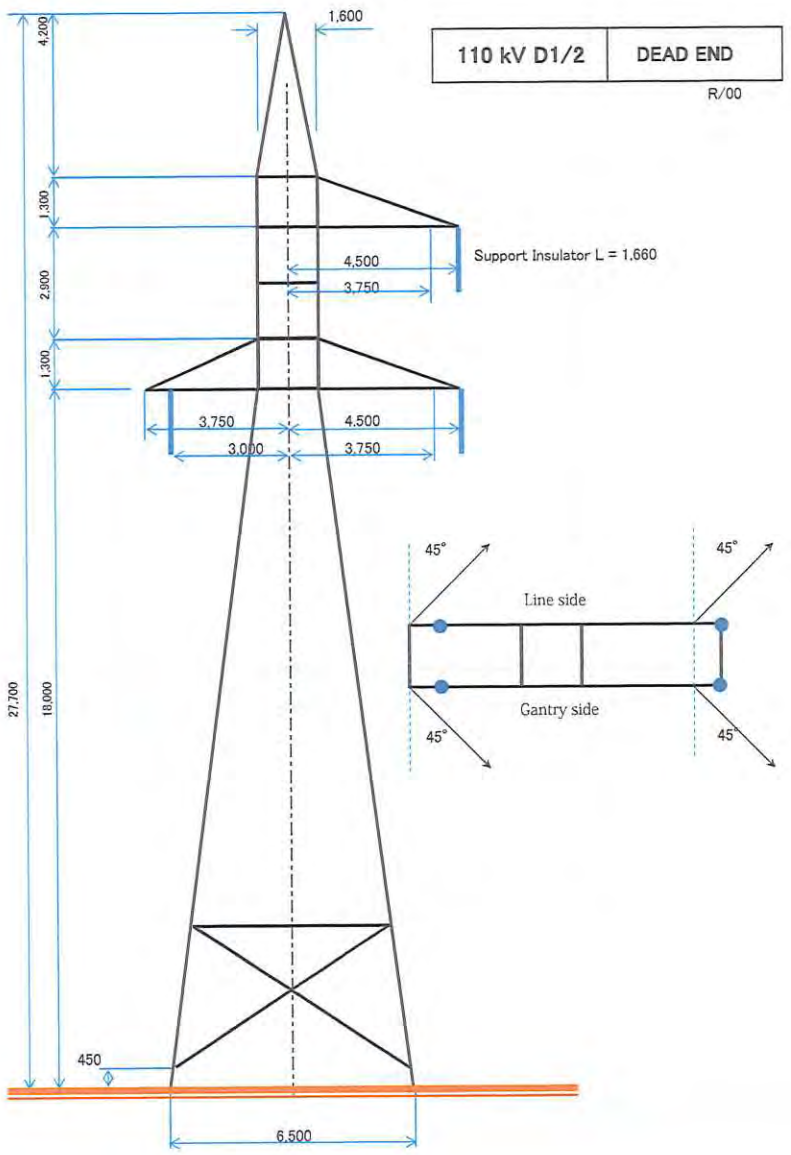


Description		Unit	Design Value	
Voltage		kV	110	
Circuit		cct	1	
Tower Type		–	110-D1	
			Line side	Gantry side
Wind Span		m	200	50
Line Angle		deg	0 – 30	0
Vertical Angle		Σ tan δ	±0.15	0.15
			Line side	Gantry side
CONDUCTOR	Code	–	ACSR 240/40	
	Numbers	–	1	
	Diameter	mm	21.8	
	Unit Mass	kg/m	0.976	
	Unit Tension	N/wire	26,478	9,807
GROUND WIRE	Code	–	OPGW-100	
	Numbers	–	1	
	Diameter	mm	14.0	
	Unit Mass	kg/m	0.467	
	Unit Tension	N/wire	20,594	6,865
			Line side	Gantry side
Insulator	Kind	–	250mm Suspension	
	Numbers	–	9 x 2 TEN	9 x 2 TEN
	Weight	kg/set	180	180
	Length	mm	3,200	
	Jumper Depth	mm	1,600	
	Wind	N/set	386	386
	Support Insulator	mm	1,660	
	Weight	kg	55	
	Wind	N/set	170	
Wind Pressure	Tower	Pa	1,599	
	Conductor	Pa	552	
	Ground Wire	Pa	552	

※ Body Extension +3, +6, +9

※ Safety facter = 1.0 for Body, 1.2 for Arm

A5-43



Description		Unit	Design Value	
Voltage		kV	110	
Circuit		cct	1	
Tower Type		–	110-D1	
			Line side	Gantry side
Wind Span		m	250	50
Line Angle		deg	0 – 45	0 – 45
Vertical Angle		Σ tan δ	±0.15	0.15
			Line side	Gantry side
CONDUCTOR	Code	–	ACSR 240/40	
	Numbers	–	1	
	Diameter	mm	21.8	
	Unit Mass	kg/m	0.976	
	Unit Tension	N/wire	26,478	9,807
GROUND WIRE	Code	–	OPGW-100	
	Numbers	–	1	
	Diameter	mm	14.0	
	Unit Mass	kg/m	0.467	
	Unit Tension	N/wire	20,594	6,865
			Line side	Gantry side
Insulator	Kind	–	250mm Suspension	
	Numbers	–	9 x 2 TEN	9 x 2 TEN
	Weight	kg/set	180	180
	Length	mm	3,200	
	Jumper Depth	mm	1,600	
	Wind	N/set	386	386
	Support Insulator	mm	1,660	
	Weight	kg	55	
	Wind	N/set	170	
Wind Pressure	Tower	Pa	1,599	
	Conductor	Pa	552	
	Ground Wire	Pa	552	

※ Body Extension +3, +6, +9

※ Safety facter = 1.0 for Body, 1.2 for Arm

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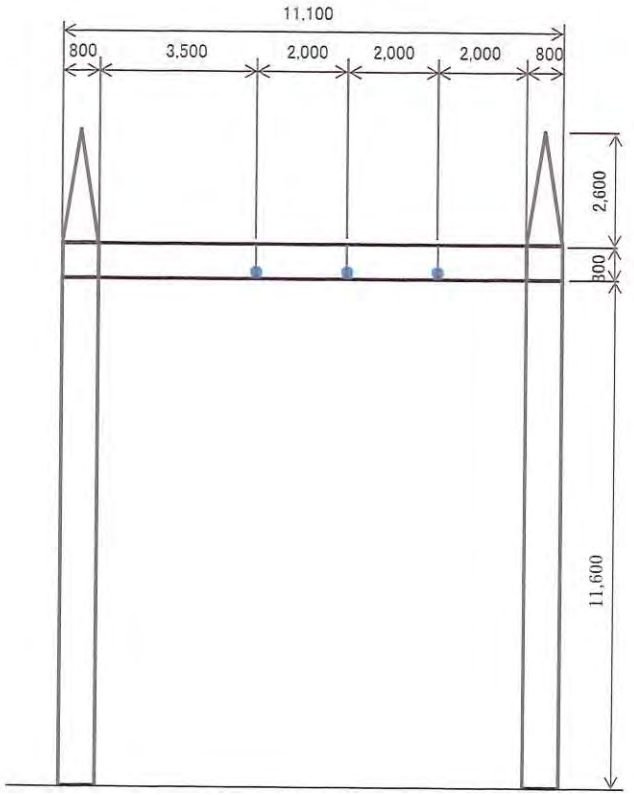
110 kV JABANA S/S GANTRY



Description		Unit	Design Value	
Voltage		kV	110	
Circuit		cct	1	
Tower Type		–	GANTRY at JABANA S/S	
			Line side	End side
Wind Span		m	50	0
Line Angle		deg	0 – 5	0
Vertical Angle		Σ tan δ	0.15	0
			Line side	End side
CONDUCTOR	Code	–	ACSR 240/40	
	Numbers	–	1	
	Diameter	mm	21.8	
	Unit Mass	kg/m	0.976	
	Unit Tension	N/wire	9,807	150
GROUND WIRE	Code	–	OPGW-100	
	Numbers	–	1	
	Diameter	mm	14.0	
	Unit Mass	kg/m	0.467	
	Unit Tension	N/wire	6,865	100
Insulator			Line side	
	Kind	–	250mm Suspension	
	Numbers	–	9 x 1 TEN	
	Weight	kg/set	180	
	Length	mm	3,200	
	Jumper Depth	mm	1,600	
	Wind	N/set	488	
Wind Pressure	Tower	Pa	1,599	
	Conductor	Pa	552	
	Ground Wire	Pa	552	

※ Body Extension Nil

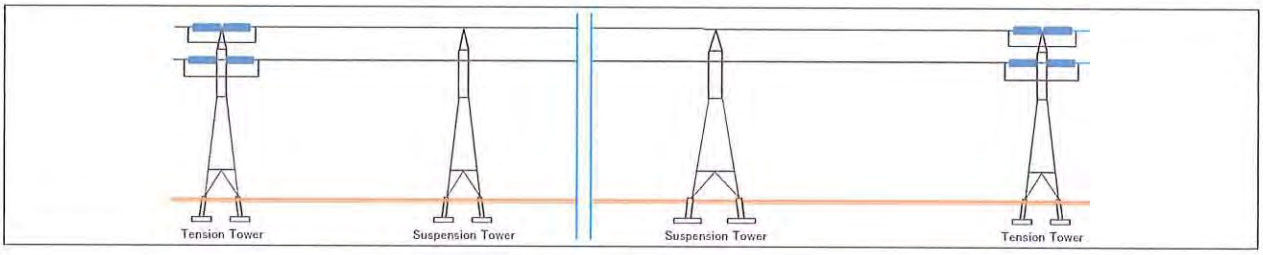
※ Safety facter = 1.0 for Body, 1.2 for Arm

TL-05

Dismantle and New Construction of 110 kV Transmission Line between JABANA Sub Station and BIREMBO Sub Station

This plan has been made for the purpose of checking feasibility and budgeting. Therefore, this paper does not bind the contractor's free hand to apply any method as far as it is reasonable.

Present Situation

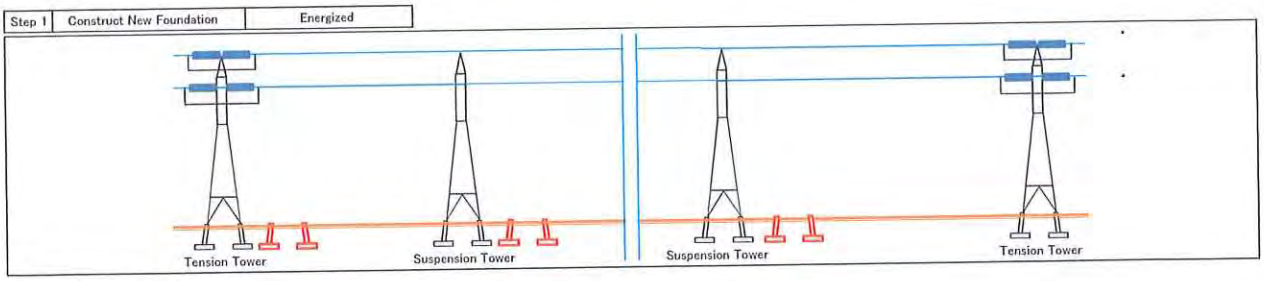


DETAILED WORK STEP

1. **Work shall be performed with maximum care to avoid collapse of existing towers during construction. To achieve this, it is essential to apply each and all adequate countermeasure.**
2. **Some of the preparatory work has to be done with energized condition. Maximum care is deemed to be necessary in order not to make electrical accident.**
3. **To minimize the shut down duration, it is essential to plan and apply parallel works as much as possible.**

Step	Activity	Site Condition	Work By	Cycle	Remarks	Work day (day)
Step 1	Construct New Foundation	Energized	Japan		Construction to be in accordance with the design	150
Step 2	Shut down the circuit	Energized to Shut down	EUCL		Under responsibility of EUCL	1
Step 3	Set stay wire to the tower to avoid collapse of tower by unbalanced tension.	Shut down	EUCL	Repeat Step-3 to Step-12 for all string section	Repeat Step-3 to Step-11 for all ground wire and conductor of the same string section: Check adequate stay wire tension	45
Step 4	Hang snatch block				Type to be adequate to the conductor	
Step 5	Release ground wire or conductor from suspension clamp and set on to the snatch block				Avoid conductor fall down to the ground	
	Jumper loop at the tension towers shall be open				Only expert shall work	
Step 6	Set Winch and Tensioner at the both side of tension tower.				Set straight to the line	
Step 7	Connect messenger wire of the winch to the end of the clamp				Use adequate jig which have enough strength	
Step 8	Connect messenger wire of the tensioner to the end of the clamp				Use adequate jig which have enough strength	
Step 9	Dismantle both side of tension clamp				Care not to give vibration to tower	
Step 10	Wind the conductor. Tesioner must give adequate tension to the conductor.				Watch sag not to drop the conductor	
Step 11	After whole conductor is rewinded, repeat the same to the next conductor (Repeat from step-4)					
Step 12	Same procedure shall be applied to the next section until to complete.					
Step 13	Disassemble stay wire, anchor and snatch block. Remove winch and tensioner from the site.					
Step 14	Dismantle existing towers		EUCL	Parallel	Work to be done by EDUL	120
	Erect new towers on the new foundation		Japan		Parallel work with dismantling work by EDUL	
Step 15	Set snatch block at each tower to the string section towers		Japan	Repeat step 15 to 22 / Repeat step 15 to 21 for adjucet span	Repeat step 13 to 19 for this span: Special care not to damage insulators	45
	Hang adequate insulator string					
	Set winch, tensioner and conductor dram at the position				Watch sag and tension not to drop the conductor	
Step 16	Pull messenger with winch until the conductor reaches the string section end tower				Care not to give vibration to tower	
Step 17	Pull the conductor by adequate tool to set the conductor tension to design value.				Care not to give vibration to tower	
Step 18	Separate the conductor from the tower					
Step 19	Remove snatch blocks, conductor dram from the tower				Confirm necessary stay wire tension	
Step 20	Set stay wire to the position of strung conductor and proceed the same for next conductor					
Step 21	Set stay wire at the strung conductor and proceed the same for the adjacent string span					
Step 22	Connect ground wire and conductor with jumper loop at the tension tower					
Step 23	Repeat the same procedure for all the string spans are completed					
Step 24	Disassemble stay wires					
	Re energize the line	Shut down to Energized	EUCL		Under responsibility of EUCL	1
Step 25	Dismantle existing foundation	Energized	EUCL		Under responsibility of EUCL	120

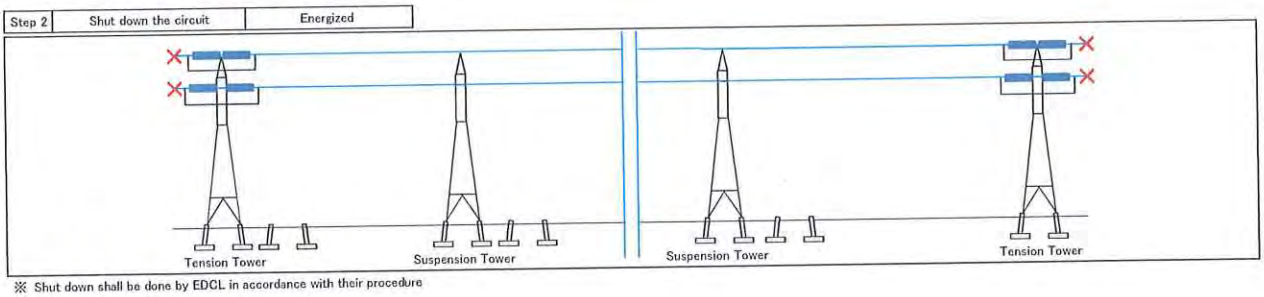
Step 1	Construct New Foundation	Energized



※ Construction to be in accordance with the design, plan and profile drawings

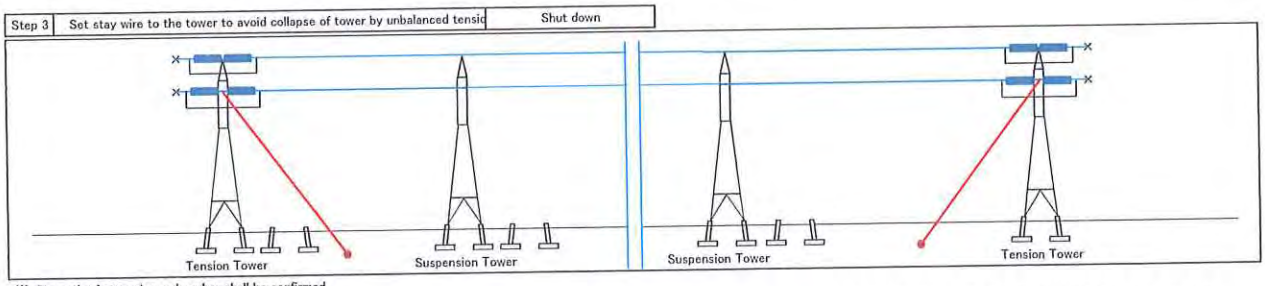
※ Work shall be done with highest care with the energized conductor.

Step 2	Shut down the circuit	Energized



※ Shut down shall be done by EDCL in accordance with their procedure

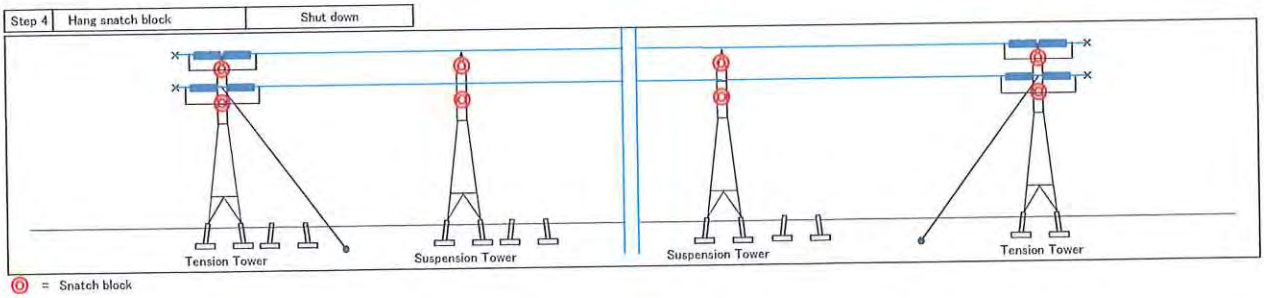
Step 3	Set stay wire to the tower to avoid collapse of tower by unbalanced tensio	Shut down



※ Strength of stay wire and anchor shall be confirmed

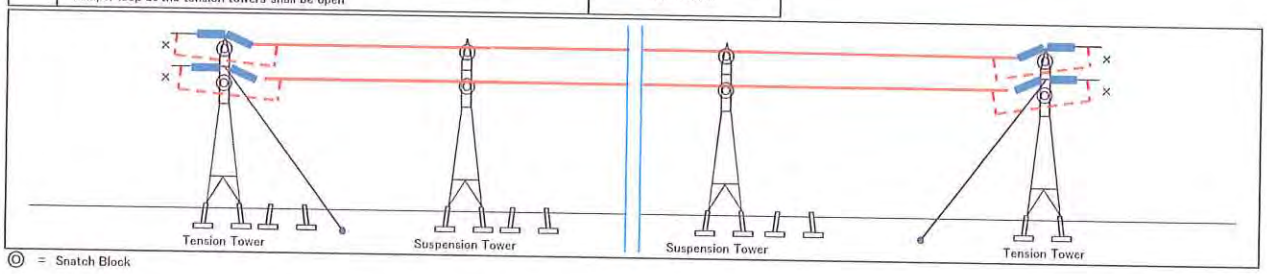
※ Theoretically, step-3 to step-11 shall be performed between Tension tower and tension tower, however, if the distance between tension tower to tension tower is longer than the capacity of pulling machine, it is acceptable to do so between suspension towers. In this case, however, special care shall be taken to avoid unbalance tension to the towers.

Step 4	Hang snatch block	Shut down



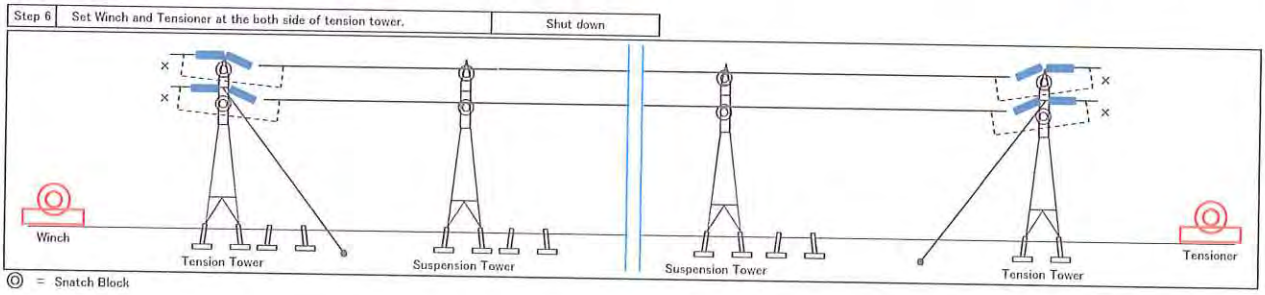
◎ = Snatch block

Step 5	Release ground wire or conductor from suspension clamp and set on to the snatch block Jumper loop at the tension towers shall be open	Shut down



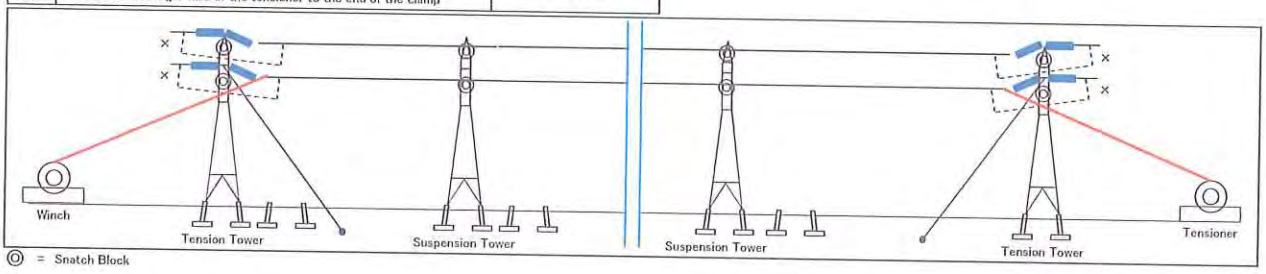
◎ = Snatch Block

Step 6	Set Winch and Tensioner at the both side of tension tower.	Shut down



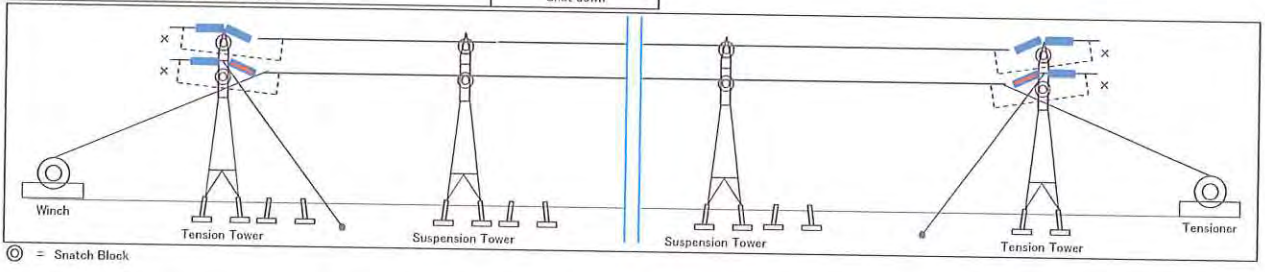
◎ = Snatch Block

Step-7 Step-8	Connect messenger wire of the winch to the end of the clamp Connect messenger wire of the tensioner to the end of the clamp	Shut down



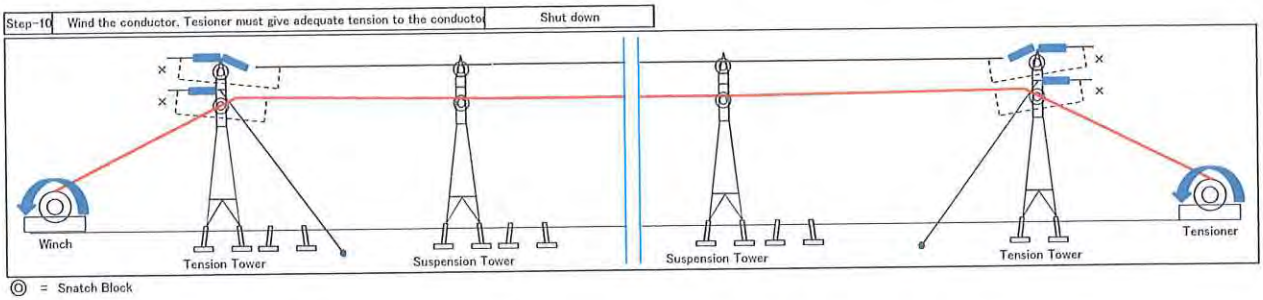
◎ = Snatch Block

Step-9	Dismantle both side of tension clamp	Shut down



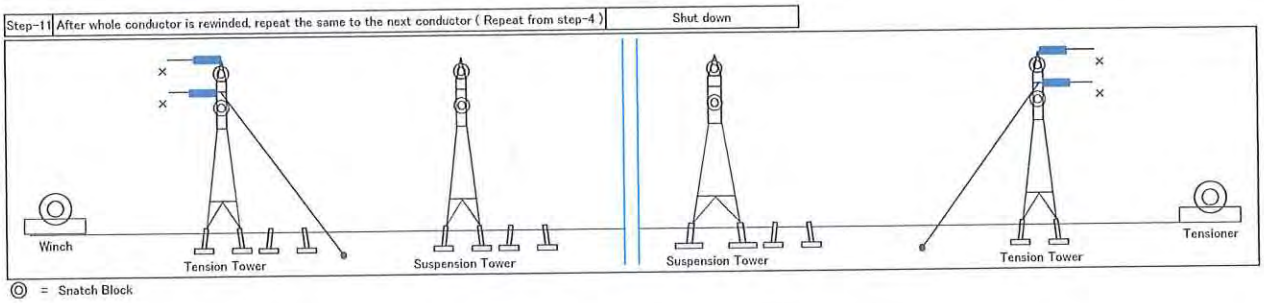
◎ = Snatch Block

Step-10	Wind the conductor. Tesioner must give adequate tension to the conductor	Shut down



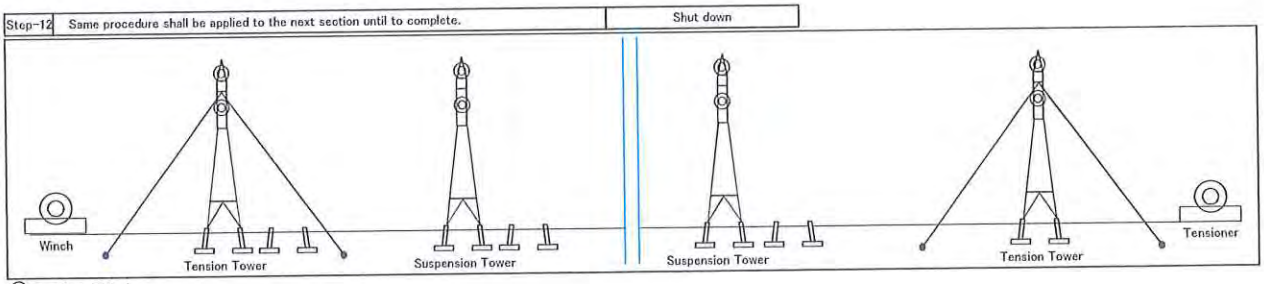
◎ = Snatch Block

Step-11	After whole conductor is rewinded, repeat the same to the next conductor (Repeat from step-4)	Shut down



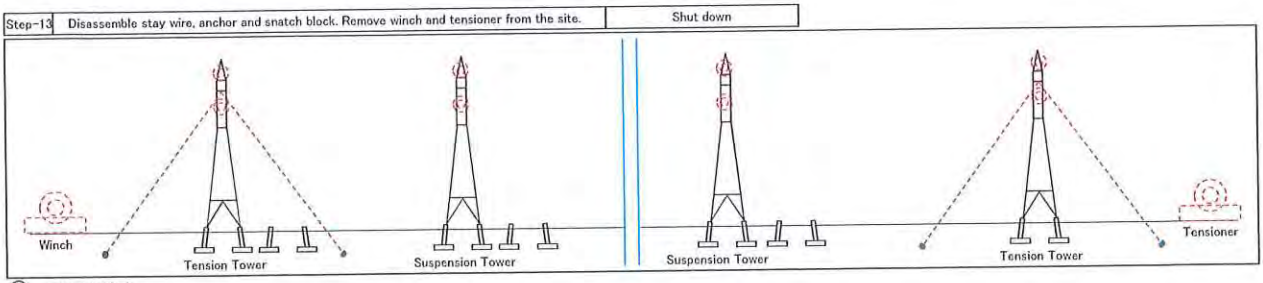
◎ = Snatch Block

Step-12	Same procedure shall be applied to the next section until to complete.	Shut down



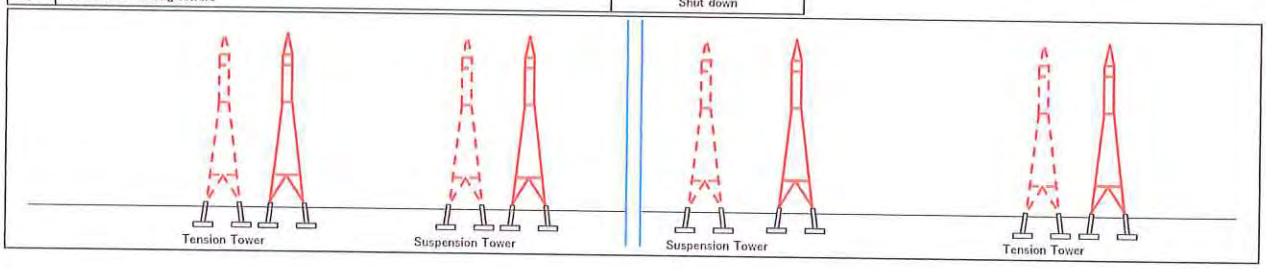
◎ = Snatch Block

Step-13	Disassemble stay wire, anchor and snatch block. Remove winch and tensioner from the site.	Shut down

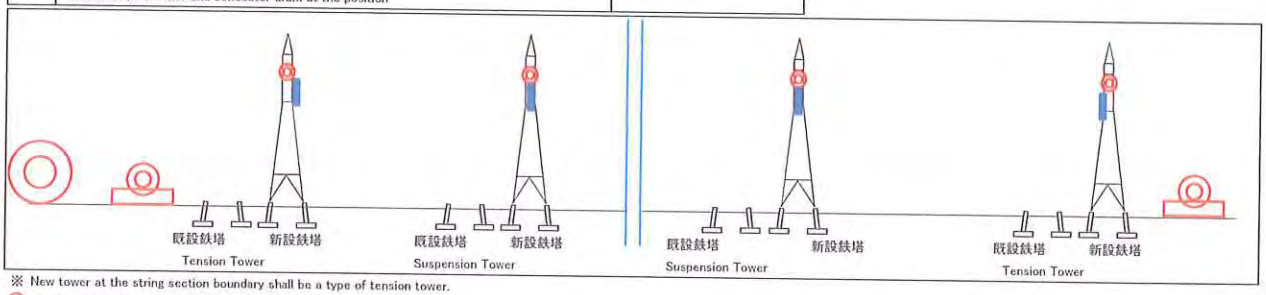


◎ = Snatch Block

Step-14	Dismantle existing towers	Shut down



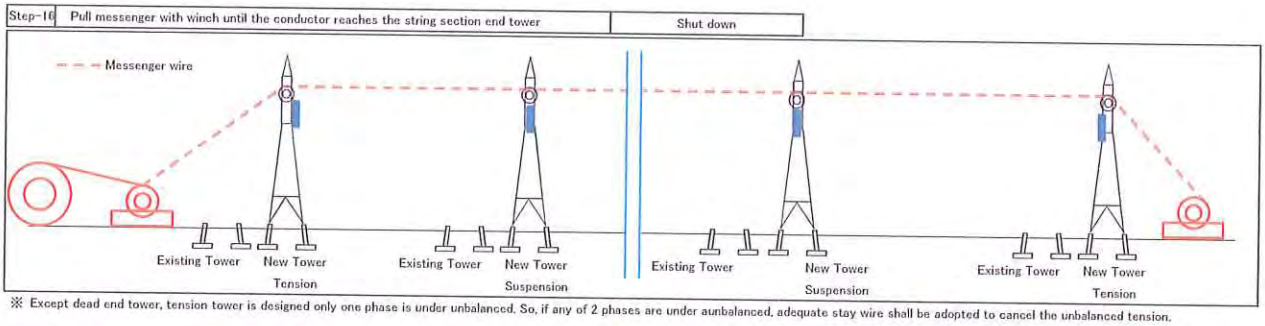
Step-15	Set snatch block at each tower to the string section towers Hang adequate insulator string Set winch, tensioner and conductor dram at the position	Shut down



※ New tower at the string section boundary shall be a type of tension tower.

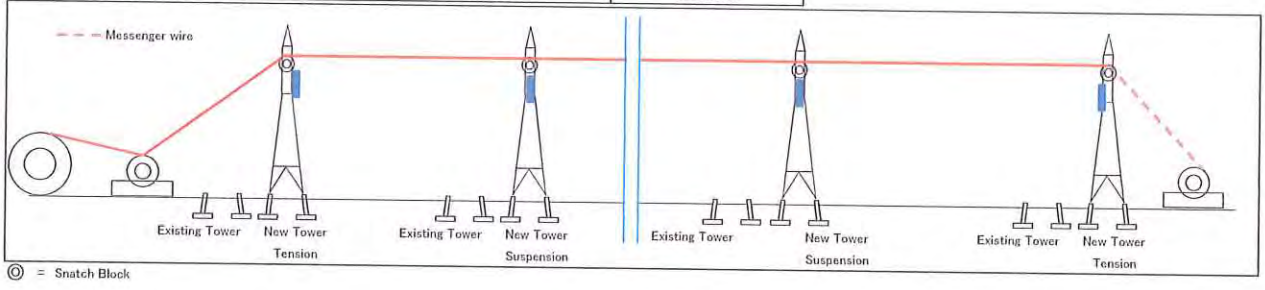
◎ = Snatch Block

Step-16	Pull messenger with winch until the conductor reaches the string section end tower	Shut down



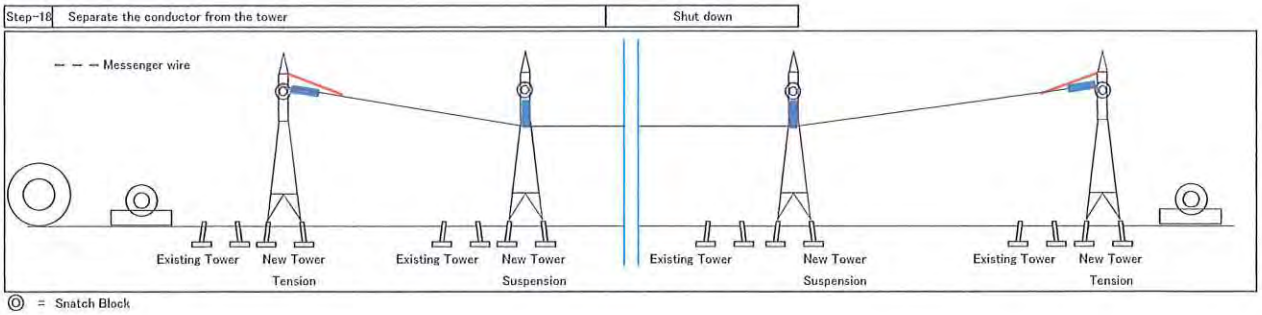
※ Except dead end tower, tension tower is designed only one phase is under unbalanced. So, if any of 2 phases are under aunbalanced, adequate stay wire shall be adopted to cancel the unbalanced tension.

Step-17	Pull the conductor by adequate tool to set the conductor tension to design value.	Shut down



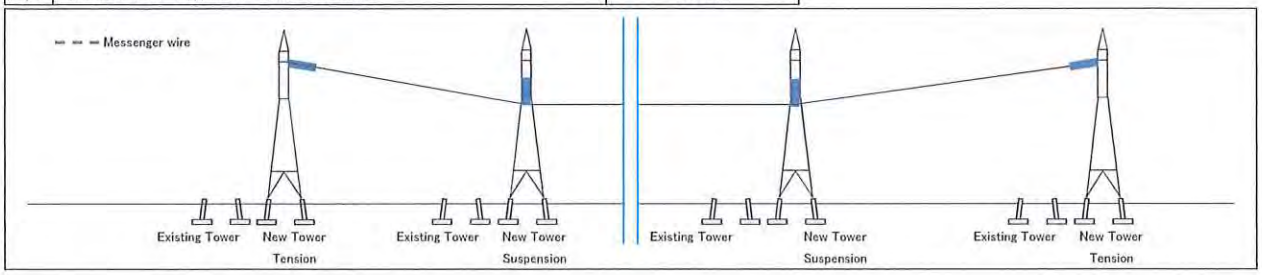
◎ = Snatch Block

Step-18	Separate the conductor from the tower	Shut down

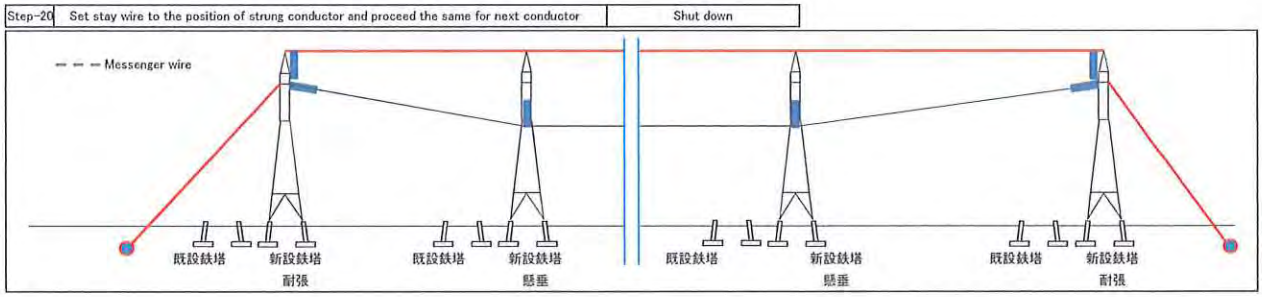


◎ = Snatch Block

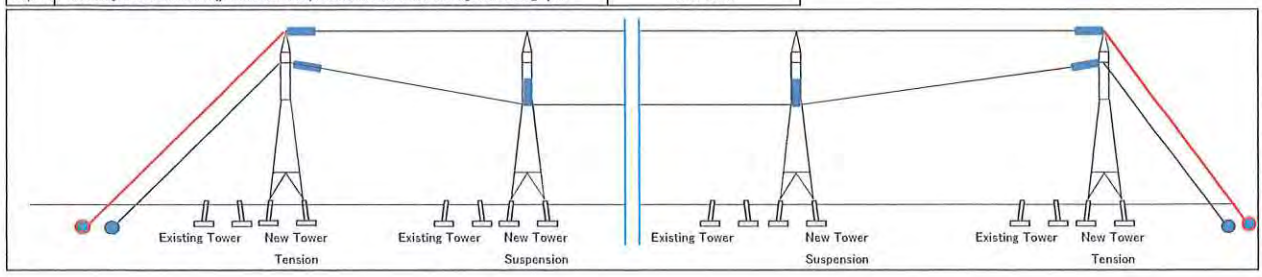
Step-19	Remove snatch blocks, conductor dram from the tower	Shut down



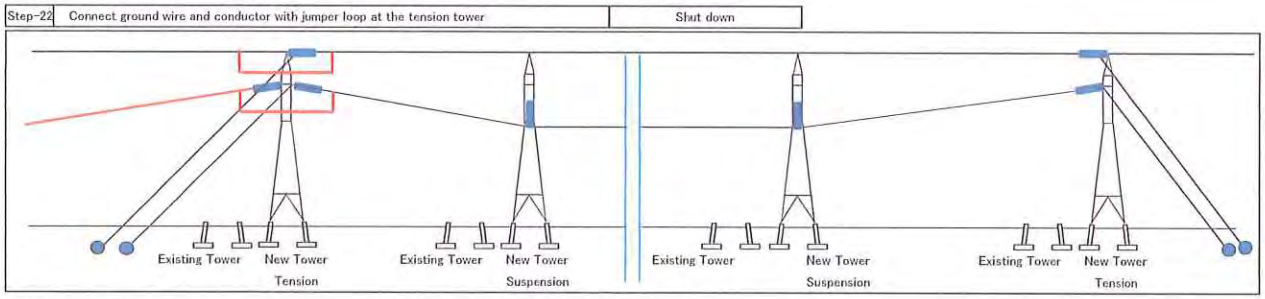
Step-20	Set stay wire to the position of strung conductor and proceed the same for next conductor	Shut down



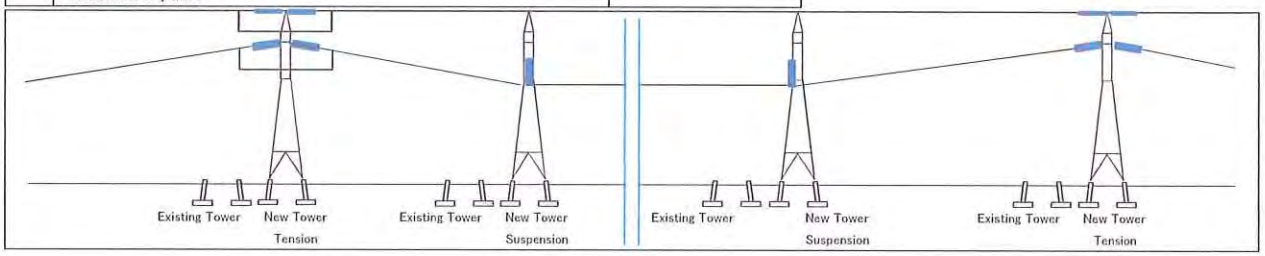
Step-21	Set stay wire at the strung conductor and proceed the same for the adjacent string span	Shut down



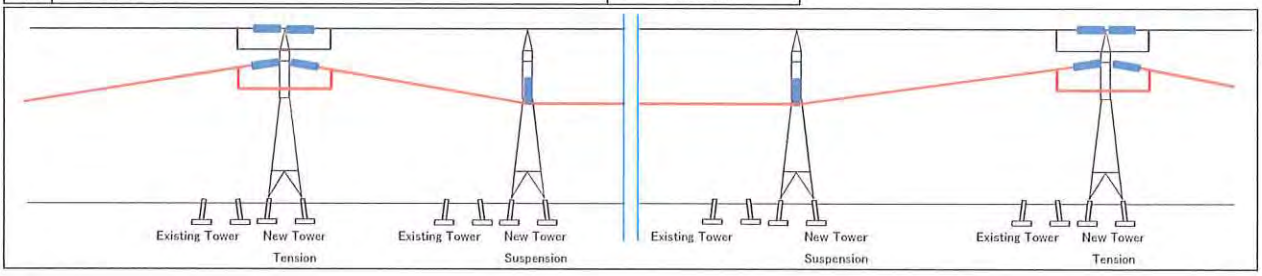
Step-22	Connect ground wire and conductor with jumper loop at the tension tower	Shut down



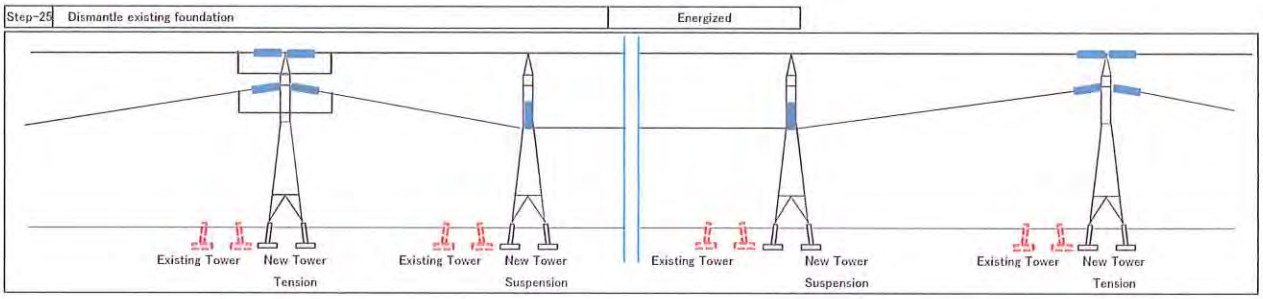
Step-23	Repeat the same procedure for all the string spans are completed Disassemble stay wires	Shut down



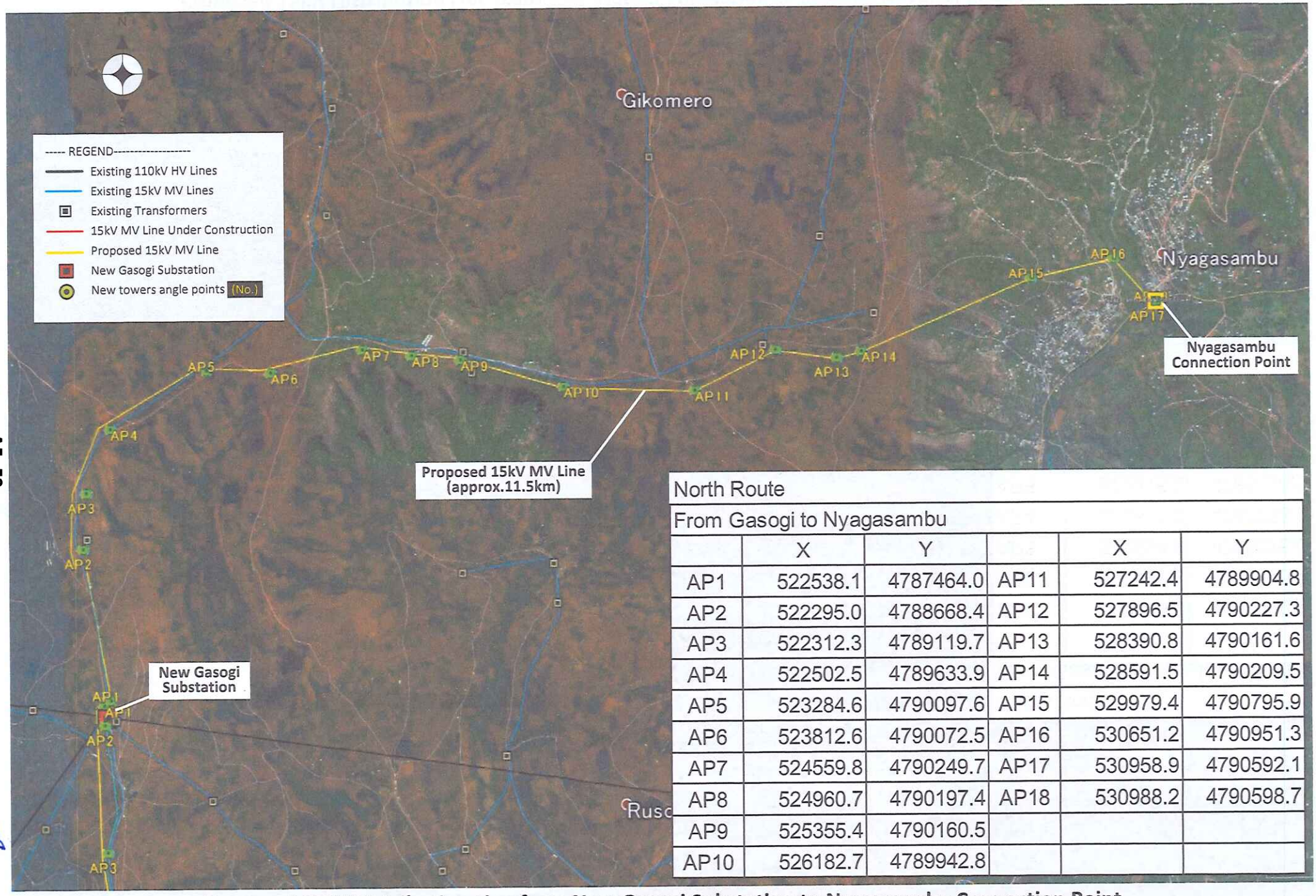
Step-24	Re energize the line	Shut down



Step-25	Dismantle existing foundation	Energized



終わり



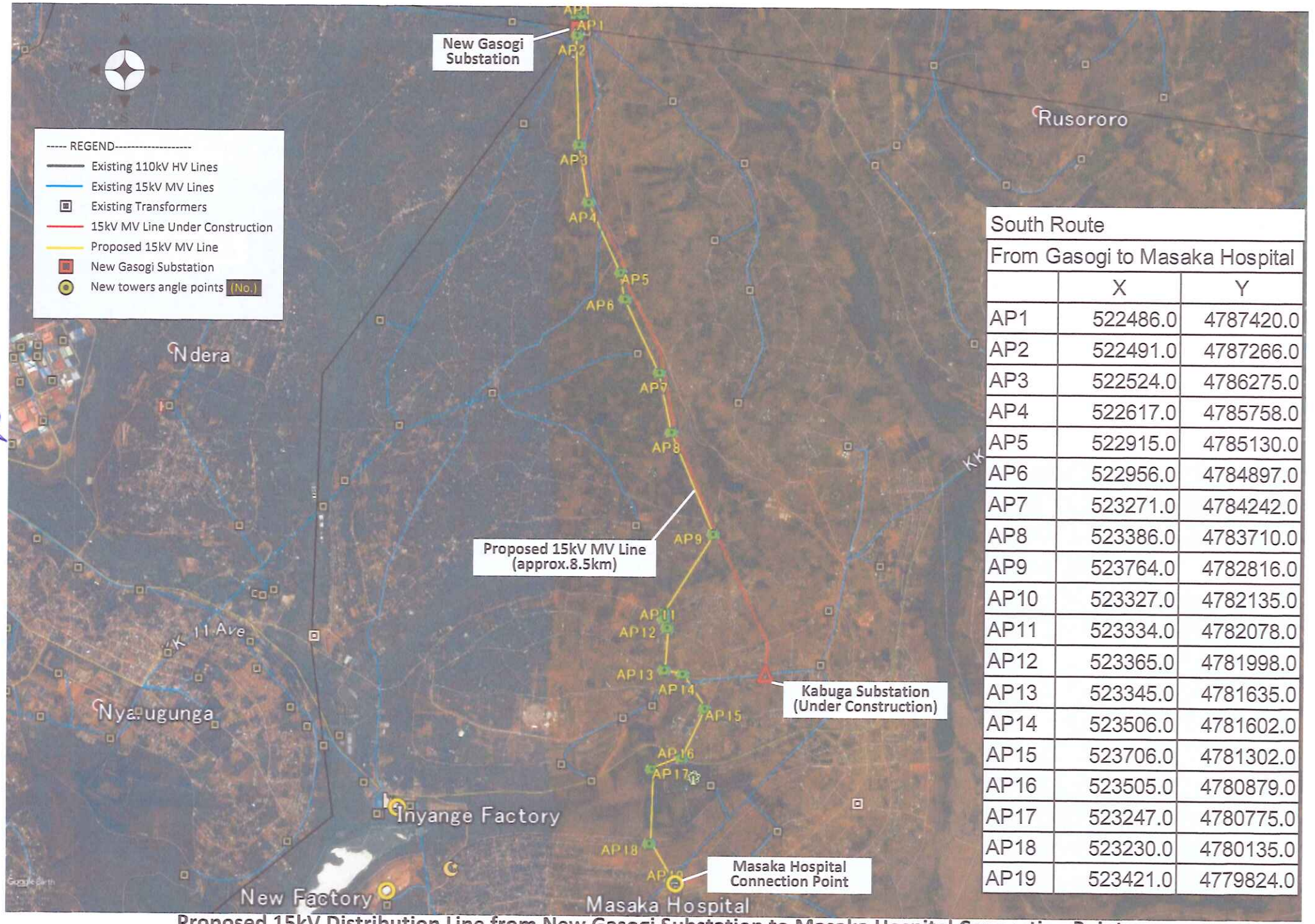
North Route

From Gasogi to Nyagasambu

	X	Y		X	Y
AP1	522538.1	4787464.0	AP11	527242.4	4789904.8
AP2	522295.0	4788668.4	AP12	527896.5	4790227.3
AP3	522312.3	4789119.7	AP13	528390.8	4790161.6
AP4	522502.5	4789633.9	AP14	528591.5	4790209.5
AP5	523284.6	4790097.6	AP15	529979.4	4790795.9
AP6	523812.6	4790072.5	AP16	530651.2	4790951.3
AP7	524559.8	4790249.7	AP17	530958.9	4790592.1
AP8	524960.7	4790197.4	AP18	530988.2	4790598.7
AP9	525355.4	4790160.5			
AP10	526182.7	4789942.8			

Proposed 15kV Distribution Line from New Gasogi Substation to Nyagasambu Connection Point

A5-53



South Route		
From Gasogi to Masaka Hospital		
	X	Y
AP1	522486.0	4787420.0
AP2	522491.0	4787266.0
AP3	522524.0	4786275.0
AP4	522617.0	4785758.0
AP5	522915.0	4785130.0
AP6	522956.0	4784897.0
AP7	523271.0	4784242.0
AP8	523386.0	4783710.0
AP9	523764.0	4782816.0
AP10	523327.0	4782135.0
AP11	523334.0	4782078.0
AP12	523365.0	4781998.0
AP13	523345.0	4781635.0
AP14	523506.0	4781602.0
AP15	523706.0	4781302.0
AP16	523505.0	4780879.0
AP17	523247.0	4780775.0
AP18	523230.0	4780135.0
AP19	523421.0	4779824.0

A5-54

Proposed 15kV Distribution Line from New Gasogi Substation to Masaka Hospital Connection Point

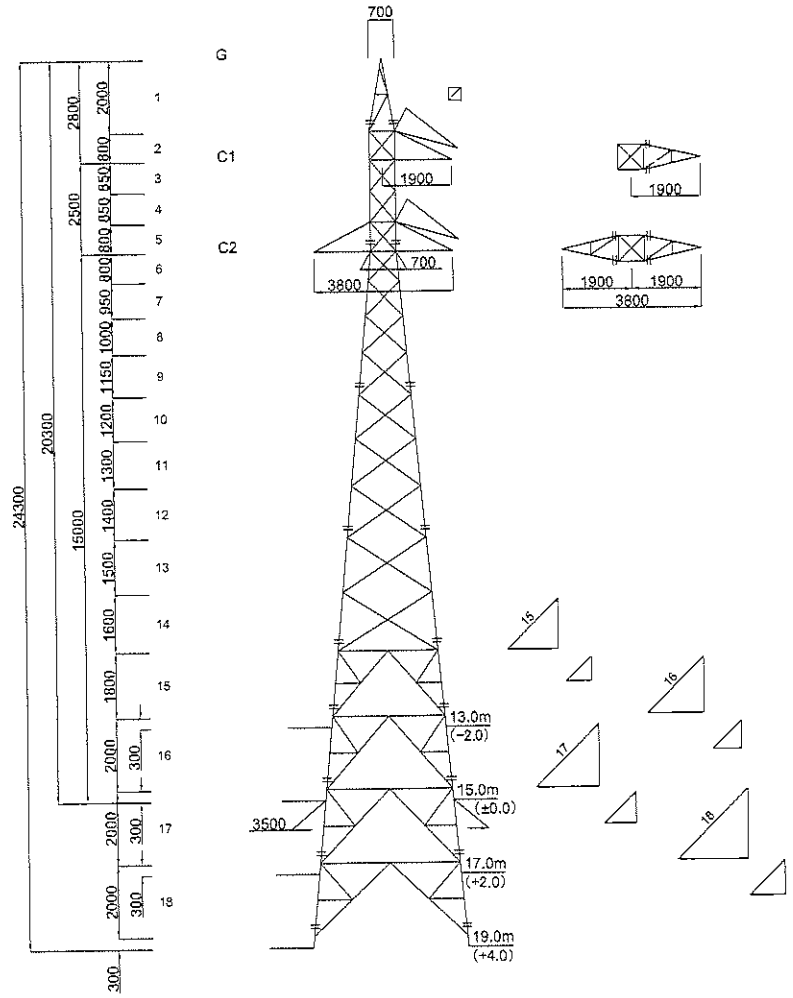
A5-55

Suspension Tower Type

1. Classification for Member and Bolt

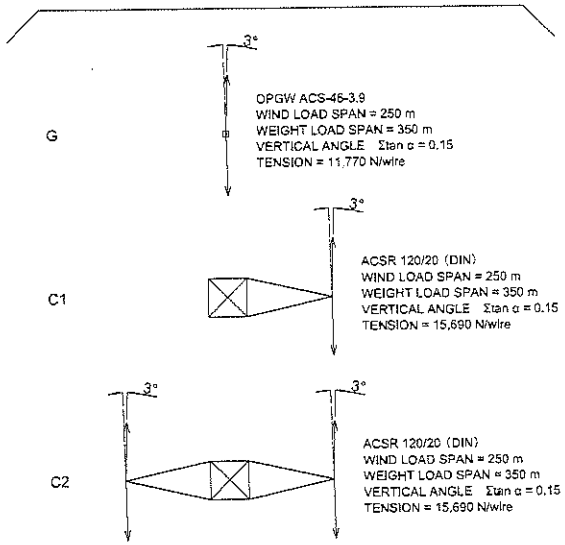
Standard	Class	Members	Bolts
JIS G 3101	SS400	L45×4 — L100×10	
	SS540	More than HL120×8	
JIS B 1051	5.8		16
	6.8		20

2. All dimensions are in millimeter.



DESIGN CONDITION TABLE			
DESCRIPTION		UNIT	DESIGN VALUE
VOLTAGE		kV	15 (30)
CIRCUIT		cct	1
TYPE TOWER		—	15-TA1
WIND LOAD SPAN		m	250
WEIGHT LOAD SPAN		m	350
LINE ANGLE		Degree	0 ~ 3
VERTICAL ANGLE		Σ tan α	0.15
CONDUCTOR	CODE	—	ACSR 120/20 (DIN)
	NUMBERS	—	(ONE) 1
	DIAMETER	mm	15.5
	UNIT MASS	kg/m	0.496
	UNIT TENSION	N/wire	15,690 (1,600 kgf/wire)
GROUND WIRE	CODE	—	OPGW-ACS-45-3.9
	NUMBERS	—	(ONE) 1
	DIAMETER	mm	9.6
	UNIT MASS	kg/m	0.352
	UNIT TENSION	N/wire	11,770 (1,200 kgf/wire)
INSULATOR	KIND	—	250mm Suspension Type
		Numbers	4 × 2 (Double Suspension)
	WEIGHT	kg/set	120
	WIND	N/set	346 (35.3 kgf/set)
WIND PRESS	TOWER	Pa	1,569 (163.1 kgf/m²)
	CONDUCTOR	Pa	552 (56.3 kgf/m²)
	GROUND WIRE	Pa	552 (56.3 kgf/m²)
NOTE			1.Standard (JEC-127) 2.Minimum Safety Factor : Body=1.0 , Arm=1.2

Wire Condition Diagram



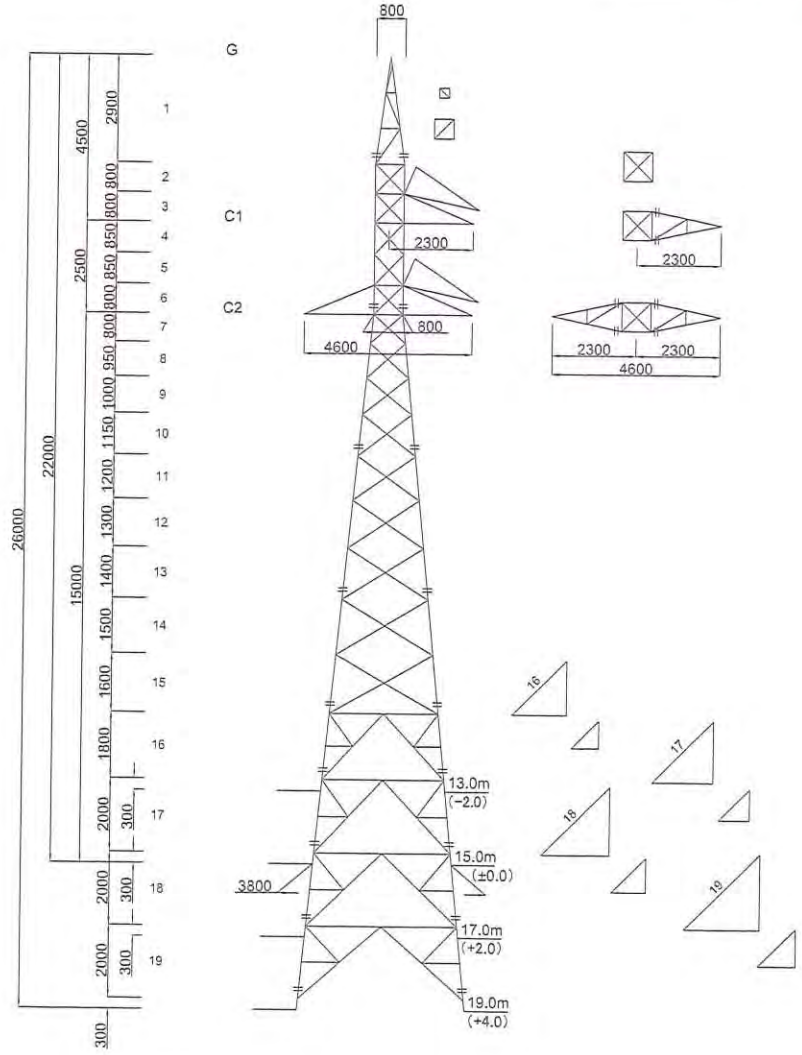
APPROVED BY		15kV DISTRIBUTION LINE SINGLE CIRCUIT TYPE 15 - TA1 TOWER SKELETON DRAWING	
CHECKED BY			
DESIGNED BY			
DRAWN BY			
DATE			
DRAWING No. NE201505-1000		SCALE 1/100	UNIT mm

Tension Tower Type

1. Classification for Member and Bolt

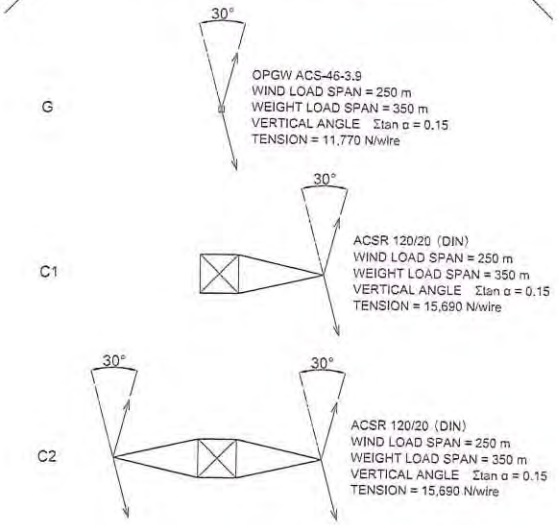
Standard	Class	Members	Bolts
JIS G 3101	SS400	L45×4 — L100×10	
	SS540	More than HL120×8	
JIS B 1051	5.8		16
	6.8		20

2. All dimensions are in millimeter.



DESIGN CONDITION TABLE			
DESCRIPTION		UNIT	DESIGN VALUE
VOLTAGE		kV	15 (30)
CIRCUIT		cct	1
TYPE TOWER		—	15-TB1
WIND LOAD SPAN		m	250
WEIGHT LOAD SPAN		m	350
LINE ANGLE		Degree	0 ~ 30
VERTICAL ANGLE		Σ tan α	0.15
CONDUCTOR	CODE	—	ACSR 120/20 (DIN)
	NUMBERS	—	(ONE) 1
	DIAMETER	mm	15.5
	UNIT MASS	kg/m	0.496
	UNIT TENSION	N/wire	15,690 (1,600 kgf/wire)
GROUND WIRE	CODE	—	OPGW-ACS-46-3.9
	NUMBERS	—	(ONE) 1
	DIAMETER	mm	9.6
	UNIT MASS	kg/m	0.352
	UNIT TENSION	N/wire	11,770 (1,200 kgf/wire)
INSULATOR	KIND	—	250mm Suspension Type
		Numbers	4 × 2 (Double Tension)
	WEIGHT	kg/set	210
	WIND	N/set	458 (46.7 kgf/set)
WIND PRESS	TOWER	Pa	1,599 (163.1 kgf/m²)
	CONDUCTOR	Pa	552 (56.3 kgf/m²)
	GROUND WIRE	Pa	552 (56.3 kgf/m²)
NOTE	1.Standard (JEC-127) 2.Minimum Safety Factor : Body=1.0 , Arm=1.2		

Wire Condition Diagram



APPROVED BY		15kV DISTRIBUTION LINE SINGLE CIRCUIT TYPE 15 - TB1 TOWER SKELETON DRAWING	
CHECKED BY			
DESIGNED BY			
DRAWN BY			
DATE			
DRAWING No. NE201505-2000		SCALE 1/100	UNIT mm

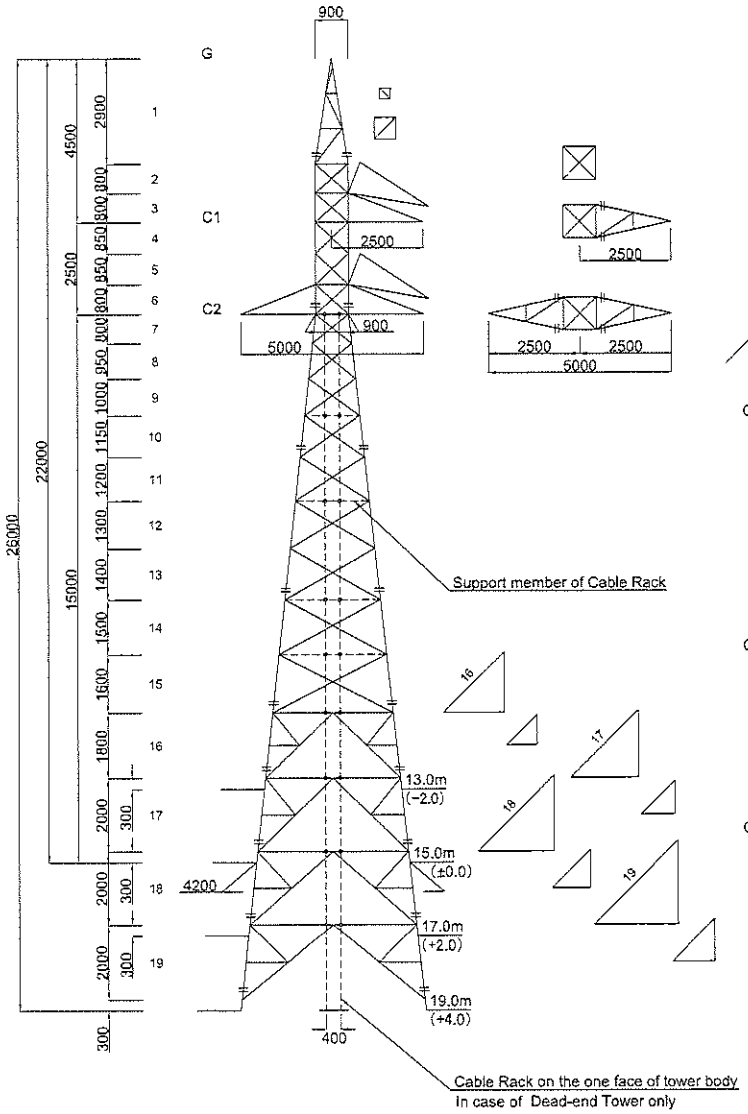
Dead-end and Heavy-angle Tower Type

1. Classification for Member and Bolt

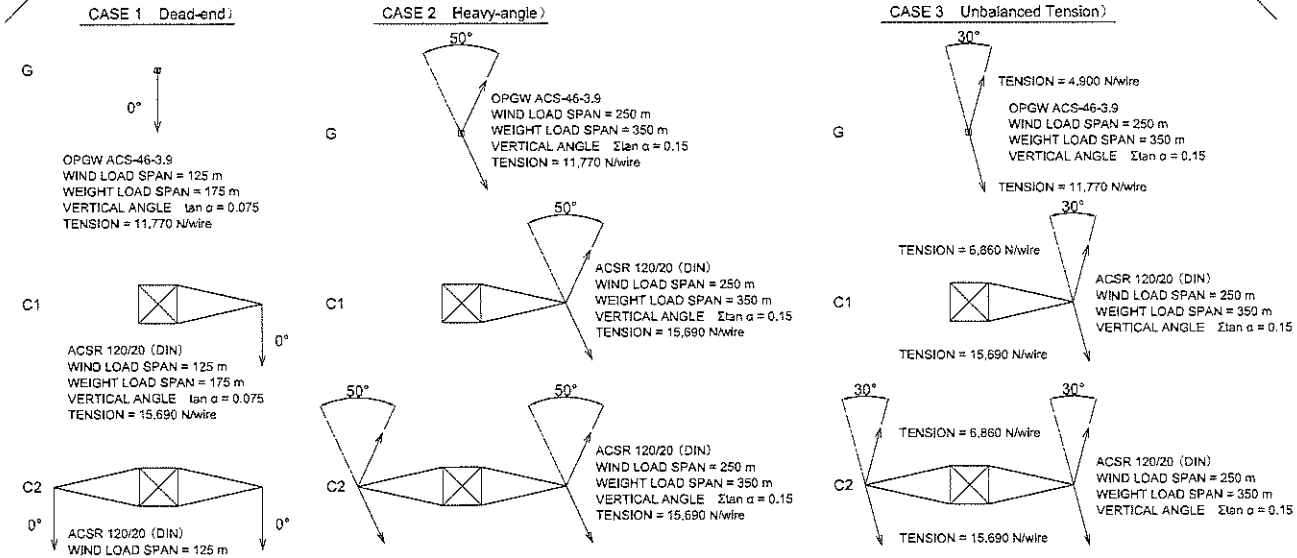
Standard	Class	Members	Bolts
JIS G 3101	SS400	L45×4 ~ L100×10	
	SS540	More than HL120×8	
JIS B 1051	5.8		16
	6.8		20

2. All dimensions are in millimeter.

DESIGN CONDITION TABLE		
DESCRIPTION	UNIT	DESIGN VALUE
VOLTAGE	kV	15 (3ϕ)
CIRCUIT	cct	1
TYPE TOWER	—	15-TD1
WIND LOAD SPAN	m	Dead-end = 125 , Heavy-angle = 250
WEIGHT LOAD SPAN	m	Dead-end = 175 , Heavy-angle = 350
LINE ANGLE	Degree	Dead-end = 0 , Heavy-angle = 0 ~ 50
VERTICAL ANGLE	Σtan α	Dead-end = 0.075 , Heavy-angle = 0.15
CONDUCTOR CODE	----	ACSR 120/20 (DIN)
CONDUCTOR NUMBERS	—	(ONE) 1
CONDUCTOR DIAMETER	mm	15.5
CONDUCTOR UNIT MASS	kg/m	0.496
CONDUCTOR UNIT TENSION	N/wire	15,690 (1,600 kgf/wire), 6,860 (700 kgf/wire)
GROUND WIRE CODE	----	OPGW-ACS-46-3.9
GROUND WIRE NUMBERS	—	(ONE) 1
GROUND WIRE DIAMETER	mm	9.6
GROUND WIRE UNIT MASS	kg/m	0.352
GROUND WIRE UNIT TENSION	N/wire	11,770 (1,200 kgf/wire), 4,900 (500 kgf/wire)
INSULATOR KIND	—	250mm Suspension Type
INSULATOR KIND	Numbers	4 × 2 (Double Tension)
INSULATOR WEIGHT	kg/set	210
INSULATOR WIND	N/set	450 (46.7 kgf/set)
WIND PRESS TOWER	Pa	1,590 (163.1 kgf/m²)
WIND PRESS CONDUCTOR	Pa	552 (56.3 kgf/m²)
WIND PRESS GROUND WIRE	Pa	552 (56.3 kgf/m²)
NOTE		1.Standard (JEC-127) 2.Minimum Safety Factor : Body=1.0 , Arm=1.2 3.CV Cable240㎟ Weight = 2.746 kg/m, Diameter = 32 mm 4.Cable Rack Weight = 6.0 kg/m, Wind Area = 0.25 m²/m 5.Cable Head Weight = 2.0 kg/one



Wire Condition Diagram



APPROVED BY		15kV (30kV) DISTRIBUTION LINE SINGLE CIRCUIT TYPE 15 - TD1 TOWER SKELETON DRAWING
CHECKED BY		
DESIGNED BY		
DRAWN BY		
DATE		
DRAWING No. NE201505-3000	SCALE 1/100	UNIT mm

A5-57

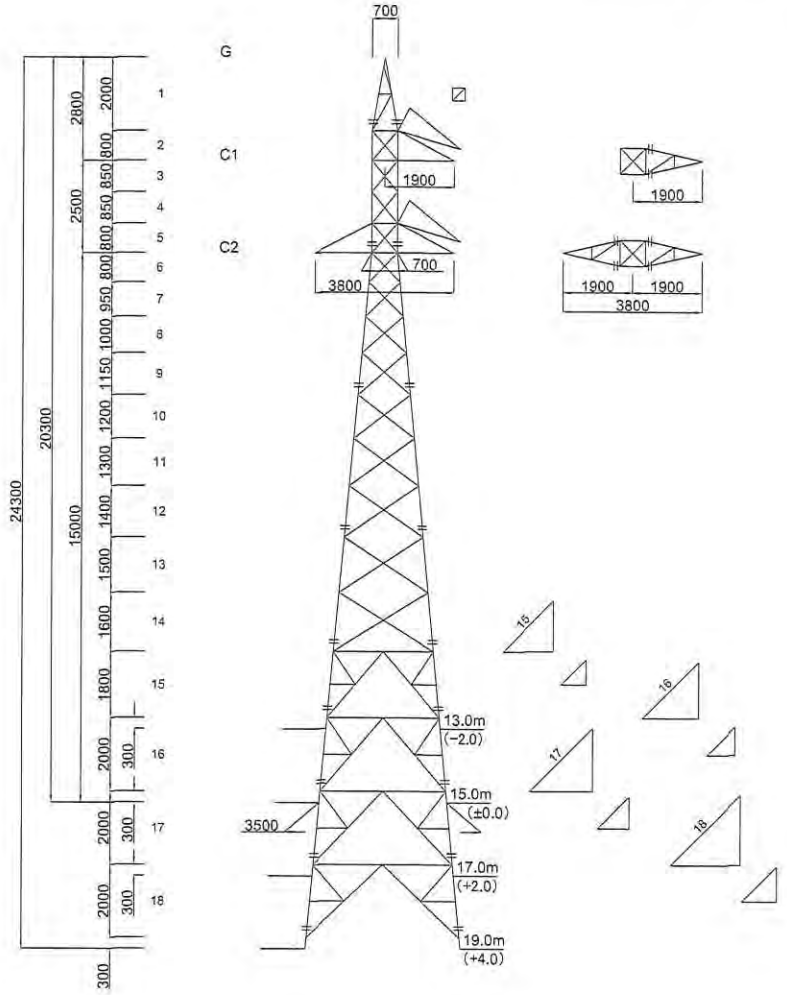
DL-03

Suspension Tower Type

1. Classification for Member and Bolt

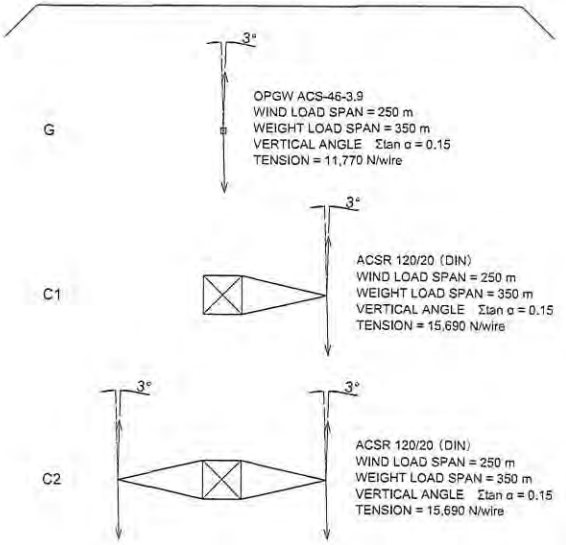
Standard	Class	Members	Bolts
JIS G 3101	SS400	L45×4 — L100×10	
	SS540	More than HL120×8	
JIS B 1051	5.8		16
	6.8		20

2. All dimensions are in millimeter.



DESIGN CONDITION TABLE			
DESCRIPTION		UNIT	DESIGN VALUE
VOLTAGE		kV	15 (33)
CIRCUIT		cct	1
TYPE TOWER		—	15-TA1
WIND LOAD SPAN		m	250
WEIGHT LOAD SPAN		m	350
LINE ANGLE		Degree	0 ~ 3
VERTICAL ANGLE		Σ tan α	0.15
CONDUCTOR	CODE	—	ACSR 120/20 (DIN)
	NUMBERS	—	(ONE) 1
	DIAMETER	mm	15.5
	UNIT MASS	kg/m	0.486
	UNIT TENSION	N/wire	15,690 (1,600 kgf/wire)
GROUND WIRE	CODE	—	OPGW-ACS-46-3.9
	NUMBERS	—	(ONE) 1
	DIAMETER	mm	9.6
	UNIT MASS	kg/m	0.352
	UNIT TENSION	N/wire	11,770 (1,200 kgf/wire)
INSULATOR	KIND	—	250mm Suspension Type
		Numbers	4 × 2 (Double Suspension)
	WEIGHT	kg/set	120
	WIND	N/set	346 (35.3 kgf/set)
WIND PRESS	TOWER	Pa	1,599 (163.1 kgf/m²)
	CONDUCTOR	Pa	552 (56.3 kgf/m²)
	GROUND WIRE	Pa	552 (56.3 kgf/m²)
NOTE			1.Standard (JEC-127) 2.Minimum Safety Factor : Body=1.0 , Arm=1.2

Wire Condition Diagram



APPROVED BY		15kV DISTRIBUTION LINE SINGLE CIRCUIT TYPE 15 - TA1 TOWER SKELETON DRAWING	
CHECKED BY			
DESIGNED BY			
DRAWN BY			
DATE			
DRAWING No. NE201505-1000		SCALE 1/100	UNIT mm

A5-58

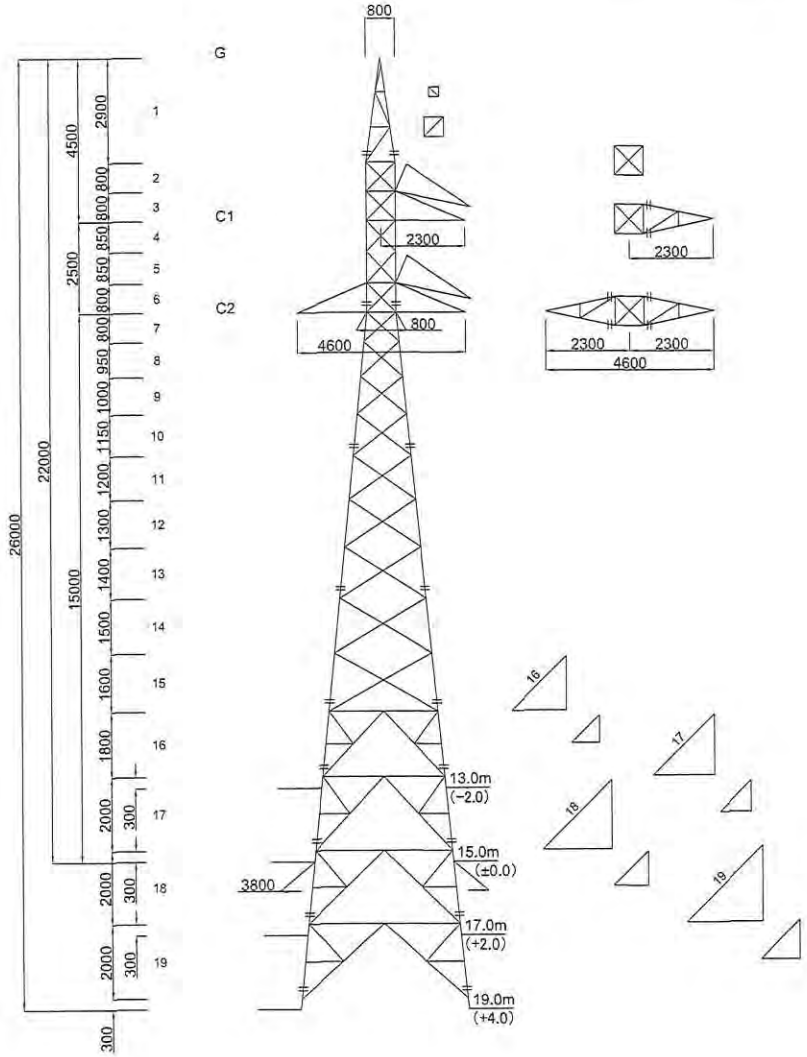
A5-59

Tension Tower Type

1. Classification for Member and Bolt

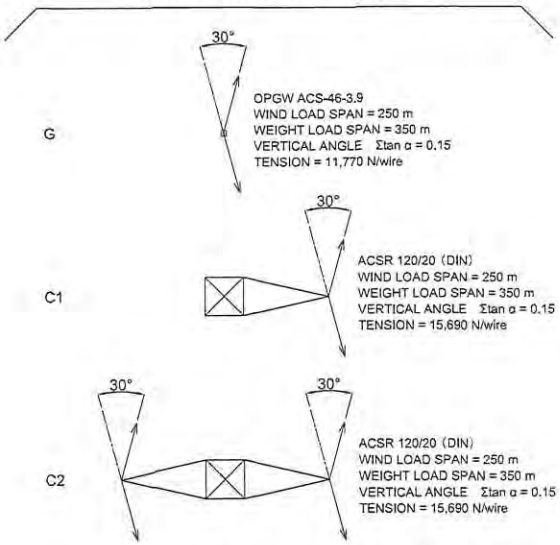
Standard	Class	Members	Bolts
JIS G 3101	SS400	L45×4 — L100×10	
	SS540	More than HL120×8	
JIS B 1051	5.8		16
	6.8		20

2. All dimensions are in millimeter.



DESIGN CONDITION TABLE			
DESCRIPTION		UNIT	DESIGN VALUE
VOLTAGE		kV	15 (30)
CIRCUIT		cct	1
TYPE TOWER		—	15-TB1
WIND LOAD SPAN		m	250
WEIGHT LOAD SPAN		m	350
LINE ANGLE		Degree	0 ~ 30
VERTICAL ANGLE		Σ tan α	0.15
CONDUCTOR	CODE	—	ACSR 120/20 (DIN)
	NUMBERS	—	(ONE) 1
	DIAMETER	mm	15.5
	UNIT MASS	kg/m	0.496
	UNIT TENSION	N/wire	15,690 (1,600 kgf/wire)
GROUND WIRE	CODE	—	OPGW-ACS-46-3.9
	NUMBERS	—	(ONE) 1
	DIAMETER	mm	9.6
	UNIT MASS	kg/m	0.352
	UNIT TENSION	N/wire	11,770 (1,200 kgf/wire)
INSULATOR	KIND	—	250mm Suspension Type
		Numbers	4 × 2 (Double Tension)
	WEIGHT	kg/set	210
	WIND	N/set	458 (46.7 kgf/set)
WIND PRESS	TOWER	Pa	1,599 (163.1 kgf/m²)
	CONDUCTOR	Pa	552 (56.3 kgf/m²)
	GROUND WIRE	Pa	552 (56.3 kgf/m²)
NOTE	1.Standard (JEC-127) 2.Minimum Safety Factor : Body=1.0 , Arm=1.2		

Wire Condition Diagram



APPROVED BY		15kV DISTRIBUTION LINE SINGLE CIRCUIT TYPE 15 - TB1 TOWER SKELETON DRAWING	
CHECKED BY			
DESIGNED BY			
DRAWN BY			
DATE			
DRAWING No. NE201505-2000		SCALE 1/100	UNIT mm

A5-60

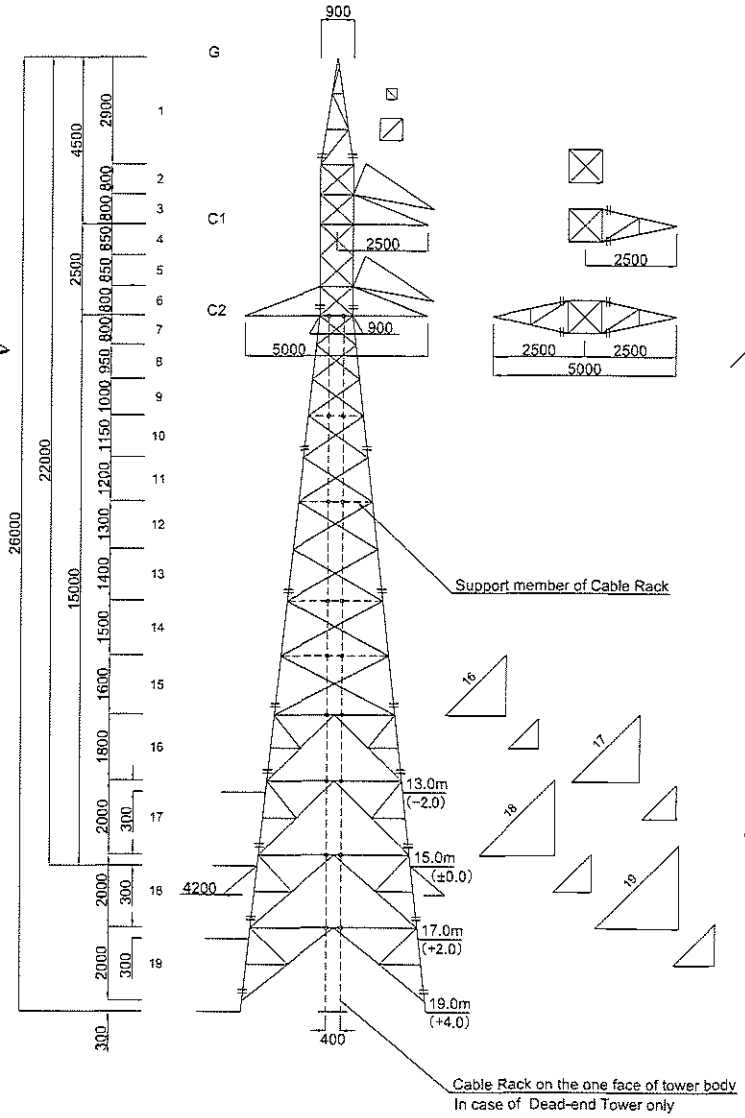
Dead-end and Heavy-angle Tower Type

1. Classification for Member and Bolt

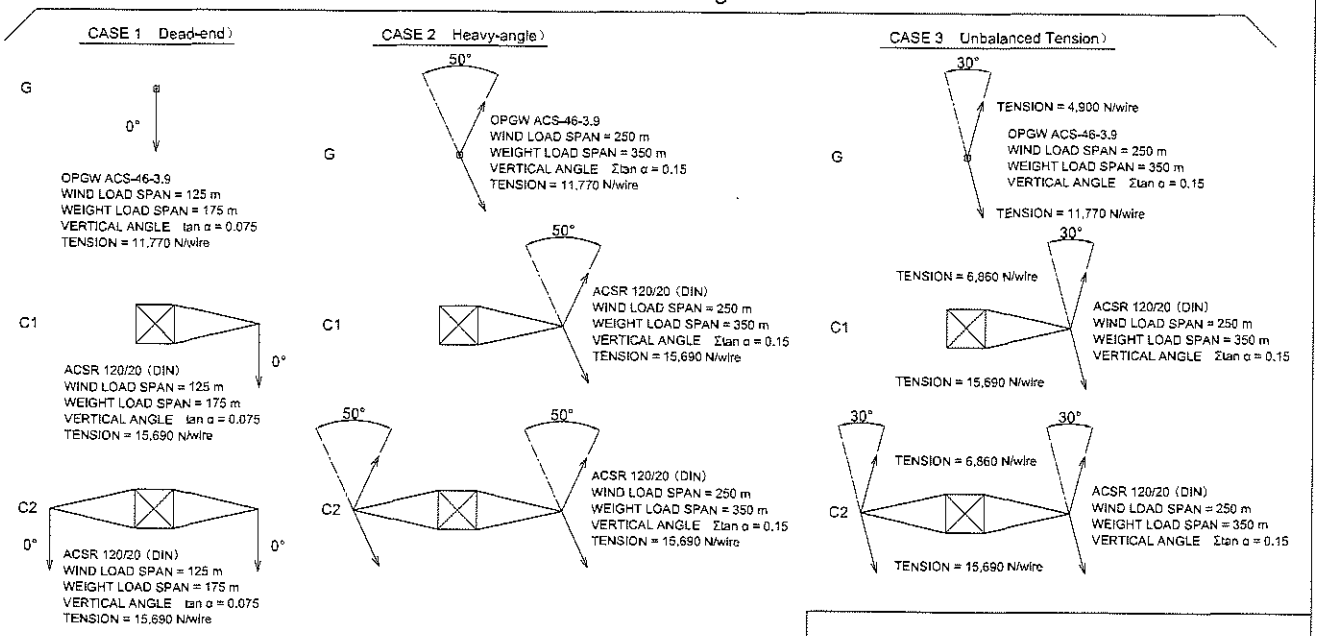
Standard	Class	Members	Bolts
JIS G 3101	SS400	L45×4 — L100×10	
	SS540	More than HL120×8	
JIS B 1051	5.8		16
	6.8		20

2. All dimensions are in millimeter.

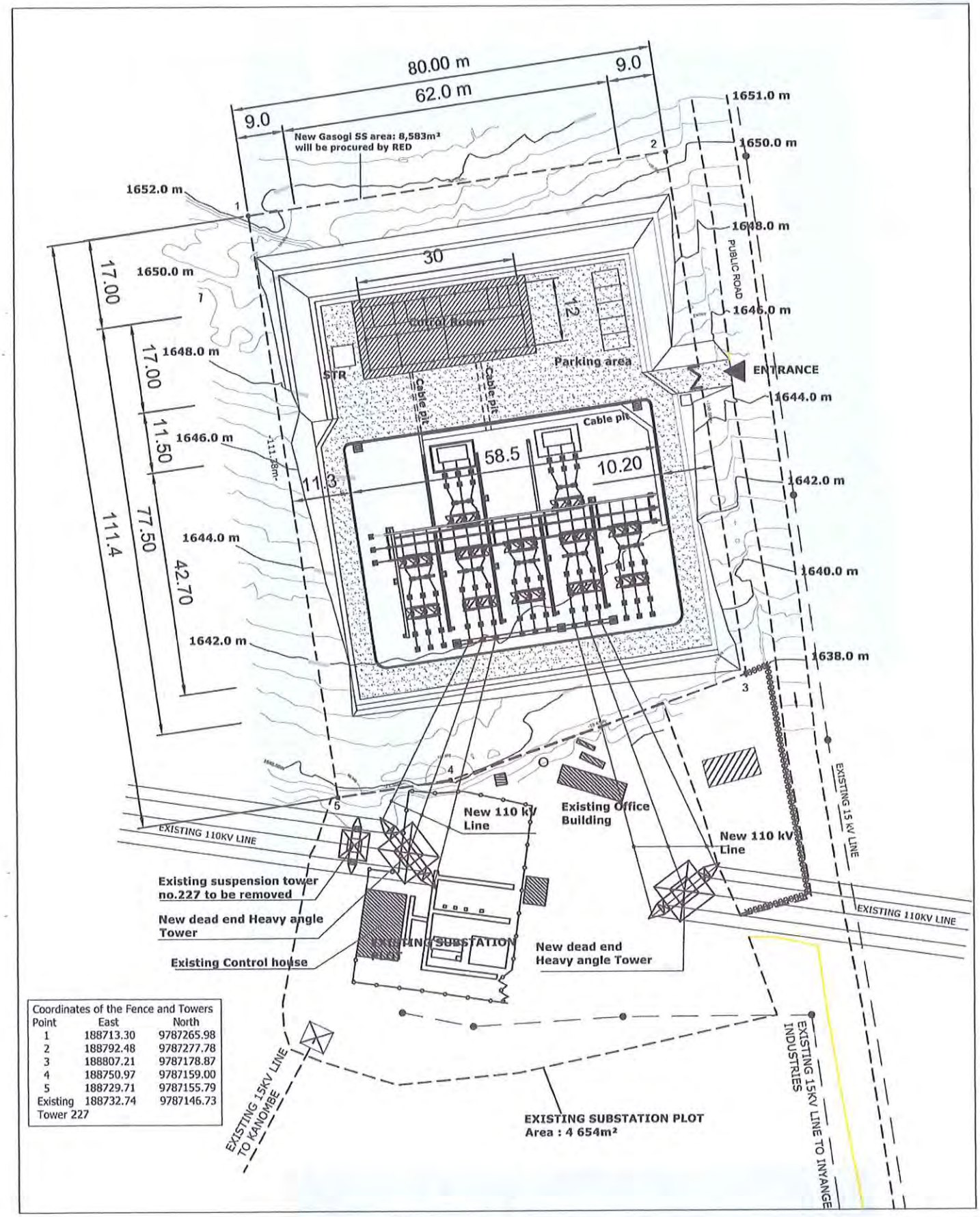
DESIGN CONDITION TABLE			
DESCRIPTION		UNIT	DESIGN VALUE
VOLTAGE		kV	15 (30)
CIRCUIT		cct	1
TYPE TOWER		-----	15-TD1
WIND LOAD SPAN		m	Dead-end = 125 , Heavy-angle = 250
WEIGHT LOAD SPAN		m	Dead-end = 175 , Heavy-angle = 350
LINE ANGLE		Degree	Dead-end = 0 , Heavy-angle = 0 ~ 90
VERTICAL ANGLE		Σtan α	Dead-end = 0.075 , Heavy-angle = 0.15
CONDUCTOR	CODE	-----	ACSR 120/20 (DIN)
	NUMBERS	-----	(ONE) 1
	DIAMETER	mm	15.5
	UNIT MASS	kg/m	0.496
	UNIT TENSION	N/wire	15,690 (1,600 kgf/wire), 6,860 (700 kgf/wire)
GROUND WIRE	CODE	-----	OPGW-ACS-46-3.9
	NUMBERS	-----	(ONE) 1
	DIAMETER	mm	9.6
	UNIT MASS	kg/m	0.352
	UNIT TENSION	N/wire	11,770 (1,200 kgf/wire), 4,900 (500 kgf/wire)
INSULATOR	KIND	-----	250mm Suspension Type
		Numbers	4 × 2 (Double Tension)
	WEIGHT	kg/set	210
	WIND	N/set	458 (46.7 kgf/set)
WIND PRESS	TOWER	Pa	1,596 (163.1 kgf/m²)
	CONDUCTOR	Pa	552 (56.3 kgf/m²)
	GROUND WIRE	Pa	552 (56.3 kgf/m²)
NOTE	1.Standard (JEC-127) 2.Minimum Safety Factor : Body=1.0 , Arm=1.2 3.CV Cable240mm² Weight = 2.746 kg/m, Diameter = 32 mm 4.Cable Rack Weight = 8.0 kg/m , Wind Area = 0.25 m²/m 5.Cable Head Weight = 2.0 kg/one		



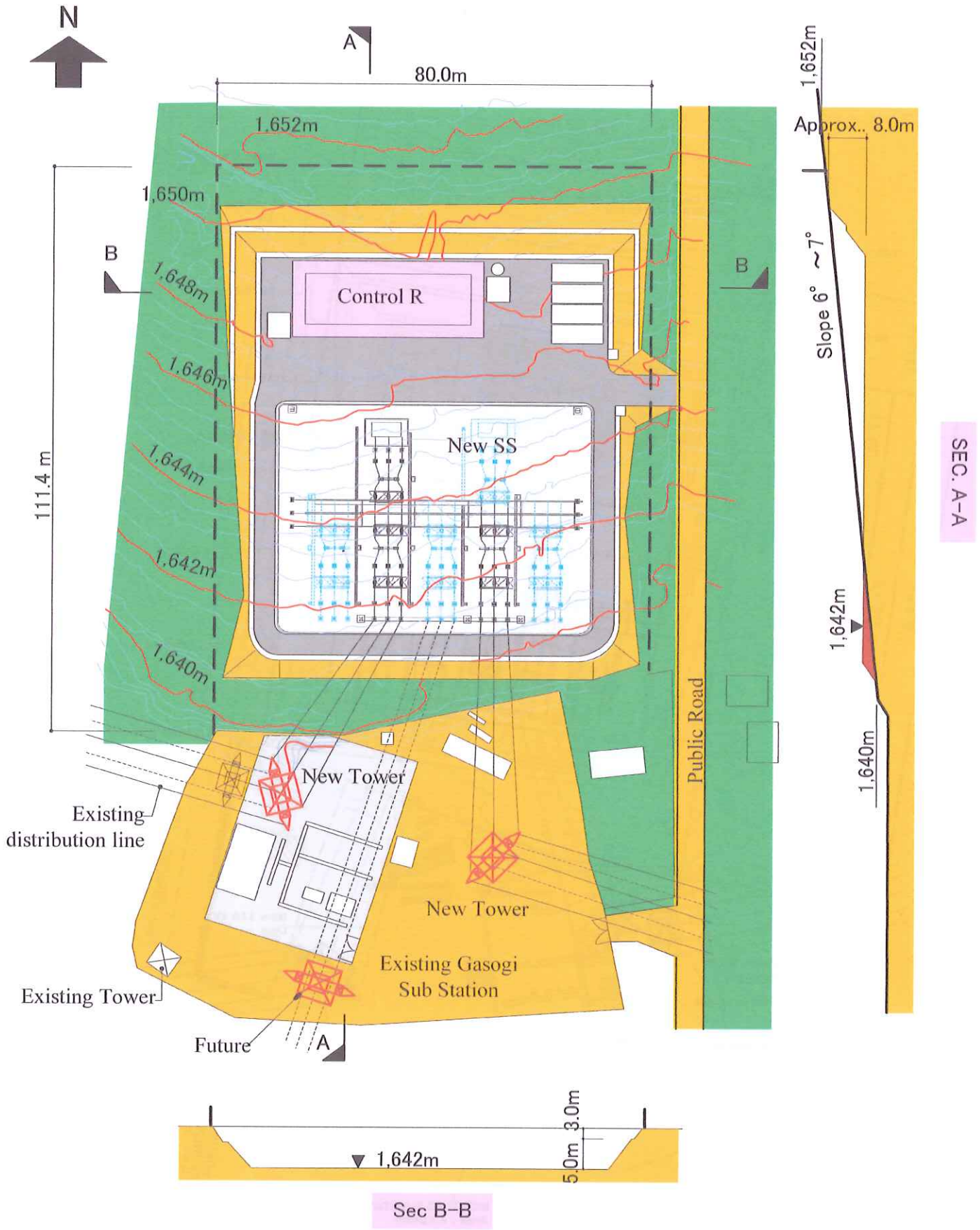
Wire Condition Diagram



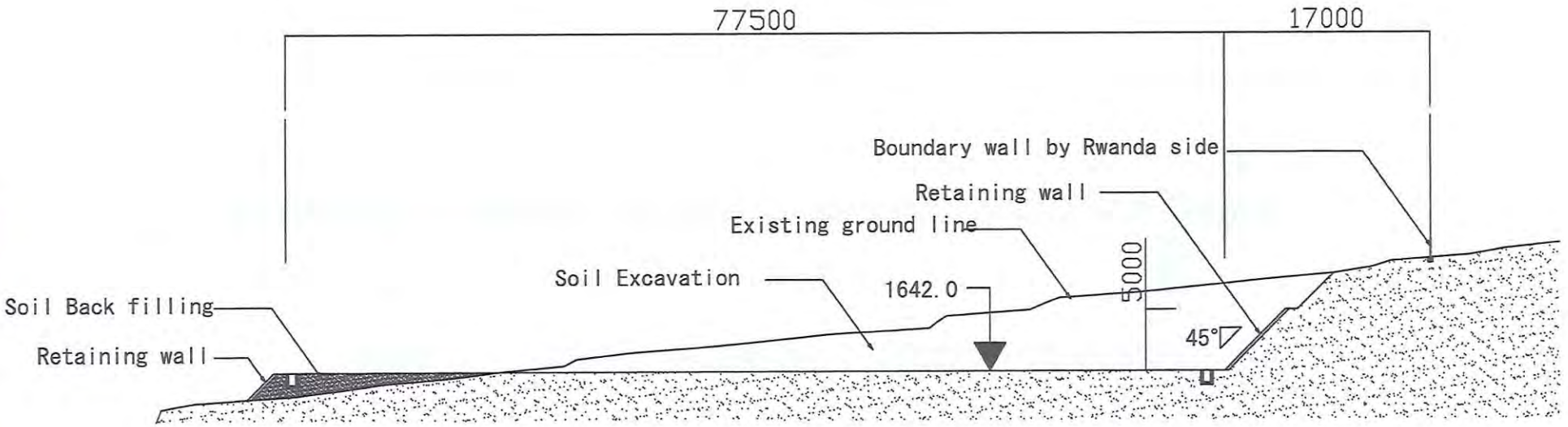
APPROVED BY		15kV (30kV) DISTRIBUTION LINE SINGLE CIRCUIT TYPE 15 - TD1 TOWER SKELETON DRAWING	
CHECKED BY			
DESIGNED BY			
DRAWN BY			
DATE			
DRAWING No.	NE201505-3000	SCALE	1/100
		UNIT	mm



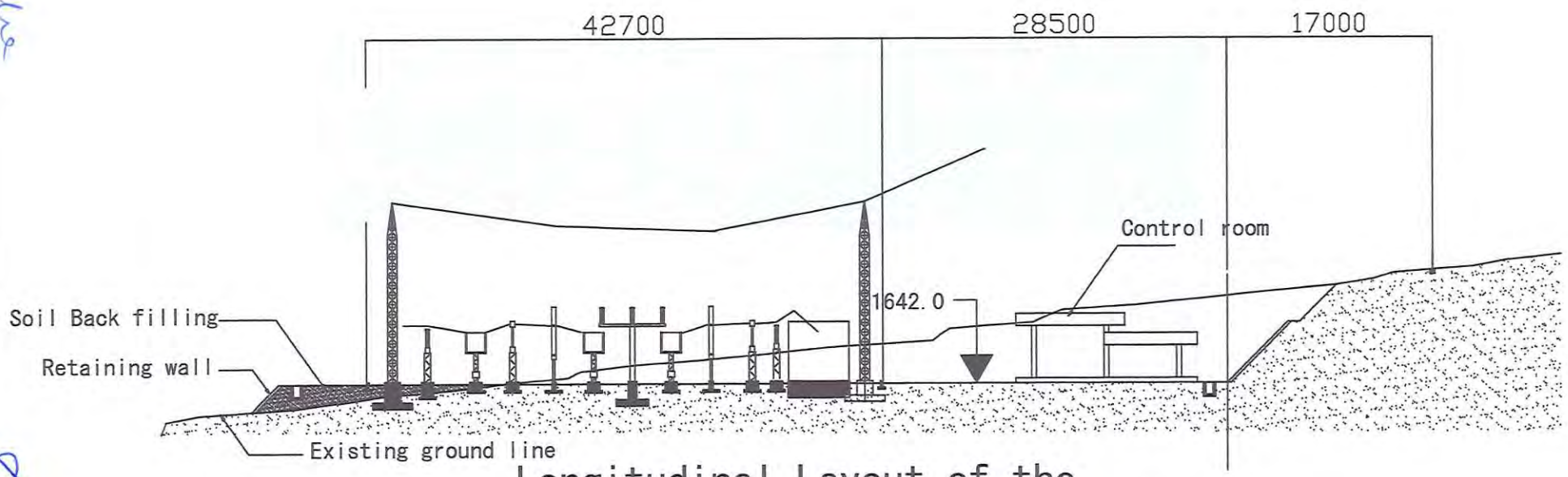
Coordinates of the Fence and Towers		
Point	East	North
1	188713.30	9787265.98
2	188792.48	9787277.78
3	188807.21	9787178.87
4	188750.97	9787159.00
5	188729.71	9787155.79
Existing Tower 227	188732.74	9787146.73



New Gasogi Sub Station Layout plan

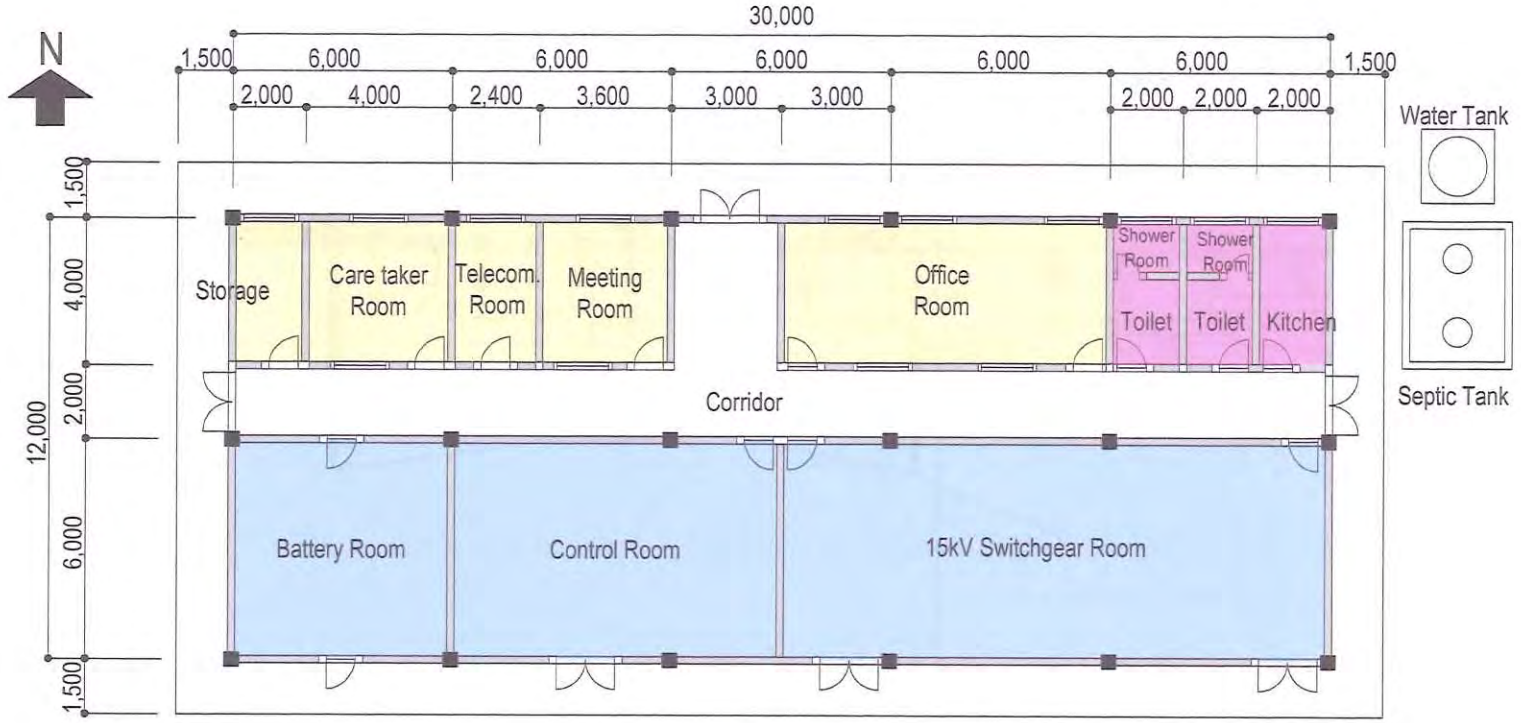


Longitudinal Section

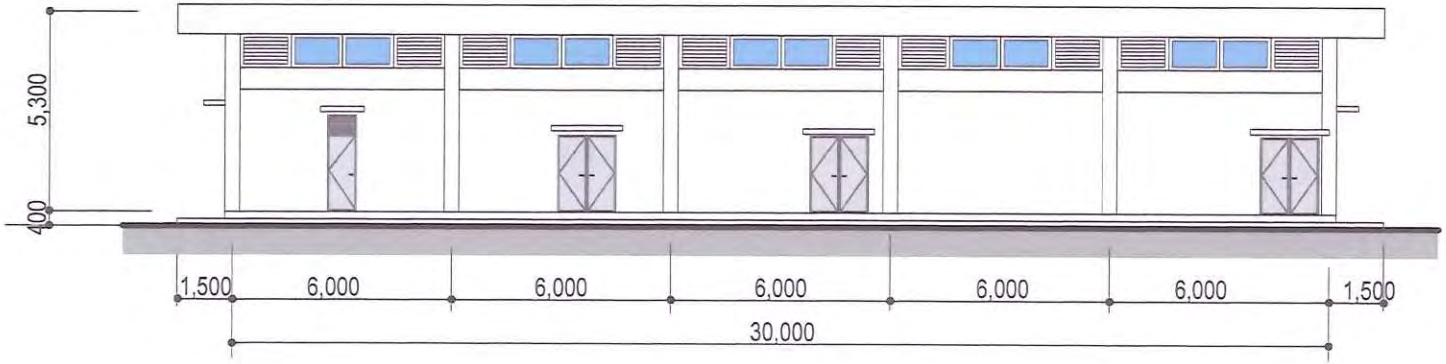


Longitudinal Layout of the
Control room and Transformer Yard

A5-63

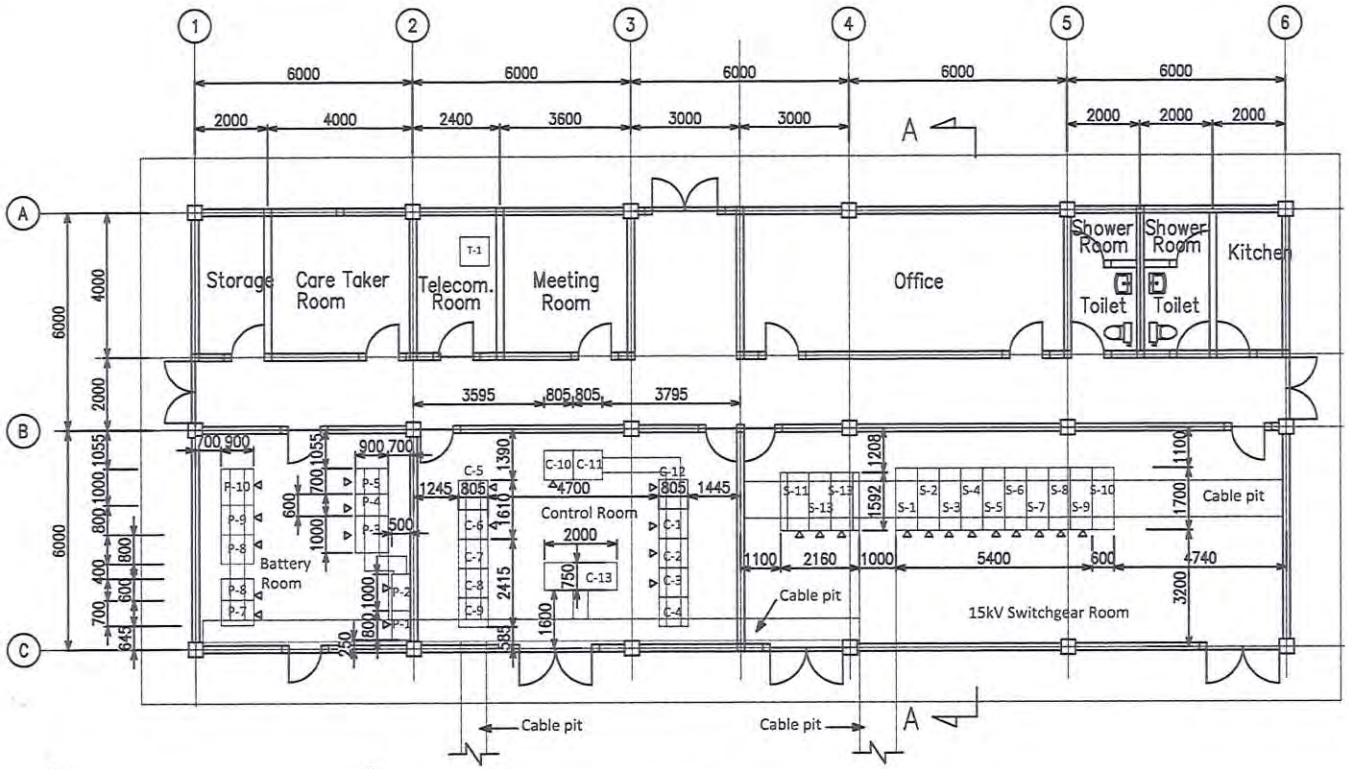


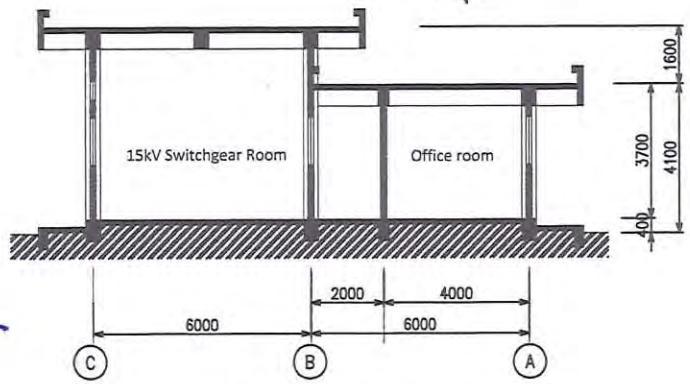
GFL Plan



South Elevation

A5-64





Section A–A

15 kV Switchgear Room

No.	Panel Name	Note
S–1	T1 Transformer	
S–2	Bus Connection (Send)	
S–3	Busbar VT	
S–4	Kanombe (existing)	
S–5	Inyange (existing)	
S–6	Rutunga (existing)	
S–7	New feeder (JICA Phase–3)	
S–8	Spare feeder	
S–9	Aux. Tr	
S–10	T2 Transformer	for future
S–11	Bus Connection (Receive)	
S–12	Kabuga (JICA Phase–2)	
S–13	New feeder (JICA Phase–3)	

Control Room

No.	Panel Name	Note
C–1	Sub station control Panel–1	
C–2	Sub station control Panel–2	
C–3	15 kV Control Panel–1	
C–4	15 kV Control Panel–2	for future
C–5	110 kV Transmission line Panel–1	to Ndera
C–6	110 kV Transmission line Panel–2	to Musha
C–7	110 kV Transmission line Panel–3	for future
C–8	110 kV Transmission line Panel–4	for future
C–9	110 kV Transmission line Panel–5	for future
C–10	T1 Transformer Control Panel–1	
C–11	T2 Transformer Control Panel–2	for future
C–12	Telcom Panel	
C–13	Desk for SCADA	

Charger Room

No.	Panel Name
P–1	DC Distribution panel
P–2	AC Distribution panel
P–3	UPS (Inverter)
P–4	UPS (Battery charger)
P–5	UPS (Battery)
P–6	48 V DC Battery charger
P–7	48 V DC Battery panel
P–8	110 V DC No.2 Battery charger panel
P–9	110 V DC No.1 Battery charger panel
P–10	110 V Battery panel

PROJECT	LOCATION	CONSULTANTS	TITLE	DRG NO :
The Project for Improvement of Substation and Distribution Network Phase 3 in the Republic of Rwanda		YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN	Equipment Layout in Control Building for Gasogi Substation	
			DESIGNED BY : / CHECKED BY : / APPROVED BY : / DATE :	SCALE : for A4 paper

A5-65

Attachment

1. Member List of the Study Team

First Field Survey

Name	Assignment	Organization
Tsunenari SOYAMA	Vice Team Leader	Japan International Corporation Agency
Makoto ABE	Chief Consultant/ Transmission and Distribution Planning	Yachiyo Engineering Co., Ltd.
Kenji SAKEMURA	Substation Facilities	West Japan Engineering Consultants, Inc.
Seiji SATO	Substation Facilities-2	West Japan Engineering Consultants, Inc.
Taro NAKAMURA	Power Flow Analysis/ Protection Control	West Japan Engineering Consultants, Inc.
Michio ISHIGAMORI	Transmission and Distribution Facilities	Yachiyo Engineering Co., Ltd.
Kyohei KUROHANE	Equipment Planning/ Cost Estimation	Yachiyo Engineering Co., Ltd.
Hisayuki YAMAMOTO	Facility Planning/ Cost Estimation	Yachiyo Engineering Co., Ltd
Akihiro OSADA	Social and Environmental Considerations	Yachiyo Engineering Co., Ltd.

Work Demarcation for the Project

No.	Work Items	Japan Side		Rwanda Side	
		Provision	Installation	Provision	Installation
General					
(1)	Access road to the project sites			●	●
(2)	Temporary storage yard for equipment and materials			●	●
1.	New Gasogi Substation				
(1)	Land acquisition, Bush clearing and removal of obstacles			●	●
(2)	Site leveling (Land development)	●	●		
(3)	Gate and fence			●	●
(4)	Road and parking lot in the site	●	●		
(5)	Building work of the substation (including control room, support structure, steel gantry and foundations)	●	●		
(6)	110 kV switchgear	●	●		
(7)	20 MVA 110/15 kV transformers	●	●		
(8)	160 kVA grounding (earthing) transformer	●	●		
(9)	250 kVA auxiliary transformer	●	●		
(10)	15 kV switchgear	●	●		
(11)	Substation control and protection equipment	●	●		
(12)	110 V DC battery and charger	●	●		
(13)	48 V DC battery and charger	●	●		
(14)	AC 230 V Uninterruptible Power Supply (UPS)	●	●		
(15)	Communication equipment including RTU and SDH equipment	●	●		
(16)	15kV cables between transformers and switchgear	●	●		
(17)	Outgoing 15 kV Cables	●	●		
(18)	Protection Relay setting confirmation and change of the substations where the transmission lines from New Gasogi substation to be interconnected				●
(19)	Spare parts for substation	●			
(20)	Maintenance tools for substation	●			
(21)	Technical training for equipment		●		

No.	Work Items	Japan Side		Rwanda Side	
		Provision	Installation	Provision	Installation
2	110 kV Transmission line (Switch over to New Gasogi)				
(1)	Land acquisition, Bush clearing and removal of obstacles, tree cutting work within the 110 kV transmission line Right Of Way			●	●
(2)	Gate and Fence			●	●
(3)	Dead end heavy angle steel towers and foundations	●	●		
(4)	Overhead conductor	●	●		
(5)	Overhead grounding wire (including OPGW)	●	●		
(6)	Connection bow for OPGW	●	●		
(7)	Power outage				●
(8)	Removal work of the existing conductor, grounding wire, accessories, steel tower and foundation etc.				●
3.	15 kV Distribution Line (D/L)				
(1)	Land acquisition, Bush clearing, tree cutting and removal of obstacles			●	●
(2)	Power outage				●
(3)	Replacement or reconnection of the existing lines			●	●
(4)	Steel towers and foundations	●	●		
(5)	Overhead conductor	●	●		
(6)	Overhead grounding wire (including OPGW)	●	●		
(7)	Switching device	●	●		
4.	110 kV Transmission line (from Jabana substation to Birembo substation)				
(1)	Land acquisition, Bush clearing and removal of obstacles and tree cutting work within the 110 kV transmission line Right Of Way			●	●
(2)	Steel towers and foundations	●	●		
(3)	Overhead conductor	●	●		
(4)	Overhead grounding wire (including OPGW)	●	●		
(5)	Connection bow for OPGW	●	●		
(6)	Power outage				●
(7)	Removal work of the existing conductor,			●	●

No.	Work Items	Japan Side		Rwanda Side	
		Provision	Installation	Provision	Installation
	grounding wire, accessories, steel tower and foundation etc.				
(8)	Reinforcement of 110kV outgoing bay at Jabana substation (Replacement of steel gantry and foundation, replacement of partial busbar conductor, and 110 kV disconnecting switch (busbar side), circuit breaker)	●	●		
(9)	Open/close operation of existing auxiliary power supply circuits for 110 kV disconnecting switch and circuit breaker				●
5.	NECC SCADA System				
(1)	Modification of SCADA System of NECC and Network Management system for accommodation of new Gasogi S/S			●	●
(2)	Testing of communication network after installation of OPGW on 110kV transmission line between Jabana and Birembo substation			●	●

Tentative Implementation Schedule of the Project