

## **5. 技術討議録 (Field Report)**

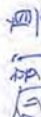
**(1) 第 1 次現地調査 Field Report**

**(2) 第 2 次現地調査 Technical Note**


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

13<sup>th</sup> FEBRUARY 2019


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[Attachment]

Attachment - 1 Member List of the Study Team

Attachment - 2 Procedure of Installation of the equipment for Kanengo substation







## 1. Outline of the Project

### 1.1 Background of the Project

In response to the request from the Government of the Republic of Malawi (Malawi), 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 in Lilongwe city in the Republic of Malawi (the Project).

JICA sent to Malawi the Preparatory Survey Team (the Team) headed by Mr. Daisuke IJIMA, Director of Team2, Energy and Mining Group, Industrial Development and Public Policy Department, JICA, to conduct the first field survey and the Team was scheduled to stay in the country from 19<sup>th</sup> January to 17<sup>th</sup> February, 2019.

The Team continued discussions with the concerned officials of Malawi and the field survey in Malawi. Electricity Supply Corporation of Malawi (ESCOM) 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. ESCOM 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 Malawi 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 ESCOM 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 Natural Resources, Energy and Mining (MNREM).
- The executing agency is Electricity Supply Corporation of Malawi (ESCOM).
- The Operation and Maintenance agency is Electricity Supply Corporation of Malawi (ESCOM).

### 1.3 The Scope of the Japanese side

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	Quantity
<b>Procurement and Installation Work</b>	
1. Expansion and rehabilitation of Kanengo Substation (132/66/33/11 kV)	
(a) 50 MVA 132/66 kV transformer with OLTC	2 sets
(b) 25 MVA 66/33 kV transformer with OLTC	1 set
(c) 25 MVA 66/11 kV transformer with OLTC	1 lot
(d) 132 kV outdoor conventional type switchgear	1 lot
(e) 66 kV outdoor conventional type switchgear	1 lot
(f) 33 kV outdoor conventional type switchgear	1 lot
(g) 11 kV indoor type switchgear	1 lot
(h) Control and Protection panel	1 lot
(i) Station Transformer	1 lot
(j) A/C and D/C distribution facility	1 lot
(k) Local SCADA System	1 lot
(l) Substation Earthing System	1 lot
(m) Control Building	1 lot
2. Renewal of Old Town Substation (66/33/11 kV)	
(a) 25 MVA 66/33 kV transformer with OLTC	1 set
(b) 25 MVA 66/11 kV transformer with OLTC	1 set
(c) 66 kV outdoor conventional bus-bars with a bus coupler	1 lot
(d) 66 kV outdoor conventional type switchgear	1 lot
(e) 33 kV indoor type switchgear	1 lot
(f) 11 kV indoor type switchgear	1 lot
(g) Control and Protection panel	1 lot
(h) Station Transformer	1 lot
(i) A/C and D/C distribution facility	1 lot
(j) Local SCADA System	1 lot
(k) Substation Earthing System	1 lot
(l) Control Building	1 lot
<b>Procurement Work</b>	
3. Maintenance Tools for the Equipment to be procured under the Project	1 lot
4. Spare parts for the Equipment to be procured under the Project	1 lot
[Remark] Quantities shall be examined in the outline design.	

## 1.4 Obligations/Undertakings of the Malawi side for the Project

### 1.4.1 Preconditions

In addition to the "Annex5 Major Undertakings to be taken by the Government of Malawi" stipulated in the minutes of discussions signed on 8<sup>th</sup> February, 2019 between Malawi side (MNREM, Ministry of Finance, Economic Planning and Development, ESCOM) and JICA Preparatory Survey Team, the Malawi side has agreed to conduct the undertakings in terms of technical aspect as indicated in Table 1.4.2-1.

### 1.4.2 Necessary Inputs by the Malawi side

Work Demarcation for both Japanese and Malawi sides is as shown in Table 1.4.2-1.



Table 1.4.2-1 Work Demarcation for the Project

No.	Work Items	Japanese side		Malawi side	
		Procurement	Installation	Procurement	Installation
1. Before the Bid					
(1)	Secure and clear the project sites (Kanengo Substation and Old Town Substation)	-	-	•	TL (Transmission)
(2)	[Kanengo Substation] Replacement of existing overhead conductor with underground cable. Relocation of all existing underground cables and 33 kV VT.	-	-	•	DL (Distribution)
(3)	Preparation for Access road to the project sites	-	-	•	Admin
(4)	Procession of EIA (tentative); if necessary- Acquisition of Approval, if not necessary- Acquisition of Certification	-	-	•	Admin
(5)	Approval of construction work from City council (Drawing will be submitted by consultant by August 2019)	-	-	•	Admin
2. Before the Project Implementation					
(1)	Clearance of the project site (the existing obstacle, Materials and Trees)	-	-	•	TL
(2)	Preparation of Stockyard for the project sites (during the implementation period)	-	-	•	DOPD (Directorate of Planning and Development)
3. During the Project Implementation					
(3)	[Kanengo Substation] Removal of existing 132/11kV 20MVA transformer (T4T) and related bay equipment and its foundation	-	-	•	TL
(4)	[Kanengo Substation] Removal of existing 66/11kV 12.5MVA transformer (currently out of service) and related bay equipment and its foundation	-	-	•	TL
(1)	Leveling work for the project sites	•	•	-	-
(2)	Gate and Fence for substation	-	-	•	Admin
(3)	Road and parking lot in the site	•	•	-	-
(4)	Construction of control building (Furniture such as desk, chair, reception set, electric appliances and else shall be procured at the Malawi side)	•	•	-	-
(5)	Replacement of substation equipment and Construction work for the project (Procurement, Installation, testing and adjustment, foundation work)	•	•	-	-
(6)	Installation, testing and adjustment of the control system inside the substation (local SCADA system) subject to the project	•	•	-	-
(7)	Modification, relocation, re-connection, testing and adjustment of SCADA system in National Control Center or other substation	-	-	•	TL
(8)	Submission of necessary interface information to connect to local SCADA system, and witness for testing as requested.	-	-	•	TL
(9)	Temporary power outage management during the work	-	-	•	SMO (System and Market Operator)

No.	Work Items	Japanese side		Malawi side	
		Procurement	Installation	Procurement	Installation
(10)	[Kanengo Substation] Switching over of outgoing feeder of 11kV switchgear from existing control building to new one	-	-	•	DL
(11)	[Kanengo Substation] Removal of existing 66/11kV 12.5MVA transformer (currently used 66/33kV) and related bay equipment	-	-	•	TL
(12)	[Kanengo Substation] Removal of foundation for 66/33kV 25MVA Transformer	•	•	-	-
(13)	[Kanengo Substation] Installation of disconnecting switch for new 132/66kV transformer including connection work to the 132kV bus-bars	-	-	•	TL
(14)	[Old Town Substation] Switching over of outgoing feeder of 33kV and 11kV switchgear from existing control building to new one	-	-	•	DL
(15)	[Old Town Substation] Rerouting of 66 kV Existing Transmission Line to Gantry with support structure, if necessary	-	-	•	TL
(16)	Electrical isolation work including cables for existing equipment before removal work	-	-	•	TL
(17)	Spare Parts	•	•	-	-
(18)	Maintenance Tools	•	•	-	-
(19)	FAT ESCOM participation	-	-	-	DOPD
(20)	On-the-job training (OJT) for the Equipment	-	-	•	-
4. After the Project					
(1)	[Kanengo Substation] Expansion of Control Building	-	-	•	Admin
(2)	[Kanengo Substation] Relocation and switching over of all of existing equipment from existing control building to expanded one	-	-	•	TL/ DL
(3)	[Old Town Substation] Removal of existing substation equipment	-	-	•	TL/ DL

Note: All the work demarcated is subject to change.

- 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

Items	Values
Altitude	1,000-1,100 m
Ambient Temperature	Maximum 32.5 Degrees Centigrade



	Minimum	8.4 Degrees Centigrade
	Mean	21.1 Degrees Centigrade
Maximum Wind Velocity		30 m/s
Annual Rain Fall (Maximum)		426 mm/month
Seismic Force		Horizontal 0.10 G
Soil Bearing Capacity		100-200 kN/m <sup>2</sup> Depends on the soil survey result

(b) System voltage

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

(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.

- 132 kV : 25 kA or more
- 66 kV : 25 kA or more
- 33 kV : 25 kA or more
- 11 kV : 40 kA or more

(e) Grounding system

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

(f) Pollution level for Insulator

Light (IEC-60815)

(g) Applicable Codes and Standards

As a rule, the substation system equipment shall be designed in accordance with IEC and/or IEC equivalent or higher standards.

2.1.2 Technical requirements for the equipment of Kanengo Substation

The following equipment should be installed or replaced for Kanengo Substation.

Main reason are as follows:

- Temporary 132/11 kV, 20MVA and 66/33 kV, 7.5MVA transformers are being operated to cope with demand,

- and 132/66 kV, 25 MVA transformer is operated over 40 years,
- and 66/11 kV, 12.5 MVA transformer has not been operated due to a breakdown.
- Two (2) units of 132/66 kV, 50 MVA transformer (one is replaced, the other is newly installed)
- One (1) unit of 66/33 kV, 25 MVA transformer (newly installed)
- One (1) unit of 66/11 kV, 25 MVA transformer (newly installed)
- Two (2) bays of 132 kV outdoor conventional type switchgears
- Three (3) bays of 66 kV outdoor conventional type switchgears
- One (1) bay of 33 kV outdoor conventional type switchgears
- Indoor type, 11 kV air insulated switchgear in the new control building.
- Control & protection equipment of related the above transformers

This specification described in the table below will be reviewed by ESCOM by 21st February 2019 and if there is no comment by that date it will be assumed that ESCOM has accepted the specification for the bid purpose.

Table 2.1.2-1 Equipment to be provided for Kanengo Substation

No.	Equipment	Q'ty	Unit	Major Specifications
KG-1	132/66 kV Transformer	2	Units	<p>Note; Insulator creepage distance: 27.8 mm/kV or longer is applied to the electrical equipment list.</p> <ol style="list-style-type: none"> <li>1) Type: Outdoor use, with On-load tap changer</li> <li>2) Continuous Rated Capacity: 50 MVA</li> <li>3) Rated Primary Voltage: 132 kV</li> <li>4) Rated Secondary Voltage: 66 kV</li> <li>5) Rated Tertiary Voltage: 11 kV</li> <li>6) Type of Cooling: ONAN</li> <li>7) Number of phase: 3</li> <li>8) Frequency: 50 Hz</li> <li>9) Tap Voltages: 132 kV +3/- 11*1.43%</li> <li>10) Number of taps: 15 taps</li> <li>11) step voltage: 1.43%</li> <li>12) Winding Connections: <ul style="list-style-type: none"> <li>- Primary &amp; Secondary: Star with solidly grounded</li> <li>- Tertiary: Delta</li> <li>- Vector Group: YNa001</li> </ul> </li> <li>13) Impedance: <ul style="list-style-type: none"> <li>- Considering parallel operation with existing transformers (ref. (IBT) Tap1/5/7: 9.38/9.35/9.95%)</li> </ul> </li> <li>14) Lightning Impulse Withstand Voltage: <ul style="list-style-type: none"> <li>- Primary: 650 kV or higher</li> <li>- Secondary: 325 kV or higher</li> <li>- Tertiary: 95 kV or higher</li> </ul> </li> <li>15) Power Frequency Withstand Voltage (1 min.): <ul style="list-style-type: none"> <li>- Primary: 275 kV or higher</li> <li>- Secondary: 140 kV or higher</li> <li>- Neutral on Primary &amp; Secondary: 95 kV or higher</li> <li>- Tertiary: 28 kV or higher</li> </ul> </li> </ol>

No.	Equipment	Q'ty	Unit	Major Specifications
KG-2	132 kV Circuit Breaker (3-phases)	2	Sets	<p>16) Connections</p> <ul style="list-style-type: none"> <li>- Primary: Overhead conductors</li> <li>- Secondary: Overhead conductors</li> </ul> <p>17) Bushing CT</p> <ul style="list-style-type: none"> <li>- Primary: 400/1/1/1/1 A</li> <li>- Secondary: 800/1/1/1/1 A</li> <li>- Primary neutral: 400/1 A</li> <li>- Secondary neutral: 800/1 A</li> </ul> <p>18) Others</p> <ul style="list-style-type: none"> <li>- Parallel operation should be done with these new transformers.</li> <li>- The mounting provisions for fans shall be made on the radiators for future 65 MVA ONAF (oil-immersed, air-forced cooled) cooling in order to increase the transformer capacity.</li> <li>- Fan control circuits and associated power supply circuits for ONAF cooling are provided in a local control box from the beginning.</li> </ul> <p>1) Type</p> <ul style="list-style-type: none"> <li>- Three-pole, outdoor use, gas circuit breaker</li> </ul> <p>2) Rated Voltage: 145 kV or higher</p> <p>3) Rated Current: 1,250 A or higher</p> <p>4) Rated Interrupting Current: 25 kA or higher</p> <p>5) Operating Sequence: O-0.3 sec.-CO-3 min.-CO</p> <p>6) Lightning Impulse Withstand Voltage: 650 kV or higher</p> <p>7) Power Frequency Withstand Voltage (1 min.): 275 kV or higher</p> <p>8) Control Voltage: DC 110 V</p> <p>1) Type:</p> <ul style="list-style-type: none"> <li>- Outdoor use, single phase, porcelain insulator</li> </ul> <p>2) Rated Voltage: 145 kV or higher</p> <p>3) Rated Primary Current: 400 A</p> <p>4) Rated Secondary Current: 1/1/1/1 A</p> <p>5) Accuracy:</p> <ul style="list-style-type: none"> <li>- Core 1: Class 0.5 or higher, Core 2: Class x, Core 3, 4: Class 5P20 or higher</li> </ul> <p>6) Rated Burden: 30 VA each or higher</p> <p>7) Rated Short-time Current: 25 kA-2 sec. or higher</p> <p>8) Lightning Impulse Withstand Voltage: 650 kV or higher</p> <p>9) Power Frequency Withstand Voltage (1 min.): 275 kV or higher</p>
KG-3	132 kV Current Transformer (3-phases)	2	Sets	<p>1) Type</p> <ul style="list-style-type: none"> <li>- Outdoor use, Metal oxide gapless type, single phase</li> </ul> <p>2) Rated Voltage: 120 kV</p> <p>3) Rated Discharge Current: 10 kA</p>
KG-4	132 kV Lightning Arrester (3-Phases)	2	Sets	<p>1) Type:</p> <ul style="list-style-type: none"> <li>- Outdoor use, single phase, porcelain insulator</li> </ul>
KG-5	132 kV Voltage Transformer (3-Phases)	2	Sets	<p>1) Type:</p> <ul style="list-style-type: none"> <li>- Outdoor use, single phase, porcelain insulator</li> </ul>

No.	Equipment	Q'ty	Unit	Major Specifications
KG-6	66/33 kV Transformer	1	Unit	<p>2) Rated Primary Voltage: 132kV/√3 V</p> <p>3) Rated Secondary Voltage: 110/√3 V</p> <p>4) Highest system Voltage: 145 kV</p> <p>5) Accuracy:</p> <ul style="list-style-type: none"> <li>- measurement: Class 0.5 or higher, protection: Class 3P or higher</li> </ul> <p>6) Rated Burden: 50 VA each or higher</p> <p>7) Lightning Impulse Withstand Voltage: 650 kV or higher</p> <p>8) Power Frequency Withstand Voltage (1 min.): 275 kV or higher</p> <p>1) Type: Outdoor use, with On-load tap changer</p> <p>2) Continuous Rated Capacity: 25 MVA</p> <p>3) Rated Primary Voltage: 66 kV</p> <p>4) Rated Secondary Voltage: 33 kV</p> <p>5) Type of Cooling: ONAN</p> <p>6) Number of phase: 3</p> <p>7) Frequency: 50 Hz</p> <p>8) Tap Voltages: +4/- 12* 1.25%</p> <p>9) Number of taps: 17 taps</p> <p>10) step voltage: 1.25%</p> <p>11) Winding Connections:</p> <ul style="list-style-type: none"> <li>- Primary: Star with solidly grounded</li> <li>- Secondary: Star with solidly grounded</li> <li>- Tertiary: Delta</li> <li>- Vector Group: YNyn0+d1</li> </ul> <p>12) Impedance:</p> <ul style="list-style-type: none"> <li>- Considering parallel operation with existing transformers</li> </ul> <p>13) Lightning Impulse Withstand Voltage:</p> <ul style="list-style-type: none"> <li>- Primary: 325 kV or higher</li> <li>- Secondary: 170 kV or higher</li> <li>- Tertiary: 95 kV or higher</li> </ul> <p>14) Power Frequency Withstand Voltage (1 min.):</p> <ul style="list-style-type: none"> <li>- Primary: 140 kV or higher</li> <li>- Secondary: 70 kV or higher</li> <li>- Neutral on Primary &amp; Secondary: 70 kV or higher</li> <li>- Tertiary: 28 kV or higher</li> </ul> <p>15) Connections</p> <ul style="list-style-type: none"> <li>- Primary: Overhead conductors</li> <li>- Secondary: Overhead conductors</li> </ul> <p>16) Bushing CT</p> <ul style="list-style-type: none"> <li>- Secondary: 600/1 A</li> <li>- Primary neutral: 300-600/1 A</li> <li>- Secondary neutral: 300-600/1 A</li> </ul> <p>17) Others</p> <ul style="list-style-type: none"> <li>- Parallel operation with the existing transformer is considered.</li> <li>- The mounting provisions for fans shall be made on the radiators for future 31.5 MVA ONAF (oil-immersed, air-forced cooled) cooling in order to increase the transformer capacity.</li> </ul>



No.	Equipment	Q'ty	Unit	Major Specifications
KG-7	66/11 kV Transformer			<p>Fan control circuits and associated power supply circuits for ONAF cooling are provided in a local control box from the beginning.</p> <p>1) Type: Outdoor use, with On-load tap changer  2) Continuous Rated Capacity: 25 MVA  3) Rated Primary Voltage: 66 kV  4) Rated Secondary Voltage: 11 kV  5) Type of Cooling: ONAN  6) Number of phase: 3  7) Frequency: 50 Hz  8) Tap Voltages: +/- 12* 1.25%  9) Number of taps: 17 taps  10) step voltage: 1.25%  11) Winding Connections:  - Primary: Star with solidly grounded  - Secondary: Star with solidly grounded  - Tertiary: Delta  - Vector Group: YNyn0+d1  12) Impedance:  - Considering parallel operation with existing transformer  13) Lightning Impulse Withstand Voltage:  - Primary: 325 kV or higher  - Secondary: 95 kV or higher  - Tertiary: 95 kV or higher  14) Power Frequency Withstand Voltage (1 min.):  - Primary: 140 kV or higher  - Secondary: 28 kV or higher  - Neutral on Primary &amp; Secondary: 28 kV or higher  - Tertiary: 28 kV or higher  15) Connections  - Primary: Overhead conductors  - Secondary: Overhead conductors  16) Bushing CT  - Secondary: 2,000/1 A  - Primary neutral : 1,000-2,000/1 A  - Secondary neutral : 1,000-2,000/1 A  17) Others  - Future parallel operation of the other transformers is considered.  - The mounting provisions for fans shall be made on the radiators for future 31.5 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.</p>
KG-8	66 kV Circuit Breaker (3-phases)	4	Sets	

No.	Equipment	Q'ty	Unit	Major Specifications
1	For 132/66 kV Transformer	2	Sets	<p>1) Type  - Three-pole, outdoor use, gas circuit breaker  2) Rated Voltage: 72.5 kV or higher  3) Rated Current: 1,250 A or higher  4) Rated Interrupting Current: 25 kA or higher  5) Operating Sequence: O-0.3 sec.-CO-3 min.-CO  6) Lightning Impulse Withstand Voltage: 325 kV or higher  7) Power Frequency Withstand Voltage (1 min.): 140 kV or higher  8) Control Voltage: DC 110 V  Ditto</p>
2	For 66/33 kV Transformer	1	Set	Ditto
3	For 66/11 kV Transformer	1	Set	Ditto
KG-9	66 kV Disconnecting Switch (3-phases)	4	Sets	<p>1) Type  - Three-pole, outdoor use, horizontal double break rotating, porcelain insulator  2) Rated Voltage  - 72.5 kV or higher  3) Rated Current  - 1,250 A or higher  4) Rated Short-time Current  - 25 kA-2 sec. or higher  5) Lightning Impulse Withstand Voltage  - 325 kV or higher  6) Power Frequency Withstand Voltage (1 min.)  - 140 kV or higher  7) Control &amp; Operating Voltage  - DC 110 V  Ditto</p>
1	For 132/66 kV Transformer	2	Sets	Ditto
2	For 66/33 kV Transformer	1	Set	Ditto
3	For 66/11 kV Transformer	1	Set	Ditto
KG-10	66 kV Current Transformer (3-phases)	4	Sets	
1	For 132/66 kV Transformer	2	Sets	<p>1) Type  - Outdoor use, single phase, porcelain insulator  2) Rated Voltage  - 74.5 kV or higher  3) Rated Primary Current  - 1,250 A  4) Rated Secondary Current  - 1/1/1 A</p>



No.	Equipment	Q'ty	Unit	Major Specifications
2	For 66/33 kV Transformer	1	Set	5) Tolerances - Core 1: Class 0.5 or higher - Core 2,3: Class 5P20 or higher 6) Rated Burden - 30 VA each or higher 7) Rated Short-time Current - 25 kA-2 sec. or higher 8) Lightning Impulse Withstand Voltage - 325 kV or higher 9) Power Frequency Withstand Voltage (1 min.) - 140 kV or higher
3	For 66/11 kV Transformer	1	Set	Ditto
KG-11	For 66 kV Lightning Arrester (3-phases)	4	Sets	Ditto
1	For 132/66 kV Transformer	2	Sets	1) Type - Outdoor use, Metal oxide gapless type, single phase 2) Rated Voltage: 60 kV 3) Rated Discharge Current: 10 kA
2	For 66/33 kV Transformer	1	Set	Ditto
3	For 66/11 kV Transformer	1	Set	Ditto
KG-12	For 66 kV Voltage Transformer (3-Phases)	1	Set	1) Type: - Outdoor use, single phase, porcelain insulator 2) Rated Primary Voltage: 66kV/√3 V 3) Rated Secondary Voltage: 110/√3 V 4) Highest system Voltage: 72.5 kV 5) Accuracy: - measurement: Class 0.5 or higher, protection: Class 3P or higher 6) Rated Burden: 50 VA each or higher 7) Lightning Impulse Withstand Voltage: 325 kV or higher 8) Power Frequency Withstand Voltage (1 min.): 140 kV or higher
KG-13	66 kV Bus-bar expansion	1	Set	1) 66 kV Bus-bars for extension - Aluminum pipe or equivalent 2) Steel structures for 66 kV bus-bars 3) Post Insulators for 66 kV bus-bars
KG-14	33 kV Circuit Breaker (3-phases)	1	Set	

No.	Equipment	Q'ty	Unit	Major Specifications
	For connection to 33 kV Bus-bar	1	Set	1) Type - Three pole, Outdoor use, gas circuit breaker 2) Rated Voltage - 36 kV 2) Rated Current: - 1,250 A or higher 4) Rated Interrupting Current - 25 kA or higher 5) Rated Short-time Current - 25 kA-2 sec. or higher 6) Lightning Impulse Withstand Voltage - 170 kV or higher 7) Power Frequency Withstand Voltage (1 min.) - 70 kV or higher 8) Control Voltage - DC 110 V
KG-15	33 kV Disconnecting Switch (3-phases)	1	Set	
1	For connection to 33 kV Bus-bar	1	Set	1) Type - Three-pole, outdoor use, horizontal double break rotating insulator 2) Rated Voltage - 36 kV or higher 3) Rated Current - 1,250 A or higher 4) Rated Short-time Current - 25 kA-2 sec. or higher 5) Lightning Impulse Withstand Voltage - 170 kV or higher 6) Power Frequency Withstand Voltage (1 min.) - 70 kV or higher 7) Control & Control Voltage - DC 110 V
KG-16	33 kV Current Transformer (3-phases)	1	Set	
1	For connection to 33 kV Bus-bar	1	Set	1) Type - Outdoor use 2) Rated Voltage - 36 kV or higher 3) Rated Primary Current - 1,250 A 4) Rated Secondary Current - 1/1/1 A 5) Tolerances - Core 1: Class 0.5 or higher - Core 2,3: Class 5P20 or higher 6) Rated Burden

No.	Equipment	Q'ty	Unit	Major Specifications
KG-17	33 kV Lightning Arrester (3-Phases)	2	Sets	- 30 VA each or higher 7) Rated Short-time Current - 25 kA-2 sec. or higher 8) Lightning Impulse Withstand Voltage - 170 kV or higher 9) Power Frequency Withstand Voltage (1 min.) - 70 kV or higher
1	For connection to 33 kV Bus-bar	1	Set	1) Type - Outdoor use, Metal oxide gapless type, single phase 2) Rated Voltage - 30 kV 3) Rated Discharge Current - 10 kA - Ditto
2	For 66/33 kV Transformer	1	Set	1) Type: - Outdoor use, single phase type 2) Rated Primary Voltage: 33kV/√3 V 3) Rated Secondary Voltage: 110/√3 V 4) Highest system Voltage: 36 kV 5) Accuracy: - measurement: Class 0.5 or higher, protection: Class 3P or higher 6) Rated Burden: 50 VA each or higher 7) Lightning Impulse Withstand Voltage: 170 kV or higher 8) Power Frequency Withstand Voltage (1 min.): 70 kV or higher
KG-18	33 kV Voltage Transformer (3-Phases)	1	Set	1) Type - Indoor use, Metal enclosed or Metal clad type, 2) Rated Voltage - 12 kV 3) Rated Current (bus-bar): 4,000A or higher 4) Rated Interrupting Current 40 kA or higher 5) Rated Short-time Current - 40 kA-2 sec. or higher 6) Lightning Impulse Withstand Voltage - 75 kV or higher 7) Power Frequency Withstand Voltage (1 min.) - 28 kV or higher 8) Control Voltage - DC 110 V
KG-19	11kV Switchgear Panel	8	Panels	

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No.	Equipment	Q'ty	Unit	Major Specifications
1	For 66/11 kV Transformer	1	Panel	Ditto 1) Rated Current: 2,000A or higher
2	For 11 kV Feeders	4	Panels	Ditto 1) Rated Current: 800A or higher
3	For Diesel Engine Generator	1	Panel	Ditto 1) Rated Current: 800A or higher
4	For Station transformer	1	Panel	Ditto 1) Rated Current: 800A or higher
5	For Voltage transformer	1	Panel	Ditto
KG-20	Control and Protection Panel	1	Set	- Indoor use, air insulated, metal enclosed self-standing type
1	For 132/66 kV Transformer	2	Panels	- Ditto
2	For 66/33 kV Transformer	1	Panel	- Ditto
3	For 66/11 kV Transformer	1	Panel	- Ditto
KG-21	11/0.4 kV Station Service Transformer	1	Set	1) Type - Outdoor use, with No-load tap changer 2) Continuous Rated Capacity - 300 kVA 3) Rated Primary Voltage - 11 kV 4) Rated Secondary Voltage - 400-230 V (three phases, four wires) 5) Type of Cooling - ONAN 6) Number of phase - 3 7) Frequency - 50 Hz 8) Tap Voltages - 11 kV +/-5.0% 9) Number of taps - 5 tap 10) Step voltage - 2.5% 11) Winding Connections - Primary: Delta

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No.	Equipment	Q'ty	Unit	Major Specifications
				<ul style="list-style-type: none"> <li>- Secondary: Star with solidly grounded Vector Group: Dyn11</li> <li>- 12) Impedances approximately 5%</li> <li>- 13) Connections               <ul style="list-style-type: none"> <li>- Primary &amp; Secondary: Cables</li> </ul> </li> </ul>
KG-22	AC Panel for Station Power Supply	1	Set	<ul style="list-style-type: none"> <li>1) Type               <ul style="list-style-type: none"> <li>- Indoor use, air insulated, metal enclosed self-standing type</li> </ul> </li> <li>2) Ratings               <ul style="list-style-type: none"> <li>- AC 400 - 230 V, three phase and four wires</li> <li>- Indoor use, air insulated, metal enclosed self-standing type, 110 V DC</li> </ul> </li> </ul>
KG-23	DC Panel for Station Power Supply	1	Set	
KG-24	Battery charging panel	1	Set	
1	For 110V batteries	1	Set	<ul style="list-style-type: none"> <li>1) Type               <ul style="list-style-type: none"> <li>- Thyristor type, indoor use, air insulated, metal enclosed self-standing type</li> </ul> </li> <li>2) System               <ul style="list-style-type: none"> <li>- Duplicate charger system (Dump-less transfer system)</li> </ul> </li> <li>3) Input               <ul style="list-style-type: none"> <li>- 400 V AC or 230 V AC</li> </ul> </li> <li>4) Output               <ul style="list-style-type: none"> <li>- 110 V DC (+/-3 V), 120A</li> <li>- Output voltage should be regulated by Silicon droppers or equivalent.</li> </ul> </li> </ul>
2	For 48V batteries	1	Set	<ul style="list-style-type: none"> <li>1) Type               <ul style="list-style-type: none"> <li>- Thyristor type, indoor use, air insulated, metal enclosed self-standing type</li> </ul> </li> <li>2) System               <ul style="list-style-type: none"> <li>- Duplicate charger system (Dump-less transfer system)</li> </ul> </li> <li>3) Input               <ul style="list-style-type: none"> <li>- 400 V AC or 230 V AC</li> </ul> </li> <li>4) Output               <ul style="list-style-type: none"> <li>- 48 V DC (+/-3 V), 120A</li> <li>- Output voltage should be regulated by Silicon droppers or equivalent.</li> </ul> </li> </ul>
3	For Uninterruptible Power Supply (UPS)	1	Set	<ul style="list-style-type: none"> <li>1) Type               <ul style="list-style-type: none"> <li>- Indoor use, air insulated, metal enclosed self-standing type, Inverter type or equivalent</li> </ul> </li> <li>2) Input               <ul style="list-style-type: none"> <li>- 400 V AC or 230 V AC, and 110 V DC (Substation battery)</li> </ul> </li> <li>3) Output               <ul style="list-style-type: none"> <li>- AC 230 V (single phase) +/- 5%, 50 A</li> </ul> </li> <li>4) Others               <ul style="list-style-type: none"> <li>- Distribution circuits for UPS output shall be included.</li> </ul> </li> </ul>

No.	Equipment	Q'ty	Unit	Major Specifications
KG-25	Batteries for Station Power Supply	2	Sets	
1	110V batteries	1	Set	<ul style="list-style-type: none"> <li>- Lead-acid Battery with control valves or equivalent, 700 Ah/8 Hr., 54 cells</li> </ul>
2	48V batteries	1	Set	<ul style="list-style-type: none"> <li>- Lead-acid Battery with control valves or equivalent, 700 Ah/8 Hr., 24 cells</li> </ul>
KG-26	Gantry Tower	4	Sets	<ul style="list-style-type: none"> <li>- Material: Mild steel</li> <li>- Coating: Hot dip galvanizing</li> <li>- Size: Similar to the existing structure</li> </ul>
1	For 132/66 kV Transformer	2	Sets	<ul style="list-style-type: none"> <li>- Ditto</li> </ul>
2	For connection of 66 kV Bus-bar	2	Sets	<ul style="list-style-type: none"> <li>- Ditto</li> </ul>
KG-27	Supporting Structure for Cables (3-Phases)	2	Sets	<ul style="list-style-type: none"> <li>- Material: Mild steel</li> <li>- Coating: Hot dip galvanizing</li> <li>- Size: Suitable to the transformer and underground cables</li> </ul>
1	For 66/33 kV Transformer	1	Set	<ul style="list-style-type: none"> <li>- Ditto</li> </ul>
2	For 66/11 kV Transformer	1	Set	<ul style="list-style-type: none"> <li>- Ditto</li> </ul>
KG-28	Overhead Line	1	Set	<ul style="list-style-type: none"> <li>1) 132 kV Overhead Conductors for 2 circuits               <ul style="list-style-type: none"> <li>- Hard aluminum stranded wires (AAC 160 mm<sup>2</sup> or higher) or equivalent</li> </ul> </li> <li>1) 66 kV Overhead Conductors for 2 circuits               <ul style="list-style-type: none"> <li>- Hard aluminum stranded wires (AAC 400 mm<sup>2</sup> or higher) or equivalent</li> </ul> </li> <li>3) Other necessary materials               <ul style="list-style-type: none"> <li>- Terminals, connectors and other necessary materials</li> </ul> </li> </ul>
KG-29	Insulator (incl. supporting pole)	1	Set	
KG-30	Underground cable	2	Sets	
1	33 kV cable (incl. terminal)	1	Set	<ul style="list-style-type: none"> <li>1) Type               <ul style="list-style-type: none"> <li>- XLPE Cables</li> </ul> </li> <li>2) Purpose               <ul style="list-style-type: none"> <li>- Between Transformers and 33 kV Switchgear panels (including 33 kV temporary cables)</li> </ul> </li> <li>3) Others               <ul style="list-style-type: none"> <li>- Cable sealing ends, Structures for Cable heads and</li> </ul> </li> </ul>



This specification described in the table below will be reviewed by ESCOM by 21st February 2019 and if there is no comment by that date it will be assumed that ESCOM has accepted the specification for the bid purpose.

**Table 2.1.3-1 Equipment to be provided for Old Town Substation**

No.	Equipment	Q'ty	Unit	Major Specifications
OT-1	66/33 kV Transformer	1	Unit	<p>Note: Insulator creepage distance: 27.8 mm/kV or longer is applied to the electrical equipment list.</p> <ol style="list-style-type: none"> <li>1) Type: Outdoor use, with On-load tap changer</li> <li>2) Continuous Rated Capacity: 25 MVA</li> <li>3) Rated Primary Voltage: 66 kV</li> <li>4) Rated Secondary Voltage: 33 kV</li> <li>5) Type of Cooling: ONAN</li> <li>6) Number of phase: 3</li> <li>7) Frequency: 50 Hz</li> <li>8) Tap Voltages: +4/- 12* 1.25%</li> <li>9) Number of taps: 17 taps</li> <li>10) step voltage: 1.25%</li> <li>11) Winding Connections: <ul style="list-style-type: none"> <li>- Primary: Star with solidly grounded</li> <li>- Secondary: Star with solidly grounded</li> <li>- Tertiary: Delta</li> <li>- Vector Group: YNyn0+d1</li> </ul> </li> <li>12) Impedance: 9.47%(ESCOM Standard)</li> <li>13) Lightning Impulse Withstand Voltage: <ul style="list-style-type: none"> <li>- Primary: 325 kV or higher</li> <li>- Secondary: 170 kV or higher</li> <li>- Tertiary: 95 kV or higher</li> </ul> </li> <li>14) Power Frequency Withstand Voltage (1 min.): <ul style="list-style-type: none"> <li>- Primary: 140 kV or higher</li> <li>- Secondary: 70 kV or higher</li> <li>- Neutral on Primary &amp; Secondary: 70 kV or higher</li> <li>- Tertiary: 28 kV or higher</li> </ul> </li> <li>15) Connections <ul style="list-style-type: none"> <li>- Primary: Overhead conductors</li> <li>- Secondary: Overhead conductors</li> </ul> </li> <li>16) Bushing CT <ul style="list-style-type: none"> <li>- Secondary A Phase: 600/1 A</li> <li>- Secondary B Phase: 600/1 A</li> <li>- Primary neutral Core 1: 300-600/1 A</li> <li>- Secondary neutral Core 2: 300-600/1 A</li> </ul> </li> <li>17) Others <ul style="list-style-type: none"> <li>- Future parallel operation of the two transformers is considered.</li> <li>- The mounting provisions for fans shall be made on the radiators for future 31.5 MVA ONAF (oil-immersed, air-forced cooled) cooling in order to increase the transformer capacity.</li> <li>- Fan control circuits and associated power supply circuits for ONAF cooling are provided in a local control box from the beginning.</li> </ul> </li> </ol>

No.	Equipment	Q'ty	Unit	Major Specifications
2	11kV cable (incl. terminal)	1	Set	<ul style="list-style-type: none"> <li>- XLPE Cables</li> <li>- Between Transformers and 11 kV Switchgear panels (including 11 kV temporary cables)</li> <li>- Others</li> <li>- Cable sealing ends, Structures for Cable heads and other necessary materials</li> <li>- Conduits, cable racks and others</li> </ul>
KG-31	Low Voltage Cable	1	Set	<ul style="list-style-type: none"> <li>- Conduits, cable racks and others</li> </ul>
KG-32	Cable for protection and communication	1	Set	<ul style="list-style-type: none"> <li>- Earthing conductors and accessories</li> <li>- Overhead grounding wires for new 132 kV switchgear and transformer area</li> </ul>
KG-33	Substation Earthing System	1	Set	<ol style="list-style-type: none"> <li>1) Component (IEC 61850) <ul style="list-style-type: none"> <li>- Substation control panel</li> <li>- 132/66 kV Transformer Bay Control Units (BCU)</li> <li>- 66/33 kV Transformer BCU</li> <li>- 66/11 kV Transformer BCU</li> <li>- Control and Monitoring Work Stations</li> <li>- Ethernet/Optical fiber Cables and other necessary materials to connect to the existing communication equipment</li> <li>- Gateway unit x2(redundancy)</li> </ul> </li> <li>2) Communication(IEC-60870-1-101/104) <ul style="list-style-type: none"> <li>- Communication with SCADA system based on IEC-60870-1-101/104</li> </ul> </li> <li>3) Control Voltage <ul style="list-style-type: none"> <li>- 230 V AC by UPS</li> </ul> </li> </ol>
KG-34	Local SCADA System for the Project equipment	1	Set	<ul style="list-style-type: none"> <li>- Control and Monitoring Work Stations</li> <li>- Ethernet/Optical fiber Cables and other necessary materials to connect to the existing communication equipment</li> <li>- Gateway unit x2(redundancy)</li> <li>- Communication(IEC-60870-1-101/104)</li> <li>- Communication with SCADA system based on IEC-60870-1-101/104</li> <li>- Control Voltage <ul style="list-style-type: none"> <li>- 230 V AC by UPS</li> </ul> </li> </ul>

**2.1.3 Technical requirements for the equipment of Old Town Substation**

The following equipment should be installed as new Old Town Substation because existing two (2) 66/11 kV, 12.5 MVA transformers are operated about 40 years, and working life is not much left.

- One (1) unit of 66/33 kV, 25 MVA transformer
- One (1) unit of 66/11 kV, 25 MVA transformer
- 66 kV outdoor conventional bus-bars with a bus coupler
- Gantry for two (2) transmission lines
- 66/33/11kV switchgears
- Control & protection equipment in the new control building

No.	Equipment	Q'ty	Unit	Major Specifications
OT-2	66/11 Transformer	1	Unit	<p>1) Type: Outdoor use, with On-load tap changer  2) Continuous Rated Capacity: 25 MVA  3) Rated Primary Voltage: 66 kV  4) Rated Secondary Voltage: 11 kV  5) Type of Cooling: ONAN  6) Number of phase: 3  7) Frequency: 50 Hz  8) Tap Voltages: +/- 12* 1.25%  9) Number of taps: 17 taps  10) step voltage: 1.25%  11) Winding Connections:  - Primary: Star with solidly grounded  - Secondary: Star with solidly grounded  - Tertiary: Delta  - Vector Group: YNyn0+d1  12) Impedance: 6.03%(ESCOM Standard)  13) Lightning Impulse Withstand Voltage:  - Primary: 325 kV or higher  - Secondary: 95 kV or higher  - Tertiary: 95 kV or higher  14) Power Frequency Withstand Voltage (1 min.):  - Primary: 140 kV or higher  - Secondary: 28 kV or higher  - Neutral on Primary &amp; Secondary: 28 kV or higher  - Tertiary: 28 kV or higher  15) Connections  - Primary: Overhead conductors  - Secondary: Overhead conductors  16) Bushing CT  - Secondary A Phase: 2,000/1 A  - Secondary B Phase: 2,000/1 A  - Primary neutral Core 1: 1,000-2,000/1 A  - Secondary neutral Core 2: 1,000-2,000/1 A  17) Others  - Future parallel operation of the two transformers is considered.  - The mounting provisions for fans shall be made on the radiators for future 31.5 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.</p>

No.	Equipment	Q'ty	Unit	Major Specifications
OT-3	66 kV Circuit Breaker (3-phases)	5	Sets	<p>1) Type  - Three-pole, outdoor use, gas circuit breaker  2) Rated Voltage: 72.5 kV or higher  3) Rated Current: 1,250 A or higher  4) Rated Interrupting Current: 25 kA or higher  5) Operating Sequence: O-0.3 sec.-CO-3 min.-CO  6) Lightning Impulse Withstand Voltage: 325 kV or higher  7) Power Frequency Withstand Voltage (1 min.): 140 kV or higher  8) Control Voltage: DC 110 V</p>
1	For 66 kV Incoming Line	2	Sets	Ditto
2	For 66/33 kV Transformer	1	Set	Ditto
3	For 66/11 kV Transformer	1	Set	Ditto
4	For connection of 66 kV Bus coupler	1	Set	Ditto
OT-4	66 kV Disconnecting Switch (3-phases)	8	Sets	<p>1) Type  - Three-pole, single-throw, outdoor use, horizontal double break rotating, porcelain insulator and motor-driven type  2) Rated Voltage  - 72.5 kV or higher  3) Rated Current  - 1,250 A or higher  4) Rated Short-time Current  - 25 kA-2 sec. or higher  5) Lightning Impulse Withstand Voltage  - 325 kV or higher  6) Power Frequency Withstand Voltage (1 min.)  - 140 kV or higher  7) Control &amp; Operating Voltage  - DC 110 V</p>
1	For 66 kV Incoming Line (with Earthing Switch)	2	Sets	Ditto Earthing switch: motor-driven type
2	For 66/33 kV Transformer	1	Set	Ditto
3	For 66/11 kV Transformer	1	Set	Ditto
4	For connection of 66 kV Bus-bar	2	Sets	Ditto
OT-5	66 kV Current Transformer (3-phases)	4	Sets	<p>1) Type  - Outdoor use, single phase, porcelain insulator  2) Rated Voltage  - 74.5 kV or higher</p>



No.	Equipment	Q'ty	Unit	Major Specifications
1	For 66 kV Incoming Line For 66/33 kV Transformer	2	Sets	3) Rated Primary Current - 1,250 A 4) Rated Secondary Current - 1/1/1 A 5) Tolerances - Core 1: Class 0.5 or higher - Core 2,3: Class 5P20 or higher 6) Rated Burden - 30 VA each or higher 7) Rated Short-time Current - 25 kA-2 sec. or higher 8) Lightning Impulse Withstand Voltage - 325 kV or higher 9) Power Frequency Withstand Voltage (1 min.) - 140 kV or higher
2	For 66/11 kV Transformer	1	Set	Ditto
3	For 66/11 kV Transformer	1	Set	Ditto
OT-6	66 kV Lightning Arrester (3-Phases)	8	Sets	1) Type - Outdoor use, Metal oxide gapless type, single phase 2) Rated Voltage: 60 kV 3) Rated Discharge Current: 10 kA
1	For 66 kV Incoming Line For 66/33 kV Transformer	2	Sets	Ditto
2	For 66/11 kV Transformer (3-Phases)	1	Set	Ditto
3	For 66/11 kV Transformer (3-Phases)	1	Set	Ditto
OT-7	66 kV Voltage Transformer (3-Phases)	4	Sets	1) Type: - Outdoor use, single phase 2) Rated Primary Voltage: 66kV/√3 V 3) Rated Secondary Voltage: 110/√3 V 4) Highest system Voltage: 72.5 kV 5) Accuracy: - measurement: Class 0.5 or higher, protection Class 3P or higher 6) Rated Burden: 50 VA each or higher 7) Lightning Impulse Withstand Voltage: 325 kV or higher 8) Power Frequency Withstand Voltage (1 min.): 140 kV or higher
1	For 66 kV Incoming Line	2	Sets	Ditto

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No.	Equipment	Q'ty	Unit	Major Specifications
2	For connection of 66 kV Bus coupler	2	Sets	Ditto
OT-8	66 kV Bus-bar (incl. Supporting structure)	1	Set	1) 66 kV Bus-bars Aluminum pipe or equivalent 2) Post Insulators for 66 kV bus-bars 3) Steel structures for 66 kV post insulators
OT-9	33 kV Switchgear Panel	4	Panels	1) Type - Indoor use, Metal enclosed or Metal clad type 2) Rated Voltage - 36 kV 3) Rated Current (Bus-bar): 1,250A or higher 4) Rated Interrupting Current - 25 kA or higher 5) Rated Short-time Current - 25 kA-2 sec. or higher 6) Lightning Impulse Withstand Voltage - 170 kV or higher 7) Power Frequency Withstand Voltage (1 min.) - 70 kV or higher 8) Control Voltage - DC 110 V 9) Protection Relays - Overcurrent relays and others
1	For 66/33 kV Transformer	1	Panel	Ditto
2	For 33 kV Feeders	2	Panels	1) Rated Current: 600A or higher
3	For Voltage Transformer	1	Panel	1) Rated Current: 600A or higher
OT-10	11kV Switchgear Panel	9	Panels	1) Type - Indoor use, Metal enclosed or Metal clad type, 2) Rated Voltage - 12 kV 3) Rated Current (Bus-bar): 4,000A or higher 4) Rated Interrupting Current - 40 kA or higher 5) Rated Short-time Current - 40 kA-2 sec. or higher 6) Lightning Impulse Withstand Voltage - 75 kV or higher 7) Power Frequency Withstand Voltage (1 min.) - 28 kV or higher 8) Control Voltage - DC 110 V

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No.	Equipment	Q'ty	Unit	Major Specifications
1	For 66/11 kV Transformer	1	Panels	Ditto 1) Rated Current: 4,000A or higher
2	For 11 kV Feeders	4	Panels	Ditto 1) Rated Current: 1,000A or higher
3	For Diesel Engine Generator	2	Panels	Ditto 1) Rated Current: 1,000A or higher
4	For Station transformer	1	Panels	Ditto 1) Rated Current: 1,000A or higher
5	For Voltage transformer	1	Panel	Ditto
OT-11	Control and Protection Panel	1	Set	- Indoor use, metal enclosed self-standing type
1	For 66 kV Transmission line	2	Panel	Ditto
2	For 66kV Bus-bar	1	Panel	Ditto
3	For 66/33 kV Transformer	1	Panel	Ditto
4	For 66/11 kV Transformer	1	Panels	Ditto
OT-12	11/0.4 kV Station Service Transformer	1	Sets	1) Type - Outdoor use, with No-load tap changer 2) Continuous Rated Capacity - 300 kVA 3) Rated Primary Voltage - 11 kV 4) Rated Secondary Voltage - 400-230 V (three phases, four wires) 5) Type of Cooling - ONAN 6) Number of phase - 3 7) Frequency - 50 Hz 8) Tap Voltages - 11 kV +/-5.0% 9) Number of taps - 5 tap 10) Step voltage - 2.5% 11) Winding Connections - Primary: Delta - Secondary: Star with solidly grounded Vector Group: Dyn11 12) Impedances - approximately 5% 13) Connections - Primary & Secondary: Cables

No.	Equipment	Q'ty	Unit	Major Specifications
OT-13	AC Panel for Station Power Supply	1	Set	1) Type - Indoor use, air insulated, metal enclosed self-standing type 2) Ratings - AC 400 - 230 V, three phase and four wires - Indoor use, air insulated, metal enclosed self-standing type, 110 V DC
OT-14	DC Panel for Station Power Supply	1	Set	-
OT-15	Battery charging panel	1	Set	-
1	For 110V batteries	1	Set	1) Type - Thyristor type, indoor use, air insulated, metal enclosed self-standing type 2) System - Duplicate charger system (Dump-less transfer system) 3) Input - 400 V AC or 230 V AC 4) Output - 110 V DC (+/-3 V), 120A - Output voltage should be regulated by Silicon droppers or equivalent.
2	For 48V batteries	1	Set	1) Type - Thyristor type, indoor use, air insulated, metal enclosed self-standing type 2) System - Duplicate charger system (Dump-less transfer system) 3) Input - 400 V AC or 230 V AC 4) Output - 48 V DC (+/-3 V), 120A - Output voltage should be regulated by Silicon droppers or equivalent.
3	For Uninterruptible Power Supply (UPS)	1	Set	1) Type - Indoor use, air insulated, metal enclosed self-standing type, Inverter type or equivalent 2) Input - 400 V AC or 230 V AC, and 110 V DC (Substation battery) 3) Output - AC 230 V (single phase) +/- 5%, 50 A 4) Others - Distribution circuits for UPS output shall be included.
OT-16	Batteries for Station Power Supply	2	Sets	-
1	110V batteries	1	Set	- Lead-acid Battery with control valves or equivalent, 700 Ah/8 Hr., 54 cells
2	48V batteries	1	Set	- Lead-acid Battery with control valves or equivalent, 700 Ah/8 Hr., 24 cells

No.	Equipment	Q'ty	Unit	Major Specifications
OT-17	Gantry Tower	2	Sets	- Material: Mild steel - Coating: Hot dip galvanizing - Size: Similar to the existing structure
OT-18	Supporting Structure for Cables (3-Phases)	3	Sets	- Material: Mild steel - Coating: Hot dip galvanizing - Size: Suitable to the transformer and underground cables
1	For 66/33 kV Transformer	1	Set	- Ditto
2	For 66/11 kV Transformer	1	Set	- Ditto
OT-19	Insulator (incl. supporting pole)	1	Set	1) Type: creepage distance: 27.8 mm/kV or longer
OT-20	Underground cable	2	Sets	1) Type - XLPE Cables 2) Purpose - Between Transformers and 33 kV Switchgear panels (including 33 kV temporary cables) 3) Others - Cable sealing ends, Structures for Cable heads and other necessary materials
1	33 kV cable (incl. terminal)	1	Set	1) Type - XLPE Cables 2) Purpose - Between Transformers and 11 kV Switchgear panels (including 11 kV temporary cables) 3) Others - Cable sealing ends, Structures for Cable heads and other necessary materials
OT-21	Low Voltage Cable	1	Set	- Conduits, cable racks and others
OT-22	Cable for protection and communication	1	Set	- Conduits, cable racks and others
OT-23	Substation Earthing System	1	Set	- Earthing conductors and accessories
OT-24	Lightning Protection	1	Set	- Overhead grounding wires for new equipment including support towers
OT-25	Local SCADA System for the Project equipment	1	Set	1) Component (IEC 61850) - Substation Control System Panel - 66 kV Transmission Line Bay Control Units (BCU) - 66/33 kV Transformer BCU - 66/11 kV Transformer BCU - 66 kV Bus coupler BCU - Control and Monitoring Work Stations - Ethernet Cables and other necessary materials

No.	Equipment	Q'ty	Unit	Major Specifications
				2) Communication Communication with SCADA system based on IEC-60870-1-101/104 3) Control Voltage - 230 V AC by UPS

## 2.2 Environmental and Social Consideration

This project is not expected to acquire environmental impact assessment because it is unnecessary to acquire a new land or to expand outside the premises substation site. However, EIA exemption certificates may be necessary even if EIA is deemed unnecessary, and ESCOM needs to inform the Team as soon as possible after obtaining confirmation from relevant authorities.

The flow for acquisition of EIA license confirmed in the previous survey or acquisition of EIA exemption certificate is as follows.

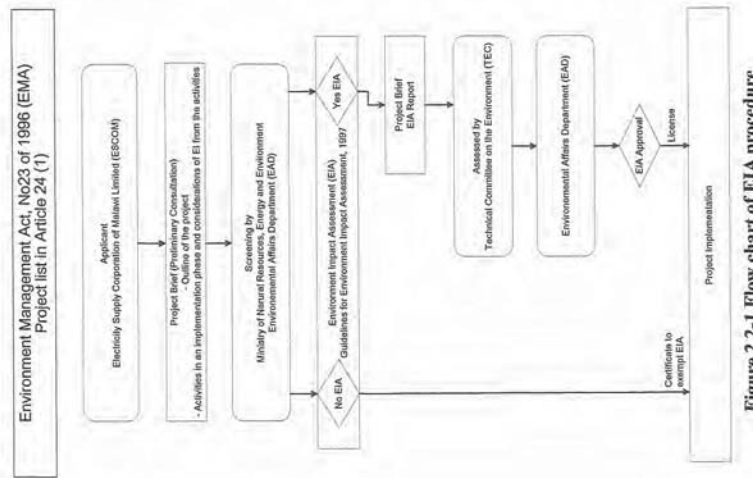


Figure 2.2-1 Flow chart of EIA procedure



### 2.3 Procurement Plan of Spare Parts and Maintenance Tools

Capability of sustainable operation and maintenance tools for the equipment of the Project by the Recipient is one of conditions for the Japan's Grant Aid. The Malawi 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 2.3-1 and Table 2.3-2 are recommended to be procured. More detailed parts, tools, test equipment and the quantity will be explained in the Draft Final Report.

Table 2.3-1 Recommended Spare Part List

No.	Name of Spare Parts	Unit	Q'ty
1.	Transformer		
1.1	Power transformer		
(1)	Gasket (complete set)	Set	1 each
(2)	Bueholz relay set	Set	1 each
(3)	Oil temperature indicator (main tank and conservator)	Piece	1 each
(4)	Oil level indicators (main tank and conservator)	Piece	1 each
1.2	Station transformer		
(1)	Oil temperature indicator	Piece	1 each
2.	132 kV Switchgear equipment		
2.1	132 kV Circuit breaker		
(1)	Closing coil	Set	1 each
(2)	Tripping coil	Set	1 each
2.2	132 kV Disconnecting Switch (DS)		
(1)	Fixed and moving contact (3 phase set for DS)	Set	3 each
(2)	Fixed and moving contact (3 phase set for Earthing switch)	Set	3 each
3.	66 kV Switchgear equipment		
3.1	66 kV Circuit breaker		
(1)	Closing coil	Set	1 each
(2)	Tripping coil	Set	1 each
3.2	66 kV Disconnecting Switch (DS)		
(1)	Fixed and moving contact (3 phase set for DS)	Set	3 each
(2)	Fixed and moving contact (3 phase set for Earthing switch)	Set	3 each
4.	33 kV Switchgear equipment		

4.1	33 kV Circuit breaker		
(1)	Closing coil	Set	1 each
(2)	Tripping coil	Set	1 each
(3)	Withdrawable Circuit breaker with accessory	Set	1
4.2	33 kV Disconnecting Switch (DS)		
(1)	Fixed and moving contact (3 phase set for DS)	Set	3 each
(2)	Fixed and moving contact (3 phase set for Earthing switch)	Set	3 each
5.	11 kV Switchgear equipment		
5.1	11 kV Circuit breaker		
(1)	Closing coil	Set	1 each
(2)	Tripping coil	Set	1 each
(3)	Withdrawable Circuit breaker with accessory	Set	1
5.2	11 kV Disconnecting Switch (DS)		
(1)	Fixed and moving contact (3 phase set for DS)	Set	3 each
(2)	Fixed and moving contact (3 phase set for Earthing switch)	Set	3 each
6.	Control and Protection		
(1)	Protection relay (each type)	Piece	1 each
(2)	Bay control unit	Piece	1 each
(3)	Fuse (each type)	Piece	100%
(4)	Meter (each type)	Piece	1 each
(5)	Auxiliary relay (each type)	Piece	1 each
(6)	Control and selector switch, if any (each type)	Piece	1 each
7.	Station LV Power Supply Equipment		
7.1	AC Distribution Board		
(1)	MCCB (each type)	Piece	1 each
(2)	Indicating lamp, if any (each type)	Piece	1 each
(3)	Fuse (each type)	Piece	100%
(4)	Meter (each type)	Piece	1 each
7.2	DC Distribution Board		
(1)	MCCB (each type)	Piece	1 each
(2)	Indicating lamp, if any (each type)	Piece	1 each
(3)	Fuse (each type)	Piece	100%
(4)	Meter (each type)	Piece	1 each
7.3	Battery and Charger		
(1)	DC 110 V and 48 V Battery	Cell	2 each
(2)	Control Card and diode module	Piece	1 each
(3)	Indicating lamp, if any (each type)	Piece	1 each
(4)	Fuse (each type)	Piece	100%
(5)	Meter (each type)	Piece	1 each
8.	Communication		
(1)	RTU card and/or related card (if necessary)	Piece	1 each



**Table 2.3-2 Recommended Maintenance tools**

No.	Name of Spare Parts	Unit	Qty
1.	Withstand voltage testing device for insulation oil of transformer	Set	1
2.	Testing device for protection relays	Set	1
3.	Vacuum Insulation Oil Degassing Apparatus (Incl. tank)	Set	1

**2.4 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 Malawi 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 132 kV and 66 kV substation equipment
- Protection relay setting
- Fault analysis and operation record management

**2.5 Power Demand Forecast**

ESCOM considers development plan based on IRP edited by Norconsult. According to the hearing survey to ESCOM, demand forecast on IRP does not constituted by the information of demand forecast of individual substations since there is no such information existing. Regarding the operation record, the records acquired are limited.

Considering the situation mentioned above, demand forecasts of up to 2032 for the Kanengo substation and Old Town substation were implemented based on the policy described (1) to (4). In the demand forecast, "Malawi Electricity Access Project (MEAP)" by WB was not taken into consideration at the moment, since, based on the discussion with a consultant for WB together with ESCOM, MEAP is at the initial stage and the increasing rate of demand on each substation is under consideration.

**(1) General**

- Initial value: Existing record reviewed by the Consultant
- General increasing rate of Demand forecast applied to High, Middle, and Low case.
  - 1) Very high case (10 %): Increase rate of base case of demand forecast in IRP
  - 2) High case (5 %): One of the highest increase rate of South African Power Pool (SAPP) member countries except for the special high rate of 10 % of Tanzania on JICA Report "Data Collection Survey on Southern African power pool Final Report (June 2017)"
  - 3) Base case (3 %): Increase rate of demand forecast of Malawi on the JICA Report.

**(1) Kanengo substation**

There is record in excel file for Kanengo substation from 2008. Initial value of the substation was calculated based on the record of each feeders in 2018-2019. However the time of the peak demand of has "0" as the demand because of the operation of the day. So, the initial value was calculated from total

of the peak demand of each feeders picked up from different time, considering the concurrent usage rate of 0.7.

In Kanengo substation, step loads shall be considered since approximately 33% of the total demand is for Industry. As the step loads, only 8MVA in 2019 and 5MVA in 2020 are applied to ESCOM for future connection at the moment. However, 2MVA is taken into account after 2021 as the step load every year because there are 1 to 2 applications for connection in each year and the trend is assumed to be the same.

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

The table below shows demand forecast in Very High case, High case and Base case.

**Table 2.5-1 Demand forecast for Kanengo substation**

	Initial	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Very high	76.9	88.8	99.3	108.4	118.2	128.9	140.5	153.1	166.8	181.8	198.1	216.0	235.4	256.7	279.9	305.4	332.2	363.7
High	76.9	85.7	92.5	97.4	102.5	107.7	113.2	118.8	124.6	130.7	137.0	143.6	150.4	157.5	164.9	172.5	180.5	188.8
Base	76.9	84.4	89.9	93.3	96.8	100.3	103.9	107.6	111.3	115.1	119.0	122.9	127.0	131.1	135.3	139.5	143.9	148.4

[MVA]

[Source] Prepared by JICA survey team based on ESCOM information

**(2) Old Town substation**

There is paper based record for Old Town substation partially existing for some months from 2015 to 2017. However data of 33 kV feeder has not been recorded. So the initial value was set based on the load record of each transformer at 33 kV and 11 kV.

According to ESCOM, normally peak demand is found in June and July. Information in 2015 July and in 2016 were found from the record and took the peak value in 2015 as the initial value because the value is bigger than that in 2016.

There is no Industrial customer connected and no future connection is assumed to the feeders from Old Town substation. Thus the demand forecast was estimated based on the initial value and the general increase rate for Very High case, High case and Base case.

The table below shows demand forecast in Very High case, High case and Base case.

**Table 2.5-2 Demand forecast for Old Town substation**

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

[MVA]

[Source] Prepared by JICA survey team based on ESCOM information

As the conclusion, the consultant recommend the base case. And with the Project, the demand on base



case will be covered until 2032.

**(3) Recommendation**

Even if the Project will be implemented and completed, it is important to keep on reviewing the increase rate of demand for the future expansion, considering N-1 condition. The recommended upgrade for each substation based on the base case is as described below;

**1) Kanengo Substation**

- 132/66 kV transformer (25MVA) shall be replaced by the end of 2029.
- 66/11 kV transformer (12.5MVA) shall be replaced by the end of 2028.

Other transformers shall be installed according to the demand.

**2) Old Town Substation**

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

Other transformers shall be installed according to the demand.

And if the increase rate will be higher, the implementation year shall be earlier.

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

**Table 2.5-3 Details of Demand forecast for Kanengo substation**

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	MVA
110kV																		
66kV	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130
33kV	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073
11kV	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130
33kV	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073
11kV	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	MVA
110kV																		
66kV	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130
33kV	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073
11kV	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130
33kV	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073	10.3073
11kV	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130	76.8130

(Source) Prepared by JICA survey team based on ESCOM information  
(Note) Yellow feeders are for industry and Orange feeders are for Domestic and Commercial



Table 2.5-4 Details of Demand forecast for Old Town substation

[MVA]

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
10kV	7.810	8.150	8.500	8.850	9.200	9.550	9.900	10.250	10.600	10.950	11.300	11.650	12.000	12.350	12.700	13.050	13.400	13.750
33kV	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
110kV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30kV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11kV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5kV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1kV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.5kV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.2kV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.1kV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.05kV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02kV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.01kV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

[Source] Prepared by JICA survey team based on ESCOM information

## 2.6 Power System Analysis

### (1) General

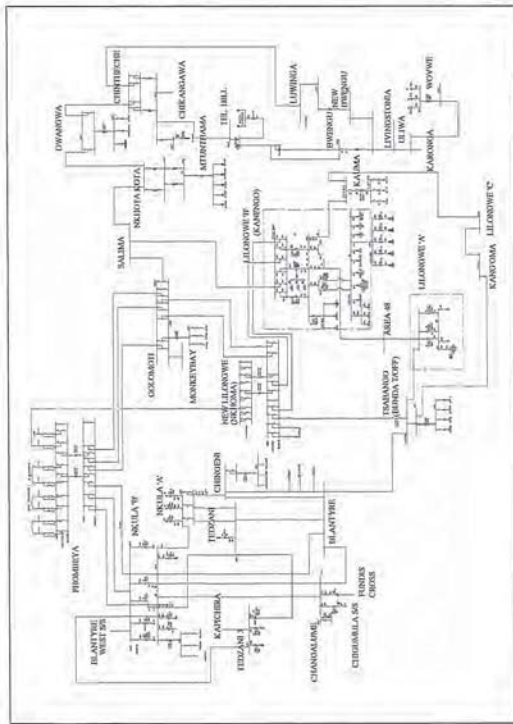
The power evacuation system for Kanengo substation and Old Town substation from the Malawi National Grid is as follows.

Kanengo substation is connected 132 kV x 3 circuit of transmission lines with Golomoti substation. The 2 circuits 132 kV transmission lines from Golomoti substation are connected at Nkhoma 400/132 kV substation and connected to Kanengo substation. Also another 1 circuit of 132 kV transmission line is connected Nanjoka substation and connected to Kanengo substation.

The Nkhoma substation has 132kV x 1 circuit of transmission line to Bunda substation and the Bunda substation has 132/66kV transformer and evacuate 66kV electricity to other substations including Old Town substation.

Old Town substation is connected to Kanengo substation by 66 kV transmission line 1 circuit through Area 48 substation.

132/400kV step up transformer is installed in Nkhoma substation and the Nkhoma substation is connected to Phombeya substation by 400 kV transmission line. Phombeya substation is constructed between Nkhoma power station and Golomoti substation, which has 400/132kV transformer and will be connected to Mozambique by 400 kV transmission line.



[Source] ESCOM

Figure 2.6-1 Malawi Central Region Grid Diagram

### 1) Kanengo Substation (Lilongwe B substation)

Kanengo substation evacuates the electricity to Lilongwe area including international airport by 66kV, 33 kV and 11kV distribution lines. 1 of 3 66/11 kV transformers has been replaced by 66/33 kV 7.5 MVA transformer to evacuate electricity to Muvura area. 132/11 kV 20 MVA transformer called T4T also had been installed in Kanengo substation. However the T4T transformer can not conduct parallel operation with other 11kV transformer because the vector group has been Y-Δ despite of other 3 x 11 kV transformers were Y-Y connection.

The Kanengo substation also has been connected 2 MVA x 5 diesel generators, which are owned by EGENCO.

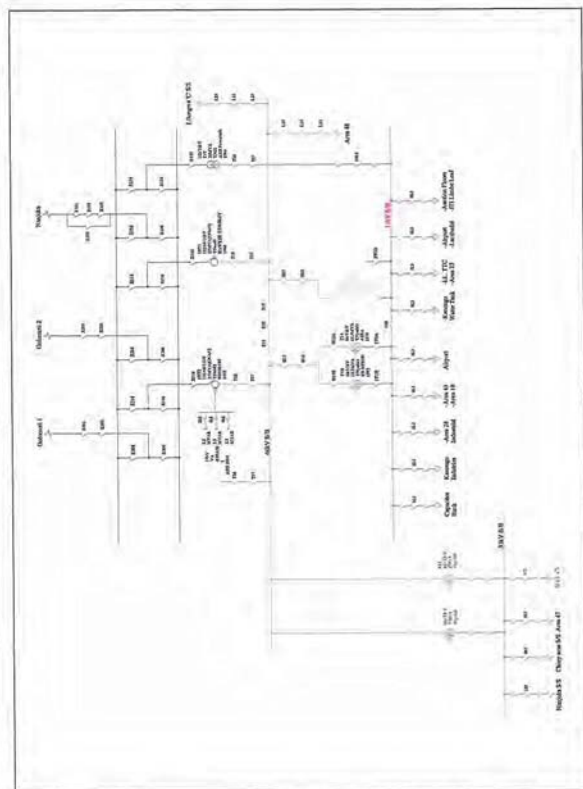


Figure 2.6-2 Kanengo substation single line diagram (Existing)

1) Old town substation (Lilongwe A substation)

Old Town substation is connected Bunda substation and Kanengo substation by 66 kV transmission lines and evacuates 33 kV to Kamuz Central Hospital and Area 47 and 11 kV to Old Town area, Area 2, Area 3, Maula area, Kawale Area, etc.

This power system analysis is conducted for 10 years from the commissioning year of Kanengo substation and Old Town substation rehabilitation works.

There are no development plan of national grid between Golomoti to Kanengo also Golomoti to Old Town substation. Therefore this power system study consider only demand forecast shown in section 2.6 to confirm the validity of this project.

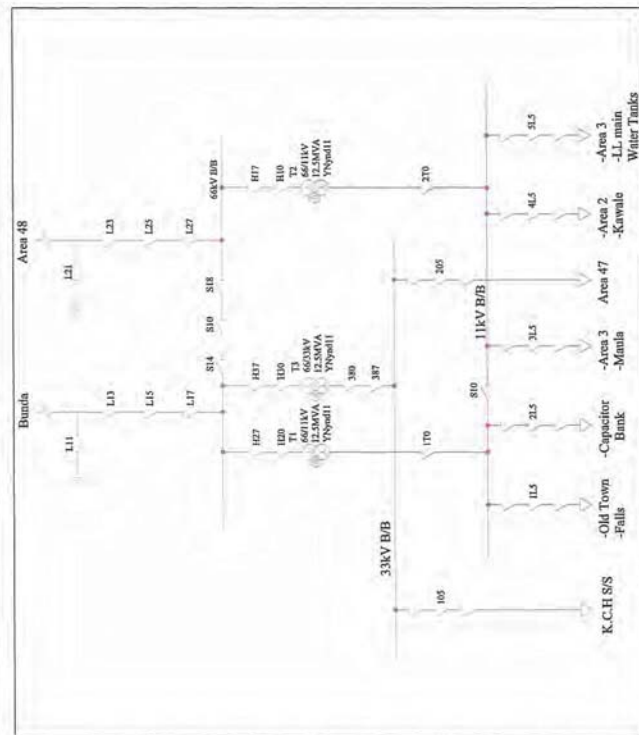


Figure 2.6-3 Old Town Substation Single Line Diagram (Existing)

The parameter which indicated in Malawi Grid Code May 2018 are as follows.

- Nominal fundamental frequency shall be limited 49.5 – 50.5 Hz
- Voltage variations
- Statutory voltage change on bus supplying customer:  $\pm 10\%$

Table 2.6-1 Standard Voltage

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

[Source] Malawi Grid Code May 2018



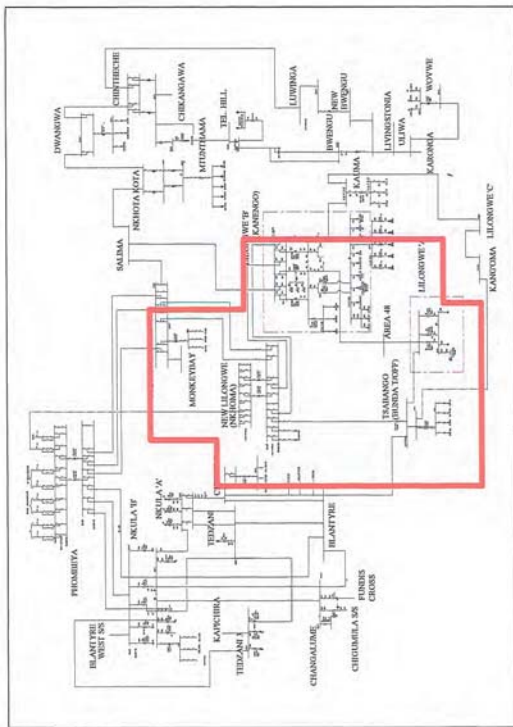


Figure 2.6-4 Power System Analysis Area

Table 2.6-2 Plans for Grid Development

Voltage [kV]	Substation		Length [km]	Cost estimate [MUSD]	To service by
	From	To			
400	Phombeya	Nkhoma	173	Ongoing	2018
	Matambo	Phombeya	210	79.7	2019
	Ma ta mbo	Border	110		
	Border	Cassapa T	45		
	Cassapa T	Phombeya	55		
	Mozambique 2	Blantyre West	215	71.2	2021
	Mozambique 2	Border	110		
	Border	Blantyre West	105		
	Phombeya	Blantyre West	60	52.6	2023
	Mpatamanga	Blantyre West	50	21.9	2023
	Mpatamanga	Cassapa T	15	7.8	2023
	Mpatamanga 2	Cassapa T2	15	7.8	2023
	Cassapa T	Phombeya	55	20.4	-
	Kholombidzo	Phombeya	15	10.9	2026
	Nkhoma	Kasungu	200	85.7	2020
Kanengo	New Bwengu	235	96.7	2023	
	On Nkhoma-Kasungu	2	20.1	2024	
Nkhoma 2	Kanengo 2	60	25.1	2024	
New Bwengu	Fufu	55	39.9	2029	

Voltage [kV]	Substation		Length [km]	Cost estimate [MUSD]	To service by	
	From	To				
132	Fufu	Coal North	120	71.5	2031	
	New Bwengu	Livingstonia*	60	20.8	-	
	Livingstonia*	Coal North	115	69.9	-	
	New Bwengu(2)	Coal North(2)	175	61.4	2031	
	Dwangwa	Kanengo	220	92.0	2028	
	Dwangwa	New Bwengu	250	85.1	2030	
	<b>2nd circuit on existing lines:</b>					
		Phombeya	Nkhoma	173	21.7	2021
		Kanengo	Kasungu	120	29.5	2019
		Kasungu	Kanyika	40	17.1	2020
		Kanyika	Chikangawa	120	24.5	2020
		Phombeya	Kammwamba	15	8.2	2019
		Tedzani IV	Tedzani	1	2.0	2019
		Chinthche	Luwinga	71	22.3	2019
		Luwinga	New Bwengu	60	20.2	2019
	New Bwengu	Livingstonia	60	20.2	2019	
	Livingstonia	Karonga	105	27.0	2020	
	Dwangwa	Kanyika	75	22.5	2020	
	Kapichira	Kap.ext	1	2.2	2024	
	Kap.ext.	Hamilton	5	0.8	2024	
	Hamilton	Blantyre West	35	9.4	2024	
	Hamilton	On Kapichira-Bl.W.	1	2.0	2025	
	Fufu	On New Bwengu-Livingst.	12	4.0	2029	
	Pamodzi	On Golomoti-Nanjoka	1	2.0	2030	
	Pamodzi	Nanjoka	35	8.0	2030	
	Karonga	"Coal North"	30	6.6	2031	
	Lower Songwe	Karonga	50	9.5	2032	
	Nkhoma	Bunda Junction	28	13.2	2020	
	Nkhoma2	Bunda Junction2	28	7.9	2022	
	Bunda Junction	Kanengo	35	7.2	2031	
	Mbongozi	Nkhotakota	60	14.0	-	
	Chikangawa	Luwinga	75	22.9	2035	

[Source] Malawi MNREM Integrated Resource Plan (Final Report May 2017)

(2) Power System Analysis

1) Optimized installed capacity on the basis of the annual demand growth rate 3%

- Major Equipment for Kanengo substation expansion
  - Replace 132/66 kV 25MVA IBT1 Transformer to 50 MVA x 1 Transformer
  - Additional 132/66 kV 50MVA x 1 Transformer
  - Additional 66/33 kV 25 MVA x 1 Transformer
  - Additional 66/11 kV 25MVA x 1 Transformer

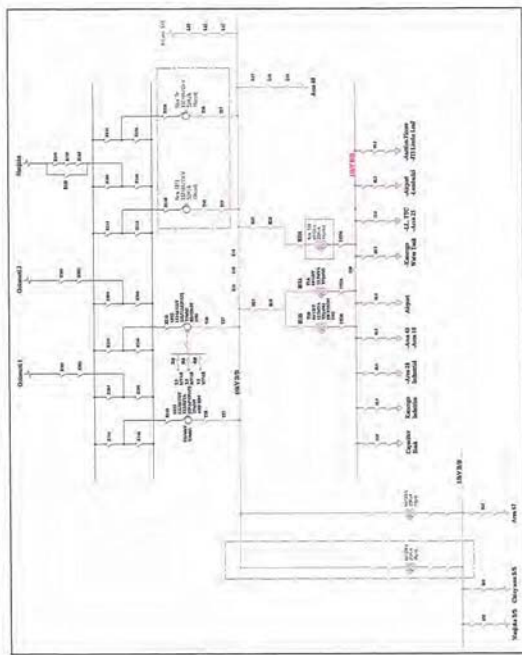


Figure 2.6-5 Kanengo substation expansion plan

Major equipment for Old Town substation replacement  
 66/33 kV 25 MVA x 1 Transformer  
 66/11 kV 25/31.5 MVA (ONAN/ONAF) x 1 Transformer

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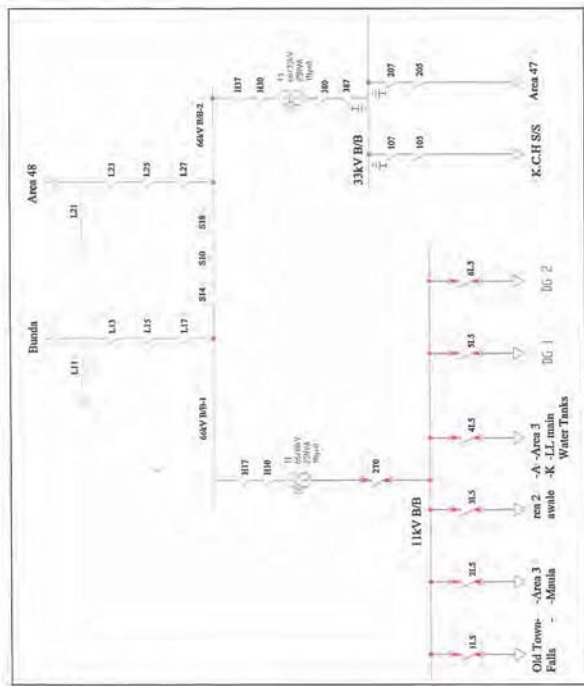


Figure 2.6-6 Old Town substation replacement plan

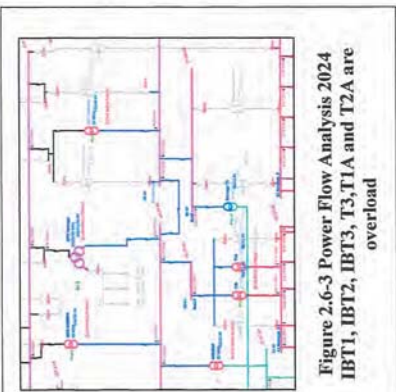
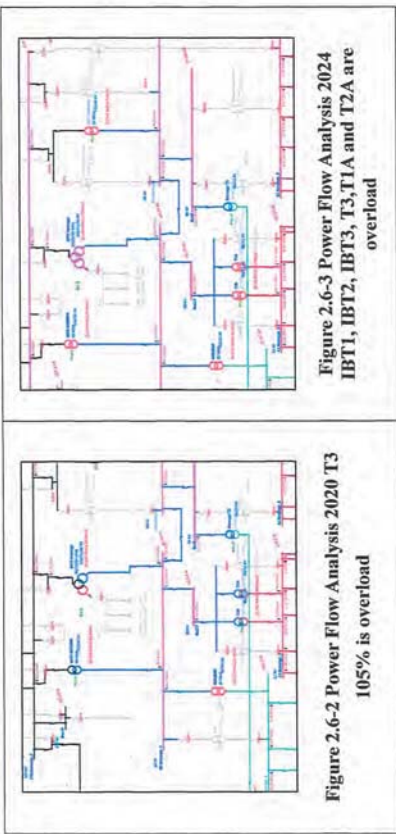
Table 2.6-8 shows each conditions of transformers' load at both Kanengo substation and Old Town substation in case of "Rehabilitated in year 2022 (w/Rehab)" and "Not rehabilitated (w/o Rehab)". If the annual demand growth rate will be 3 % at the project area, 66/33 kV 25 MVA transformer T3 of Kanengo substation will be 105 % load in the year 2020. 132/66 kV 33 MVA transformer IBT3 at Kanengo substation will be 100 % load in the year 2021. The transformer T3 evacuate electricity for Area 25 and Area 47. However those areas can be supplied power from other substation instead of Kanengo substation. However, 132/66 kV 25 MVA transformer IBT1 and IBT2 will be overload in the year 2022. As a countermeasure against above, additional 132/66 kV 50 MVA transformer IBT4 and new 66/33 kV 25 MVA transformer should be installed at Kanengo substation. Considering aged deterioration of IBT1 transformer which was manufactured in 1989, the IBT1 would be replaced with 50 MVA transformer.

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The total 11 kV load will be 25.5 MVA in the year 2028, and 2032 MVA in the year 2032 at Old Town substation. 66/11 kV 25 MVA x 1 transformer will be installed in the Old Town substation and the cooling method of the transformer will be changed from ONAN to ONAF according to the transformers' load.

**Table 2.6-3 Power demand transitions for each transformer period 2018 – 2032 (Case Annual Demand Growth Rate 3%)**

Kanengo Substation	2018	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
125/33kV Transformer														
IBT1	20.7	24.8	24.96	26.1	26.4	27.7	28.2	29.1	30.1	31.1	31.1	31.1	31.1	31.1
IBT2	17.6	20.2	21.15	22.0	22.4	23.7	24.2	25.1	26.1	27.1	27.1	27.1	27.1	27.1
IBT3	17.6	20.2	21.15	22.0	22.4	23.7	24.2	25.1	26.1	27.1	27.1	27.1	27.1	27.1
New IBT1														
New IBT2														
New IBT3														
New T3														
New T1A														
New T2A														
Old Town Substation														
T3	16.7	20.2	20.75	21.3	21.7	23.0	23.5	24.5	25.5	26.5	26.5	26.5	26.5	26.5
New 66 Tr.														
66/11kV Transformer														
T1	9.42	9.62	10.06	10.3	10.5	11.2	11.5	12.2	12.5	13.2	13.2	13.2	13.2	13.2
T1A	9.42	9.62	10.06	10.3	10.5	11.2	11.5	12.2	12.5	13.2	13.2	13.2	13.2	13.2
New T2A														
Old Town Substation														
T3	6.04	6.47	6.52	6.63	6.71	7.22	7.44	7.65	7.86	8.13	8.13	8.13	8.13	8.13
New T3														
66/11kV Transformer														
T1	9.38	9.59	10.3	10.6	10.9	11.7	12.1	12.8	13.2	14.0	14.0	14.0	14.0	14.0
T1A	9.38	9.59	10.3	10.6	10.9	11.7	12.1	12.8	13.2	14.0	14.0	14.0	14.0	14.0
New T1														

Table 2.6-4 shows loads of each year and each transformer in case of the electricity demand growth rate is 5%/year.

**Table 2.6-4 Power demand transitions for each transformer period 2018 – 2032 (Case Annual Demand Growth Rate 5%)**

Kanengo Substation	2018	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
125/33kV Transformer														
IBT1	21.7	24.8	25.76	26.7	27.1	28.4	28.9	29.9	30.9	31.9	31.9	31.9	31.9	31.9
IBT2	17.7	21.4	22.46	23.5	24.0	25.4	25.9	26.9	27.9	28.9	28.9	28.9	28.9	28.9
IBT3	17.7	21.4	22.46	23.5	24.0	25.4	25.9	26.9	27.9	28.9	28.9	28.9	28.9	28.9
New IBT1														
New IBT2														
New IBT3														
New 66 Tr.														
66/11kV Transformer														
T3	16.8	20.7	20.9	21.1	21.4	22.4	22.8	23.8	24.8	25.8	25.8	25.8	25.8	25.8
New 66 Tr.														
66/11kV Transformer														
T1	9.42	9.84	10.17	10.6	10.7	11.4	11.8	12.5	12.9	13.6	13.6	13.6	13.6	13.6
T1A	9.42	9.84	10.17	10.6	10.7	11.4	11.8	12.5	12.9	13.6	13.6	13.6	13.6	13.6
New T2A														
Old Town Substation														
T3	6.04	6.49	6.54	6.65	6.73	7.24	7.46	7.67	7.88	8.15	8.15	8.15	8.15	8.15
New T3														
66/11kV Transformer														
T1	9.37	10.4	10.5	10.6	10.7	11.4	11.8	12.5	12.9	13.6	13.6	13.6	13.6	13.6
T1A	9.37	10.4	10.5	10.6	10.7	11.4	11.8	12.5	12.9	13.6	13.6	13.6	13.6	13.6
New T1														

According to the power system analysis above Table 2.6-4, Kanengo substation will be able to operate without additional transformer after the project by year 2030 if the electricity demand growth rate will be 5%/year.

If 25/3.1.5 MVA (ONAN/ONAF) transformer will be installed in Old Town substation, the Old Town substation will be able to evacuate electricity without additional transformers by the year 2028.

**2) Fault Current Analysis**

As a power flow study of Kanengo substation expansion and Old Town substation replacement, Fault Current Analysis also have been conducted as followings.

Case: Annual electricity demand growth rate is 3%

**Table 2.6-5 Fault Current at Kanengo substation Year 2032**

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

**Table 2.6-6 Fault Current at Old Town substation Year 2032**

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

Case: Annual electricity demand growth rate is 5%

Table 2.6-7 Fault Current at Kanengo substation Year 2032

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

Table 2.6-8 Fault Current at Old Town substation Year 2032

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

### 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 June, 2020. 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 Malawi and Japanese Government shall be signed in December, 2019.
- > The Bid Opening will be held in May, 2020.
- > Installation work of the Project will start in June, 2020.
- > Commissioning of the Project will be in June, 2022.

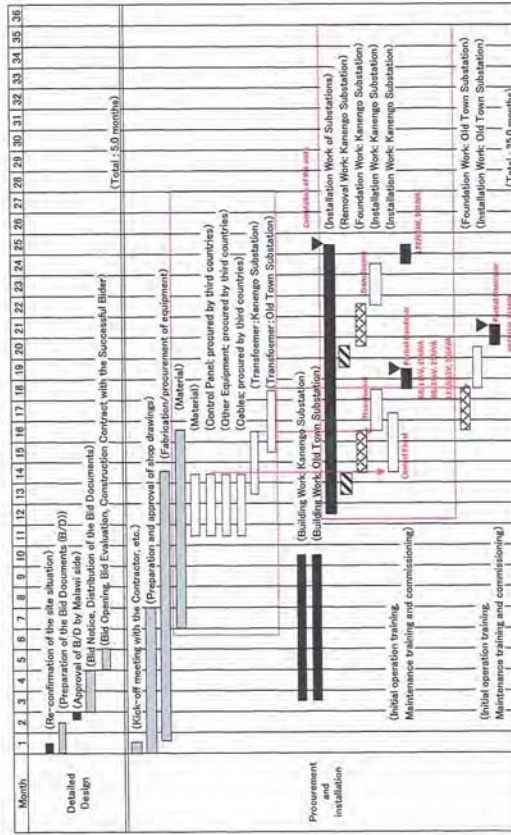


Figure 3-1 Implementation Schedule of the Project (Tentative)

### 4. Drawings

- Part 1 General
- Part 2 Substation
- Part 3 Architectural

Table 2.6-7 Fault Current at Kanengo substation Year 2032

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

Table 2.6-8 Fault Current at Old Town substation Year 2032

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



**Attachment-1. Member List of the Study Team**

**First Field Survey**

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

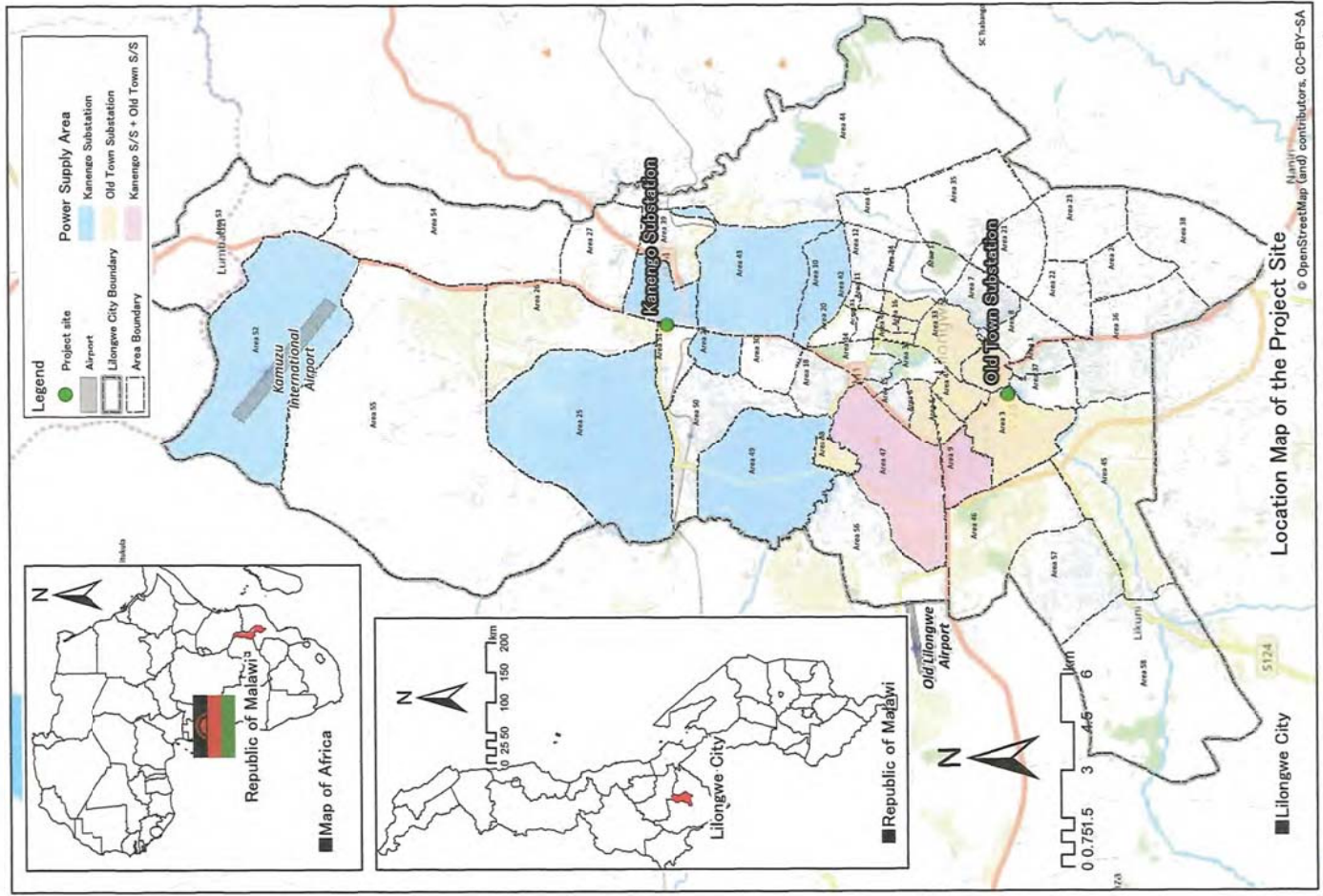
**Attachment-2. Procedure of Installation of the equipment for Kanengo substation**

SN	Main Item
R-1	<ul style="list-style-type: none"> <li>- 66/11kV transformers (T2A, temporary located on T2B, Out of service)</li> <li>- Foundation for 66/11kV transformers (T2A, temporary located on T2B)</li> <li>- Foundation for 66/33 kV transformer (T3B)</li> <li>- 132/11 kV transformer (T4T)</li> <li>- Foundation for 132/11 kV transformer (T4T)</li> <li>- 66/33 kV transformer (T2, temporary located on T2A)</li> <li>- Foundation for 66/33 kV transformer (T2, temporary located on T2A)</li> <li>- Control building</li> <li>- All the equipment in the building (Control Panel, etc.)</li> </ul>
B-1	
I-1 (1)	
F-1	<ul style="list-style-type: none"> <li>- Foundation for 66/33 kV transformer (T3B, 25 MVA) including bay</li> <li>- Foundation for 66/11 kV transformer (T2A, 25 MVA) including bay</li> <li>- Foundation for 132/66 kV transformer (IBT4, 50 MVA)</li> </ul>
I-1 (2)	<ul style="list-style-type: none"> <li>- 66/33 kV transformer (T3B, 25 MVA) including bay</li> <li>- 66/11 kV transformer (T2B, 25 MVA) including bay</li> <li>- 132/66 kV transformer (IBT4, 50 MVA) including bay</li> <li>- Testing and adjustment</li> </ul>
C-1	<ul style="list-style-type: none"> <li>- Connection of transformers to bus-bar</li> <li>- Re-connection of 11kV feeder</li> </ul>
R-2	<ul style="list-style-type: none"> <li>- 132/66 kV transformer (IBT1)</li> <li>- Foundation for 132/66 kV transformer (IBT1)</li> </ul>
F-2	<ul style="list-style-type: none"> <li>- Foundation for 132/66 kV transformer (IBT1, 50 MVA) including bay</li> </ul>
I-2	<ul style="list-style-type: none"> <li>- 132/66 kV transformer (IBT1, 50 MVA) including bay</li> <li>- Testing and adjustment</li> </ul>
C-2	<ul style="list-style-type: none"> <li>- Connection of transformers to bus-bar</li> <li>- Re-connection of 11kV feeder</li> </ul>

[Remarks]

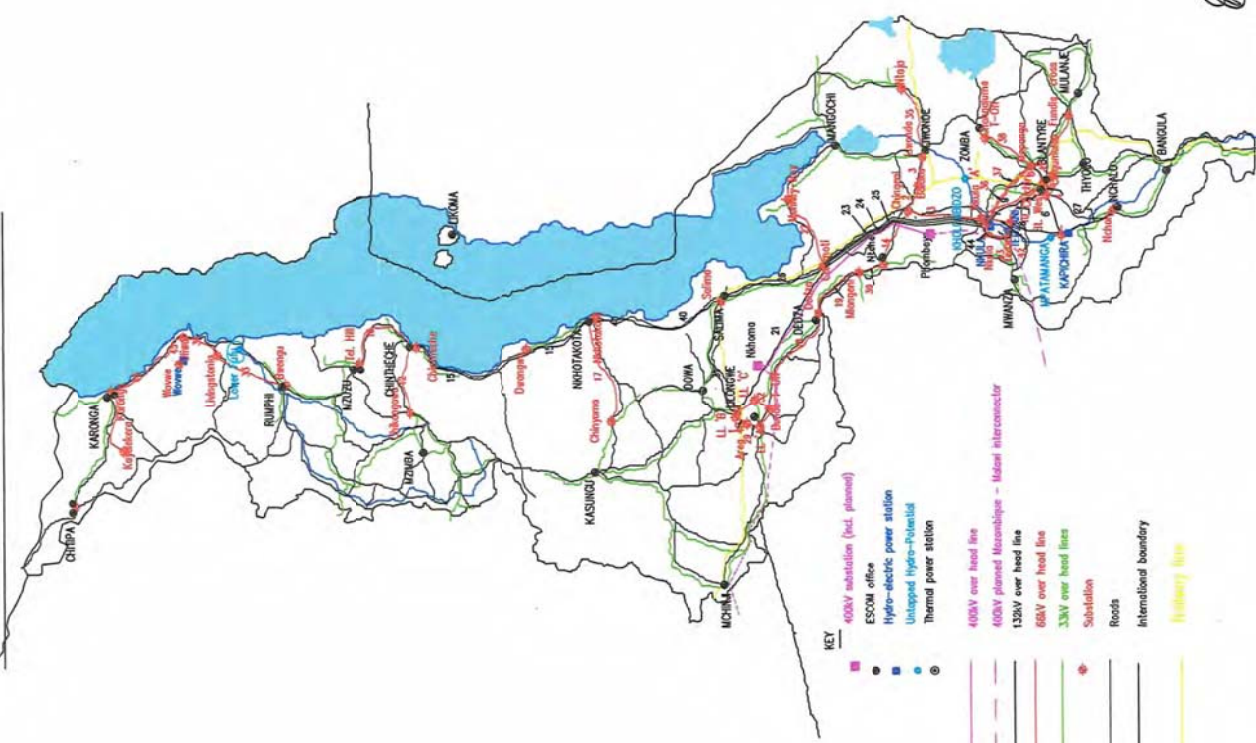
R: Removal Work, B: Building Work, F: Foundation Work, I: Installation Work, C: Connection Work

# Part 1 General





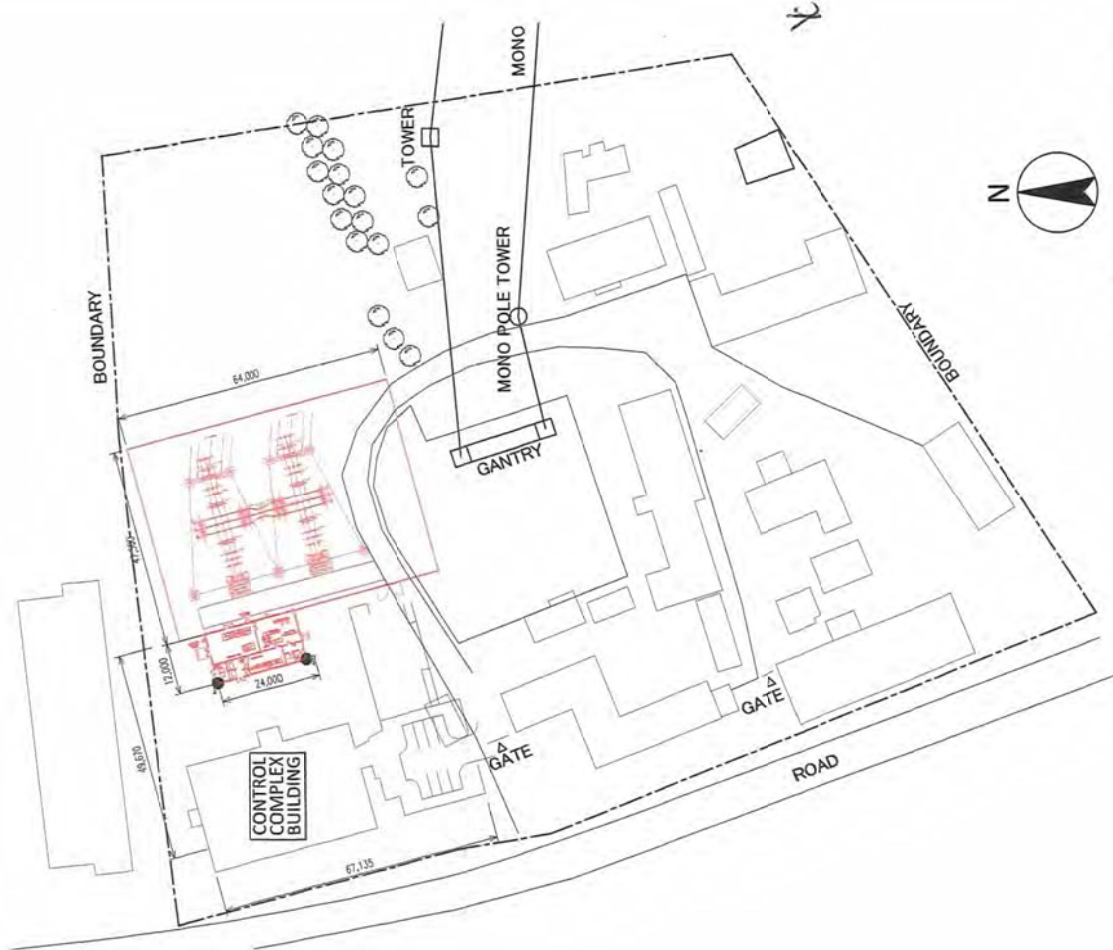
# ESCOM TRANSMISSION LINE ROUTES



- KEY**
- 400kV substation (incl. planned)
  - ESCOM office
  - Hydro-electric power station
  - Unstaged Hydro-Potential
  - Thermal power station
  - 400kV over head line
  - 132kV over head line
  - 66kV over head line
  - 33kV over head lines
  - Substation
  - Roads
  - International boundary
  - Railway line

By	Date	ESCOM POWER SYSTEM ON MAP OF MALAWI	E.S.C.O.M.	
Designed				
Computerised	25/11/04			Drng. No.
Checked				
Approved				
Scale	NTS			

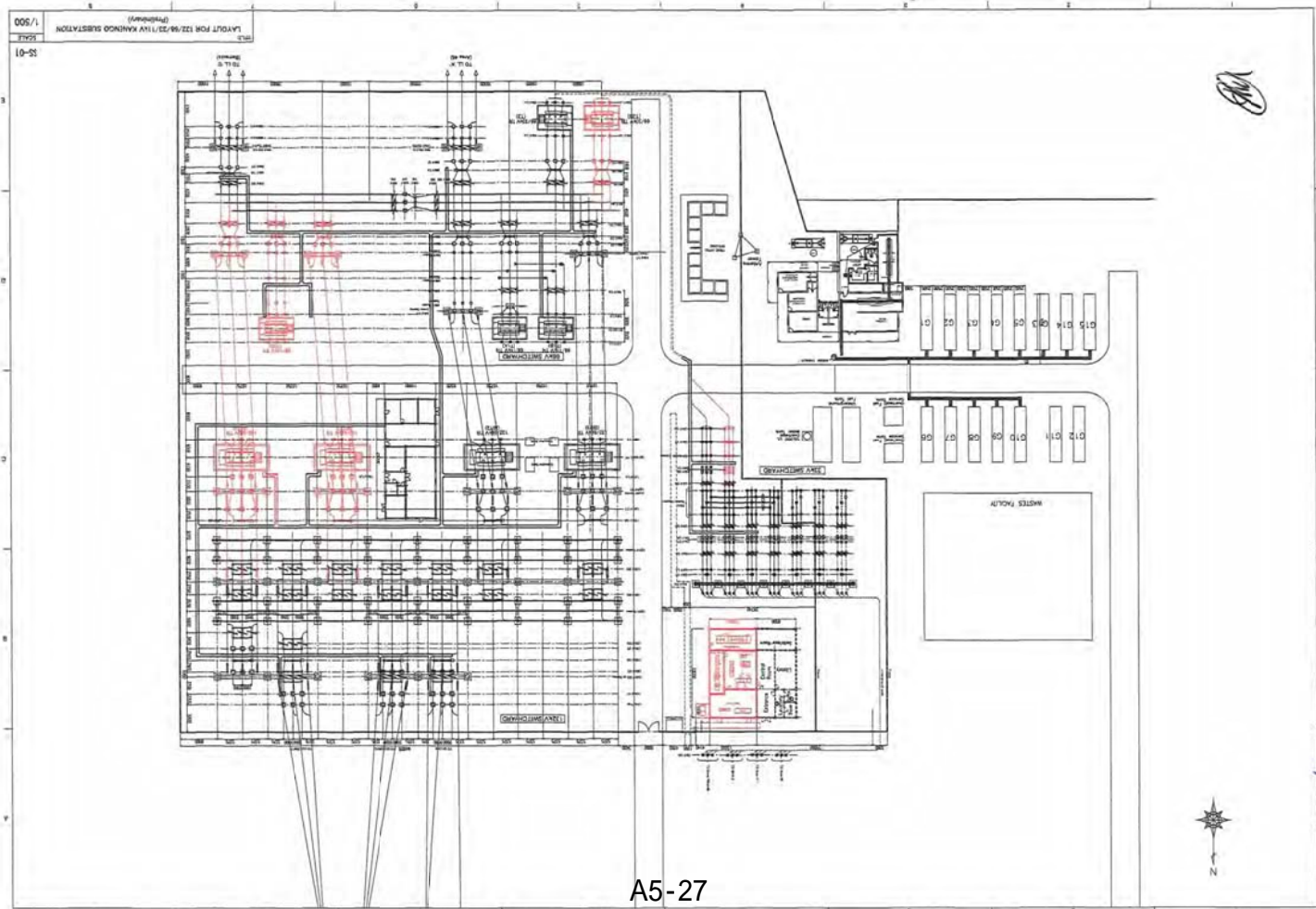
## Part 2 Substation



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SS-02 Site Plan of Old Town Substation

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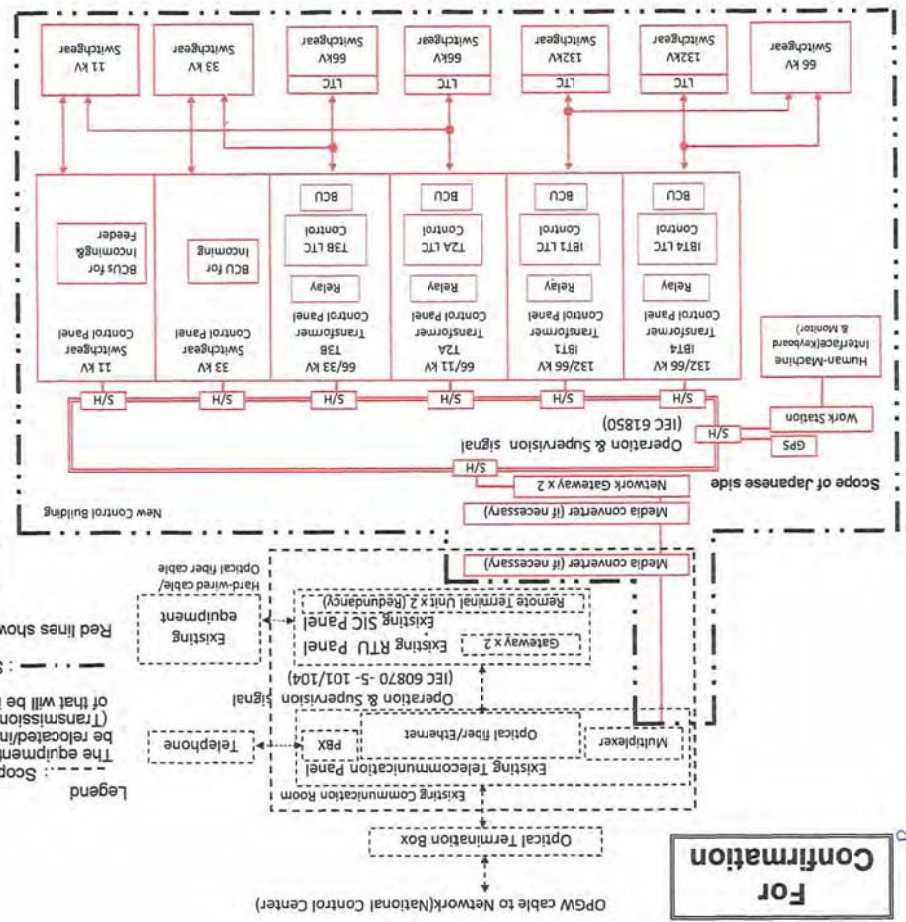
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**Drawing No. SS-04(1) rev.0**  
**SCADA System Configuration of**  
**Kanengo Substation**  
**(Preliminary)**

Note:-  
 The scope of ESCOM side should include the works as follows:  
 1 To allocate IP address to intelligent electronic devices (IED) such as BCU, Protection relays and other necessary devices which will be installed by Japanese side (if necessary).  
 2 To modify existing software of human machine interface (HMI) such as graphics of single line diagram, input/output data, interlock system and other necessary software which were installed by ESCOM side.  
 3 To submit necessary information to Japanese side such as logic sequence of the SCADA system, specifications of the existing devices, documents, drawings and other necessary information as Legend

Legend  
 BCU : Bay Control Unit  
 LTC : Load Tap Changer  
 OPGW : Optical Ground Wire  
 PBX : Private Branch exchange  
 RTU : Remote Terminal Unit  
 SIC : System Interface Cubicle  
 S/H : Switching Hub  
 S/H : Switching Hub

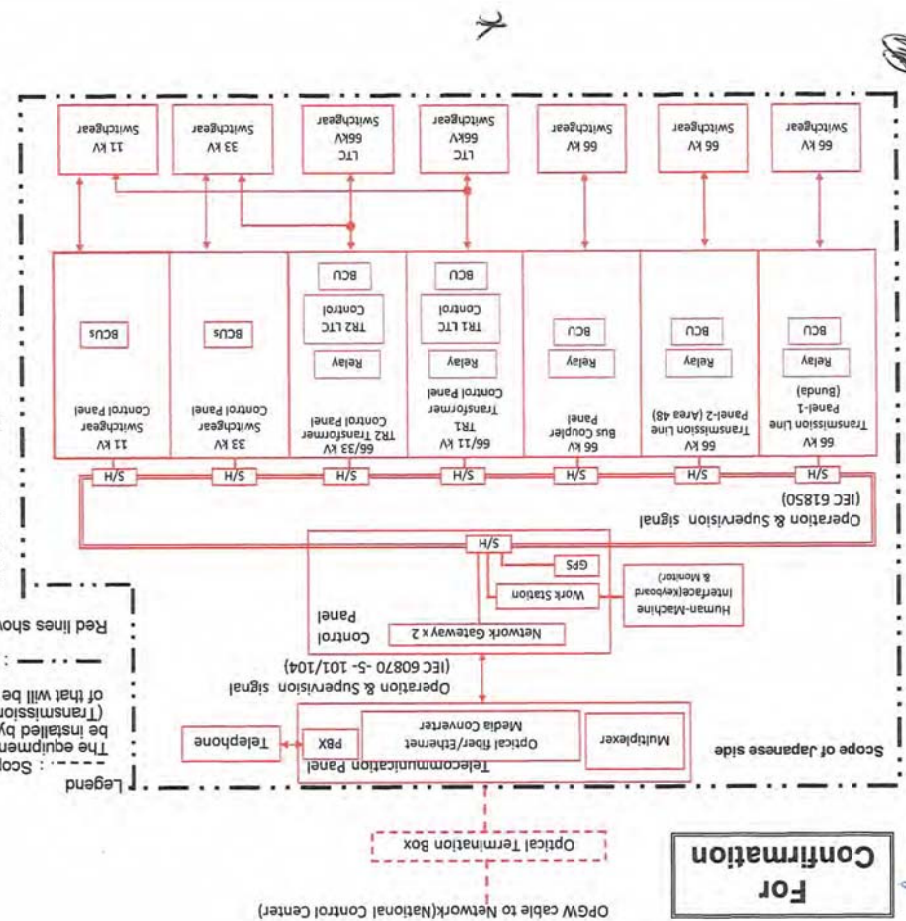


**For Confirmation**

**Drawing No. SS-03 rev.0**  
**SCADA System Configuration of**  
**Old town Substation**  
**(Preliminary)**

Note:-  
 The scope of ESCOM side should include the works as follows:  
 1 To allocate IP address to intelligent electronic devices (IED) such as BCU, Protection relays and other necessary devices which will be installed by Japanese side (if necessary).  
 2 To modify existing software of human machine interface (HMI) such as graphics of single line diagram, input/output data, interlock system and other necessary software which were installed by ESCOM side.  
 3 To submit necessary information to Japanese side such as logic sequence of the SCADA system, specifications of the existing devices, documents, drawings and other necessary information as required.

Legend  
 BCU : Bay Control Unit  
 LTC : Load Tap Changer  
 OPGW : Optical Ground Wire  
 PBX : Private Branch exchange  
 RTU : Remote Terminal Unit  
 SIC : System Interface Cubicle  
 S/H : Switching Hub  
 S/H : Switching Hub



**For Confirmation**

### Part 3 Architectural

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Abstract of switchover Procedure and demarcation

1 At the national control center, modification of substation configuration description language (SCL) such as configured IED description (CID), system configuration description (SCD) to add information of new equipment by ESCOM(Blantyre)

2 Installation of new switchgears, control&protection panels by Japanese side

3 Input/output and field operation tests for new equipment such as a circuit breaker and BCU by Japanese side

4 transmission test of an optical/ethernet cable which is connected from new equipment to the existing of that by Japanese side/ESCOM

5 At the national control center, upload the modified SCL to the existing workstation with a temporary maintenance tool by ESCOM(Blantyre)

6 At the national control center, operation and monitoring tests for the new equipment from the existing workstation by ESCOM(Blantyre)/Japanese side(witness at the substation)

**For Confirmation**

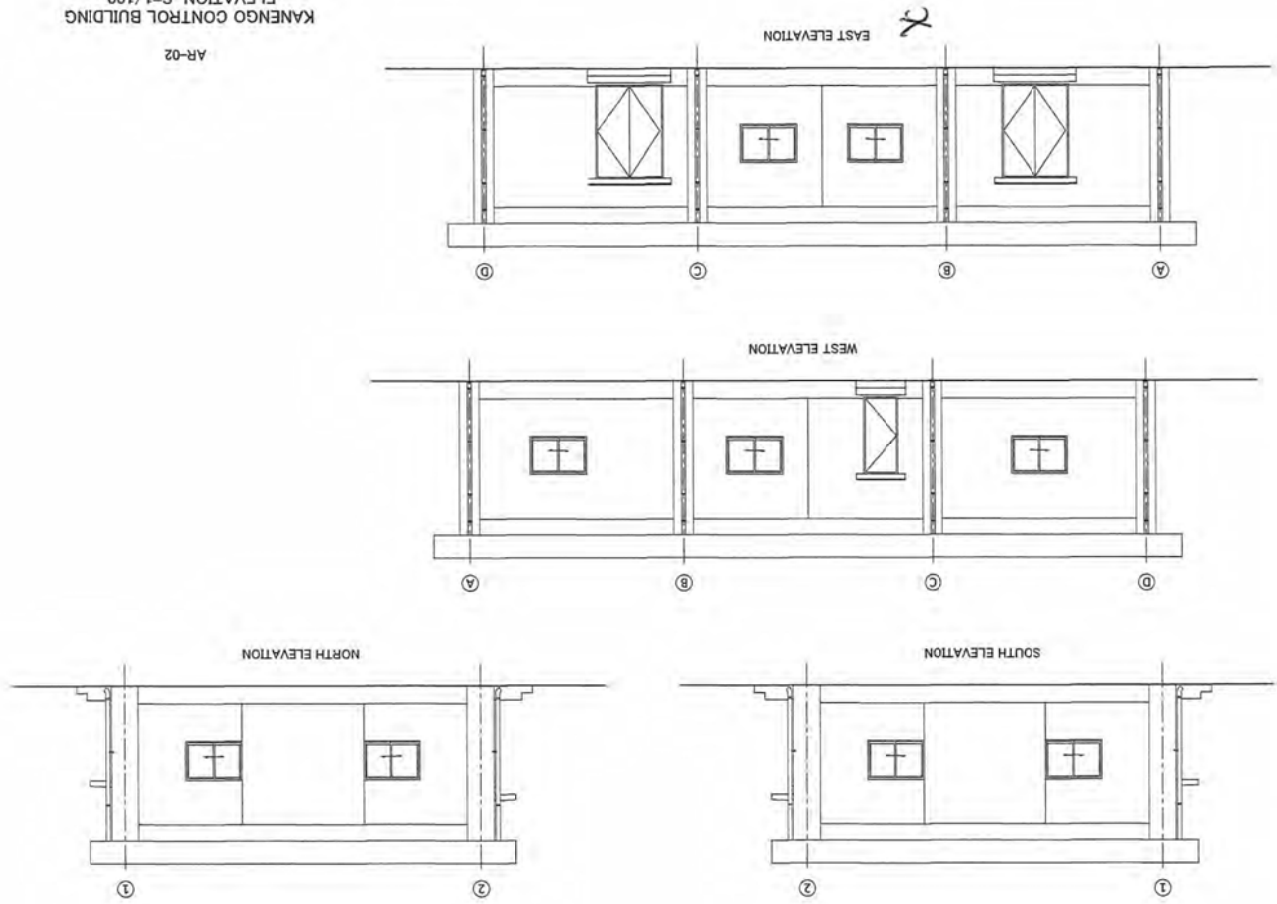
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**Drawing No. SS-04(2) rev.0  
Control System Configuration of  
Kanengo Substation  
(preliminary)**



KANENGO CONTROL BUILDING  
ELEVATION S=1/100

AR-02

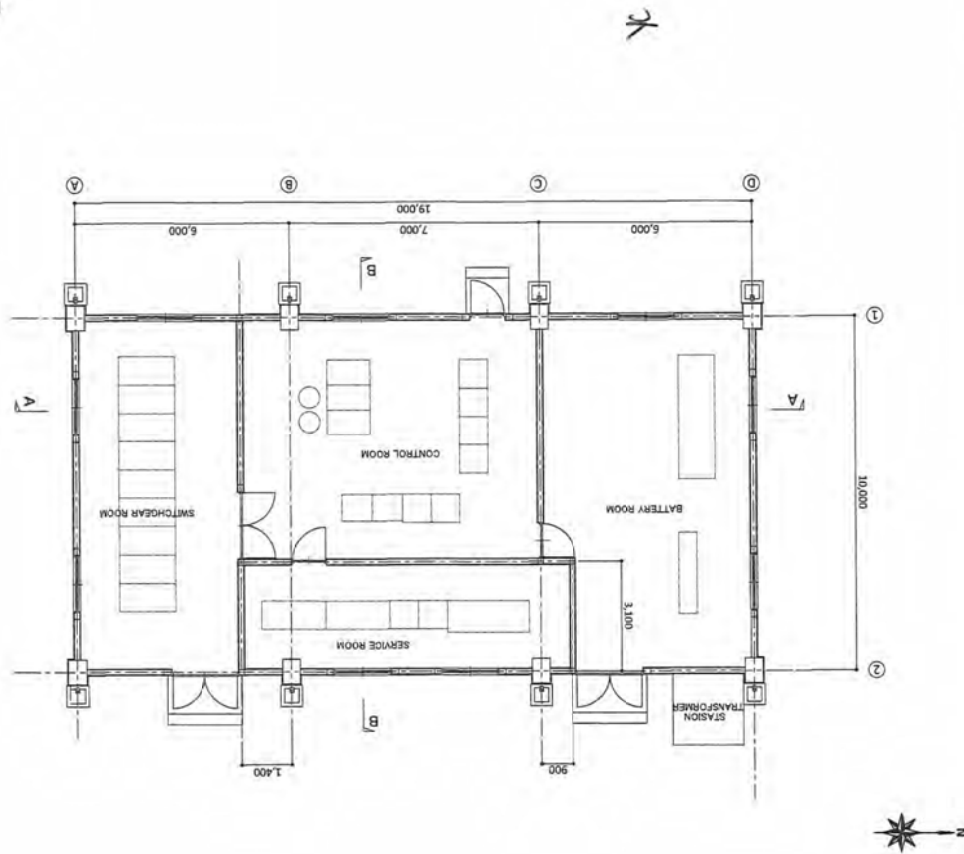


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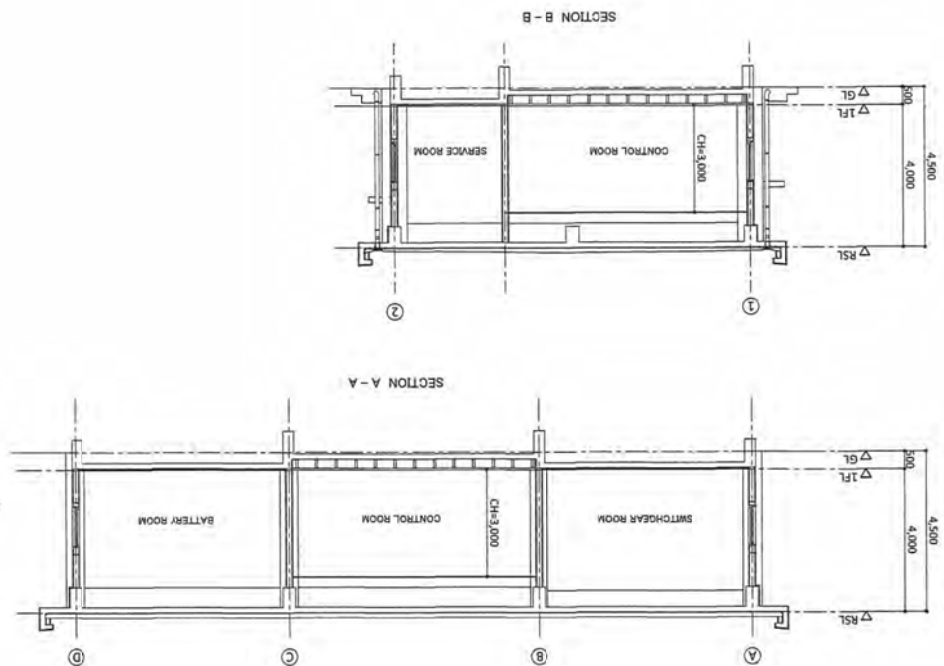
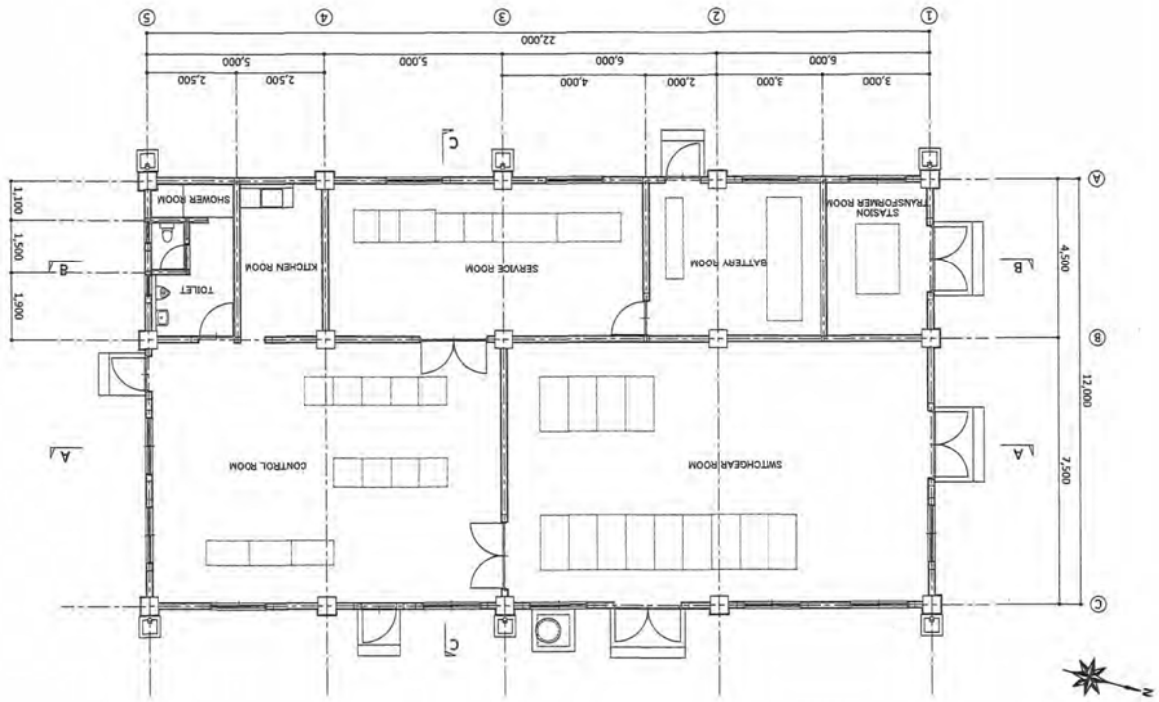
KANENGO CONTROL BUILDING  
FLOOR PLAN S=1/100

AR-01

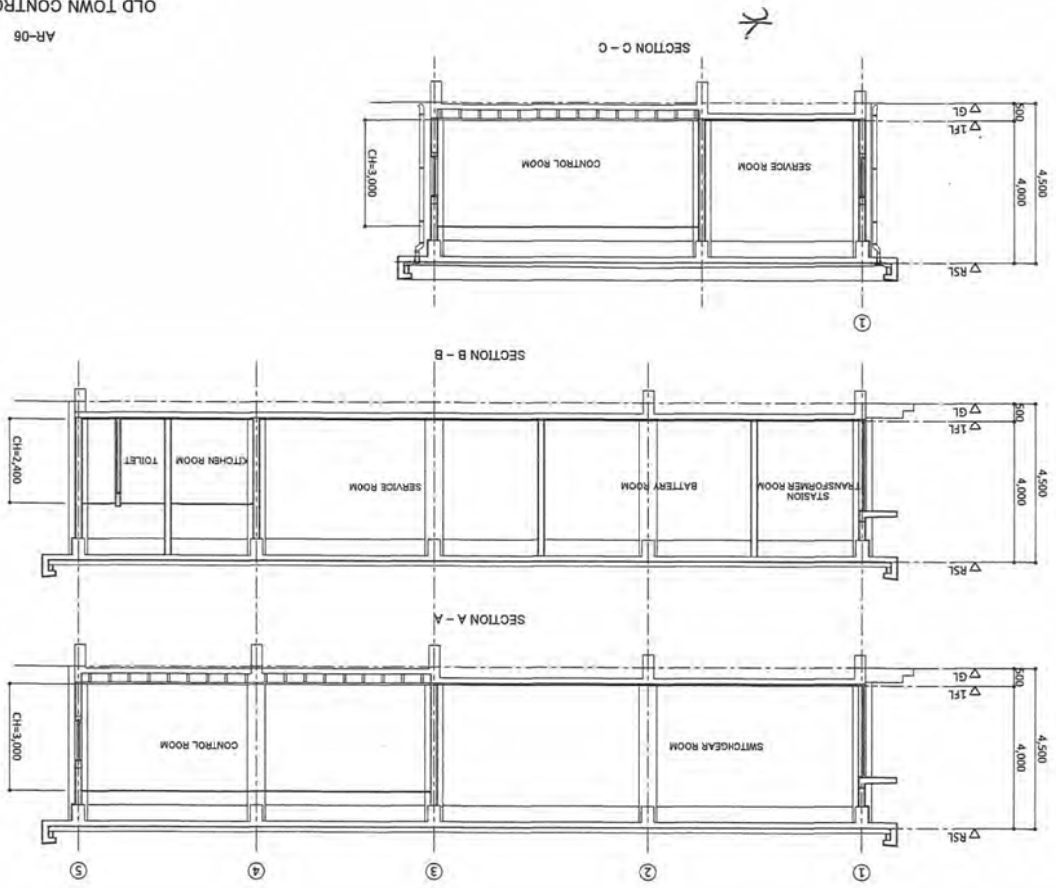


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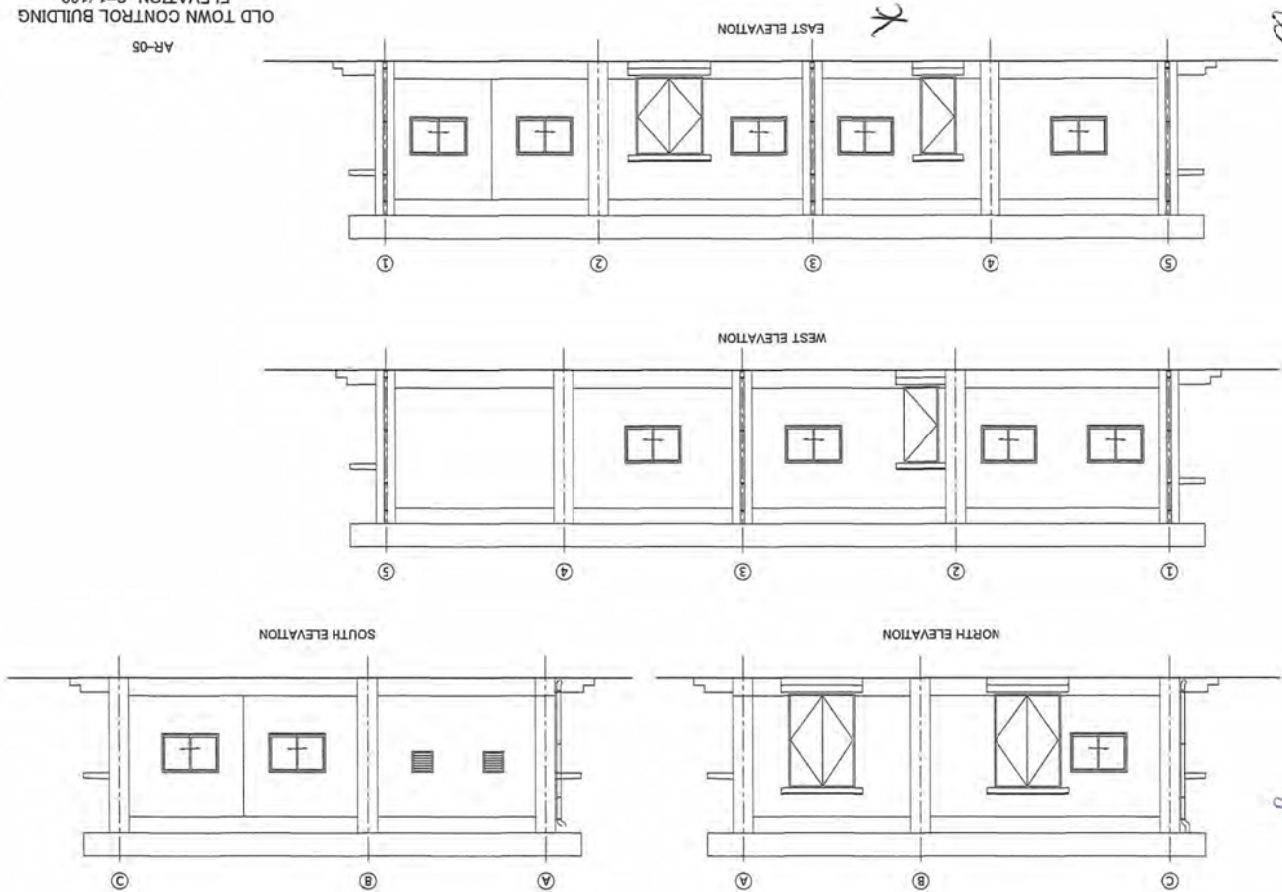






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TECHNICAL NOTE  
FOR  
PREPARATORY SURVEY  
(SECOND FIELD SURVEY)


ON  
THE PROJECT  
FOR

IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY  
IN THE REPUBLIC OF MALAWI  
AGREED BETWEEN  
ELECTRICITY SUPPLY CORPORATION OF MALAWI LIMITED  
(ESCOM)

AND  
JICA PREPARATORY SURVEY TEAM

January 23<sup>rd</sup>, 2020

阿部 真  
Mr. Makoto Abe  
Chief Consultant  
JICA Preparatory Survey Team

  
Dr. Alexon Chiyaya  
Chief Executive Officer  
Electricity Supply Corporation of Malawi  
Limited (ESCOM)  
Executing Agency for the Project

JICA Preparatory Survey Team for the Project for Improvement of Substations in Lilongwe City in the Republic of Malawi (hereinafter referred to as "the Team") and Electricity Supply Corporation of Malawi Limited (ESCOM) had series of technical discussions to form a mutual understanding of the explanations made by the Team during the Second Field Survey in January, 2020 and the parties agreed to record the following points as a conclusion of the discussions.

In addition, prior to the discussions with ESCOM, the Team explained points of the "Presentation used in the Second Field Survey" to Ministry of Finance, Economic Planning and Development (MFEPE) and Department of Energy, Ministry of Natural Resources, Energy and Mining (MNREM) to share the progress of the Survey. Major Undertakings to be taken by the Government of Malawi with outline of expected project.

1. Main objectives of the Second Field Survey

The team explained that the main objectives of the Survey are as follows:

- (1) To explain survey schedule
- (2) To confirm site condition
- (3) To explain components of the Project
- (4) To explain tentative implementation schedule
- (5) To explain undertakings to be done by the Malawi side
- (6) To explain project evaluation

2. Survey Schedule

The team explained the following tentative survey schedule;

- (1) January, 2020: Second Field Survey to explain and discuss the progress of the survey
- (2) February to July, 2020: Analysis in Japan to complete project cost estimation and project components
- (3) August, 2020: Third Field Survey to discuss on project cost, Draft Final Report
- (4) November, 2020: Submission of Final Report

3. Project Components

The team explained the outline of the project components that no major change has been made since the Team and ESCOM agreed in the Field Report signed between both parties during the First Field Survey held on February, 2019.

4. Tentative Implementation Schedule

The team explained the Tentative Implementation Schedule with the following points;

- (1) The First Exchange of Notes (E/N) between both Governments and Grant Agreement (G/A) between JICA and the Government of Malawi will be signed for the Detailed Design



and Bid preparation, upon Cabinet approval.

- (2) The Second Exchange of Notes (E/N) between both Governments and Grant Agreement (G/A) between JICA and the Government of Malawi will be signed for the rest of entire project such as bidding, evaluation of the bidders, contract with the successful bidder (the Supplier), procurement and installation work by the Supplier, commissioning and hand over, one-year warranty inspection and consulting services for those works, upon Cabinet approval.

#### 5. Undertakings to be done by the Malawi side

The team explained the contents and estimated cost of the expected undertakings to be done by the Malawi side. (Refer to attachment "Presentation used in the Second Field Survey") ESCOM acknowledged the contents and estimated cost and will take necessary budgetary measures in a timely manner to make it to the project implementation. Furthermore, the Team and ESCOM discussed some issues related to the undertakings to be done by the Malawi side and agreed the following points;

- (1) Concerning the disposal of removed equipment such as power transformers, ESCOM shall confirm and inform the Team with the fact of the matter whether any polychlorinated biphenyl (PCB) contained in the equipment or not by the end of March, 2020. If yes, ESCOM shall provide the documents showing the details of the disposal of PCB and the related cost to treat the PCB properly.
- (2) ESCOM agreed to bear any cost of the facilities related to 132 kV Bus Coupler at Kanengo Substation. ESCOM will provide the cost to the Team by the end of March, 2020.
- (3) ESCOM will submit structural design and calculation sheet of T3B Transformer foundation at Kanengo Substation by the end of March, 2020. If it is strong enough, the foundation will not need to be demolished by the project.
- (4) ESCOM requested the Team to provide the spare parts list to be procured under the project. The Team submitted the list of spare parts, consumables, maintenance tools and test instrument. ESCOM will submit additional requirements for consideration by the Team by the end of February, 2020.
- (5) The Team explained and ESCOM agreed that all spare parts, consumables, maintenance tools and test instrument must be ring fenced. The stores will be identified by ESCOM by the end of July, 2020.
- (6) The Team emphasized the importance of the record for planned and/or forced power outage (power failure records) with the cause, number and duration of the outage to calculate the forced power outage rates and energy losses. ESCOM will provide the data for last three (3) years to the Team by the end of March, 2020.
- (7) The Team suggested and ESCOM agreed that such record shall be a part of obligations by

3 / 4

Malawi side "After the Project" for "One year Warranty Inspection" and "3 year after the ex-post Evaluation".

#### 6. Other Relevant Issues

- (1) Based on the experience of the project being implemented by JICA in Malawi, the Team raised concerns about how the project may be treated by National Construction Industry Council (NCIC) and ESCOM confirmed the project falls under NCIC requirements.
- (2) The Team submitted the project technical description to ESCOM to prepare the Project Brief to Department of Environmental Affairs (DEA) during the First Field Survey and asked ESCOM if they had a feedback on whether Environmental Impact Assessment (EIA) certificate is required for the Project. ESCOM reported that they prepared the Project Brief for EIA but has not yet submitted it to DEA. ESCOM will submit it to DEA by the end of March, 2020 and expect to get feedback from DEA by the end of July, 2020.
- (3) The Team also asked ESCOM the progress to obtain permission of the construction work for the Project to be issued by the City Council. ESCOM requested the Team to provide with the architectural design, drawings and explained that the actual application for the permission shall be carried out right after the project approval by the Government of Japan. The Team will provide the required drawings with the cost by the end of January, 2020 and ESCOM shall obtain the permission before the Bid Notice.

Lastly, this Technical Note shall be shared with the Ministry of Finance, Economic Planning and Development (MFEPPD) and Department of Energy, Ministry of Natural Resources, Energy and Mining (MINREM), after signing by both the Team and ESCOM.

-End-

Attachment: Presentation used in the Second Field Survey

4 / 4

## 6. 概略設計図



## 6. 概略設計図

### 変電設備

図面番号	図面名称
KG-ES-01	カネンゴ変電所 単線結線図
KG-ES-02	カネンゴ変電所 全体配置図 (既設)
KG-ES-03	カネンゴ変電所 全体配置図 (計画)
KG-ES-04	カネンゴ変電所 制御棟屋内配置図
KG-ES-05	カネンゴ変電所 SCADA システム構成図
KG-ES-06	カネンゴ変電所 所掌区分図
OT-ES-01	オールドタウン変電所 単線結線図
OT-ES-02	オールドタウン変電所 敷地図 (計画)
OT-ES-03	オールドタウン変電所 全体配置図 (計画)
OT-ES-04	オールドタウン変電所 制御棟屋内配置図
OT-ES-05	オールドタウン変電所 SCADA システム構成図
OT-ES-06	オールドタウン変電所 所掌区分図

### 建築設備

図面番号	図面名称
KG-AA-01	カネンゴ制御棟 仕上表
KG-AA-02	カネンゴ制御棟 平面図
KG-AA-03	カネンゴ制御棟 ケーブルピット図
KG-AA-04	カネンゴ制御棟 立面図
KG-AA-05	カネンゴ制御棟 断面図
KG-AA-06	カネンゴ制御棟 建具表
KG-AA-07	カネンゴ制御棟 断面詳細図-1
KG-AA-08	カネンゴ制御棟 断面詳細図-2
KG-AA-09	カネンゴ制御棟 詳細図-1
OT-AA-01	オールドタウン制御棟 仕上表
OT-AA-02	オールドタウン制御棟 平面図 (地階)
OT-AA-03	オールドタウン制御棟 平面図 (屋上)
OT-AA-04	オールドタウン制御棟 ケーブルピット図
OT-AA-05	オールドタウン制御棟 立面図
OT-AA-06	オールドタウン制御棟 断面図
OT-AA-07	オールドタウン制御棟 建具表
OT-AA-08	オールドタウン制御棟 断面詳細図-1
OT-AA-09	オールドタウン制御棟 断面詳細図-2
OT-AA-10	オールドタウン制御棟 詳細図-1





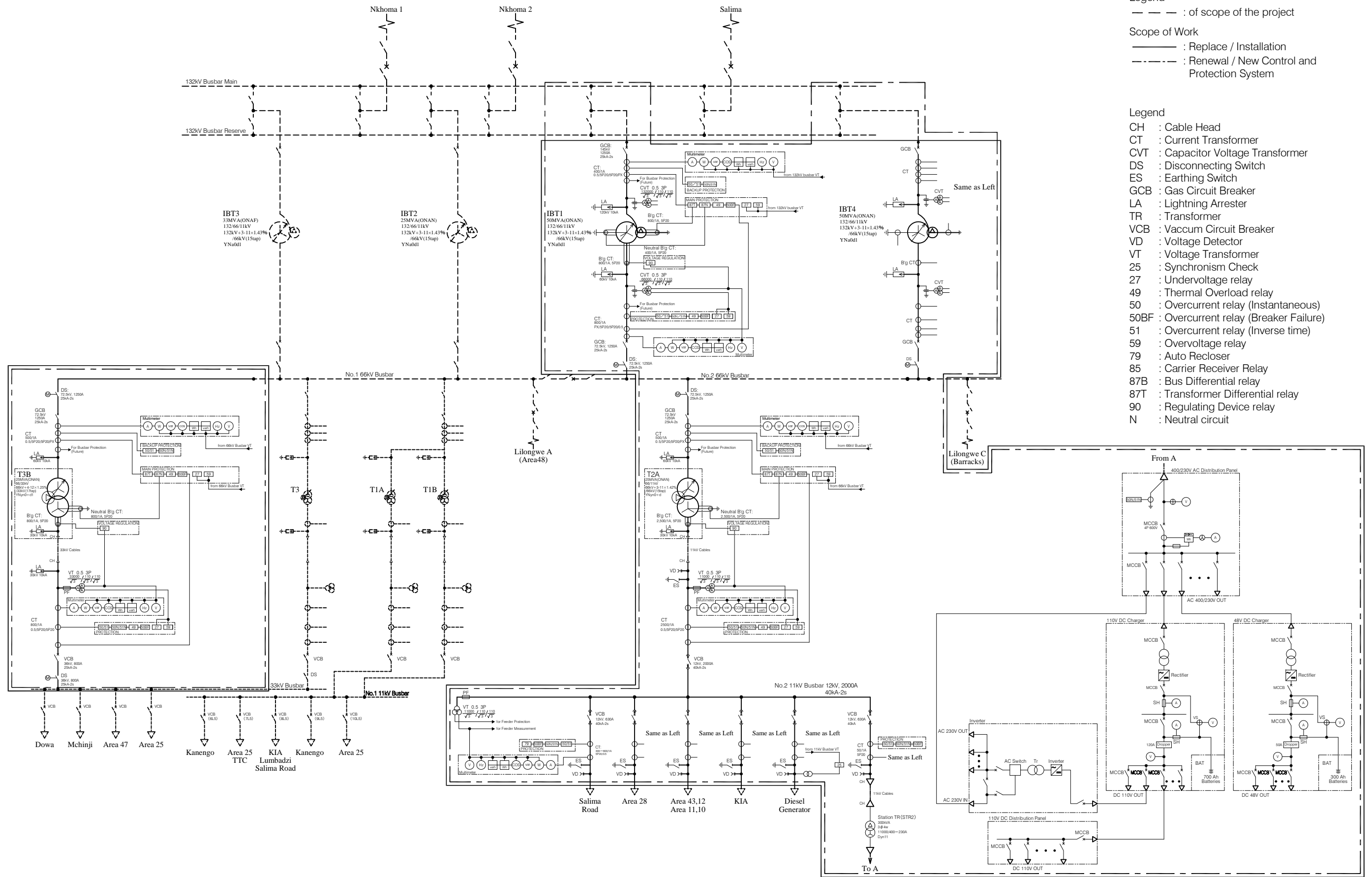
変電設備



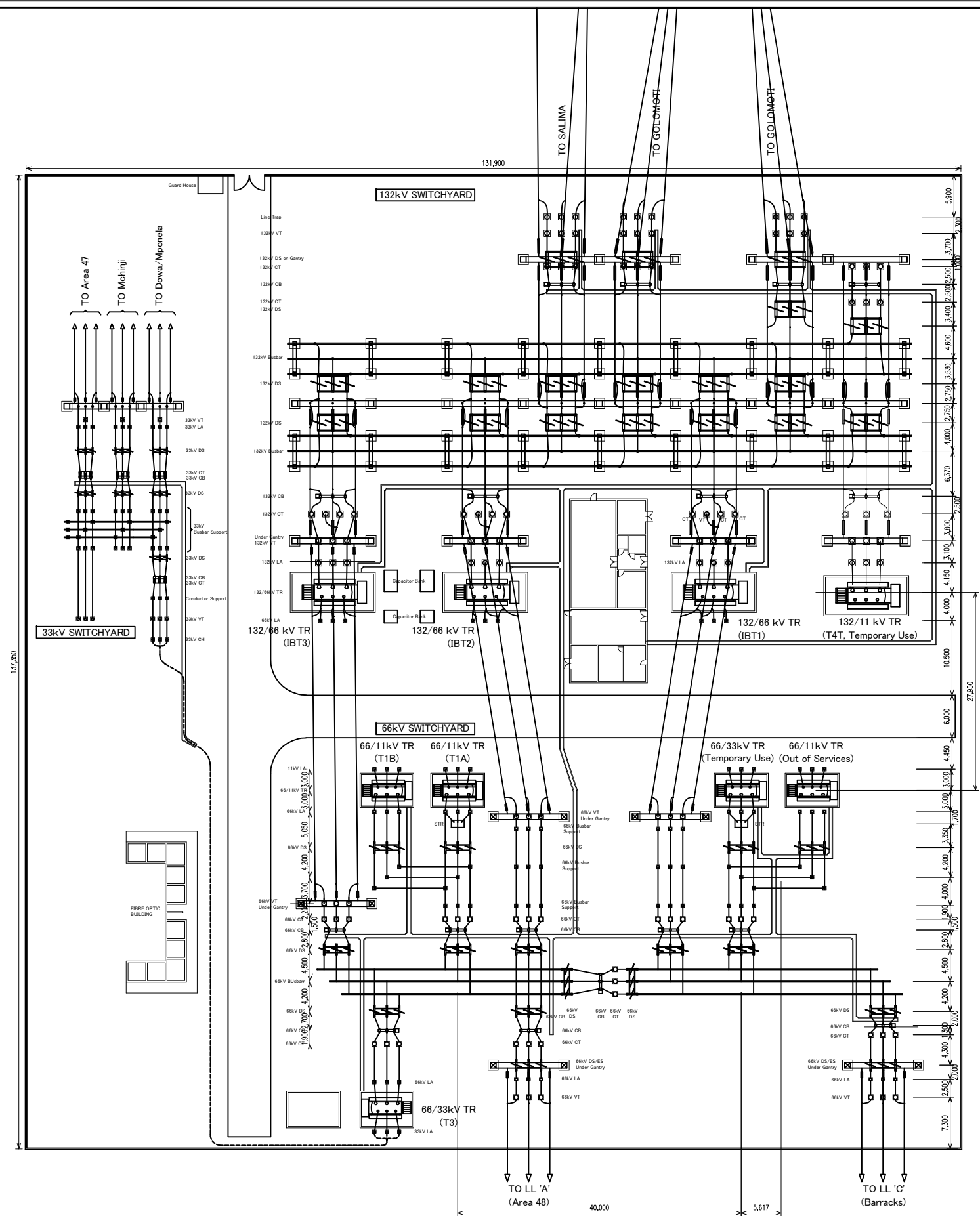


Legend  
 - - - : of scope of the project  
 Scope of Work  
 — : Replace / Installation  
 - - - : Renewal / New Control and Protection System

Legend  
 CH : Cable Head  
 CT : Current Transformer  
 CVT : Capacitor Voltage Transformer  
 DS : Disconnecting Switch  
 ES : Earthing Switch  
 GCB : Gas Circuit Breaker  
 LA : Lightning Arrester  
 TR : Transformer  
 VCB : Vacuum Circuit Breaker  
 VD : Voltage Detector  
 VT : Voltage Transformer  
 25 : Synchronism Check  
 27 : Undervoltage relay  
 49 : Thermal Overload relay  
 50 : Overcurrent relay (Instantaneous)  
 50BF : Overcurrent relay (Breaker Failure)  
 51 : Overcurrent relay (Inverse time)  
 59 : Overvoltage relay  
 79 : Auto Recloser  
 85 : Carrier Receiver Relay  
 87B : Bus Differential relay  
 87T : Transformer Differential relay  
 90 : Regulating Device relay  
 N : Neutral circuit



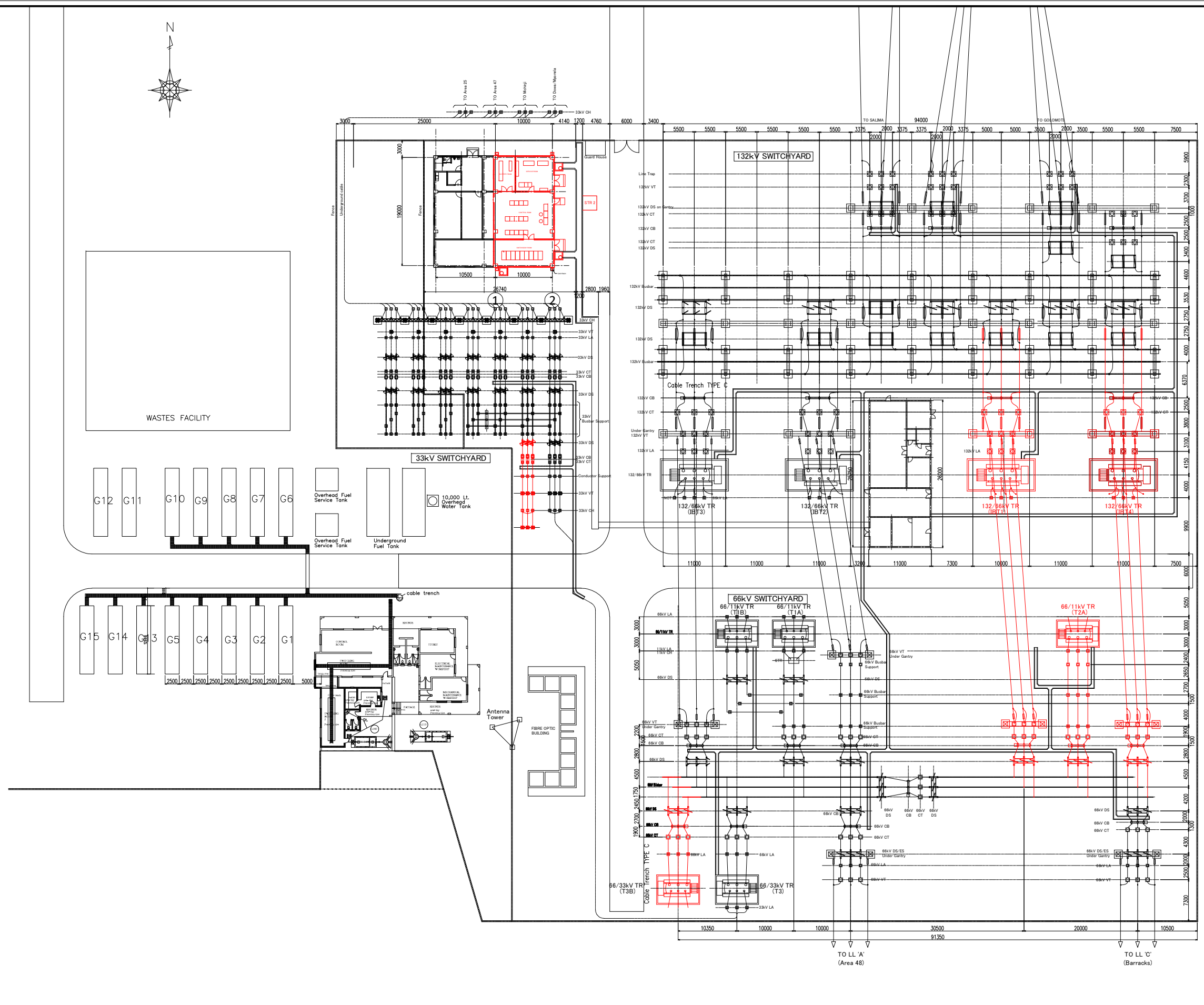
PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : KG-ES-01
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Substation Single Line Diagram	CONSULTANTS : <b>YEC</b> YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc.			SCALE : ---	(if only A3)



**LEGEND :**

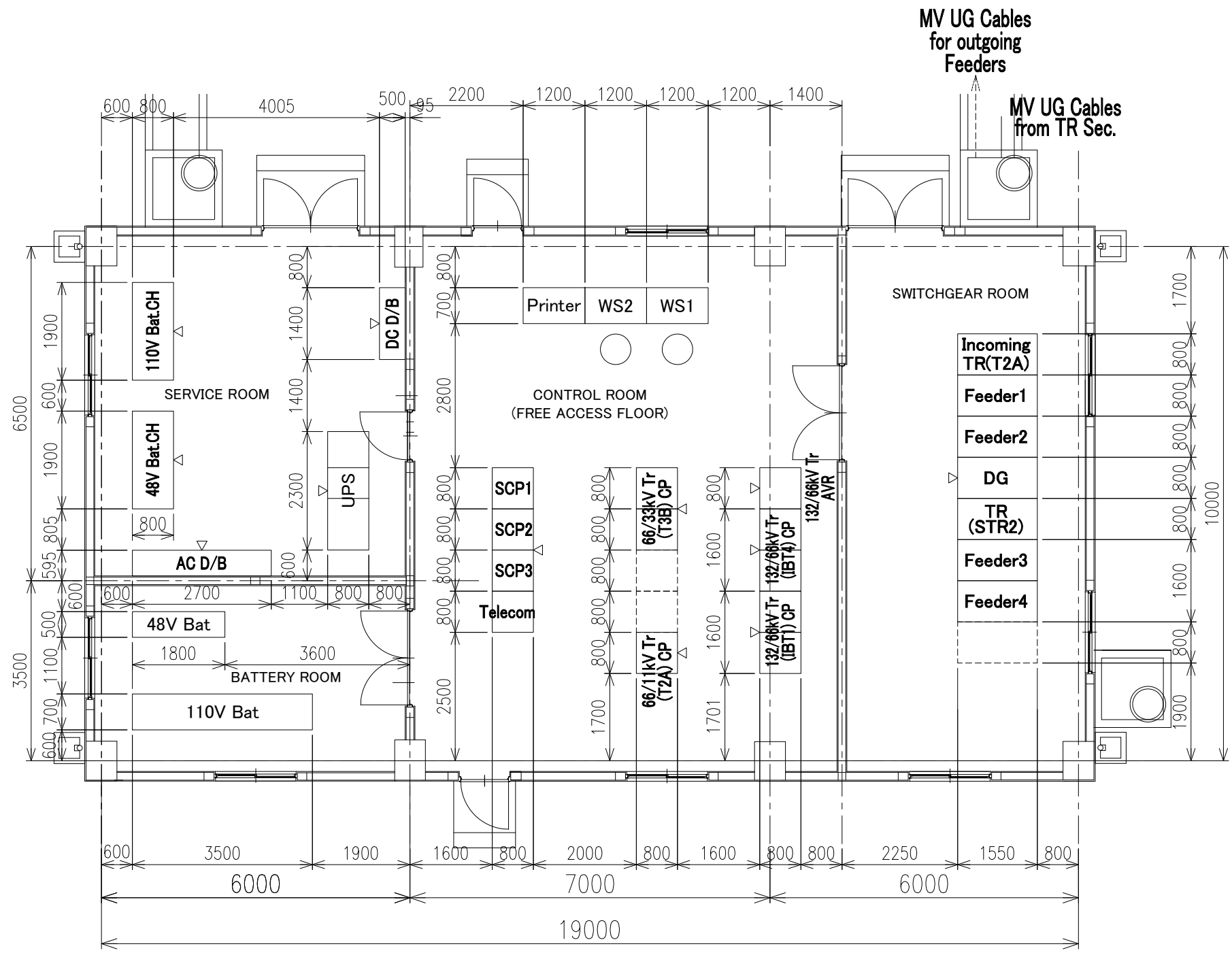
- CB : Circuit Breaker
- DS : Disconnecting Switch
- ES : Earthing Switch
- CT : Current Transformer
- VT : Voltage Transformer
- LA : Lightning Arrester
- SC : Capacitor Bank
- SP : Station Post Insulator
- CH : Cable Head

PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Substation Existing Site Layout	*****	*****	*****	*****	KG-ES-02
			CONSULTANTS :				SCALE :
			<b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <i>West Japan Engineering Consultants, Inc.</i>				1:700 (if only A3)



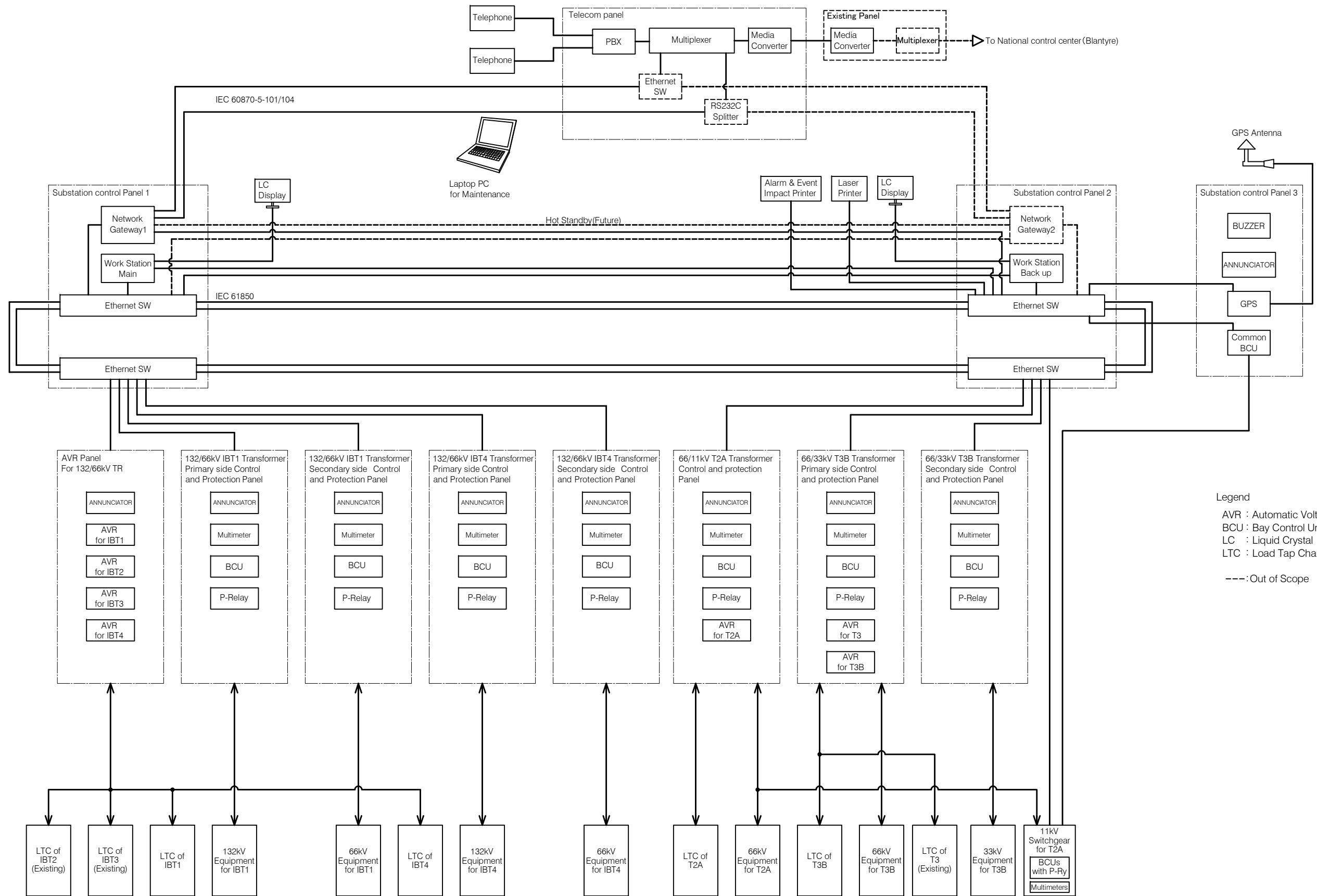
PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Substation Site Layout Plan	*****	*****	*****	*****	KG-ES-03
			CONSULTANTS :			 <b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <i>West Japan Engineering Consultants, Inc.</i>	





- LEGEND :**
- STR : Station Service Transformer
  - CP : Control & Protection Panel
  - WS : Work Station
  - SCP : Substation Control Panel
  - Telecom : Telecommunication Panel
  - AC D/B : AC Distribution Board
  - DC D/B : DC Distribution Board
  - Bat CH : Battery Charger
  - Bat : Battery
  - UPS : Uninterruptible Power Supply
  - H/H : Hand Hole
  - DG : Diesel Generator
  - TR : Transformer
  - MV : Medium Voltage
  - UG : Underground
  - AVR : Automatic Voltage Regulator
- : Out of Scope

PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Substation Control Building Layout Plan	*****	*****	*****	*****	KG-ES-04
			CONSULTANTS :				
<b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <b>West Japan Engineering Consultants, Inc.</b>					1:100 (if only A3)		

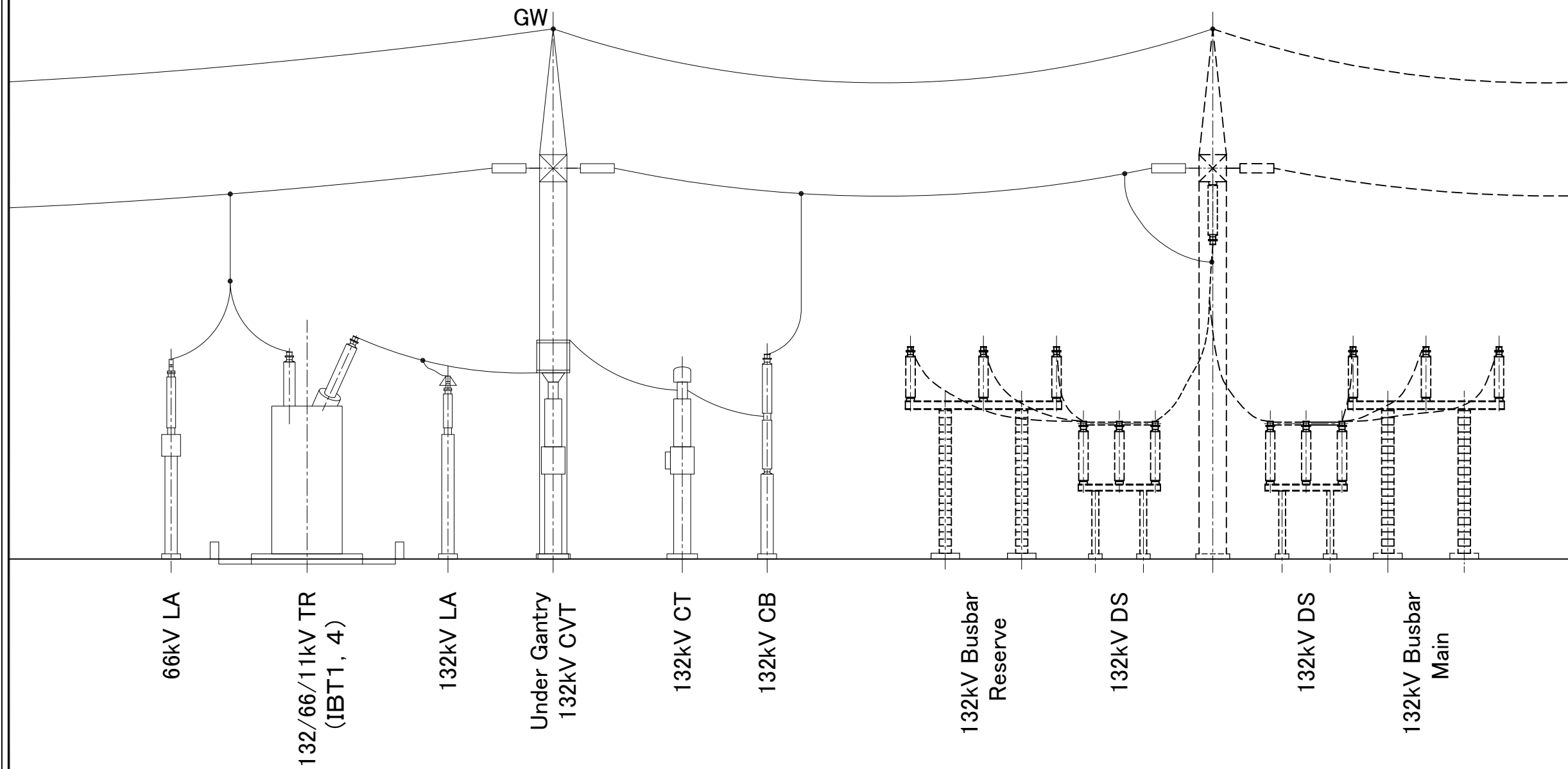



Legend  
 AVR : Automatic Voltage Regulator  
 BCU : Bay Control Unit  
 LC : Liquid Crystal  
 LTC : Load Tap Changer  
 --- : Out of Scope

PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : KG-ES-05
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Substation SCADA System Architecture	CONSULTANTS : <b>YEC</b> YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc.				SCALE : --- (if only A3)

**LEGEND :**

- CB : Circuit Breaker
- DS : Disconnecting Switch
- CT : Current Transformer
- CVT : Capacitor Voltage Transformer
- LA : Lightning Arrester
- GW : Grounding Wire
- : Out of Scope

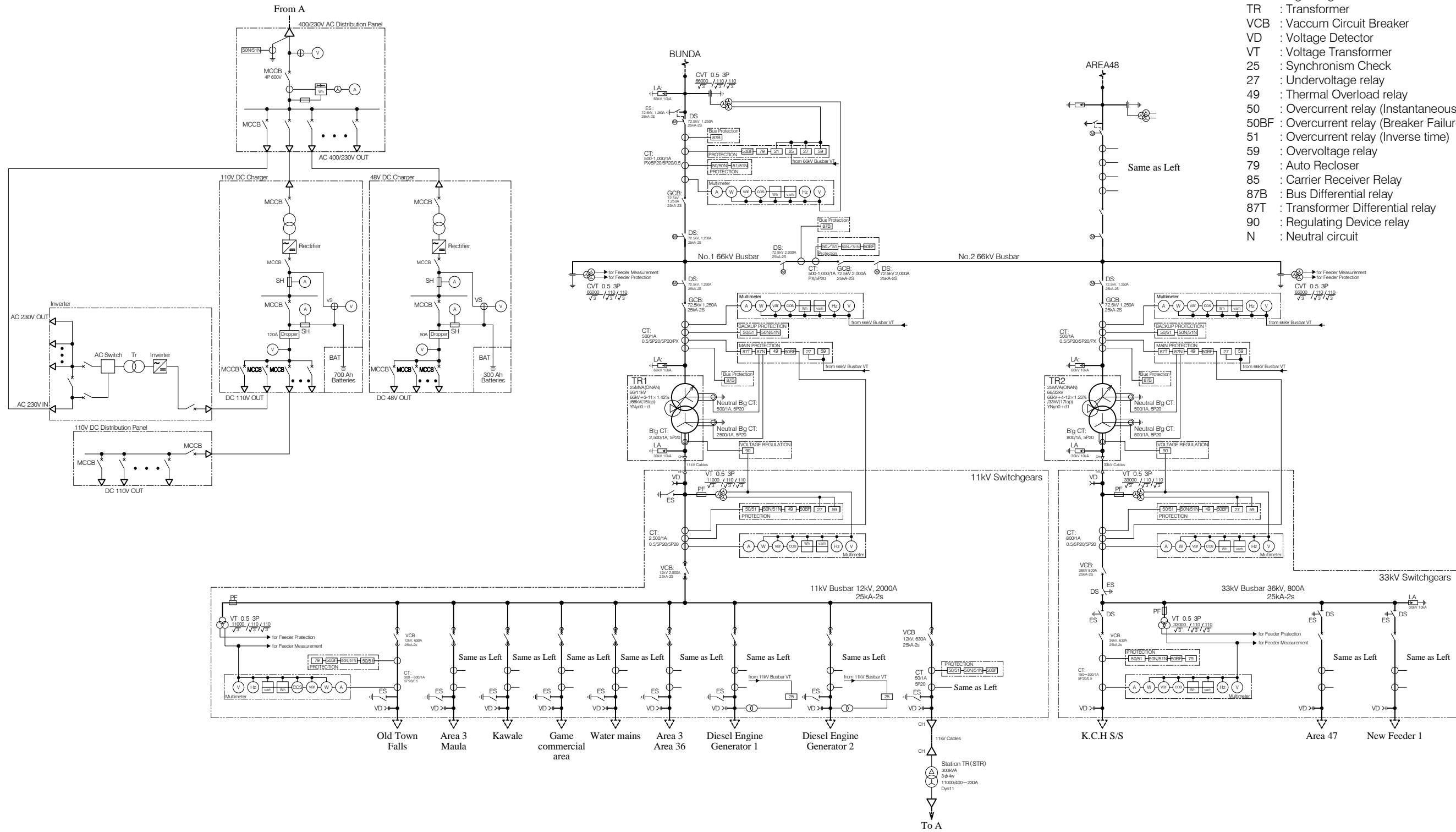


PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : KG-ES-06
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Substation Scope of the Project	CONSULTANTS :  <b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> West Japan Engineering Consultants, Inc.				SCALE : --- (if only A3)




Legend  
 --- : Out of scope of the project

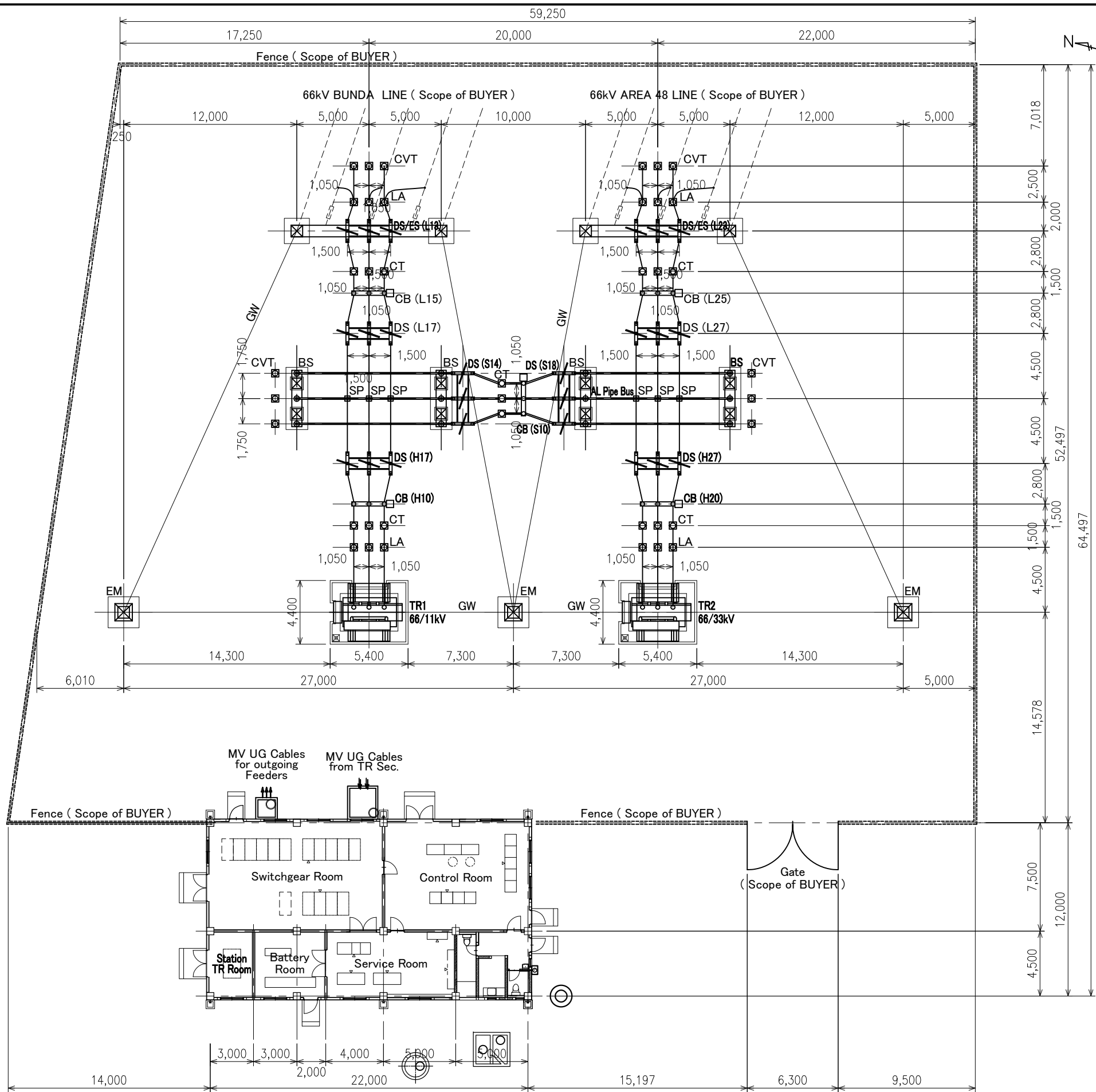
Legend  
 CH : Cable Head  
 CT : Current Transformer  
 CVT : Capacitor Voltage Transformer  
 DS : Disconnecting Switch  
 ES : Earthing Switch  
 GCB : Gas Circuit Breaker  
 LA : Lightning Arrester  
 TR : Transformer  
 VCB : Vacuum Circuit Breaker  
 VD : Voltage Detector  
 VT : Voltage Transformer  
 25 : Synchronism Check  
 27 : Undervoltage relay  
 49 : Thermal Overload relay  
 50 : Overcurrent relay (Instantaneous)  
 50BF : Overcurrent relay (Breaker Failure)  
 51 : Overcurrent relay (Inverse time)  
 59 : Overvoltage relay  
 79 : Auto Recloser  
 85 : Carrier Receiver Relay  
 87B : Bus Differential relay  
 87T : Transformer Differential relay  
 90 : Regulating Device relay  
 N : Neutral circuit



PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Substation Single Line Diagram	*****	*****	*****	*****	OT-ES-01
			CONSULTANTS :		YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc.		SCALE : --- (if only A3)

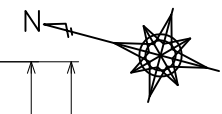


PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : OT-ES-02
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Substation Site Plan	CONSULTANTS :  <b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <b>West Japan Engineering Consultants, Inc.</b>				SCALE : 1:1000 (if only A3)



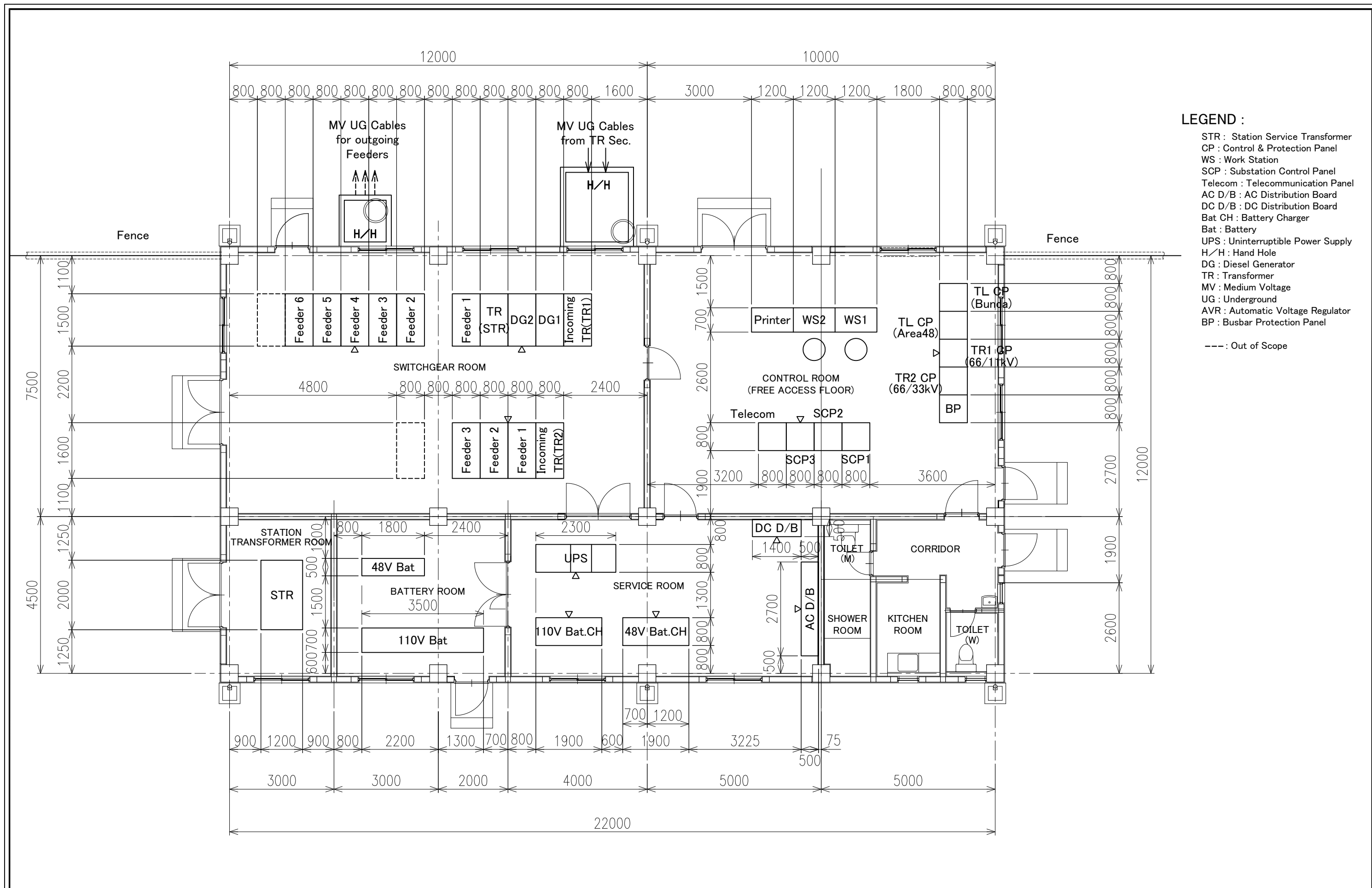
**LEGEND :**

- CB : Circuit Breaker
- DS : Disconnecting Switch
- ES : Earthing Switch
- CT : Current Transformer
- CVT : Capacitor Voltage Transformer
- LA : Lightning Arrester
- STR : Station Service Transformer
- SP : Station Post Insulator
- BS : Bus Support
- EM : Earth Mast
- GW : Grounding Wire



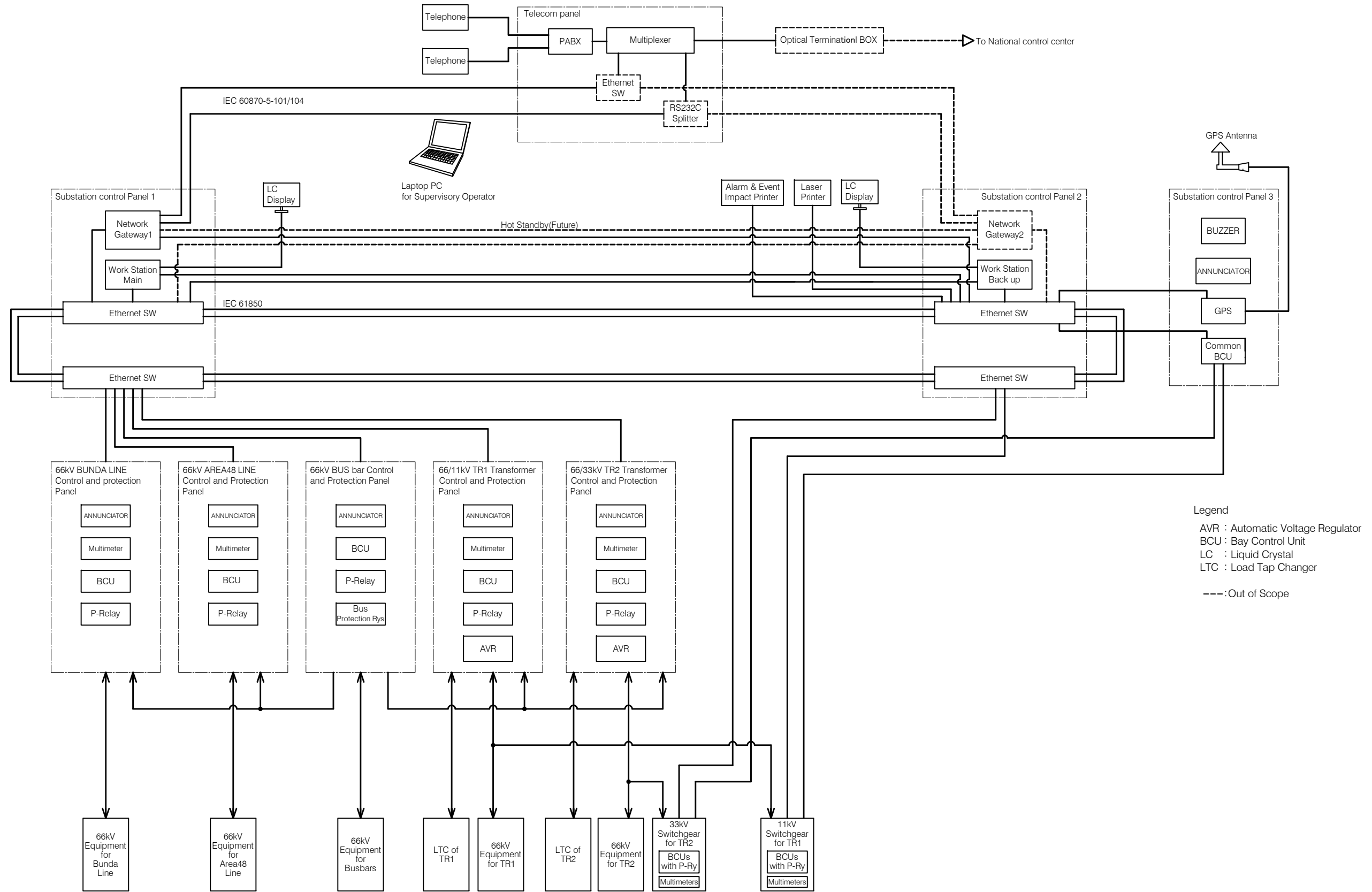
PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Substation Site Layout Plan	*****	*****	*****	*****	OT-ES-03
			CONSULTANTS :	 <b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <i>West Japan Engineering Consultants, Inc.</i>			SCALE : 1:300 (if only A3)





- LEGEND :**
- STR : Station Service Transformer
  - CP : Control & Protection Panel
  - WS : Work Station
  - SCP : Substation Control Panel
  - Telecom : Telecommunication Panel
  - AC D/B : AC Distribution Board
  - DC D/B : DC Distribution Board
  - Bat CH : Battery Charger
  - Bat : Battery
  - UPS : Uninterruptible Power Supply
  - H/H : Hand Hole
  - DG : Diesel Generator
  - TR : Transformer
  - MV : Medium Voltage
  - UG : Underground
  - AVR : Automatic Voltage Regulator
  - BP : Busbar Protection Panel
- : Out of Scope

PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :	
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Substation Control Building Layout Plan	*****	*****	*****	*****	OT-ES-04	
			CONSULTANTS :				SCALE :	
							---	
							(if only A3)	



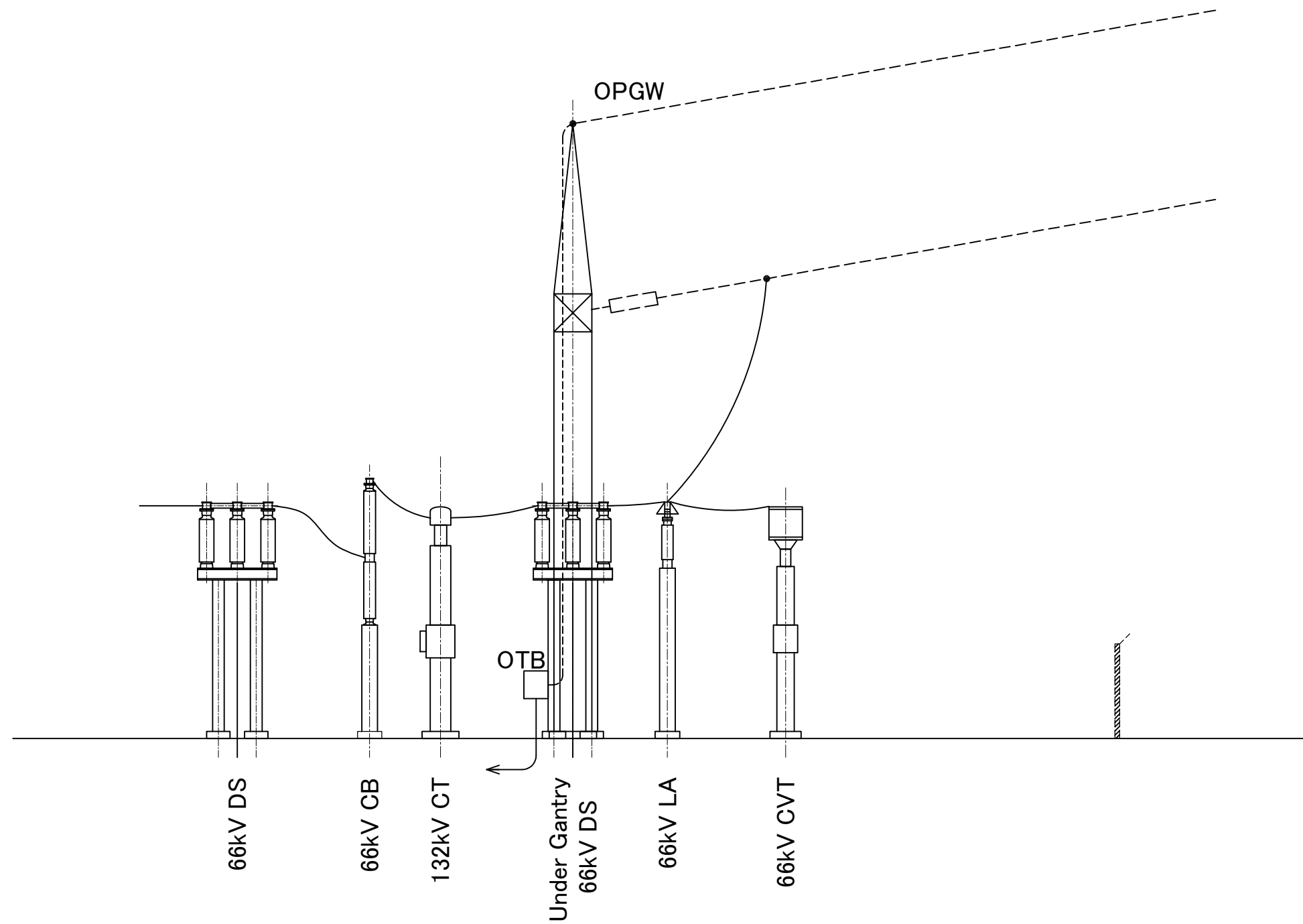
Legend  
 AVR : Automatic Voltage Regulator  
 BCU : Bay Control Unit  
 LC : Liquid Crystal  
 LTC : Load Tap Changer  
 --- : Out of Scope

PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : OT-ES-05
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Substation SCADA System Architecture	CONSULTANTS : <b>YEC</b> YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc.				SCALE : --- (if only A3)

**LEGEND :**

- CB : Circuit Breaker
- DS : Disconnecting Switch
- ES : Earthing Switch
- CT : Current Transformer
- CVT : Capacitor Voltage Transformer
- LA : Lightning Arrester
- OPGW : Optical FiberGrounding Wire
- OTB : Optical Termination Box

----- : Out of Scope



PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Substation Scope of the Project	*****	*****	*****	*****	OT-ES-06
			CONSULTANTS :				SCALE :
			<b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <b>West Japan Engineering Consultants, Inc.</b>			---	(if only A3)



建築設備



GENERAL

BUILDING AREA	206.20m <sup>2</sup>
TOTAL FLOOR AREA	206.20m <sup>2</sup>
STRUCTURE	REINFORCED CONCRETE

EXTERIOR FINISHING SCHEDULE

LOCATION	SPECIFICATION
ROOF	CONCRETE STEEL TROWEL ON PROTECTION CONCRETE WITH WELDED WIRE MESH ASPHALT MEMBRANE WATER PROOFING
DRAIN	ROOF DRAIN : CASTIRON $\phi$ 100mm DOWNSPOUT : PVC PIPE $\phi$ 100mm
WALL	PAINT FINISH (A.E.P) ON 150mm THK. CONCRETE BLOCK WITH MORTAR STEEL TROWEL 25mm THK.
COLUMN	FINISH (A.E.P) ON MORTAR STEEL TOROWEL 25mm THK.
BEAM	FINISH (A.E.P) ON MORTAR STEEL TOROWEL 25mm THK.
TERRACE	CONCRETE STEEL TROWEL


INTERIOR FINISHING SCHEDULE

ROOM NAME	FLOOR	BASEBOARD	WALL	CEILING	REMARKS
SWITCHGEAR ROOM	CERAMIC TILE 300 X 300 ON MORTAR BED FINISH 50mm THK.	PAINT FINISH(E.P) MORTAR STEEL TROWEL 20mm THK. ON 150mm THICKNESS CONCRETE BLOCK	PAINT FINISH(E.P) MORTAR STEEL TROWEL 20mm THK. ON 150mm THK. CONCRETE BLOCK	PAINT FINISH(E.P) EXPOSED CONCRETE	AIR CONDITIONING, ROOM NAME PLATE FIRE EXTINGUISHER 1 SET, VENTIRATION FAN
CONTROL ROOM	FREE ACCESS FLOOR H=300 ANTISTATIC VINYL TILE FINISH	VINYL TILE H=100	DITTO	COSMETIC GYPSUM BOARD 9.5mm THK. WITH ALUMINUM SUSPENDE FRAME	AIR CONDITIONING, ROOM NAME PLATE FIRE EXTINGUISHER 1 SET, VENTIRATION FAN
SERVICE ROOM	CERAMIC TILE 300 X 300 ON MORTAR BED FINISH 50mm THK.	PAINT FINISH(E.P) MORTAR STEEL TROWEL 20mm THK. ON 150mm THICKNESS CONCRETE BLOCK	DITTO	DITTO	AIR CONDITIONING, ROOM NAME PLATE FIRE EXTINGUISHER 1 SET, VENTIRATION FAN
BATTERY ROOM	DITTO	DITTO	DITTO	DITTO	AIR CONDITIONING, ROOM NAME PLATE FIRE EXTINGUISHER 1 SET, VENTIRATION FAN

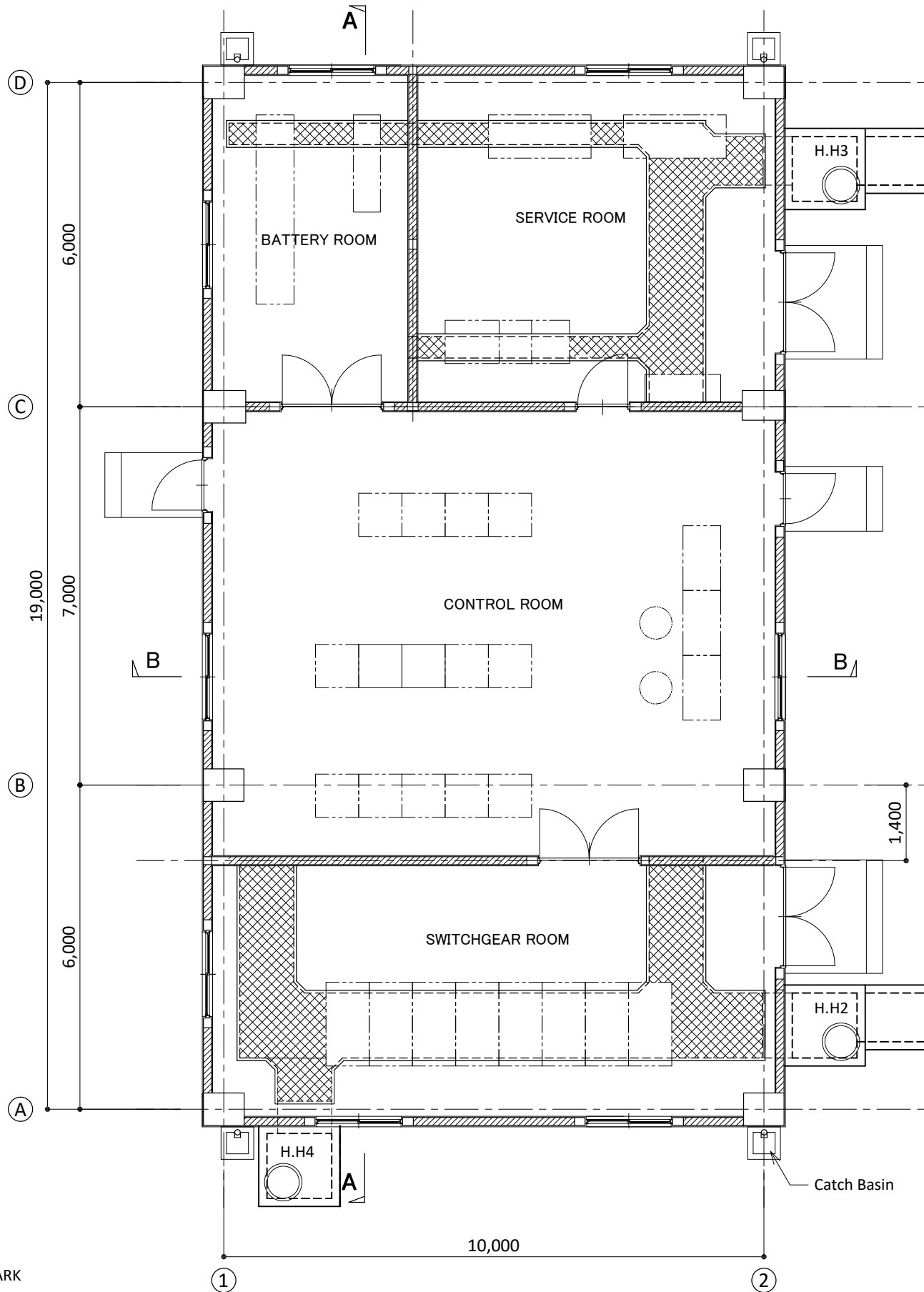
NOTES

THK. : THICKNESS

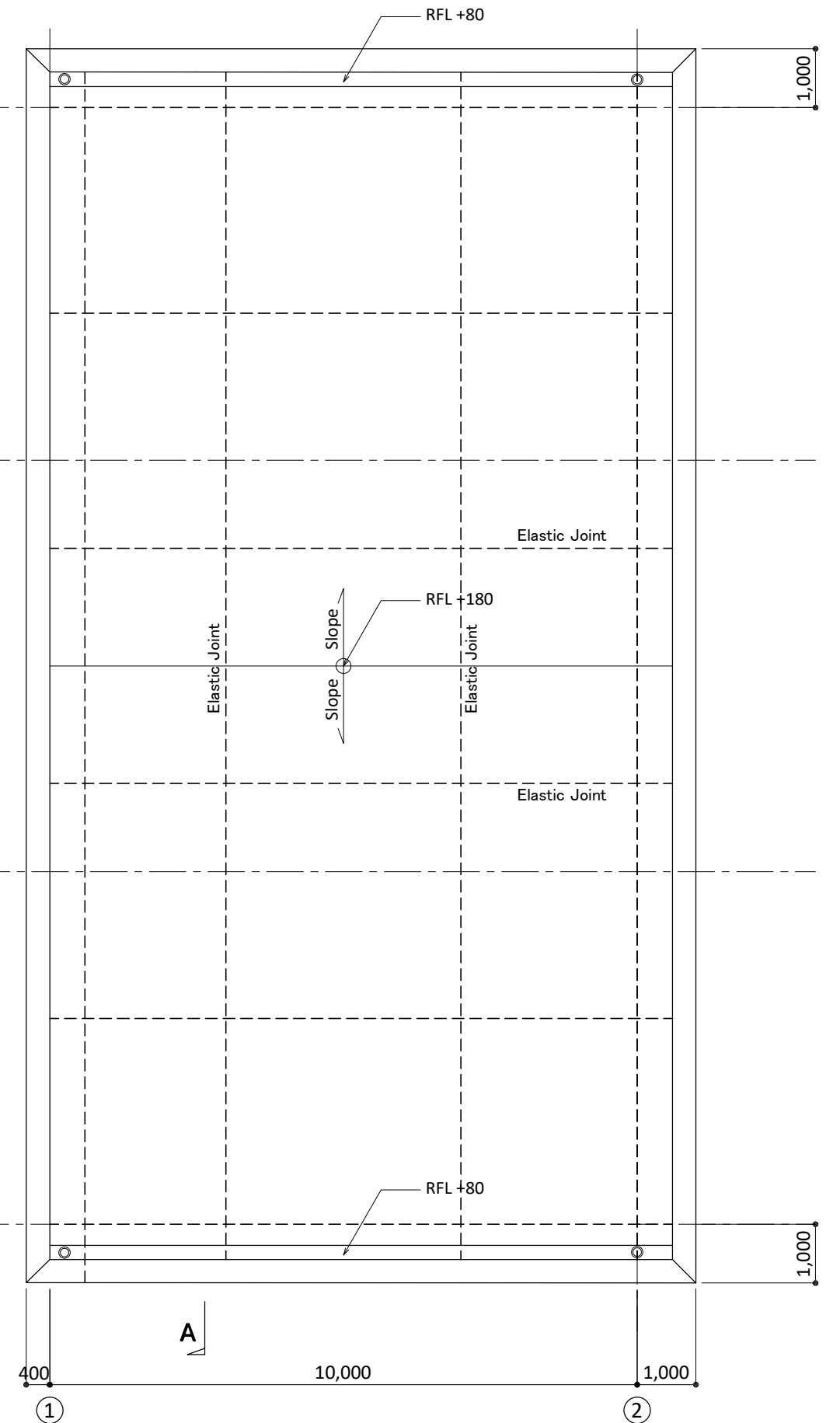
ROOM NAME PLATE : MATERIAL SHALL BE PLASTIC PLATE 5.0mm THK.

PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : KG-AA-01
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Control Building Finishing Schedule	CONSULTANTS :  <b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> West Japan Engineering Consultants, Inc.				SCALE : --- (if only A3)





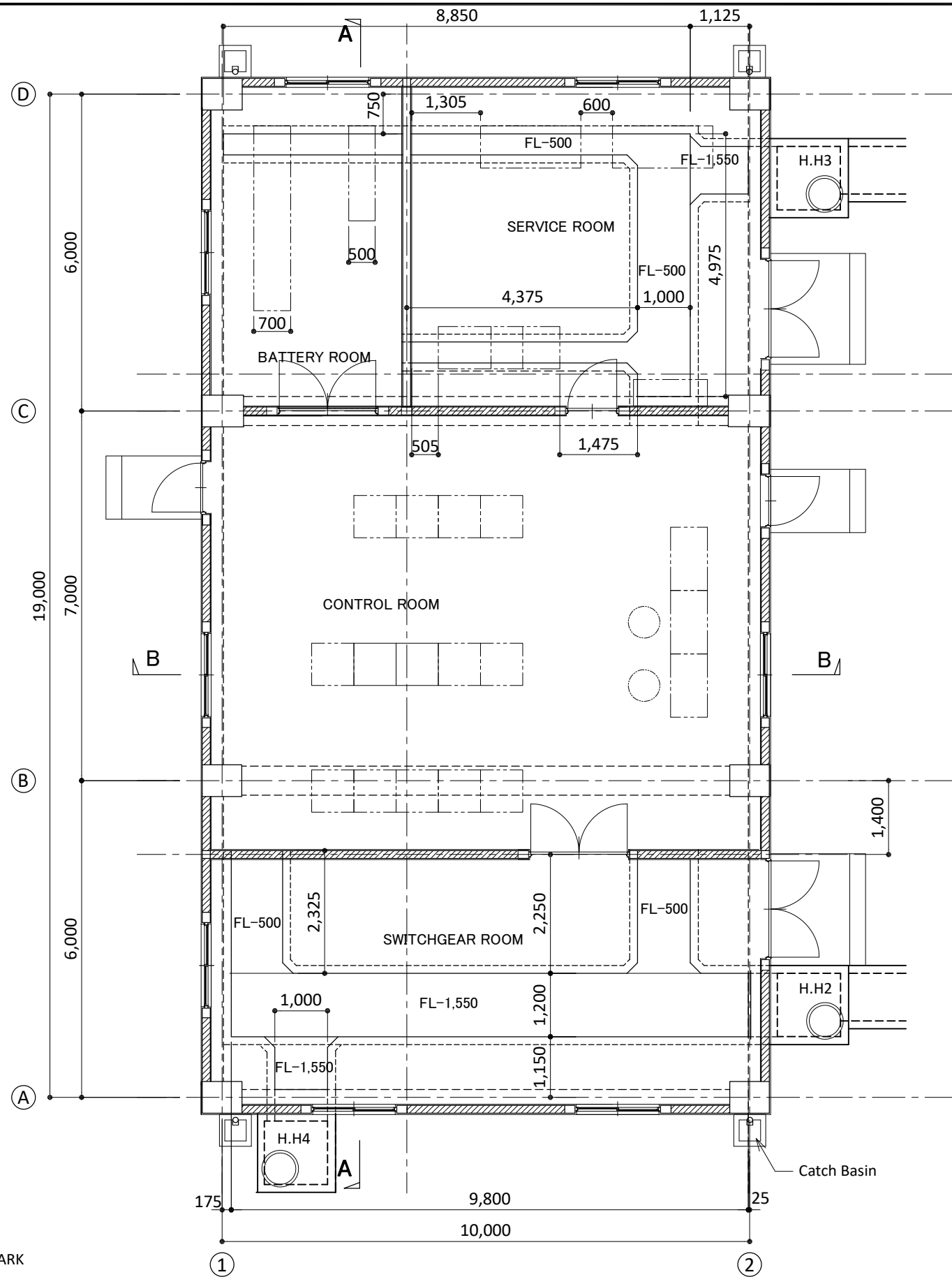
FLOOR PLAN



ROOF PLAN

REMARK  
 [Hatched Box] : Concrete Block  
 [Solid Line] : Concrete

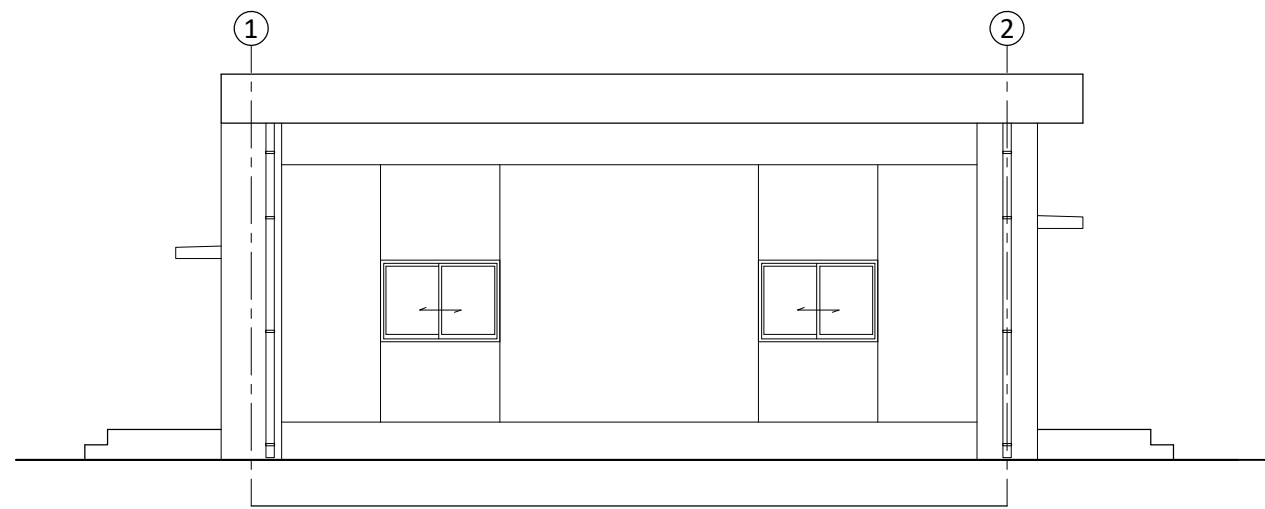
PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Control Building Floor Plan	*****	*****	*****	*****	KG-AA-02
			CONSULTANTS :				SCALE :
						YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc. 1:100 (if only A3)	



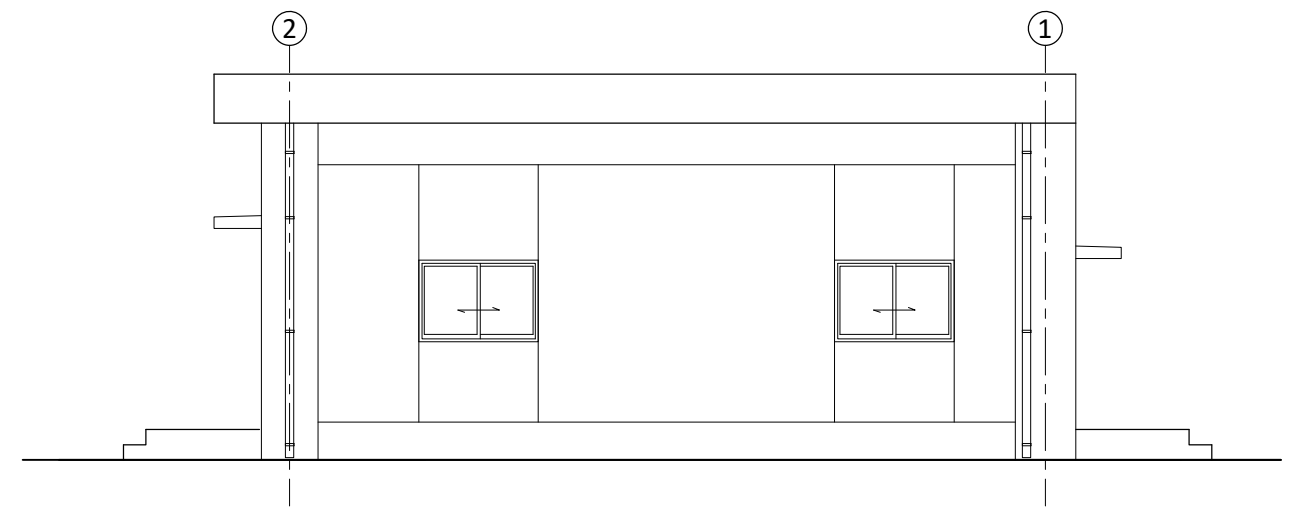
REMARK

- : Concrete Block
- : Concrete

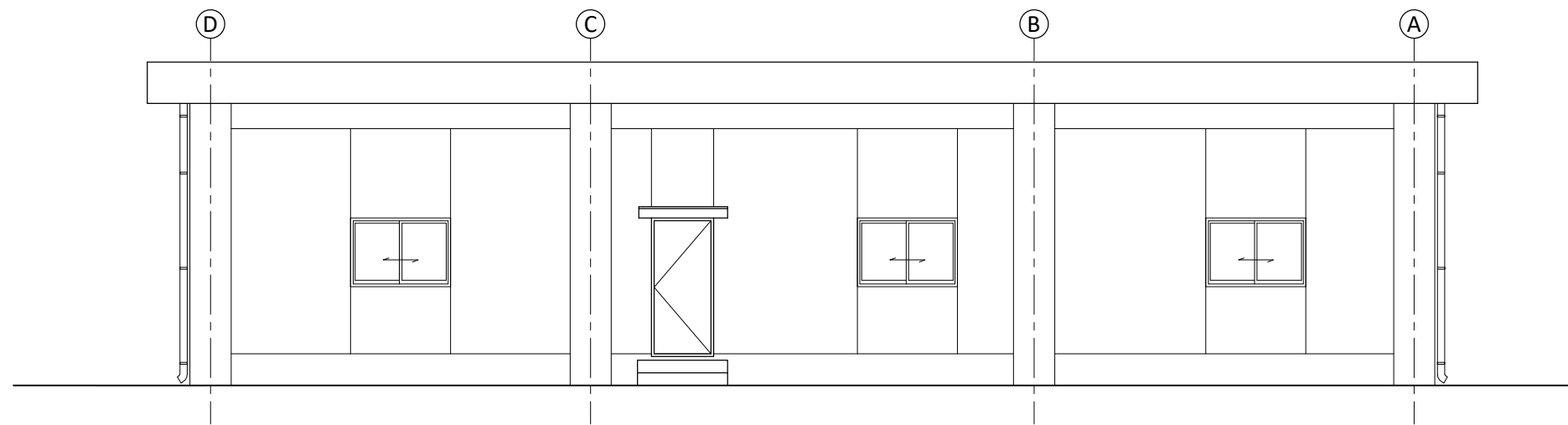
PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :	
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Control Building Cable Trench Plan	*****	*****	*****	*****	KG-AA-03	
			CONSULTANTS :					SCALE :
			<b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <b>West Japan Engineering Consultants, Inc.</b>				1:100 (if only A3)	



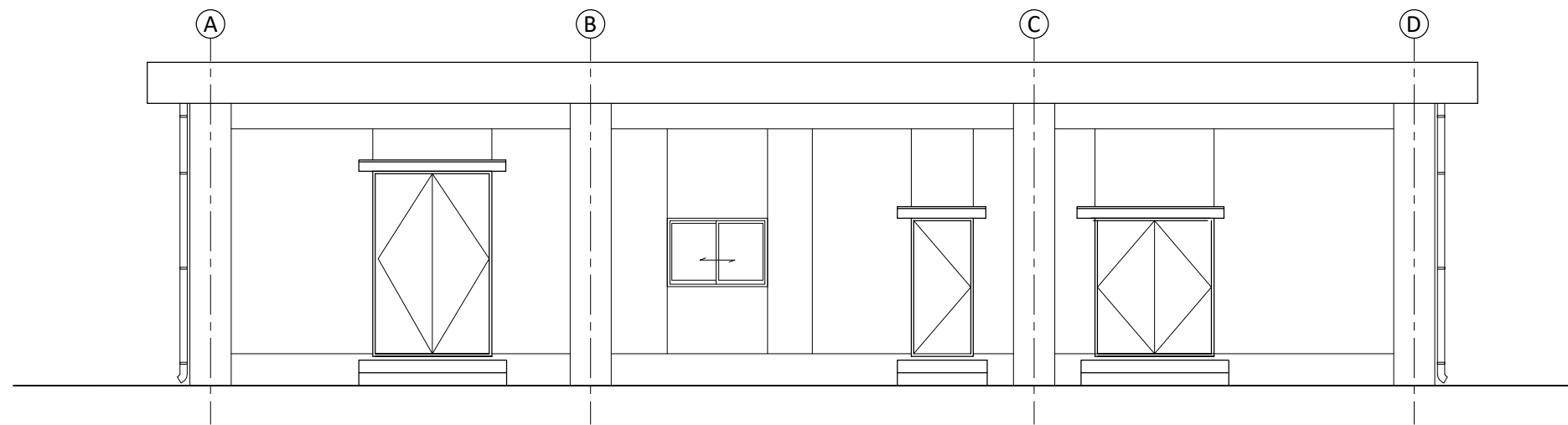
SOUTH ELEVATION




NORTH ELEVATION

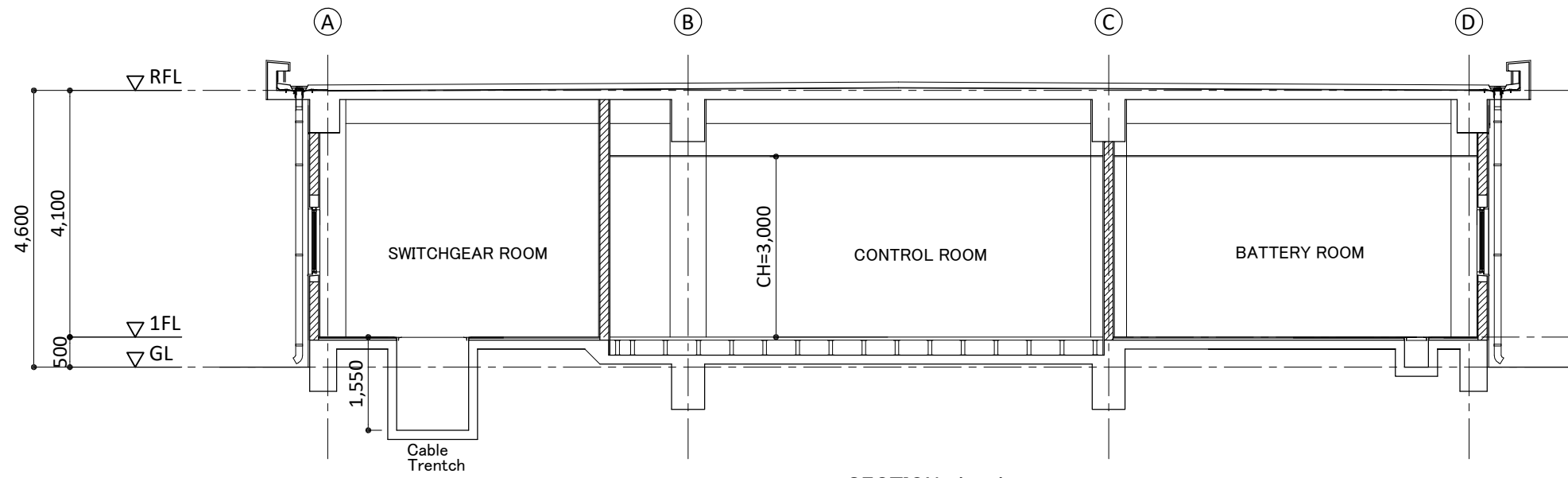


WEST ELEVATION

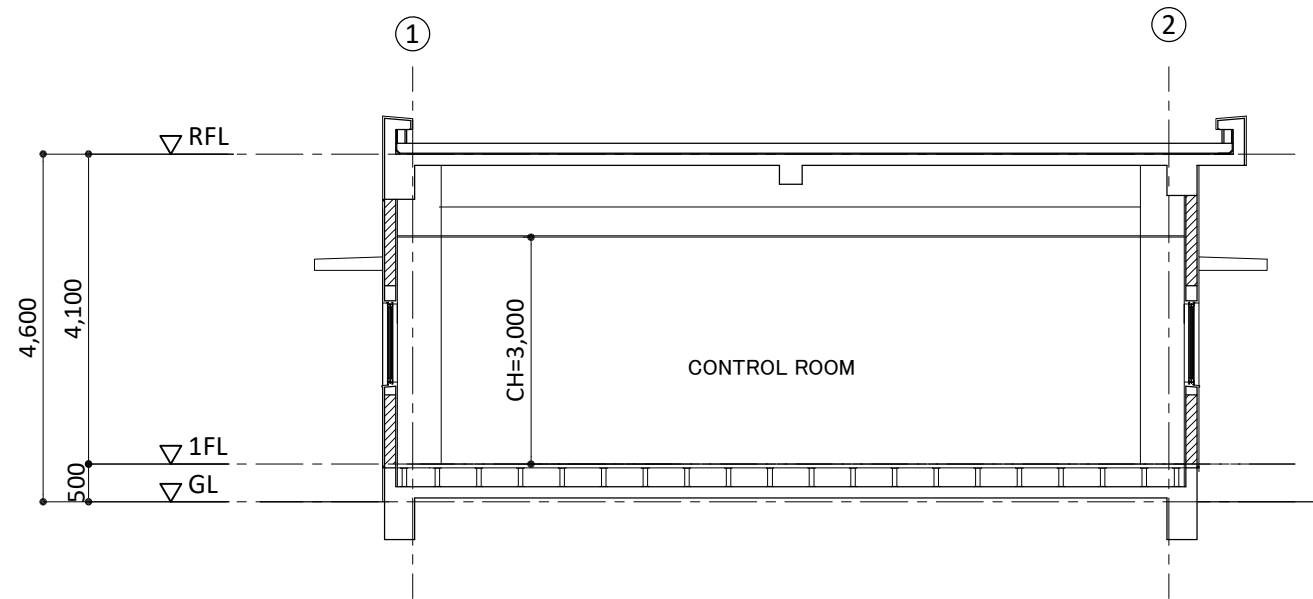


EAST ELEVATION

PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : KG-AA-04
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Control Building Elevation	CONSULTANTS :  <b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <i>West Japan Engineering Consultants, Inc.</i>				SCALE : 1:100 (if only A3)



SECTION A - A

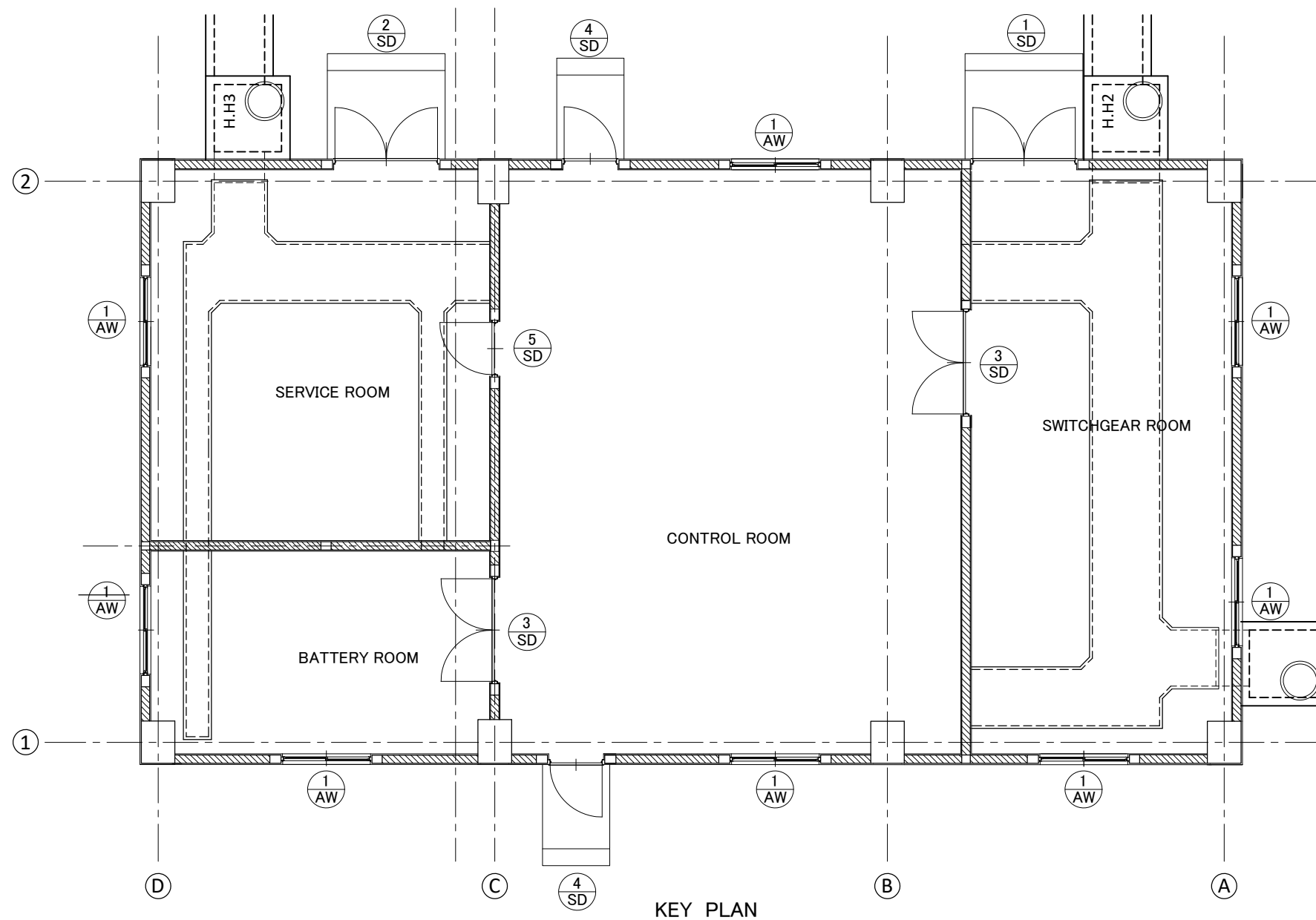


SECTION B - B

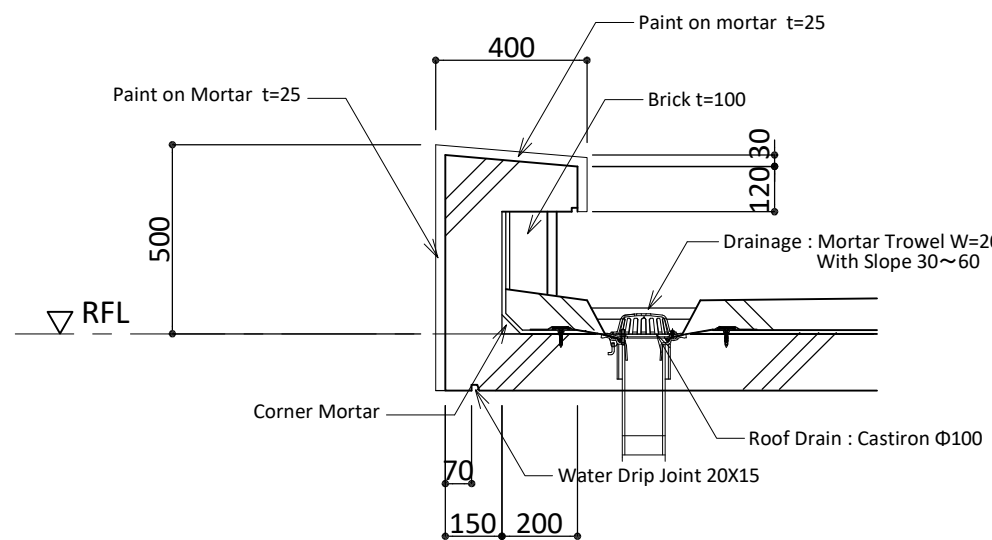
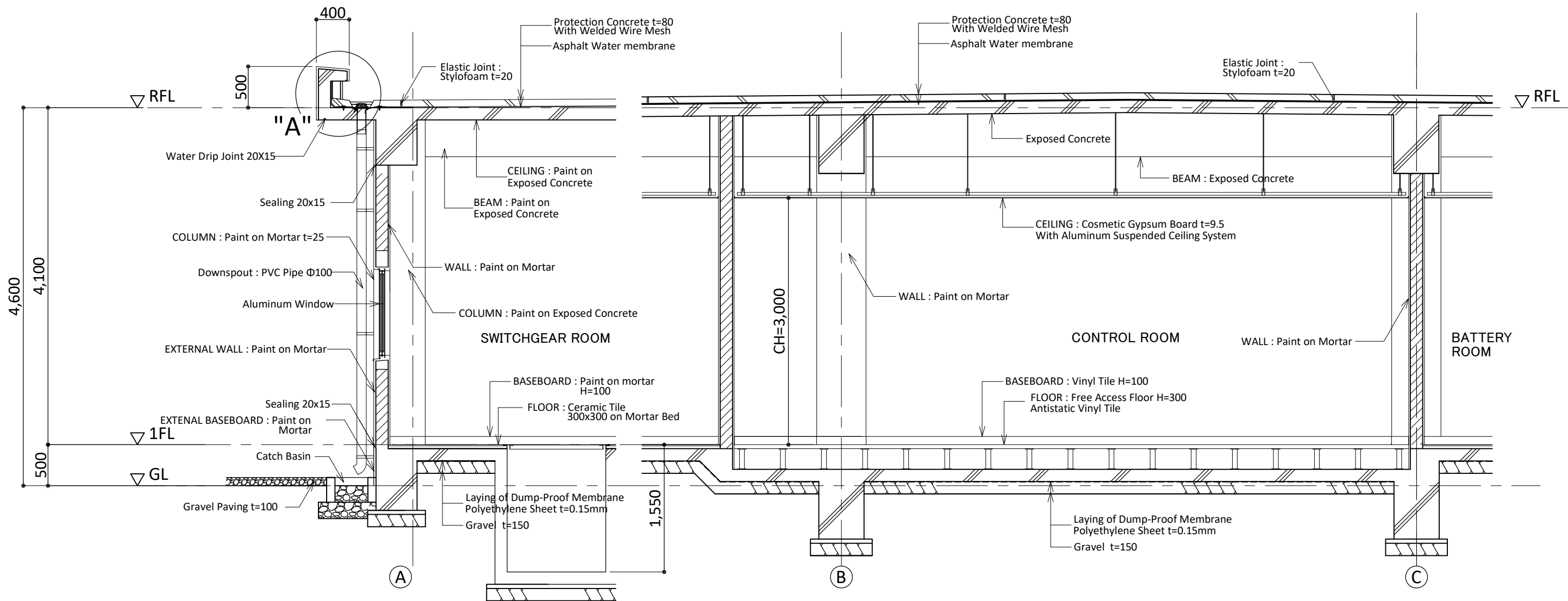
PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : KG-AA-05
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Control Building Section	CONSULTANTS :  <b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <i>West Japan Engineering Consultants, Inc.</i>				SCALE : 1:100 (if only A3)



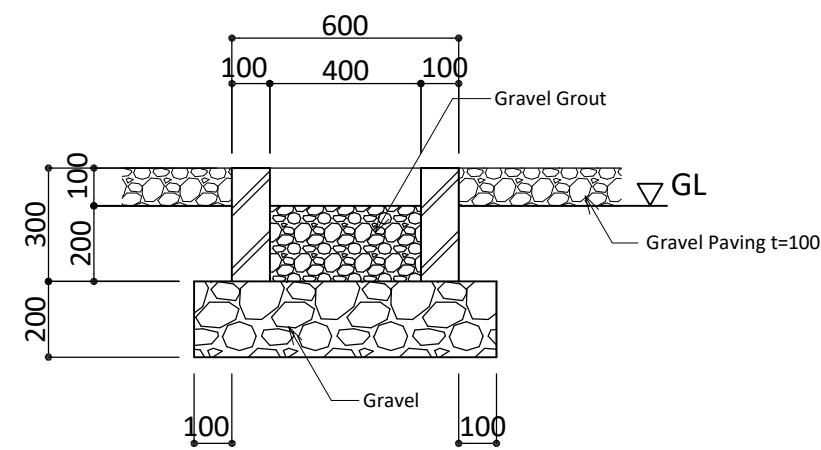
SYMBOL & Qty.	$\frac{1}{SD} \times 1$	$\frac{2}{SD} \times 1$	$\frac{3}{SD} \times 2$	$\frac{4}{SD} \times 2$	$\frac{5}{SD} \times 1$		$\frac{1}{AW} \times 8$	
ELEVATION								
TYPE	DOUBLE SWING DOOR	DOUBLE SWING DOOR	DOUBLE SWING DOOR	SINGLE SWING DOOR	SINGLE SWING DOOR		SLIDING WINDOW	
MATERIAL & FINISH	STEEL PAINT(OP)	STEEL PAINT(OP)	STEEL PAINT(OP)	STEEL PAINT(OP)	STEEL PAINT(OP)		ALUMINUM · ELECTRO COLOR	
GLASS	—	—	—	—	—		CLEAR GLASS t=5	
HARDWEAR	HINGE, LEVER HANDLE, STOPPER DOOR CLOSER, CYLINDER LOCK	HINGE, LEVER HANDLE, STOPPER DOOR CLOSER, CYLINDER LOCK	HINGE, LEVER HANDLE, STOPPER DOOR CLOSER, CYLINDER LOCK	HINGE, LEVER HANDLE, DOOR CLOSER	HINGE, LEVER HANDLE, DOOR CLOSER		CRESCENT LOCK ANTI MOSQUITO NET WINDOW	
REMARK								



PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : KG-AA-06
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Control Building Fitting Schedule	CONSULTANTS : YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc.				SCALE : 1:100 (if only A3)

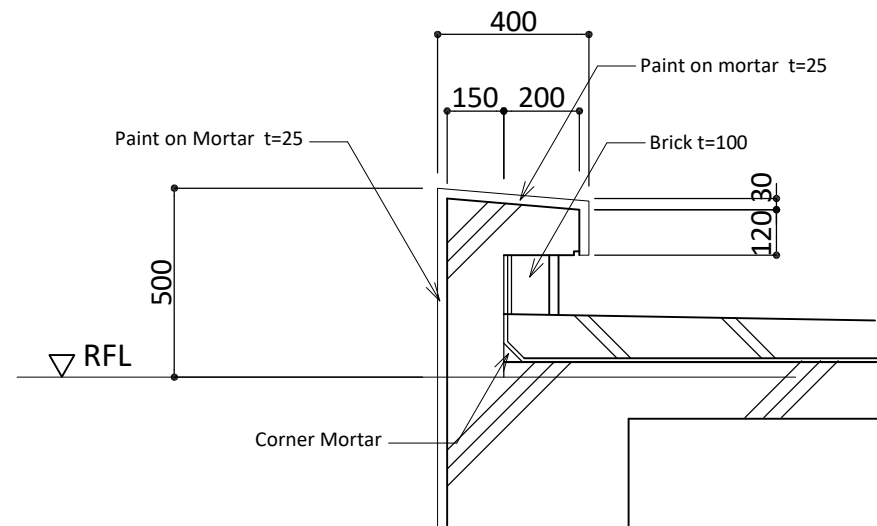
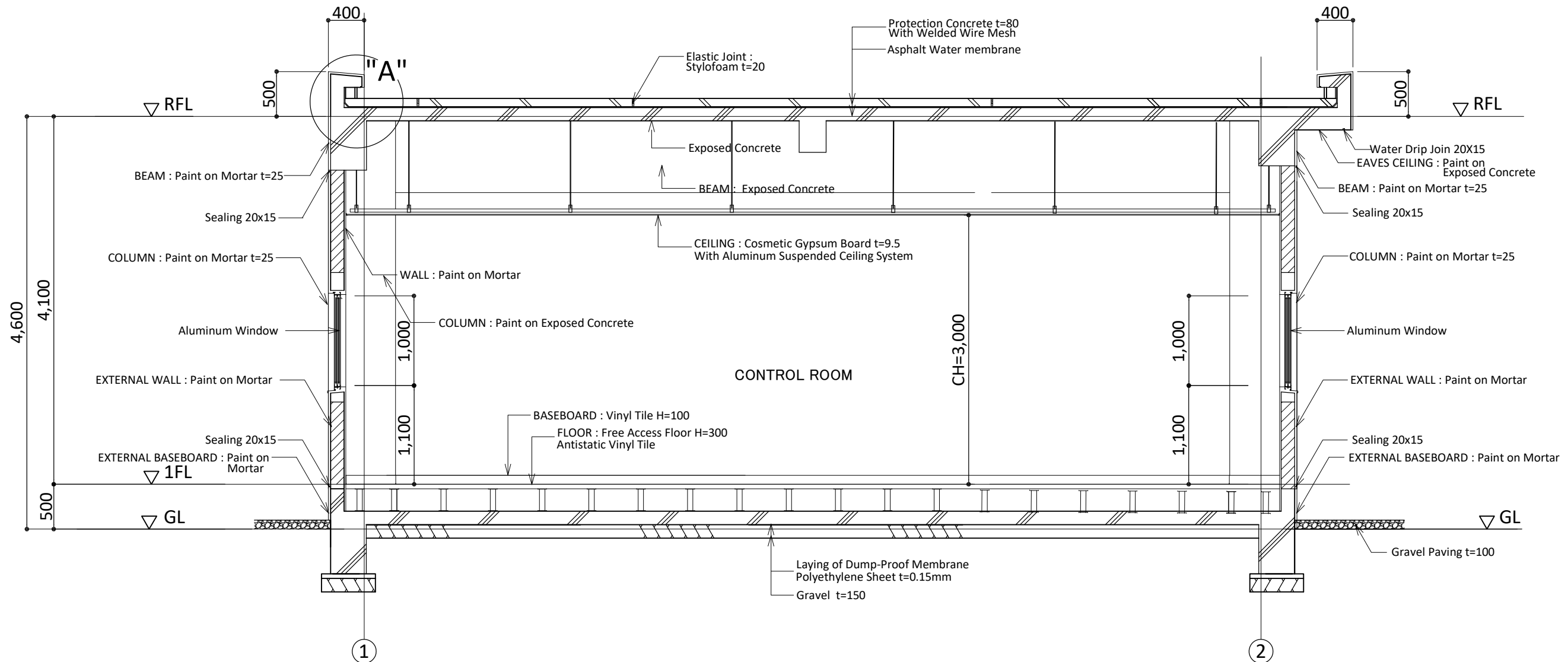


DETAIL "A"



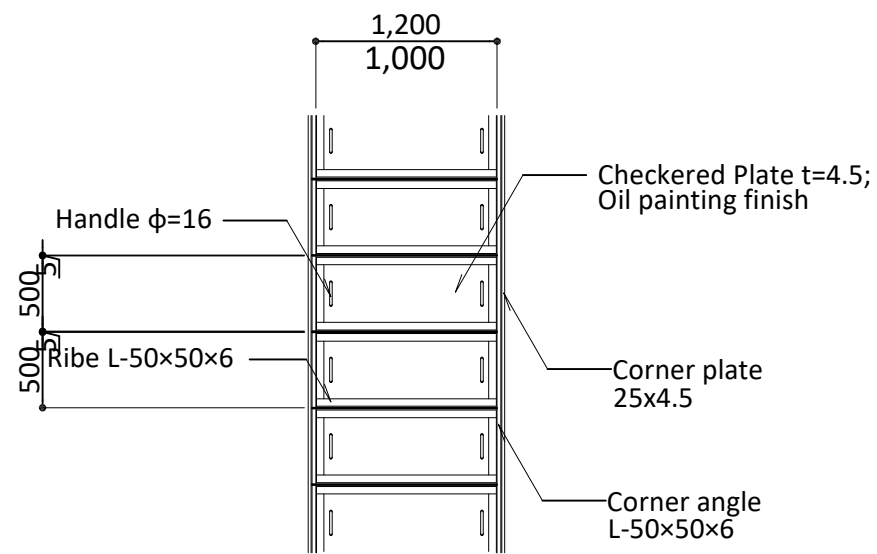
DETAIL OF CATCH BASIN

PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Control Building Detail Section - 1	*****	*****	*****	*****	KG-AA-07
			CONSULTANTS :				SCALE :
							1:50 (if only A3)

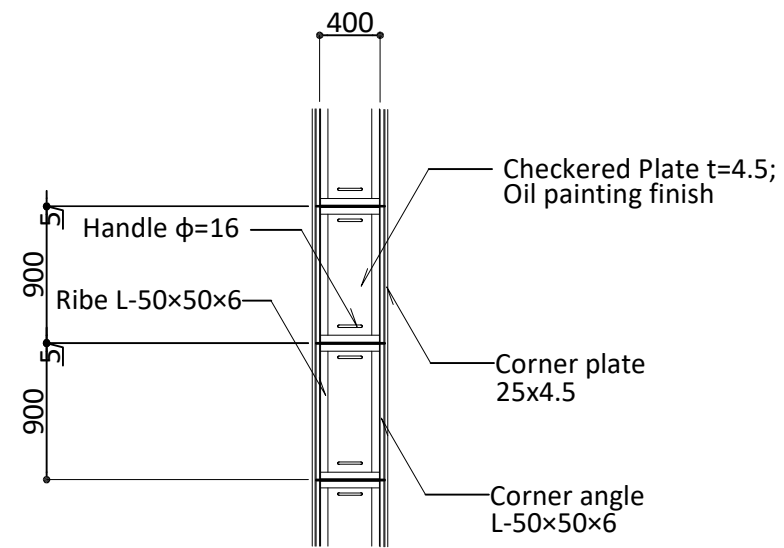


DETAIL "A"

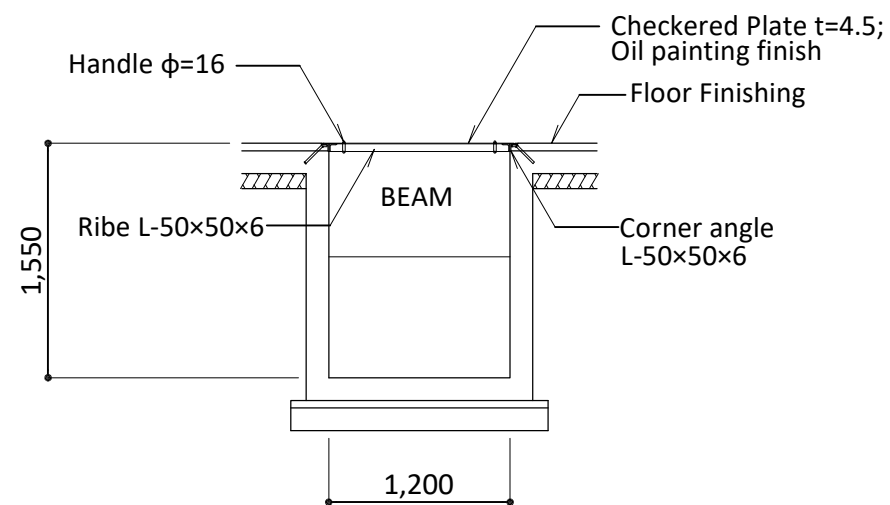
PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Control Building Detail Section - 2	*****	*****	*****	*****	KG-AA-08
			CONSULTANTS :				SCALE :
						YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc.	
						1:50 (if only A3)	



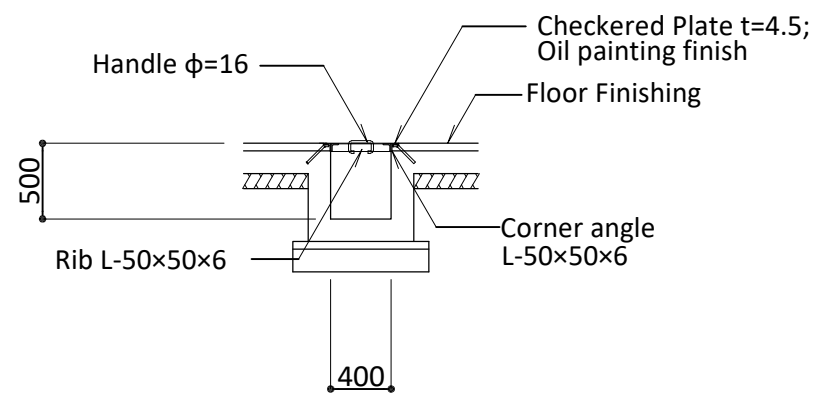
PLAN




PLAN



SECTION



SECTION

PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	KANENGO	Kanengo Control Building Detail - 1	*****	*****	*****	*****	KG-AA-09
			CONSULTANTS :				
					YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc.		1:50 (if only A3)



**GENERAL**

BUILDING AREA	276.00m <sup>2</sup>
TOTAL FLOOR AREA	276.00m <sup>2</sup>
STRUCTURE	REINFORCED CONCRETE

**EXTERIOR FINISHING SCHEDULE**

LOCATION	SPECIFICATION
ROOF	CONCRETE STEEL TROWEL ON PROTECTION CONCRETE WITH WELDED WIRE MESH ASPHALT MEMBRANE WATER PROOFING
DRAIN	ROOF DRAIN : CASTIRON $\phi$ 100mm DOWNSPOUT : PVC PIPE $\phi$ 100mm
WALL	PAINT FINISH (A.E.P) ON 150mm THK. CONCRETE BLOCK WITH MORTAR STEEL TROWEL 25mm THK.
COLUMN	FINISH (A.E.P) ON MORTAR STEEL TOROWEL 25mm THK.
BEAM	FINISH (A.E.P) ON MORTAR STEEL TOROWEL 25mm THK.
TERRACE	CONCRETE STEEL TROWEL


**INTERIOR FINISHING SCHEDULE**

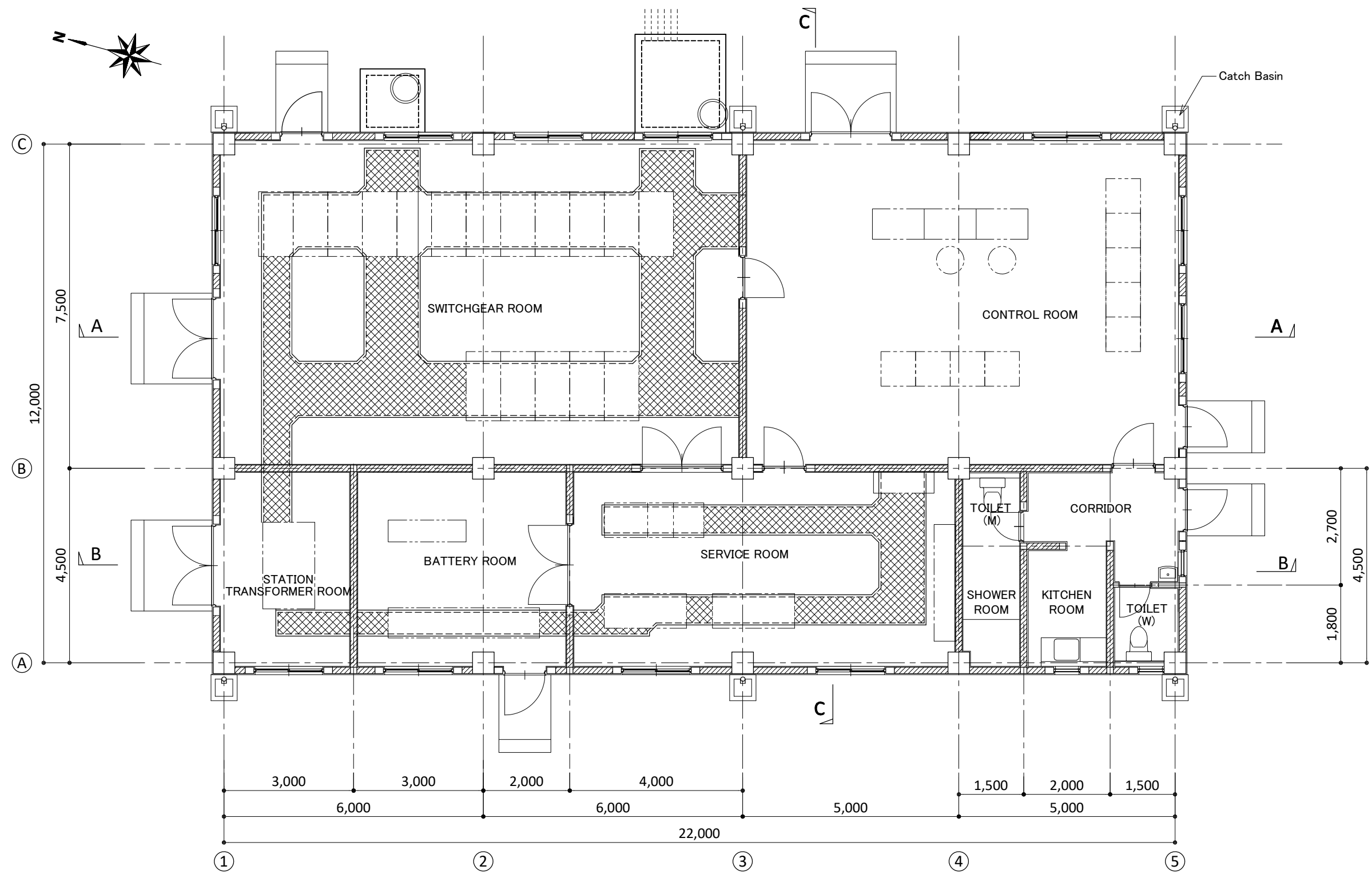
ROOM NAME	FLOOR	BASEBOARD	WALL	CEILING	REMARKS
SWITCHGEAR ROOM	CERAMIC TILE 300 X 300 ON MORTAR BED FINISH 50mm THK.	PAINT FINISH(E.P) MORTAR STEEL TROWEL 20mm THK. ON 150mm THICKNESS CONCRETE BLOCK	PAINT FINISH(E.P) MORTAR STEEL TROWEL 20mm THK. ON 150mm THK. CONCRETE BLOCK	PAINT FINISH (E.P) EXPOSED CONCRETE	AIR CONDITIONING, ROOM NAME PLATE FIRE EXTINGUISHER 1 SET, VENTIRATION FAN
CONTROL ROOM	FREE ACCESS FLOOR H=300 ANTISTATIC VINYL TILE FINISH	VINYL TILE H=100	DITTO	GOSMETIC GYPSUM BOARD 9.5mm THK. WITH ALUMINUM SUSPENDE FRAME	AIR CONDITIONING, ROOM NAME PLATE FIRE EXTINGUISHER 1 SET, VENTIRATION FAN
STATION TRANSFORMER ROOM	CERAMIC TILE 300 X 300 ON MORTAR BED FINISH 50mm THK.	PAINT FINISH(E.P) MORTAR STEEL TROWEL 20mm THK. ON 150mm THICKNESS CONCRETE BLOCK	DITTO	PAINT FINISH (E.P) EXPOSED CONCRETE	FIRE EXTINGUISHER 1 SET, ROOM NAME PLATE VENTIRATION FAN
BATTERY ROOM	DITTO	DITTO	DITTO	GOSMETIC GYPSUM BOARD 9.5mm THK. WITH ALUMINUM SUSPENDE FRAME	AIR CONDITIONING, ROOM NAME PLATE FIRE EXTINGUISHER 1 SET, VENTIRATION FAN
SERVICE ROOM	DITTO	DITTO	DITTO	DITTO	AIR CONDITIONING, ROOM NAME PLATE FIRE EXTINGUISHER 1 SET, VENTIRATION FAN
KITCHEN ROOM	DITTO	DITTO	DITTO	DITTO	VENTILATION FAN , KITCHEN SINK SET
TOILET	DITTO	---	CERAMIC TILE 300 X 300 ON MORTAR BED FINISH 30mm THK. ON 100 or 150mm THK. CONCRETE BLOCK	DITTO	VENTILATION FAN , MIRROR TOILET PAPER HOLDER, WASH BASIN URINAL, ROOM NAME PLATE
SHOWER ROOM	DITTO	---	DITTO	DITTO	SHOWER HEAD

**NOTES**

THK. : THICKNESS

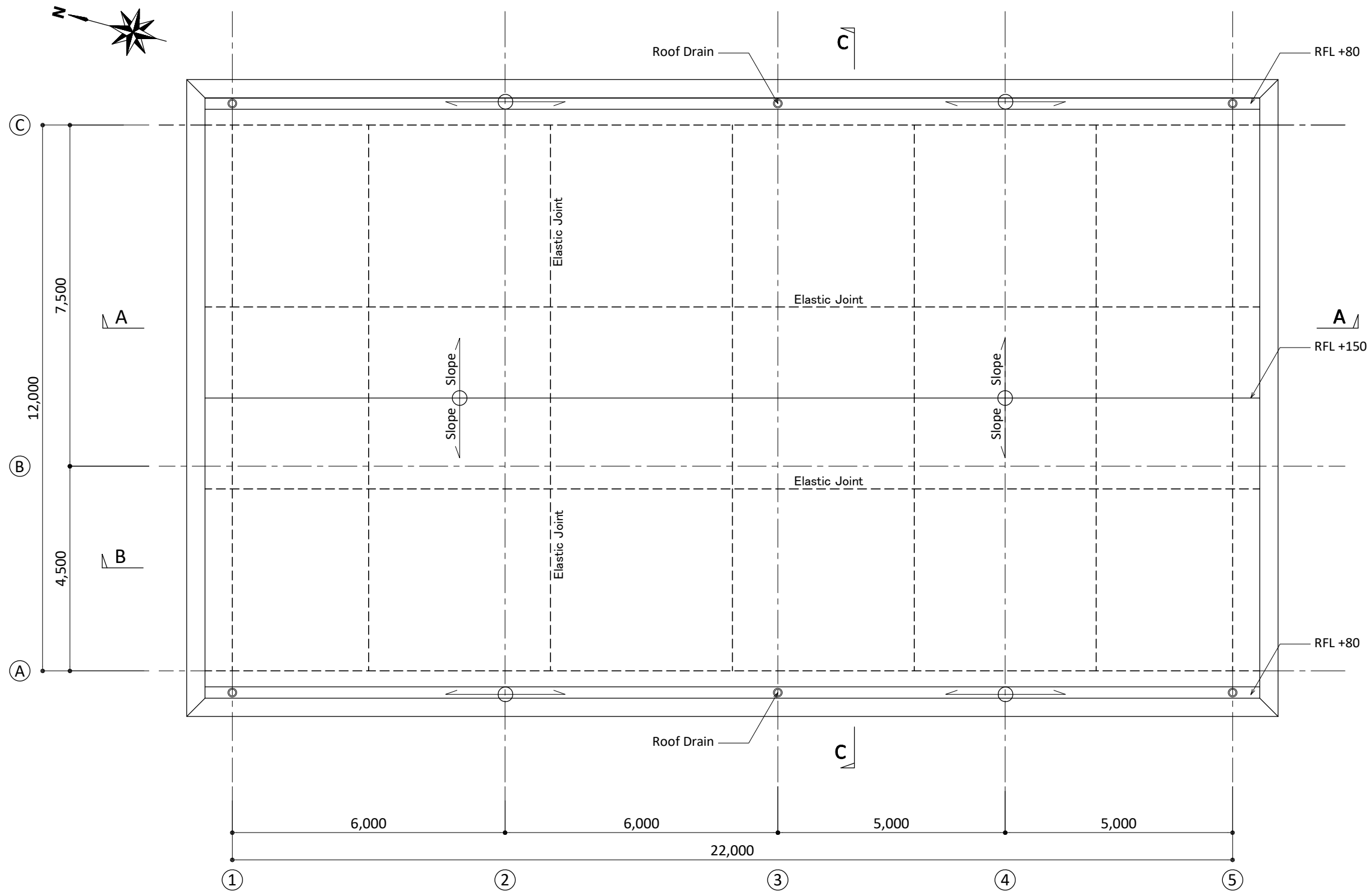
ROOM NAME PLATE : MATERIAL SHALL BE PLASTIC PLATE 5.0mm THK.


PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : OT-AA-01
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Control Building Finishing Schedule	CONSULTANTS :  <b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> West Japan Engineering Consultants, Inc.				SCALE : --- (if only A3)

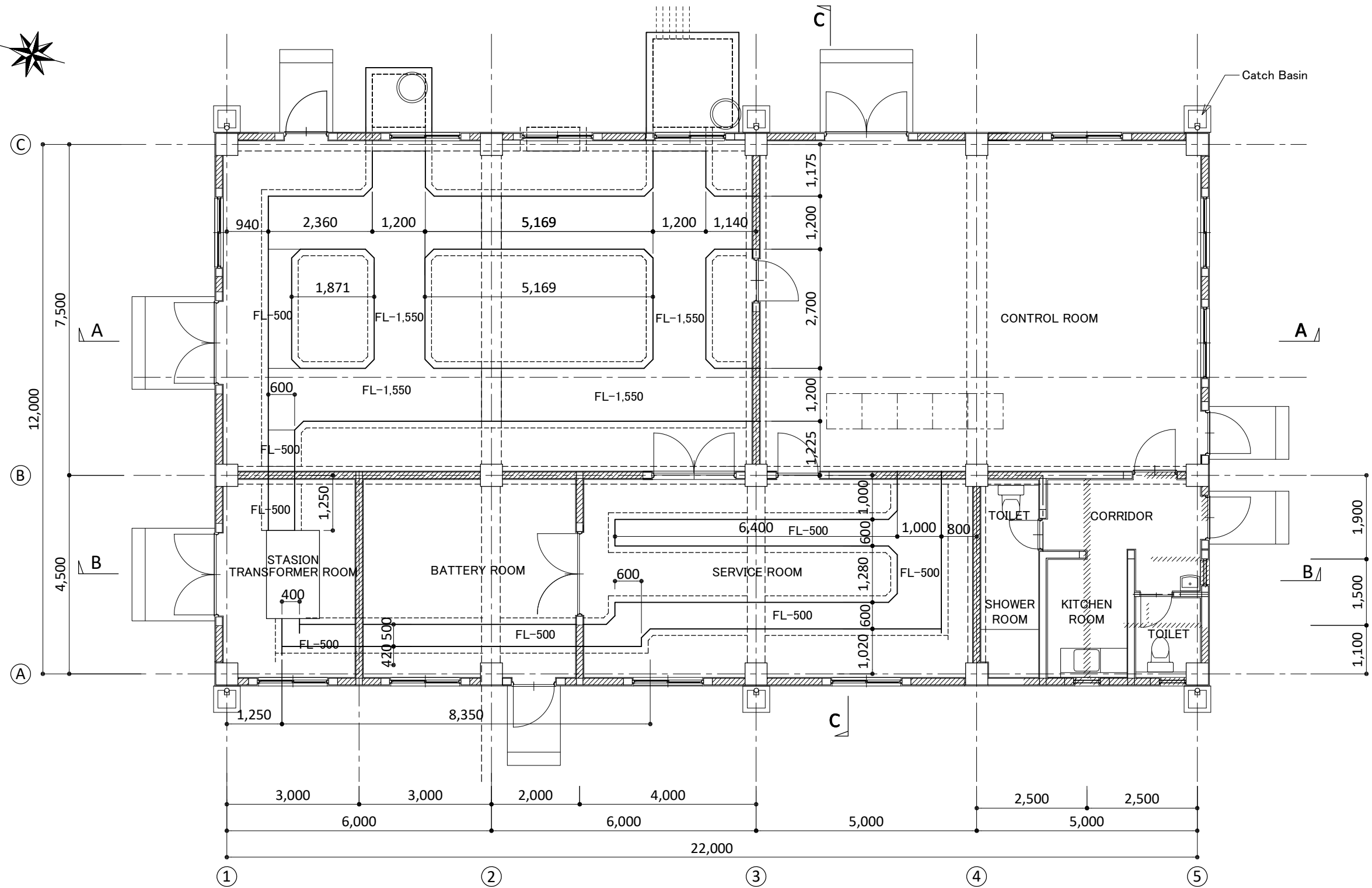


REMARK  
 [Hatched Pattern] : Concrete Block  
 [Solid Line] : Concrete

PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : OT-AA-02
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Control Building Floor Plan	CONSULTANTS : <b>yec</b> YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc.				SCALE : 1:100 (if only A3)



PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : OT-AA-03
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Control Building Roof Plan	CONSULTANTS :  <b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <b>West Japan Engineering Consultants, Inc.</b>				SCALE : 1:100 (if only A3)

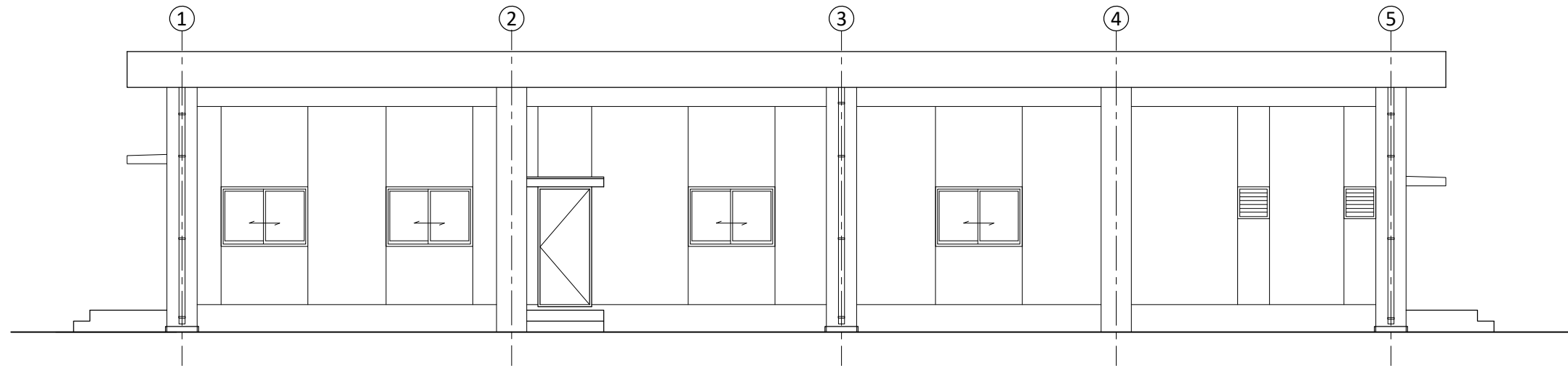


REMARK

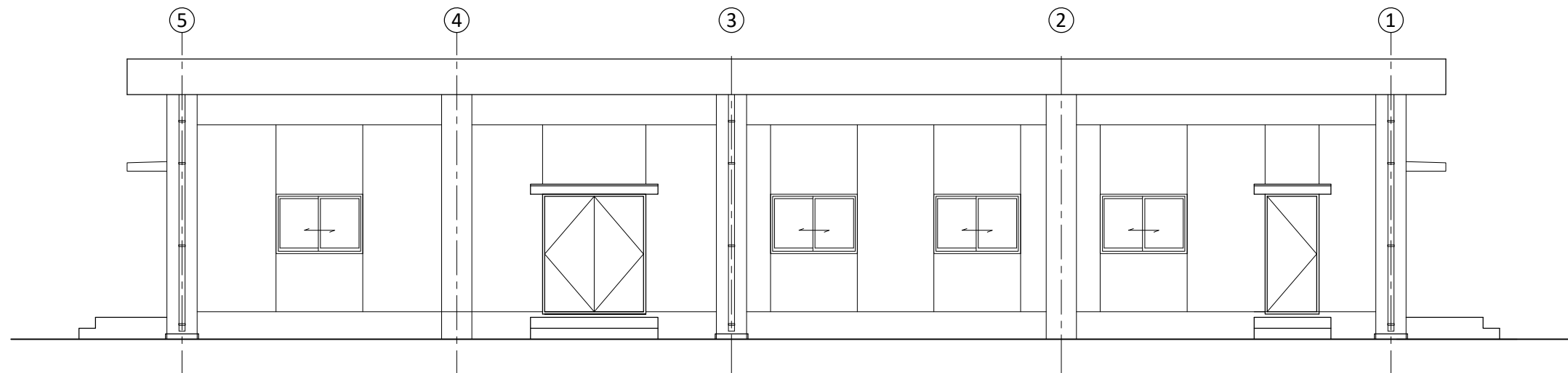
- : Concrete Block
- : Concrete

PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Control Building Cable Trench Plan	*****	*****	*****	*****	OT-AA-04
			CONSULTANTS :				
<b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <b>West Japan Engineering Consultants, Inc.</b>						1:100 (if only A3)	

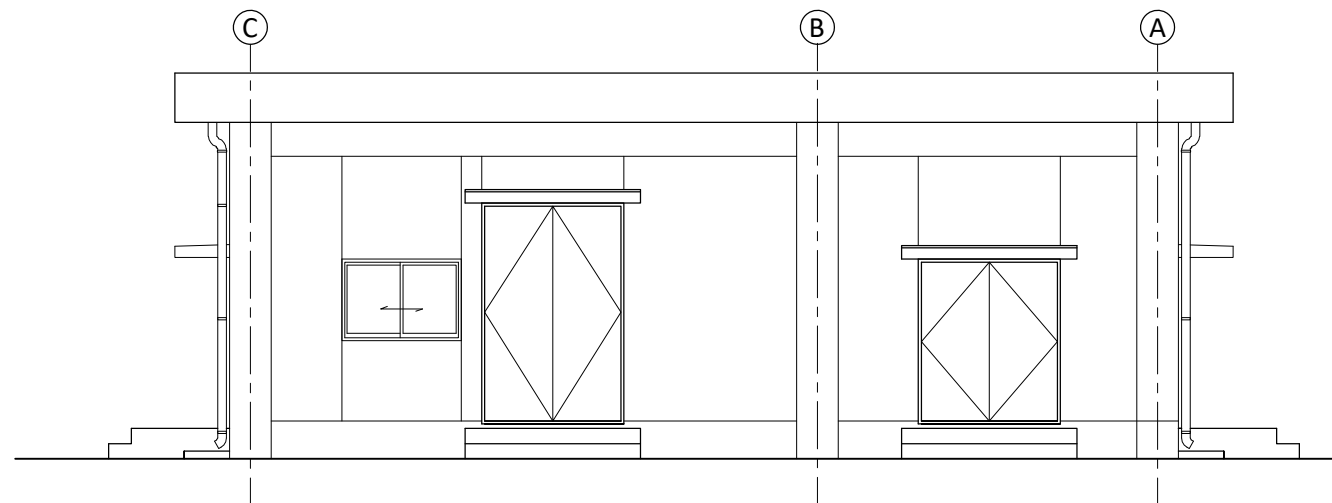




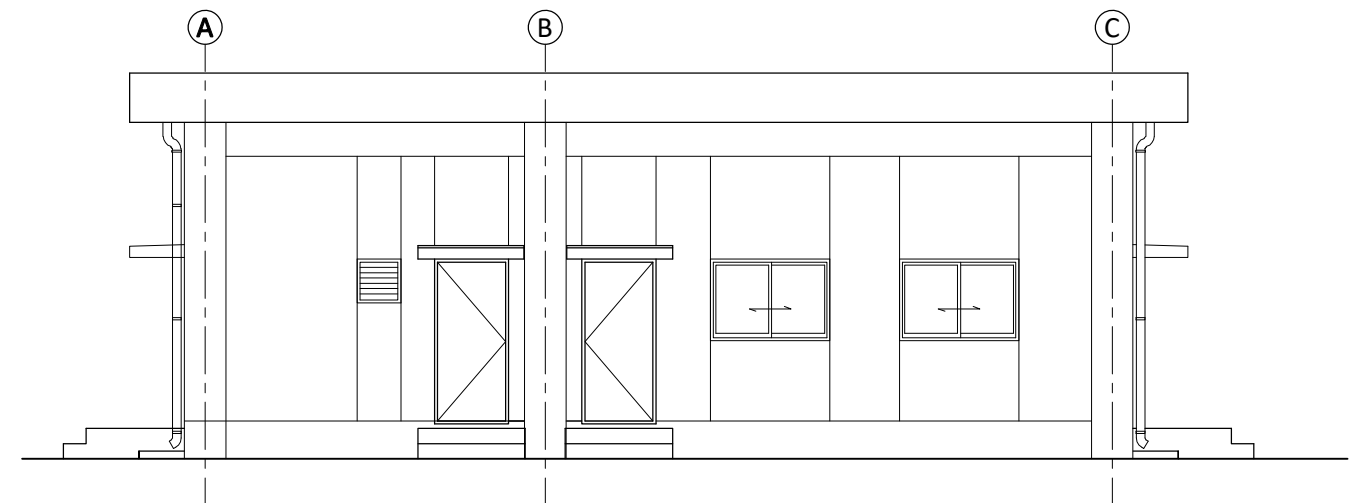
WEST ELEVATION



EAST ELEVATION

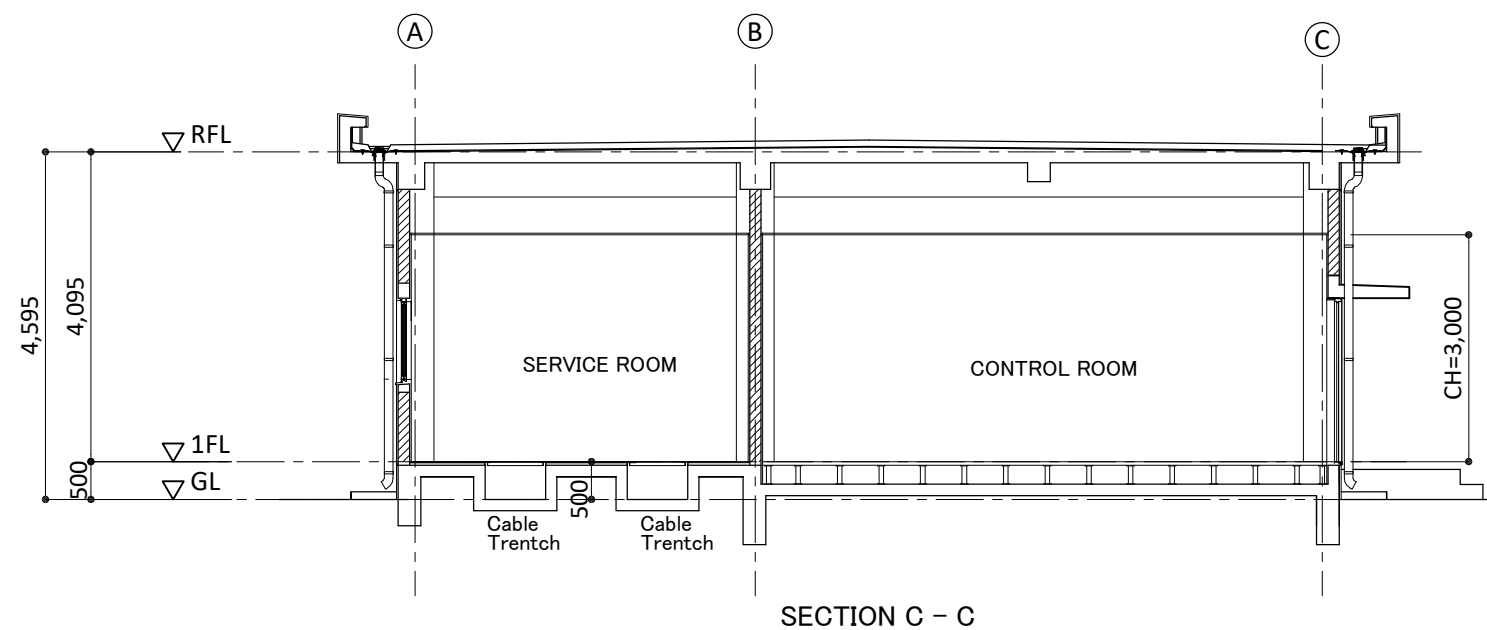
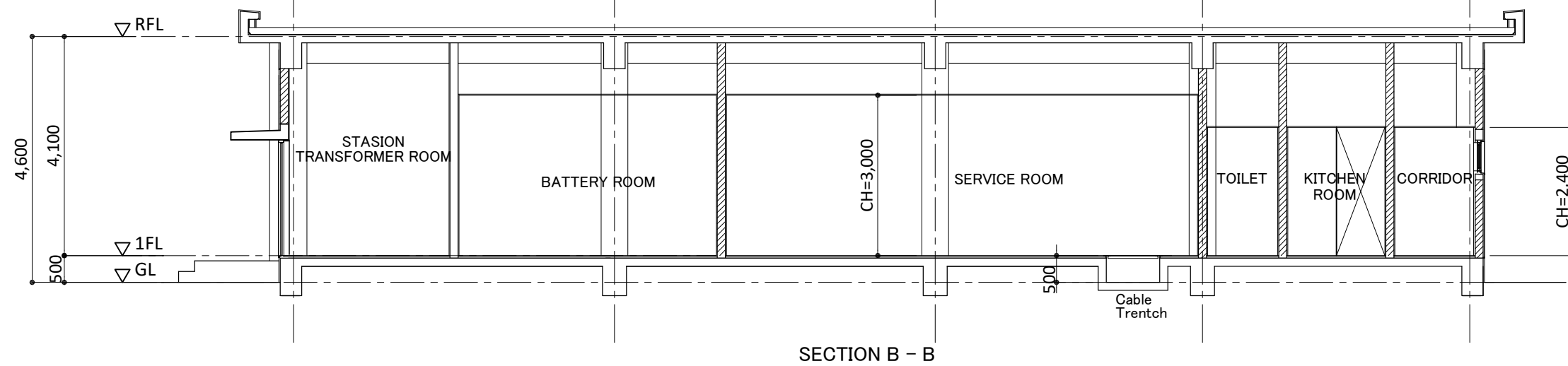
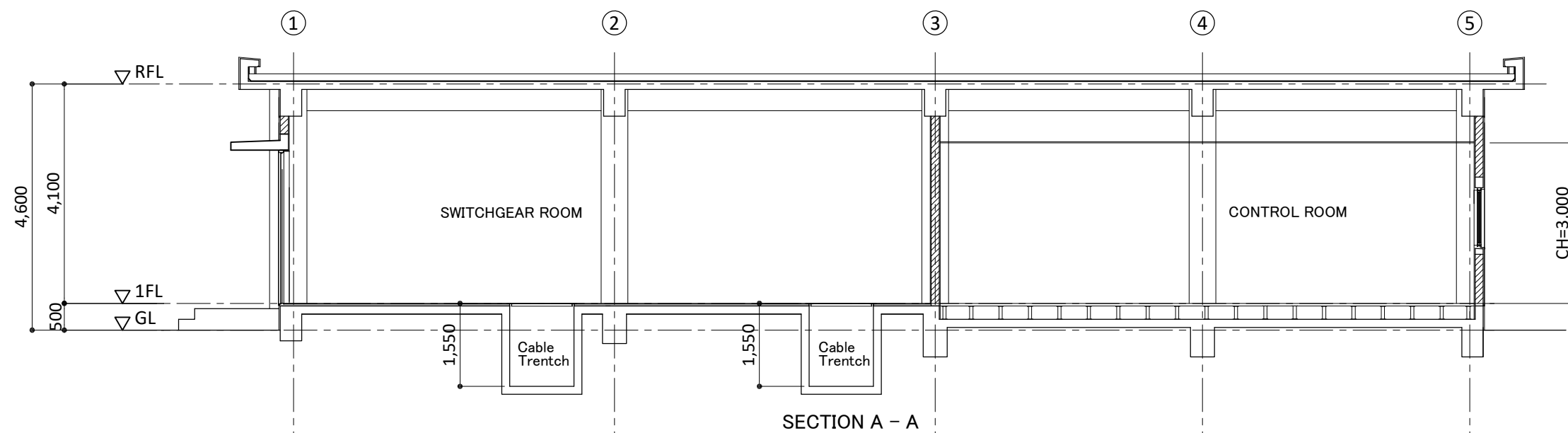


NORTH ELEVATION



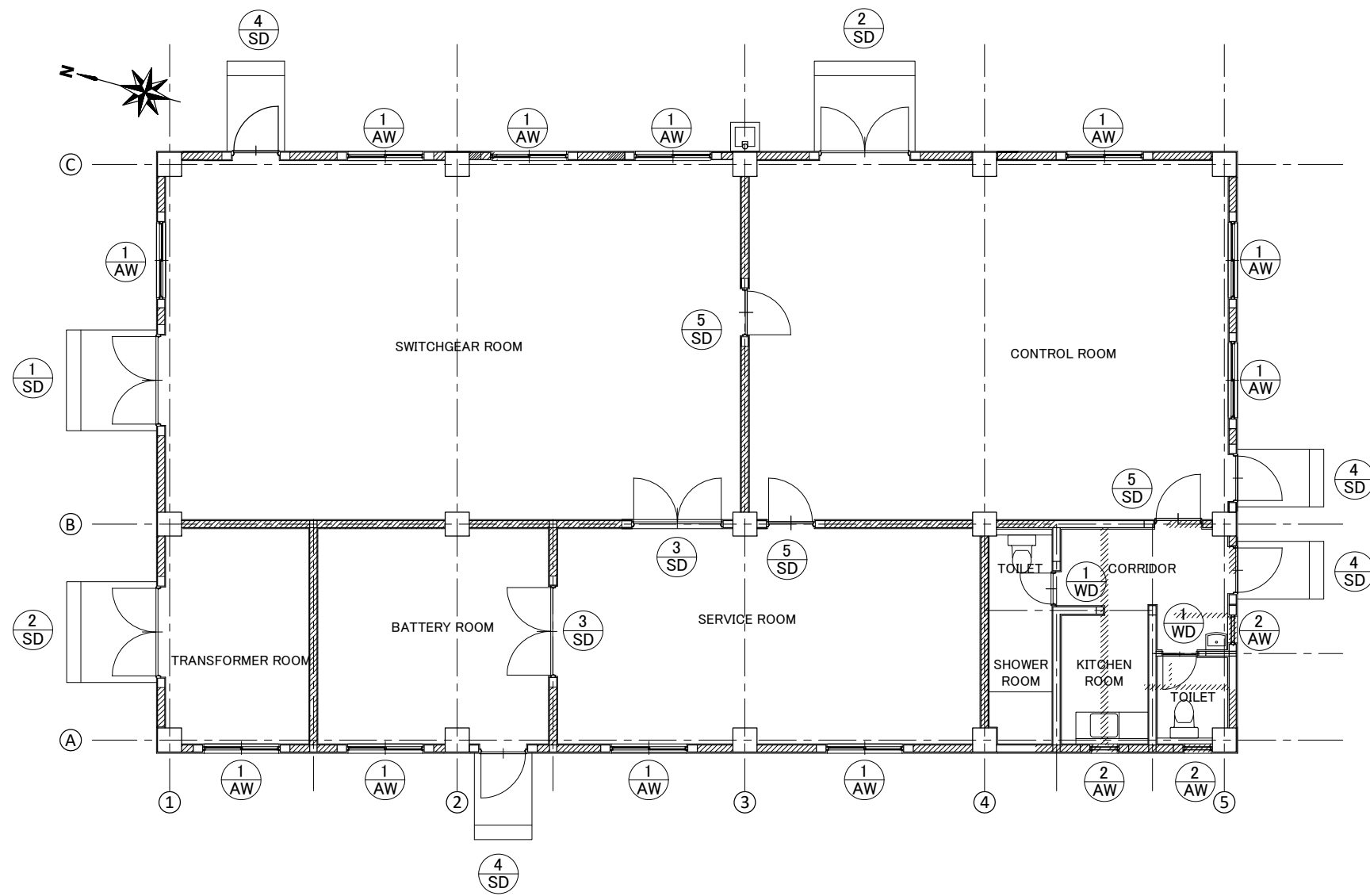
SOUTH ELEVATION

PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : OT-AA-05
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Control Building Elevation	CONSULTANTS : <b>yec</b> YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc.				SCALE : 1:100 (if only A3)



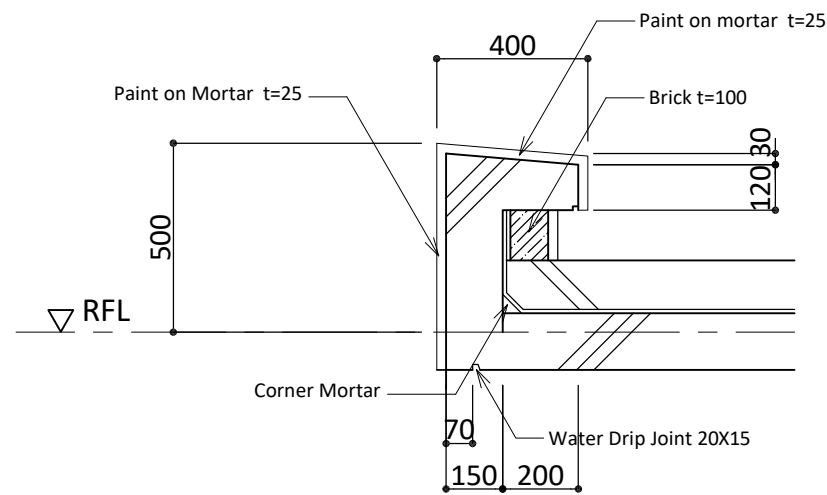
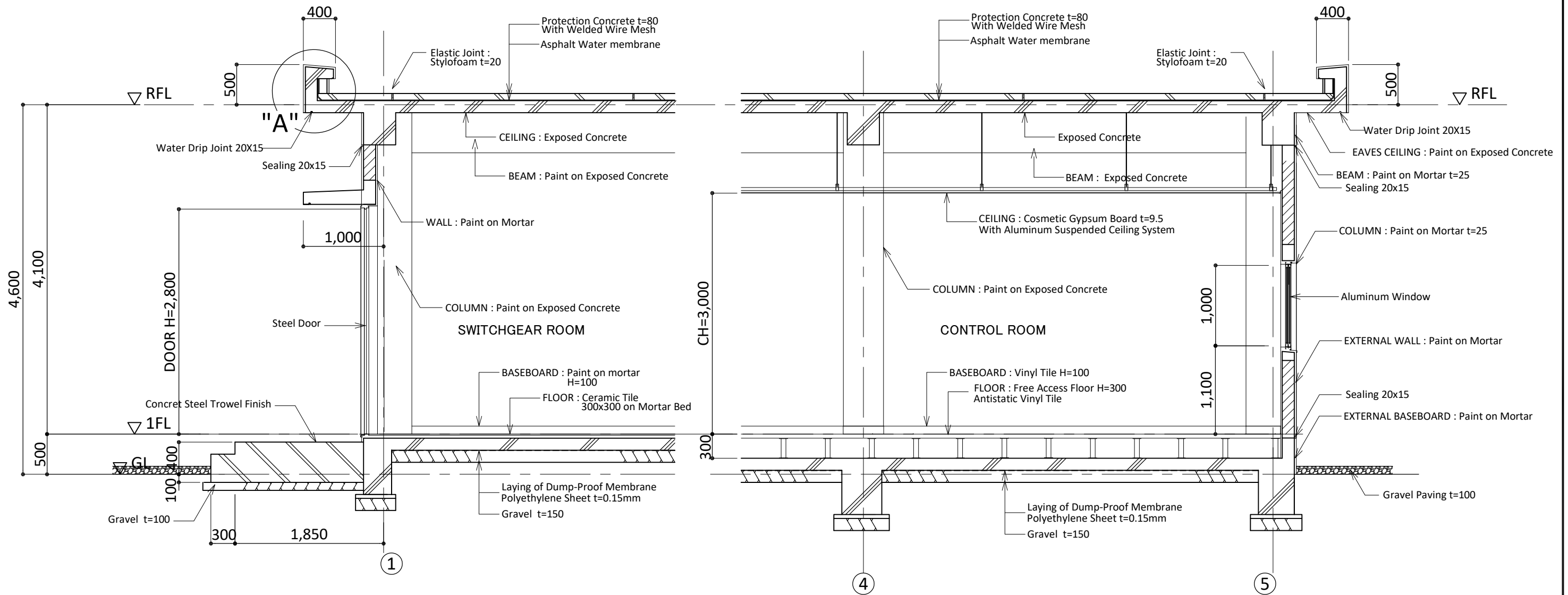
PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : OT-AA-06
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Control Building Section	CONSULTANTS :  <b>YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN</b> <i>West Japan Engineering Consultants, Inc.</i>				SCALE : 1:100 (if only A3)

SYMBOL & Qty.	$\frac{1}{SD} \times 1$	$\frac{2}{SD} \times 2$	$\frac{3}{SD} \times 2$	$\frac{4}{SD} \times 4$	$\frac{5}{SD} \times 3$	$\frac{1}{WD} \times 2$	$\frac{1}{AW} \times 11$	$\frac{2}{AW} \times 3$
ELEVATION								
TYPE	DOUBLE SWING DOOR	DOUBLE SWING DOOR	DOUBLE SWING DOOR	SINGLE SWING DOOR	SINGLE SWING DOOR	SINGLE SWING DOOR	SLIDING WINDOW	JALOUSIE WINDOW
MATERIAL & FINISH	STEEL PAINT(OP)	STEEL PAINT(OP)	STEEL PAINT(OP)	STEEL PAINT(OP)	STEEL PAINT(OP)	WOODEN FLASH DOOR (OP)	ALUMINUM ·ELECTRO COLOR	ALUMINUM ·ELECTRO COLOR
GLASS	—	—	—	—	—	—	CLEAR GLASS t=5	CLEAR GLASS t=5
HARDWEAR	HINGE, LEVER HANDLE, STOPPER DOOR CLOSER, CYLINDER LOCK	HINGE, LEVER HANDLE, STOPPER DOOR CLOSER, CYLINDER LOCK	HINGE, LEVER HANDLE, STOPPER DOOR CLOSER, CYLINDER LOCK	HINGE, LEVER HANDLE, DOOR CLOSER	HINGE, LEVER HANDLE, DOOR CLOSER	HINGE, LEVER HANDLE, DOOR CLOSER	CRESCENT LOCK ANTI MOSQUITO NET WINDOW	ANTI MOSQUITO NET WINDOW
REMARK								



KEY PLAN

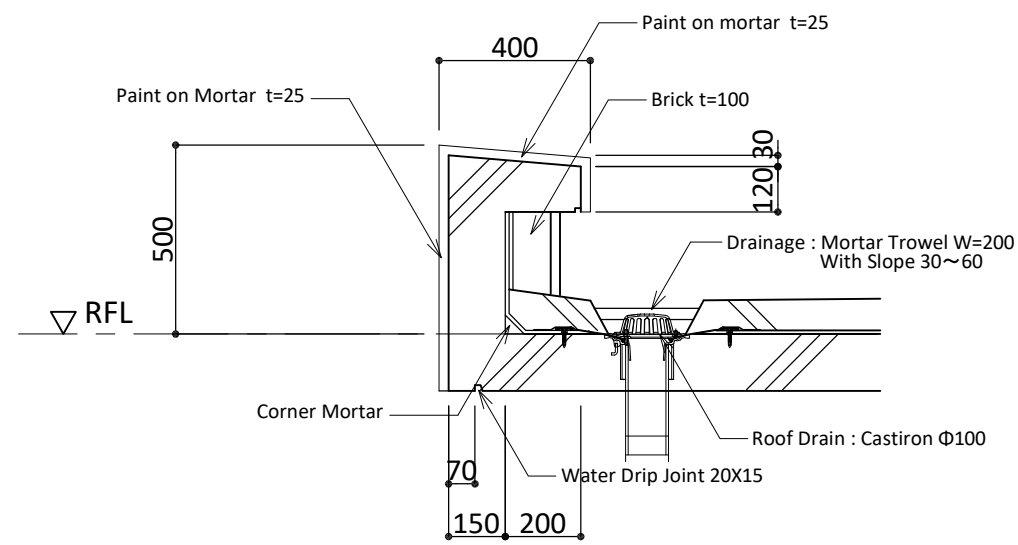
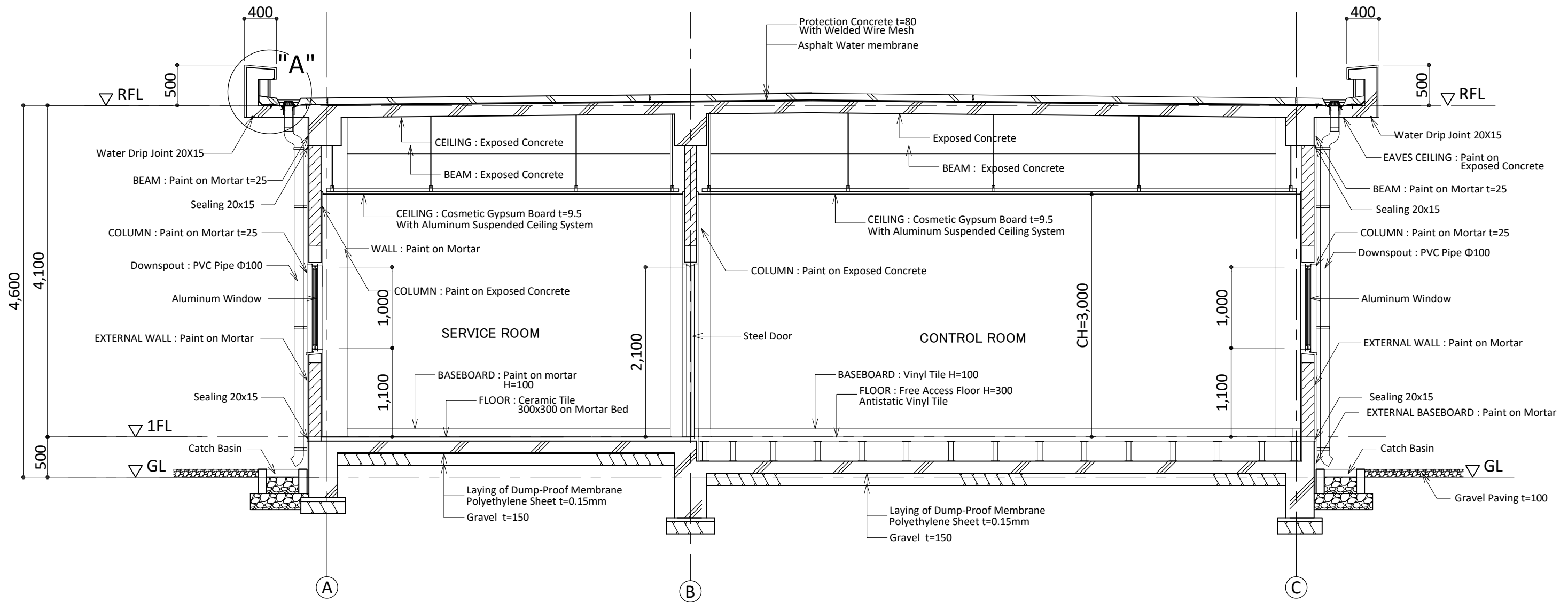
PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : OT-AA-07
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Control Building Fitting Schedule	CONSULTANTS : YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc.				SCALE : 1:100 (if only A3)



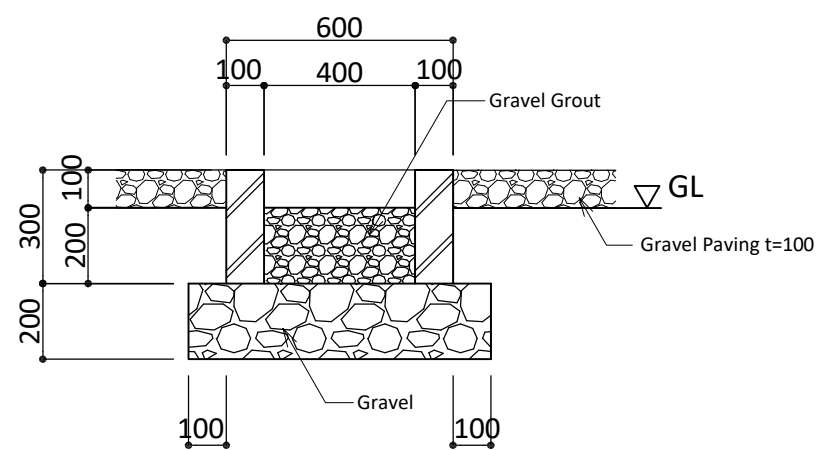
**DETAIL "A"**

PROJECT	LOCATION	TITLE	APPROVED BY : *****	CHECKED BY : *****	DESIGNED BY : *****	DATE : *****	DRG NO : OT-AA-08
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Control Building Detail Section - 1	CONSULTANTS : <b>yec</b> YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN West Japan Engineering Consultants, Inc.				SCALE : 1:50 (if only A3)



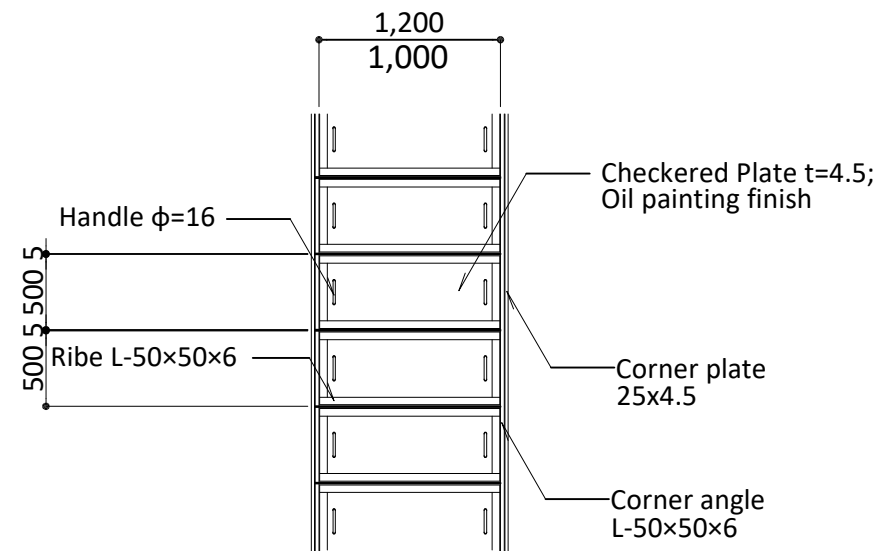


DETAIL "A"

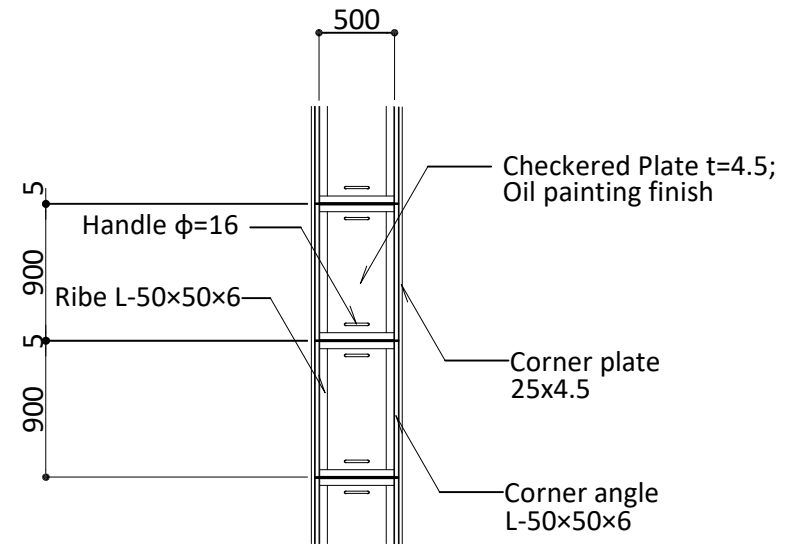


DETAIL OF CATCH BASIN

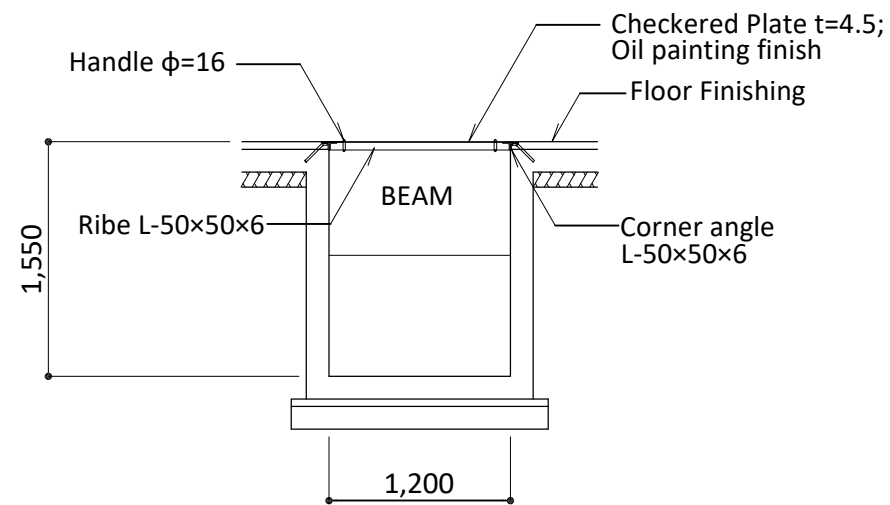
PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Control Building Detail Section - 2	*****	*****	*****	*****	OT-AA-09
			CONSULTANTS :				SCALE :
							1:50 (if only A3)



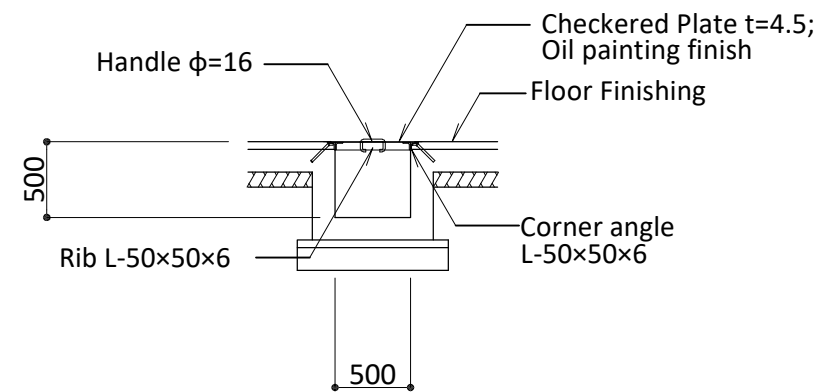
PLAN



PLAN



SECTION



SECTION

PROJECT	LOCATION	TITLE	APPROVED BY :	CHECKED BY :	DESIGNED BY :	DATE :	DRG NO :
THE PROJECT FOR IMPROVEMENT OF SUBSTATIONS IN LILONGWE CITY IN THE REPUBLIC IN MALAWI	OLD TOWN	Old Town Control Building Detail - 1	*****	*****	*****	*****	OT-AA-10
			CONSULTANTS :				SCALE :
				YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN		1:50	(if only A3)
				West Japan Engineering Consultants, Inc.			

## 7. 変電所単位の需要想定

7. 変電所単位の需要想定

表1 カネンゴ変電所における各フィーダーの需要想定

[MVA]

		Initial	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Very high		76.91763	84.60939	99.31418	108.3755	118.203	128.8732	140.4705	153.0874	166.8261	181.7987	198.1284	215.9512	235.4163	256.6878	279.9465	305.3911	333.2401	363.7341
	High	76.91763	85.68348	92.50761	97.39796	102.4628	107.7109	113.1514	118.794	124.6486	130.726	137.0373	143.5941	150.4088	157.4942	164.8639	172.532	180.5136	188.8242
	Base	76.91763	84.41714	89.87363	93.28882	96.76446	100.3024	103.9044	107.5725	111.3087	115.1149	118.9933	122.9461	126.9755	131.0837	135.2732	139.5464	143.9058	148.3539
10%	Initial																		
		35.476	39.0236	42.92596	47.21856	51.94041	57.13445	62.8479	69.13269	76.04596	83.65055	92.01561	101.2172	111.3389	122.4778	134.7219	148.1021	163.0113	179.3126
	L15	26.376	29.0136	31.91496	35.10646	38.6171	42.47881	46.72669	51.39936	56.5393	62.19323	68.41255	75.25381	82.77919	91.05711	100.1628	110.1791	121.197	133.3167
33kV	L25	9.1	10.01	11.011	12.1121	13.32331	14.65564	16.12121	17.73333	19.50666	21.45732	23.60306	25.96336	28.5597	31.41567	34.55723	38.01296	41.81425	45.95568
		19.30213	26.83234	32.45558	34.79113	37.36025	40.18627	43.2949	46.71439	50.47583	54.61341	59.16475	64.17123	69.67835	75.73618	82.3996	89.72978	97.79276	106.662
	105	3.365499	3.702049	4.072254	4.47948	4.927428	5.42017	5.962188	6.558406	7.214247	7.935672	8.729239	9.602163	10.56238	11.61862	12.78048	14.05853	15.46438	17.01082
11kV	205	6.533028	7.186317	7.904964	8.695461	9.565007	10.52151	11.57366	12.73102	14.00413	15.40454	16.94499	18.63949	20.50344	22.55379	24.80916	27.29008	30.01909	33.021
	305	3.92867	4.321357	4.753691	5.22906	5.751966	6.327163	6.958979	7.658567	8.421454	9.263599	10.18996	11.20895	12.32985	13.56284	14.91912	16.41103	18.05213	19.85735
	405	5.474931	6.022424	6.624667	7.287133	8.015846	8.817431	9.699174	10.66909	11.736	12.9096	14.20056	15.62062	17.18268	18.90095	20.79104	22.87015	25.15716	27.67288
5%	Initial																		
		35.476	37.2498	39.11229	41.0679	43.1213	45.27736	47.54123	49.91829	52.41421	55.03492	57.78667	60.676	63.7098	66.89529	70.24005	73.75206	77.43966	81.31164
	L15	26.376	27.6948	29.07954	30.53352	32.06019	33.6632	35.34636	37.11368	38.96956	40.91783	42.96372	45.11191	47.36751	49.73588	52.22268	54.83381	57.57575	60.45428
33kV	L25	9.1	9.555	10.03275	10.53439	11.06111	11.61416	12.19487	12.80461	13.44484	14.11709	14.82294	15.56409	16.34229	17.15941	18.01738	18.91825	19.86416	20.85737
		19.30213	25.86724	30.3806	31.44463	32.56186	33.73495	34.9667	36.26003	37.61804	39.04394	40.54113	42.11319	43.76385	45.49704	47.3169	49.22774	51.23413	53.34083
	105	3.365499	3.533774	3.710463	3.895986	4.090786	4.295325	4.510091	4.735956	4.972375	5.220994	5.482044	5.756146	6.043953	6.346151	6.663459	6.996632	7.346463	7.713786
11kV	205	6.533028	6.85968	7.202664	7.562797	7.940937	8.337984	8.754883	9.192627	9.652258	10.13487	10.64161	11.1737	11.73238	12.319	12.93495	13.5817	14.26078	14.97382
	305	3.92867	4.125104	4.331359	4.547927	4.775323	5.014089	5.264794	5.528034	5.804435	6.094657	6.39939	6.719359	7.055327	7.408094	7.778498	8.167423	8.575795	9.004584
	405	5.474931	5.748678	6.036111	6.337917	6.654813	6.987583	7.336931	7.703778	8.08967	8.494315	8.918086	9.36399	9.832189	10.3238	10.83999	11.37199	11.95109	12.54864
3%	Initial																		
		35.476	36.54028	37.63649	38.76558	39.92855	41.12641	42.36024	43.63101	44.93994	46.28813	47.67678	49.10708	50.58029	52.0977	53.66063	55.27035	56.92455	58.63642
	L15	26.376	27.16728	27.9823	28.82177	29.68642	30.57701	31.49432	32.43915	33.41233	34.417	35.44714	36.51055	37.60587	38.73405	39.89607	41.09295	42.32574	43.59551
33kV	L25	9.1	9.373	9.65419	9.943816	10.24213	10.54939	10.86588	11.19185	11.52761	11.87344	12.22964	12.59653	12.97442	13.36366	13.76457	14.1775	14.60283	15.04091
		19.30213	25.48119	29.57763	30.19196	30.82472	31.47646	32.14775	32.83918	33.55136	34.2849	35.04045	35.81866	36.62022	37.44583	38.2962	39.17209	40.07425	41.00348
	105	3.365499	3.466464	3.570458	3.677572	3.787899	3.901536	4.018582	4.13914	4.263314	4.391213	4.52295	4.658338	4.798397	4.942349	5.09062	5.243338	5.400639	5.562658
11kV	205	6.533028	6.729019	6.93089	7.138816	7.352991	7.57357	7.800777	8.034801	8.275845	8.52412	8.779844	9.043239	9.314536	9.593972	9.881791	10.17825	10.48359	10.7981
	305	3.92867	4.04653	4.167926	4.292964	4.421753	4.554406	4.691038	4.831769	4.976722	5.126024	5.279804	5.438199	5.601344	5.769385	5.942466	6.12074	6.304363	6.493493
	405	5.474931	5.639179	5.808354	5.982605	6.162003	6.346946	6.537354	6.733475	6.935479	7.143543	7.357849	7.578585	7.805942	8.040121	8.281324	8.529764	8.785657	9.049227
505		0	5.6	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
		22.1395	22.39566	22.65951	24.33128	26.01119	27.69951	29.39647	31.10234	32.81739	34.54189	36.27612	38.02038	39.77497	41.5402	43.31638	45.10385	46.90295	48.71401
	2L5	3.503423	3.503423	3.503423	4.903423	4.903423	4.903423	4.903423	4.903423	4.903423	4.903423	4.903423	4.903423	4.903423	4.903423	4.903423	4.903423	4.903423	4.903423
3L5		2.451064	2.451064	2.451064	2.451064	3.851064	3.851064	3.851064	3.851064	3.851064	3.851064	3.851064	3.851064	3.851064	3.851064	3.851064	3.851064	3.851064	3.851064
	4L5	2.237928	2.349824	2.467316	2.590681	2.720215	2.856226	2.999038	3.148989	3.306439	3.471761	3.645349	3.827616	4.018997	4.219947	4.430944	4.652492	4.885116	5.129372
	5L5	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853	1.238853
6L5		3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929	3.316929
	7L5	4.888807	5.133247	5.38991	5.659405	5.942375	6.239494	6.551469	6.879042	7.222995	7.584144	7.963351	8.361519	8.779595	9.218575	9.679503	10.16348	10.67165	11.20524
	8L5	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285	1.132285
9L5		1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187	1.958187
	10L5	1.412026	1.482627	1.566759	1.634597	1.716326	1.802143	1.89225	1.986862	2.086206	2.190516	2.300042	2.415044	2.535796	2.662586	2.795715	2.935501	3.082276	3.236389
	2L5				2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3L5					2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	4L5					2	2	2	2	2	2	2	2	2	2	2	2	2	2
	5L5					2	2	2	2	2	2	2	2	2	2	2	2	2	2
6L5						2	2	2	2	2	2	2	2	2	2	2	2	2	2
	7L5						2	2	2	2	2	2	2	2	2	2	2	2	2
	8L5							2	2	2	2	2	2	2	2	2	2	2	2
9L5									2	2	2	2	2	2	2	2	2	2	2
	2L5								2	2	2	2	2	2	2	2	2	2	2
	3L5									2	2	2	2	2	2	2	2	2	2

[出所] ESCOM への聞き取り調査より調査団作成。

[備考] 黄色で示したフィーダーは Industry 用であり、橙色で示したフィーダーは Domestic 及び Commercial 用である。



表2 オールドタウン変電所における各フィーダーの需要想定

[MVA]

		Initial	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Very high		23.815	26.1965	28.81615	31.69777	34.86754	38.3543	42.18973	46.4087	51.04957	56.15452	61.76998	67.94697	74.74167	82.21584	90.43742	99.48117	109.4293	120.3722
High		23.815	25.00575	26.25604	27.56884	28.94728	30.39465	31.91438	33.5101	35.1856	36.94488	38.79213	40.73173	42.76832	44.90673	47.15207	49.50967	51.98516	54.58442
Base		23.815	24.52945	25.26533	26.02329	26.80399	27.60811	28.43636	29.28945	30.16813	31.07917	32.00537	32.96553	33.9545	34.97313	36.02232	37.10299	38.21608	39.36257

10%		Initial	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
33kV	380	5.7156	6.28716	6.915876	7.607464	8.36821	9.205031	10.12553	11.13809	12.2519	13.47709	14.82479	16.30727	17.938	19.7318	21.70498	23.87548	26.26303	28.88933
11kV		18.0994	19.90934	21.90027	24.0903	26.49933	29.14926	32.06419	35.27061	38.79767	42.67744	46.94518	51.6397	56.80367	62.48404	68.73244	75.60569	83.16625	91.48288
	1L5	4.022089	4.424298	4.866728	5.3534	5.88874	6.477614	7.125376	7.837913	8.621705	9.483875	10.43226	11.47549	12.62304	13.88534	15.27388	16.80126	18.48139	20.32953
	2L5	4.424298	4.866728	5.3534	5.88874	6.477614	7.125376	7.837913	8.621705	9.483875	10.43226	11.47549	12.62304	13.88534	15.27388	16.80126	18.48139	20.32953	22.36248
	4L5	5.228716	5.751587	6.326746	6.95942	7.655362	8.420899	9.262989	10.18929	11.20822	12.32904	13.56194	14.91814	16.40995	18.05094	19.85604	21.84164	24.02581	26.42839
	5L5	4.424298	4.866728	5.3534	5.88874	6.477614	7.125376	7.837913	8.621705	9.483875	10.43226	11.47549	12.62304	13.88534	15.27388	16.80126	18.48139	20.32953	22.36248

5%		Initial	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
33kV	380	5.7156	6.00138	6.301449	6.616521	6.947348	7.294715	7.659451	8.042423	8.444544	8.866772	9.31011	9.775616	10.2644	10.77762	11.3165	11.88232	12.47644	13.10026
11kV		18.0994	19.00437	19.95459	20.95232	21.99993	23.09993	24.25493	25.46767	26.74106	28.07811	29.48202	30.95612	32.50392	34.12912	35.83557	37.62735	39.50872	41.48416
	1L5	4.022089	4.223193	4.434353	4.656071	4.888874	5.133318	5.389984	5.659483	5.942457	6.23958	6.551559	6.879137	7.223094	7.584248	7.963461	8.361634	8.779716	9.218701
	2L5	4.424298	4.645513	4.877788	5.121678	5.377762	5.64665	5.928982	6.225431	6.536703	6.863538	7.206715	7.567051	7.945403	8.342673	8.759807	9.197797	9.657687	10.14057
	4L5	5.228716	5.490151	5.764659	6.052892	6.355536	6.673313	7.006979	7.357328	7.725194	8.111454	8.517027	8.942878	9.390022	9.859523	10.3525	10.87012	11.41363	11.98431
	5L5	4.424298	4.645513	4.877788	5.121678	5.377762	5.64665	5.928982	6.225431	6.536703	6.863538	7.206715	7.567051	7.945403	8.342673	8.759807	9.197797	9.657687	10.14057

3%		Initial	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
33kV	380	5.7156	5.887068	6.06368	6.24559	6.432958	6.625947	6.824725	7.029467	7.240351	7.457562	7.681288	7.911727	8.149079	8.393551	8.645358	8.904719	9.17186	9.447016
11kV		18.0994	18.64238	19.20165	19.7777	20.37103	20.98217	21.61163	22.25998	22.92778	23.61561	24.32408	25.0538	25.80542	26.57958	27.37697	28.19828	29.04422	29.91555
	1L5	4.022089	4.142752	4.267034	4.395045	4.526896	4.662703	4.802584	4.946662	5.095062	5.247914	5.405351	5.567512	5.734537	5.906573	6.08377	6.266283	6.454272	6.6479
	2L5	4.424298	4.557027	4.693738	4.83455	4.979586	5.128974	5.282843	5.441328	5.604568	5.772705	5.945886	6.124263	6.307991	6.49723	6.692147	6.892912	7.099699	7.31269
	4L5	5.228716	5.385577	5.547144	5.713559	5.884965	6.061514	6.24336	6.430661	6.62358	6.822288	7.026956	7.237765	7.454898	7.678545	7.908901	8.146168	8.390554	8.64227
	5L5	4.424298	4.557027	4.693738	4.83455	4.979586	5.128974	5.282843	5.441328	5.604568	5.772705	5.945886	6.124263	6.307991	6.49723	6.692147	6.892912	7.099699	7.31269

[出所] ESCOM への聞き取り調査より調査団作成。

## 8. 切替工事手順（案）

## 8. 切替工事手順 (案)

### Switchover Process for Kanengo Substation (Draft)

Some of the existing equipment in Kanengo substation need to be shut down for installation or replacement work for new equipment such as transformers and switchgears. This draft shows switchover process including work items and procedure to study the duration of shutdown and plan of alternative power.

[Assumption to shorten the duration of shutdown]

- \* All existing equipment in Kanengo substation should be operated by ESCOM.
- \* Necessary alternative power during shutdown should be prepared for power distribution of the existing feeders by ESCOM.
- \* All new equipment including modification in Kanengo substation should be installed and tested as much as possible before switchover.

[Step and item]

Step	Item
0	- Existing Equipment before start of the Project
1	- Installation of 132kV Main Busbar side of Disconnecting Switch(DS) - Removal of 132/11kV Transformer(T4T)
2	- Installation of 11kV Switchgear
3	- Installation of 132/66kV Transformer(IBT4) - Installation of 66/33kV Transformer(T3B) - Installation of 66/11kV Transformer(T2A)
4	- De-Energization of No.2 66kV Busbar - Connection of 66/11kV Transformer(T2A) feeder - Connection of 66kV side DS of 132/66kV Transformer(IBT4) feeder
5	- Energization of No.2 66kV Busbar
6	- Energization of 66/11kV Transformer(T2A)
7	- Energization of the New 11kV Switchgear and Station Transformer
8	- Power Receiving of the New Station Transformer
9	- Power Supply from No.2 66kV Busbar
10	- De-Energization of No.1 66kV Busbar - Connection of 66/33kV Transformer(T3B) feeder
11	- Energization of No.2 66kV Busbar
12	- Energization of 66/33kV Transformer(T3B)
13	- Energization of 33kV Busbar
14	- Power Receiving of existing Station Transformers

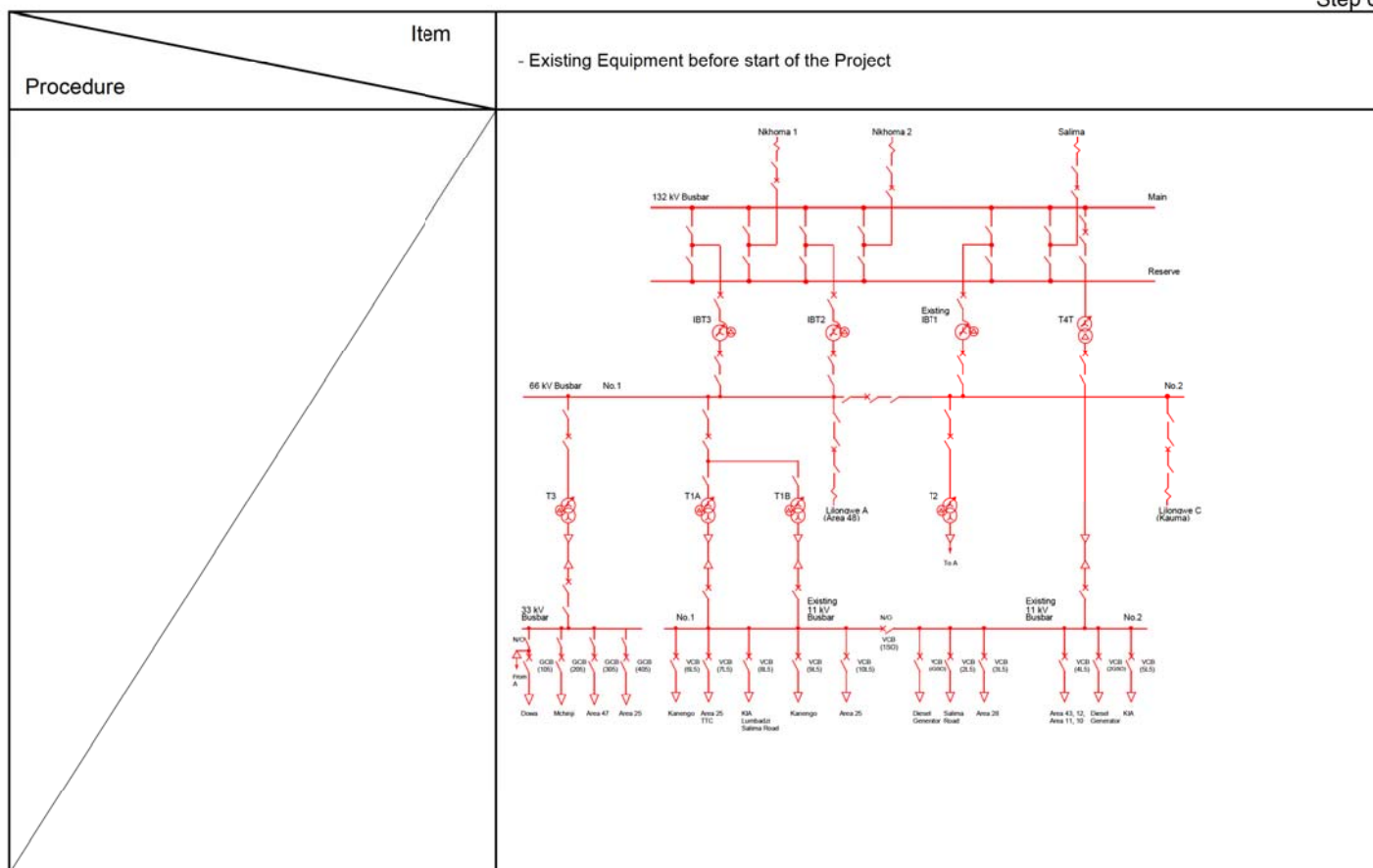
Step	Item
15	- Energization of 66/33kV Transformer(T3) feeder
16	- Power Supply from No.1 66kV Busbar
17	- De-Energization of 132kV Reserve Busbar - Connection of 132kV side of 132/66kV Transformer(IBT4)feeder
18	- Energization of 132kV Reserve Busbar
19	- Energization of 132/66kV Transformer(IBT4) feeder - Power Supply from 132/66kV Transformer(IBT4)
20	- De-Energization of No.2 66kV Busbar - Removal of conductors of 66kV side of DS of 132/66kV Transformer(IBT1) feeder - Removal of conductors of 66kV side of DS of 66/33kV Transformer(T2) feeder
21	- Energization of No.2 66kV Busbar and Power Supply
22	- Removal of 132/66kV Transformer(IBT1) feeder equipment - Removal of 66/33kV Transformer(T2) feeder equipment
23	- Installation of 132/66kV Transformer(New IBT1)
24	- De-Energization of 132kV Reserve Busbar - Connection of 132kV side of 132/66kV Transformer(New IBT1) feeder
25	- Energization of 132kV Reserve Busbar
26	- De-Energization of No.2 66kV Busbar - Connection of 66kV side of 132/66kV Transformer(New IBT1) feeder
27	- Energization of No.2 66kV Busbar and Power Supply
28	- Energization of 132/66kV Transformer(New IBT1) feeder - Power Supply from 132/66kV Transformer(New IBT1)

[Attachment]

Switchover Process for Kanengo Substation

### Switchover Process for Kanengo Substation (Draft)

Step 0



## Switchover Process for Kanengo Substation (Draft)

Step 1

Item	
Procedure	<ul style="list-style-type: none"> <li>- Installation of 132kV Main Busbar side of Disconnecting Switch(DS)</li> <li>- Removal of 132/11kV Transformer(T4T)</li> </ul>
<p>[Installation of 132kV Main Busbar side of Disconnecting Switch] Installation work needs to be conducted during De-Energization of 132kV Main Busbar.</p> <p>[Disconnection of switchgears for 132/11kV Transformer(T4T)] Disconnection work needs to be conducted after De-Energization of 132kV Reserve Busbar.</p> <p>Note;</p> <ul style="list-style-type: none"> <li>* All existing equipment in Kanengo SS should be operated by ESCOM.</li> <li>* Necessary alternative power during shutdown should be prepared for power distribution of the existing feeders by ESCOM.</li> <li>* All new equipment including modification in Kanengo substation should be installed and tested as much as possible before switchover.</li> <li>* Power of the existing 11kV feeders of No.2 11kV Busbar should be switched over to supply from the other substation by ESCOM.</li> <li>* AC/DC supplies for newly installed equipment should be fed from temporary power supply for construction work.</li> </ul>	

## Switchover Process for Kanengo Substation (Draft)

Step 2

Item	
Procedure	<ul style="list-style-type: none"> <li>- Installation of 11kV Switchgear</li> </ul>
<p>Note;</p> <ul style="list-style-type: none"> <li>* Power of the existing 11kV feeders of No.2 11kV Busbar need to be fed from the other substation by ESCOM.</li> <li>* AC/DC supplies for newly installed equipment need to be fed from the temporary power supply for construction work.</li> </ul>	

## Switchover Process for Kanengo Substation (Draft)

Step 3

Item	<ul style="list-style-type: none"> <li>- Installation of 132/66kV Transformer (IBT4)</li> <li>- Installation of 66/33kV Transformer (T3B)</li> <li>- Installation of 66/11kV Transformer (T2A)</li> </ul>
<p><b>Procedure</b></p>	<p><b>Note;</b></p> <ul style="list-style-type: none"> <li>* Power of the existing 11kV feeders of No.2 11kV Busbar need to be fed from the other substation by ESCOM.</li> <li>* AC/DC supplies for newly installed equipment need to be fed from the temporary power supply for construction work.</li> </ul>

## Switchover Process for Kanengo Substation (Draft)

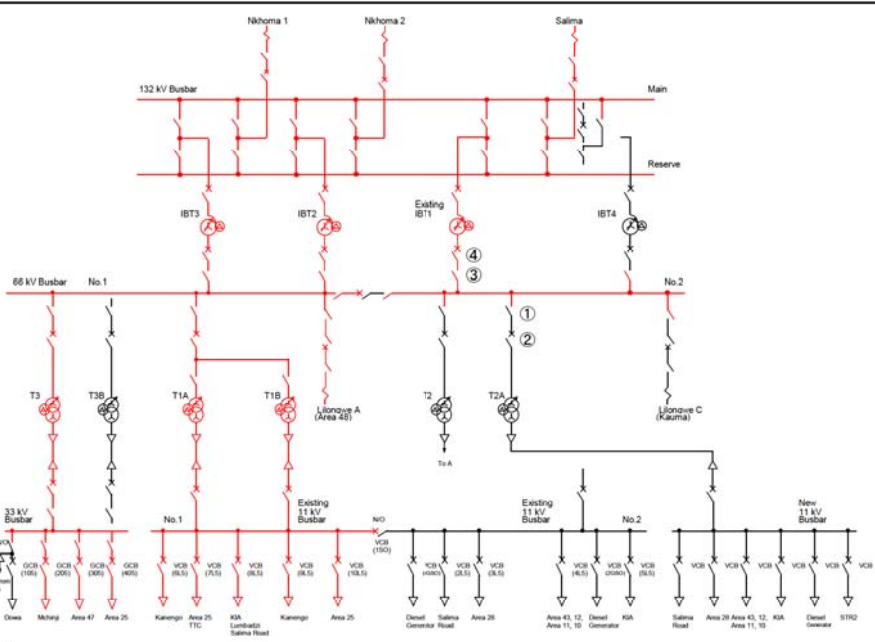
Step 4

Item	<ul style="list-style-type: none"> <li>- De-Energization of No.2 66kV Busbar</li> <li>- Connection of 66/11kV Transformer (T2A) feeder</li> <li>- Connection of 66kV side DS of 132/66kV Transformer (IBT4) feeder</li> </ul>
<p><b>Procedure</b></p>	<p>[Operation of De-Energization of No.2 66kV Busbar]</p> <ul style="list-style-type: none"> <li>- To open Circuit Breaker (CB) (1) of 33kV feeder (105)</li> <li>- To open CB (2) and DS (3) of 66/33kV Transformer (T2) feeder</li> <li>- To open CB (4) and DS (5) of 66kV Transmission line (to Kauma)</li> <li>- To open CB (6) and DS (7) of 66kV Bus coupler</li> <li>- To open CB (8) and DS (9) of 66kV side of 132/66kV Transformer (IBT1) feeder (De-Energization of No.2 66kV Busbar)</li> </ul> <p>[Connection to No.2 66kV Busbar]</p> <ul style="list-style-type: none"> <li>- To connect 66/11kV Transformer (T2A) feeder to No.2 66kV Busbar</li> <li>- To connect 66kV side DS of 132/66kV Transformer (IBT4) feeder to No.2 66kV Busbar</li> </ul> <p><b>Note;</b></p> <ul style="list-style-type: none"> <li>* All new equipment including modification in Kanengo substation should be installed and tested as much as possible before switchover.</li> <li>* Power of the existing 33kV feeder (105) of 33kV Busbar should be switched over to supply from the other substation by ESCOM.</li> <li>* Necessary Time: 8 hours</li> </ul>
<p><b>Procedure</b></p>	<p><b>Note;</b></p> <ul style="list-style-type: none"> <li>* Power of the existing 11kV feeders of No.2 11kV Busbar need to be fed from the other substation by ESCOM.</li> <li>* AC/DC supplies for newly installed equipment need to be fed from the temporary power supply for construction work.</li> </ul>



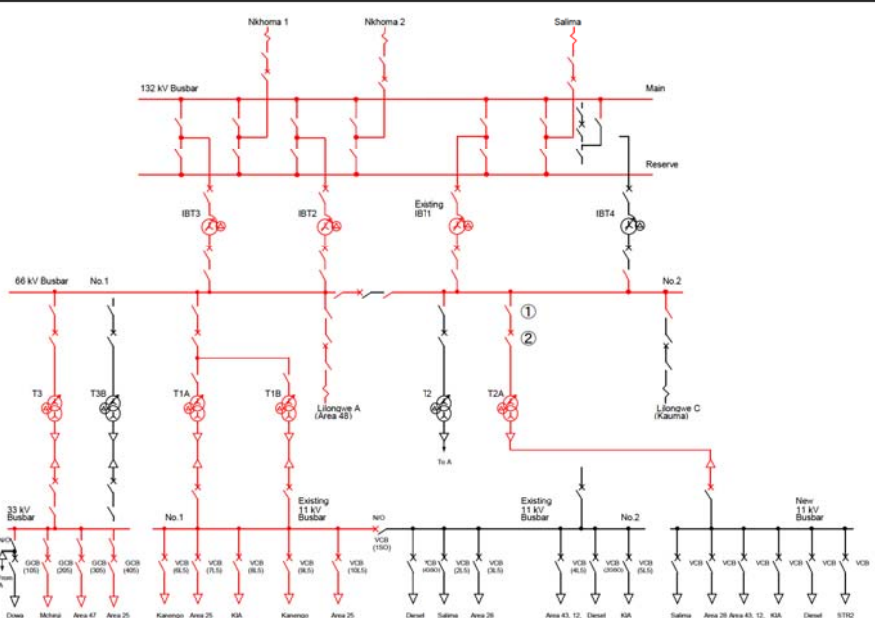
## Switchover Process for Kanengo Substation (Draft)

Step 5

Item	- Energization of No.2 66kV Busbar
<p><b>Procedure</b></p> <p>[Preparation work before Energization of No.2 66kV Busbar]                      - To confirm that all CBs, DSs of No.2 66kV Busbar are open                      - To re-confirm that DS (①) and CB (②) on 66/11kV Transformer(T2A) feeder are open                      - To confirm that all CBs of the New 11kV Switchgear are open</p> <p>[Operation of Energization of No.2 66kV Busbar]                      - To close DS(③) and CB (④) on 132/66kV Transformer(IBT1) feeder                      (Energization of No.2 66kV Busbar)</p> <p>[Check]                      - To check the voltage and phase angles of No.2 66kV Busbar</p> <p>Note;                      * Necessary Time: 1 hour</p>	 <p>Note;                      * Power of the existing 33kV feeder(105) need to be fed from the other substation by ESCOM.                      * Power of the existing 11kV feeders of No.2 11kV Busbar need to be fed from the other substation by ESCOM.                      * AC/DC supplies for newly installed equipment need to be fed from the temporary power supply for construction work.</p>

## Switchover Process for Kanengo Substation (Draft)

Step 6

Item	- Energization of 66/11kV Transformer(T2A)
<p><b>Procedure</b></p> <p>[Operation of 66/11kV Transformer(T2A) Energization]                      - To close DS (①) on Transformer(T2A) feeder                      - To close CB (②) on Transformer(T2A) feeder                      (Energization of Transformer(T2A))</p> <p>[Check]                      - To check the voltages and phase angles of 11kV side</p> <p>Note;                      * Necessary Time: 1 hour</p>	 <p>Note;                      * Power of the existing 33kV feeder(105) need to be fed from the other substation by ESCOM.                      * Power of the existing 11kV feeders of No.2 11kV Busbar need to be fed from the other substation by ESCOM.                      * AC/DC supplies for newly installed equipment need to be fed from the temporary power supply for construction work.</p>

## Switchover Process for Kanengo Substation (Draft)

Step 7

Item	- Energization of the New 11kV Switchgear and Station Transformer
<p><b>Procedure</b></p> <p>[Operation of the New 11kV Switchgear Energization]                      - To close CB (①) on the New 11kV Switchgear (Energization of the New 11kV busbar)</p> <p>[Check]                      - To check the voltages and the phase angles of the New 11kV busbar</p> <p>[Operation of 11kV/400-230 V Station Transformer Energization]                      - To close CB (②) on the New Station Transformer feeder (Energization of the New Station Transformer)</p> <p>[Check]                      - To check the voltages and phase angles of 400-230 V side</p> <p>Note;                      * Necessary Time: 1 hour</p>	<p>Note;                      * Power of the existing 33kV feeder(105) need to be fed from the other substation by ESCOM.                      * Power of the existing 11kV feeders of No.2 11kV Busbar need to be fed from the other substation by ESCOM.                      * AC/DC supplies for newly installed equipment need to be fed from the temporary power supply for construction work.</p>

## Switchover Process for Kanengo Substation (Draft)

Step 8

Item	- Power Receiving of the New Station Transformer
<p><b>Procedure</b></p> <p>[Switchover of AC/DC supplies for newly installed equipment]                      - To switch over to supply from New AC/DC distribution boards for AC/DC supplies of the newly installed equipment</p> <p>[Check]                      - To check the voltages and phase angles of the New AC/DC distribution boards (Power Receiving of the New Station Transformer)</p> <p>Note;                      * Necessary Time: 3 hours</p>	<p>Note;                      * Power of the existing 33kV feeder(105) need to be fed from the other substation by ESCOM.                      * Power of the existing 11kV feeders of No.2 11kV Busbar need to be fed from the other substation by ESCOM.</p>

## Switchover Process for Kanengo Substation (Draft)

Step 9

Item	- Power Supply from No.2 66kV Busbar
<p><b>Procedure</b></p> <p>[Operation of Power Supply from No.2 66kV Busbar]                      - To close DS (7) and CB (6) of 66kV Bus coupler                      - To close DS (5) and CB (4) of 66kV Transmission line(to Kauma)                      - To close DS (3) and CB (2) of 66/33kV Transformer(T2) feeder                      - To close CB (1) of 33kV feeder(105)                      - To close CBs (8) of 11kV feeders of the New 11kV Busbar</p> <p>[Check]                      - To check the voltages and currents of each feeder</p> <p>Note;                      * Power of the existing 33kV feeder(105) of 33kV Busbar should be switched back to supply from 66/33kV Transformer(T2) by ESCOM.                      * The existing 11kV feeders of No.2 11kV Busbar should be switched over to new 11kV Switchgear by ESCOM.                      * Necessary Time: 3 hours</p>	

## Switchover Process for Kanengo Substation (Draft)

Step 10

Item	- De-Energization of No.1 66kV Busbar - Connection of 66/33kV Transformer(T3B) feeder
<p><b>Procedure</b></p> <p>[Operation of De-Energization of No.1 66kV Busbar]                      - To open CBs (1) of 11kV feeders(6L6 - 10L5)                      - To open CBs (2, 3) of 66/11kV Transformer(T1A, T1B) feeders                      - To open DSs (4, 5) of 66/11kV Transformer(T1A, T1B) feeders                      - To open CB (6) and DS (7) of 66/33kV Transformer(T2) feeders                      - To open CBs (8) and DSs(8') of 33kV feeders(105 - 405)                      - To open CBs (9, 11) of 66/33kV Transformer(T3) feeder                      - To open DSs (10, 12) of 66/33kV Transformer(T3) feeder                      - To open CB (13) and DS (14) of 66kV Transmission line(to Area 48)                      - To open CB (15) and DS (16) of 66kV Bus coupler                      - To open CB (17) and DS (18) of 66/33kV Transformer(1BT2) feeder                      - To open CB (19) and DS (20) of 66kV side of 132/66kV Transformer(1BT3) feeder</p> <p>[Connection of 66/33kV Transformer(T3B) feeder]                      - To connect 66/33kV Transformer(T3B) feeder to No.1 66kV Busbar and 33kV Busbar</p> <p>[Disconnection of 66/33kV Transformer(T2) feeder]                      - To disconnect and removal Cable Head of 66/33kV Transformer(T2) feeder between 33kV No.105 CB and DS</p> <p>Note;                      * Necessary Time: 8 hours</p>	



## Switchover Process for Kanengo Substation (Draft)

Step 11

Item	- Energization of No.2 66kV Busbar
<p><b>Procedure</b></p> <p>[Preparation work before Energization of No.1 66kV Busbar]                      - To confirm that all CBs, DSs of No.1 66kV Busbar are open                      - To re-confirm that DS (①) and CB (②) on 66/33kV Transformer(T3B) feeder are open                      - To confirm that all CBs, DSs of 66/33kV Transformer(T3B) feeder and 33kV Switchgear are open</p> <p>[Operation of Energization of No.1 66kV Busbar]                      - To close DS(③) and CB (④) on 132/66kV Transformer(IBT2) feeder                      (Energization of No.1 66kV Busbar)</p> <p>[Check]                      - To check the voltages and phase angles of No.1 66kV Busbar</p> <p>Note;                      * Necessary Time: 1 hour</p>	<p>Note;                      * Power of the existing 33kV feeders of 33kV Busbar need to be fed from the other substation by ESCOM.                      * Power of the existing 11kV feeders of No.1 11kV Busbar need to be fed from the other substation by ESCOM.                      * AC/DC supplies for existing equipment need to be fed from temporary power supply by ESCOM.</p>

## Switchover Process for Kanengo Substation (Draft)

Step 12

Item	- Energization of 66/33kV Transformer(T3B)
<p><b>Procedure</b></p> <p>[Operation of 66/33kV Transformer(T3B) Energization]                      - To close DS (①) on Transformer(T3B) feeder                      - To close CB (②) on Transformer(T3B) feeder                      (Energization of Transformer(T3B))</p> <p>[Check]                      - To check the voltages and phase angles of 33kV side</p> <p>Note;                      * Necessary Time: 1 hour</p>	<p>Note;                      * Power of the existing 33kV feeders of 33kV Busbar need to be fed from the other substation by ESCOM.                      * Power of the existing 11kV feeders of No.1 11kV Busbar need to be fed from the other substation by ESCOM.                      * AC/DC supplies for existing equipment need to be fed from temporary power supply by ESCOM.</p>

## Switchover Process for Kanengo Substation (Draft)

Step 13

Item	- Energization of 33kV Busbar
<p><b>Procedure</b></p> <p>[Operation of 33kV Busbar Energization]                      - To close DS(①) and CB (②) on 66/33kV Transformer(T3B) feeder                      (Energization of 33kV busbar)</p> <p>[Check]                      - To check the voltages and phase angles of 33kV busbar</p> <p>Note;                      * Necessary Time: 1 hour</p>	<p>Note;                      * Power of the existing 33kV feeders of 33kV Busbar need to be fed from the other substation by ESCOM.                      * Power of the existing 11kV feeders of No.1 11kV Busbar need to be fed from the other substation by ESCOM.                      * AC/DC supplies for existing equipment need to be fed from temporary power supply by ESCOM.</p>

## Switchover Process for Kanengo Substation (Draft)

Step 14

Item	- Power Receiving of existing Station Transformers
<p><b>Procedure</b></p> <p>[Operation of Power Receiving of existing Station Transformers]                      - To close DSs (①, ②, ③) of 66/11kV Transformer(T1A, T1B) feeders                      - To close CB (④) of 66/11kV Transformer(T1A, T1B) feeders</p> <p>[Check]                      - To check the voltages and phase angles of AC/DC distribution boards                      (Power Receiving of existing Station Transformers)</p> <p>Note;                      * AC/DC supplies for existing equipment should be switched back to supply from the existing AC/DC distribution boards by ESCOM.                      * Necessary Time: 5 hours</p>	<p>Note;                      * Power of the existing 33kV feeders of 33kV Busbar need to be fed from the other substation by ESCOM.                      * Power of the existing 11kV feeders of No.1 11kV Busbar need to be fed from the other substation by ESCOM.</p>



## Switchover Process for Kanengo Substation (Draft)

Step 15

Item	- Energization of 66/33kV Transformer(T3) feeder
<p><b>Procedure</b></p> <p>[Operation of 66/33kV transformer(T3) Energization 1]                      - To adjust Transformer(T3) Tap to 66/33kV Transformer(T3B) Tap                      - To close DS (①) on Transformer(T3) feeder                      - To close CB (②) on Transformer(T3) feeder</p> <p>[Check]                      - To check the voltages and the angles of 33kV side</p> <p>[Operation of 66/33kV transformer(T3) Energization 2]                      - To close DS (③) on Transformer(T3) feeder                      - To close CB (④) on Transformer(T3) feeder (Energization of 66/33kV Transformer(T3) feeder)</p> <p>[Check]                      - To check the voltages and the phase angles of 33kV side</p> <p>Note;                      * Necessary Time: 1 hours</p>	<p>Note;                      * Power of the existing 33kV feeders of 33kV Busbar need to be fed from the other substation by ESCOM.                      * Power of the existing 11kV feeders of No.1 11kV Busbar need to be fed from the other substation by ESCOM.</p>

## Switchover Process for Kanengo Substation (Draft)

Step 16

Item	- Power Supply from No.1 66kV Busbar
<p><b>Procedure</b></p> <p>[Operation of Power Supply from No.1 66kV Busbar]                      - To close DS (①) and CB (②) of 66kV side of 132/66kV Transformer(IBT3) feeder                      - To close DS (③) and CB (④) of 66kV Bus coupler                      - To close DS (⑤) and CB (⑥) of 66kV Transmission line(to Area 48)                      - To close DSs (⑦) and CBs (⑧) of 33kV feeders(105 - 405)                      - To close CB (⑨) of 11kV side of 66/11kV Transformer(T1A) feeder                      - To close CB (⑩) of 11kV side of 66/11kV Transformer(T1B) feeder                      - To close CBs (⑪) of 11kV feeders(6L6 - 10L5)</p> <p>[Check]                      - To check the voltages and current of each feeder</p> <p>Note;                      * Power of the existing 33kV feeders of 33kV Busbar should be switched back to supply from the existing 33kV Busbar by ESCOM.                      * Power of the existing 11kV feeders of No.1 11kV Busbar should be switched back to supply from the existing No.1 11kV Busbar by ESCOM.</p> <p>* Necessary Time: 8 hours</p>	

## Switchover Process for Kanengo Substation (Draft)

Step 17

Item	
Procedure	<ul style="list-style-type: none"> <li>- De-Energization of 132kV Reserve Busbar</li> <li>- Connection of 132kV side of 132/66kV Transformer (IBT4) feeder</li> </ul>
<p>[Operation of De-Energization of 132kV Reserve Busbar] - Operation of De-Energization of 132kV Reserve Busbar depends on the close/open position of CBs and DSs connected to that busbar.</p> <p>[Connection to 132kV Reserve Busbar] - To connect 132kV side of 132/66kV Transformer (IBT4) feeder to conductor between DS for 132kV Main Busbar and DS for 132kV Reserve Busbar</p> <p>Note; * Necessary Time: 5 days</p>	

## Switchover Process for Kanengo Substation (Draft)

Step 18

Item	
Procedure	<ul style="list-style-type: none"> <li>- Energization of 132kV Reserve Busbar</li> </ul>
<p>[Operation of Energization of 132kV Reserve Busbar] - Operation of Energization of 132kV Reserve Busbar depends on the close/open position of CBs and DSs connected to that busbar.</p> <p>[Check] - To check the voltages and currents of each Transformer feeder</p> <p>Note; * Necessary Time: 4 hours</p>	

## Switchover Process for Kanengo Substation (Draft)

Step 19

Item	
Procedure	<ul style="list-style-type: none"> <li>- Energization of 132/66kV Transformer(1BT4) feeder</li> <li>- Power Supply from 132/66kV Transformer(1BT4)</li> </ul>
<p>[Operation of 132/66kV Transformer(1BT4) Energization]</p> <ul style="list-style-type: none"> <li>- To adjust Transformer(1BT4) Tap to 132/66kV Transformer(1BT3) Tap</li> <li>- To close DS (1) on Transformer(1BT4) feeder</li> <li>- To close CB (2) on Transformer(1BT4) feeder</li> </ul> <p>[Check]</p> <ul style="list-style-type: none"> <li>- To check the voltages and the phase angles of both 132kV side and 66kV side</li> </ul> <p>[Operation of Power Supply from 132/66kV Transformer(1BT4)]</p> <ul style="list-style-type: none"> <li>- To close DS (3) on Transformer(1BT4) feeder</li> <li>- To close CB (4) on Transformer(1BT4) feeder (Power Supply from 132/66kV Transformer(1BT4))</li> </ul> <p>[Check]</p> <ul style="list-style-type: none"> <li>- To check the voltages and currents of 132/66kV Transformer(1BT4)</li> </ul> <p>Note;</p> <ul style="list-style-type: none"> <li>* Necessary Time: 4 hours</li> </ul>	

## Switchover Process for Kanengo Substation (Draft)

Step 20

Item	
Procedure	<ul style="list-style-type: none"> <li>- De-Energization of No.2 66kV Busbar</li> <li>- Removal of conductors of 66kV side of DS of 132/66kV Transformer(1BT1) feeder</li> <li>- Removal of conductors of 66kV side of DS of 66/33kV Transformer(T2) feeder</li> </ul>
<p>[Operation of De-Energization of No.2 66kV Busbar]</p> <ul style="list-style-type: none"> <li>- To open CBs (1) of 11kV feeders</li> <li>- To open CBs (2, 3) and DS (4) of 66/11kV Transformer(T2A) feeder</li> <li>- To open CB (5) and DS (6) of 66kV Transmission line(to Kauma)</li> <li>- To open CB (7) and DS (8) of 66kV Bus coupler</li> <li>- To open CBs (9, 10) and DS (11) of 132/66kV Transformer(1BT4) feeder</li> <li>- To open CBs (12, 13) and DSs (14, 15, 16) of 132/66kV Transformer(1BT1) feeder (De-Energization of No.2 66kV Busbar)</li> </ul> <p>[Removal of conductors of 66kV side of DS of 132/66kV Transformer(1BT1)]</p> <ul style="list-style-type: none"> <li>- To remove conductors between No.2 66kV Busbar and 66kV side of DS of 132/66kV Transformer(1BT1)</li> </ul> <p>[Removal of conductors of 66kV side of DS of 66/33kV Transformer(T2)]</p> <ul style="list-style-type: none"> <li>- To remove conductors between No.2 66kV Busbar and 66kV side of DS of 66/33kV Transformer(T2)</li> </ul> <p>Note;</p> <ul style="list-style-type: none"> <li>* Power of the 11kV feeders of New 11kV Busbar should be switched over to supply from the other substation by ESCOM.</li> <li>* AC/DC supplies for newly installed equipment should be switched over to supply from the temporary power supply for construction work.</li> <li>* Necessary Time: 8 hours</li> </ul>	



## Switchover Process for Kanengo Substation (Draft)

Step 21

Item	- Energization of No.2 66kV Busbar and Power Supply
<p><b>Procedure</b></p> <p>[Operation of Energization of No.2 66kV Busbar]                      - To close DS (11) and CBs (10, 9) of 132/66kV Transformer(1BT4) feeder                      (Energization of No.2 66kV Busbar)</p> <p>[Check]                      - To check the voltages and the phase angles of No.2 66kV Busbar</p> <p>[Operation of Power Supply form No.2 66kV Busbar]                      - To close DS (8) and CB (7) of 66kV Bus coupler                      - To close DS (6) and CB (5) of 66kV Transmission line(to Kauma)                      - To close DS (4) and CBs (3, 2) of 66/11kV Transformer(T2A) feeder                      - To close CBs (1) of 11kV feeders                      (Power Supply from No.2 66kV Busbar)</p> <p>[Check]                      - To check the voltages and currents of 11kV feeders</p> <p>Note;                      * Power of the 11kV feeders of New 11kV Busbar should be switched back to supply from the new 11kV Switchgear by ESCOM.                      * AC/DC supplies for newly installed equipment should be switched back to supply from the New AC/DC distribution boards.                      * Necessary Time: 4 hours</p>	

## Switchover Process for Kanengo Substation (Draft)

Step 22

Item	- Removal of 132/66kV Transformer(1BT1) feeder equipment - Removal of 66/33kV Transformer(T2) feeder equipment
<p><b>Procedure</b></p>	

## Switchover Process for Kanengo Substation (Draft)

Step 23

Item	- Installation of 132/66kV Transformer(New IBT1)
Procedure	

## Switchover Process for Kanengo Substation (Draft)

Step 24

Item	- De-Energization of 132kV Reserve Busbar - Connection of 132kV side of 132/66kV Transformer(New IBT1) feeder
Procedure	
<p>[Operation of De-Energization of 132kV Reserve Busbar] - Operation of De-Energization of 132kV Reserve Busbar depends on the close/open position of CBs and DSs connected to that busbar.</p> <p>[Connection to 132kV Reserve Busbar] - To connect 132kV side of 132/66kV Transformer(New IBT1) feeder to conductor between DS for 132kV Main Busbar and DS for 132kV Reserve Busbar</p> <p>Note; * Necessary Time: 5 days</p>	



## Switchover Process for Kanengo Substation (Draft)

Step 25

Item	- Energization of 132kV Reserve Busbar
<p><b>Procedure</b></p> <p>[Operation of Energization of 132kV Reserve Busbar] - Operation of Energization of 132kV Reserve Busbar depends on the close/open position of CBs and DSs connected to that busbar.</p> <p>[Check] - To check the voltages and currents of each Transformer feeder</p> <p>Note; * Necessary Time: 4 hours</p>	

## Switchover Process for Kanengo Substation (Draft)

Step 26

Item	- De-Energization of No.2 66kV Busbar - Connection of 66kV side of 132/66kV Transformer(New IBT1) feeder
<p><b>Procedure</b></p> <p>[Operation of De-Energization of No.2 66kV Busbar] - To open CBs (1) of 11kV feeders - To open CBs (2, 3) and DS (4) of 66/11kV Transformer(T2A) feeder - To open CB (5) and DS (6) of 66kV Transmission line(to Kauma) - To open CB (7) and DS (8) of 66kV Bus coupler - To open CBs (9, 10) and DS (11) of 132/66kV Transformer(IBT4) feeder (De-Energization of No.2 66kV Busbar)</p> <p>[Connection to No.2 66kV Busbar] - To connect 66kV side DS of 132/66kV Transformer(New IBT1) feeder to No.2 66kV Busbar</p> <p>Note; * Power of the 11kV feeders of New 11kV Busbar should be switched over to supply from the other substation by ESCOM. * AC/DC supplies for newly installed equipment should be switched over to supply from the temporary power supply for construction work.</p> <p>* Necessary Time: 8 hours</p>	

## Switchover Process for Kanengo Substation (Draft)

Step 27

Item	- Energization of No.2 66kV Busbar and Power Supply
<p><b>Procedure</b></p> <p>[Operation of Energization of No.2 66kV Busbar]                      - To close DS (10) and CB (9) of 132/66kV Transformer (IBT4) feeder                      (Energization of No.2 66kV Busbar)</p> <p>[Check]                      - To check the voltages and the phase angles of No.2 66kV Busbar</p> <p>[Operation of Power Supply form No.2 66kV Busbar]                      - To close DS (8) and CB (7) of 66kV Bus coupler                      - To close DS (6) and CB (5) of 66kV Transmission line(to Kauma)                      - To close DS (4) and CBs (3, 2) of 66/11kV Transformer (T2A) feeder                      - To close CBs (1) of 11kV feeders                      (Power Supply from No.2 66kV Busbar)</p> <p>[Check]                      - To check the voltages and currents of 11kV feeders</p> <p>Note;                      * Power of the 11kV feeders of New 11kV Busbar should be switched back to supply from the new 11kV Switchgear by ESCOM.                      * AC/DC supplies for newly installed equipment should be switched back to supply from the New AC/DC distribution boards.                      * Necessary Time: 6 hours</p>	

## Switchover Process for Kanengo Substation (Draft)

Step 28

Item	- Energization of 132/66kV Transformer (New IBT1) feeder - Power Supply from 132/66kV Transformer (New IBT1)
<p><b>Procedure</b></p> <p>[Operation of 132/66kV Transformer (New IBT1) Energization]                      - To adjust Transformer (New IBT1) Tap to 132/66kV Transformer (IBT4)                      - To close DS (1) on Transformer (New IBT1) feeder                      - To close CB (2) on Transformer (New IBT1) feeder</p> <p>[Check]                      - To check the voltages and the phase angles of both 132kV side and 66kV side</p> <p>[Operation of Power Supply from 132/66kV Transformer (New IBT1)]                      - To close DS (3) on Transformer (New IBT1) feeder                      - To close CB (4) on Transformer (New IBT1) feeder                      (Power Supply from 132/66kV Transformer (New IBT1))</p> <p>[Check]                      - To check the voltages and currents of 132/66kV Transformer (New IBT1)</p> <p>(The End of the Switchover)</p> <p>Note;                      * Necessary Time: 4 hours</p>	

**9. 自然条件調査（地形調査／地質調査）  
報告書（現地再委託）**

it's not about dirty boots



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First Floor, St Martins House, City Centre, Lilongwe, Malawi

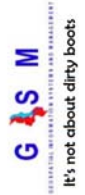
# SURVEY REPORT

## Detailed Topographic Survey for Kanengo and Old Town Substations

**Mkondo Earl Moyo**

MSc. (UK); Bsc. (MW); member RICS (UK); member CICES (UK); founding member IGS (USA); member SIM (MW)

**Chartered Land Surveyor (Geospatial Engineering)**



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### 1.0. INTRODUCTION

The detailed topographic survey works were conducted for two ESCOM substations named Kanengo and Old Town within Lilongwe City to support engineering design work.

### 2.0. SCOPE OF WORK

The survey works comprised of;

- Preparatory works (mobilization).
- Establishment of Benchmarks for subsequent survey works.
- Topographic surveys according to the agreed terms of reference.
- Preparation of detailed topographical map in Autodesk Civil 3D.
- Preparation of section view drawings in Autodesk Civil 3D.
- Report on topographical survey.

### 3.0. SITE DESCRIPTION

The site is located at Kanengo and Old Town within Lilongwe City. Both sites are developed and they live transmission equipment. The land profile at Kanengo has a normal terrain within the boundary limits of the site while Old Town site has a noticeable variation in terrain profile within its boundary. The sites are accessible. Annex 1 is a photobook for the site.

### 4.0. SURVEY TEAM

Name	Position	Tasks Assignment
Surv. Mkondo Moyo	Chartered Land Surveyor	Supervisor
Joseph Simbeye	Graduate Land Surveyor	Operation of survey equipment and data collection
Emmanuel Chirwa	Graduate Land Surveyor	Operation of survey equipment and data collection

Casual labourers were hired at the site to support the effective execution of the survey work.

### 5.0. INFORMATION, MATERIALS AND EQUIPMENT

#### 5.1. Materials

- A kml file was generated in Google Earth to preview the area of interest. Google earth was also utilised for directions to reach the sites.
- An AutoCAD file that was printed was used to preview boundary limits of the sites and for planning purposes.

### 5.2. Equipment

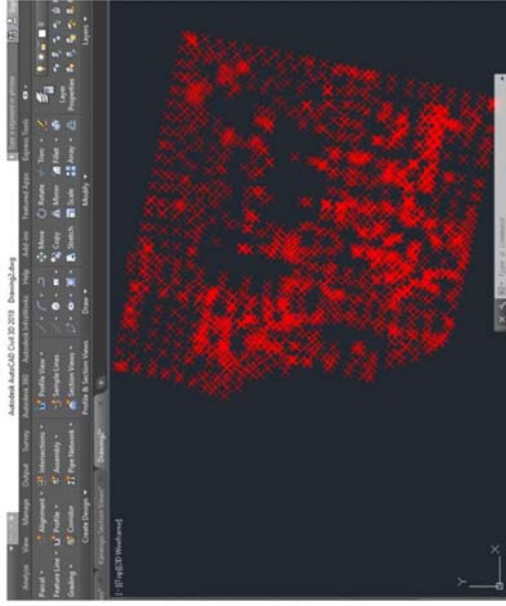
- Trimble R8/5800/5700 RTK surveying system was the solution used.



Figure 4.0. Base setup and Rover setup for RTK solution

### 5.3. Processing Software and Applications

- Autodesk AutoCAD Civil 3D 2018



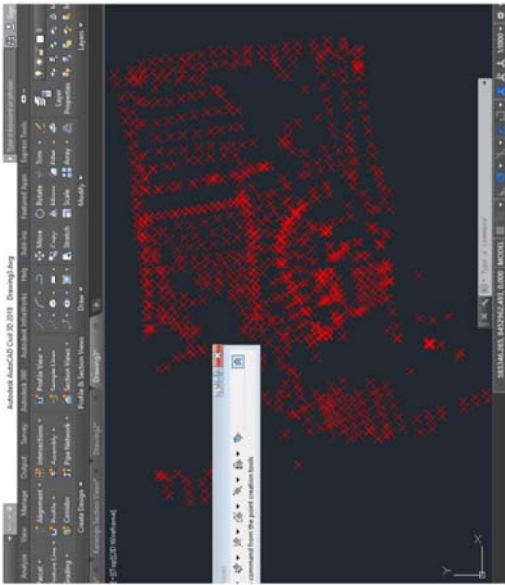


Figure 4.1. Site raw data after being imported into Autodesk AutoCAD Civil 3D 2018

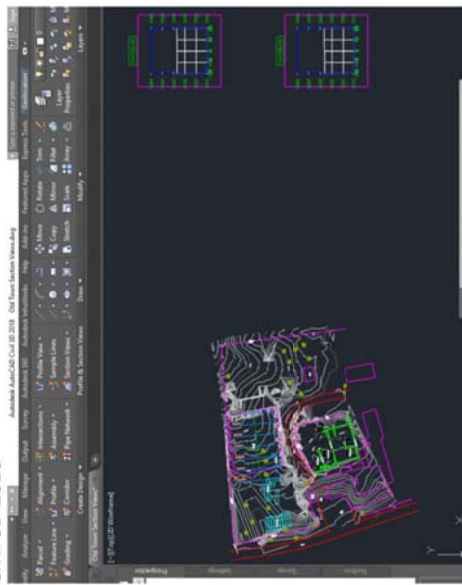


Figure 4.2. Sites contour map and section views processed in Civil 3D

Microsoft Excel

Station	Easting	Northing	Elevation
01	583129.7	583205.5	1025.985
02	583242.15	583298.2	1039.935
03	583240.89	583298.7	1039.938
04	583240.89	583298.7	1039.938
05	583242.29	583303.3	1039.906
06	583305.253	583309.3	1036.898
07	583307.391	583309.3	1036.933
08	583376.665	583304.2	1036.752
09	583234.422	583309.7	1037.232
10	583299.285	583310	1036.571
11	583299.285	583310	1036.571
12	583306.163	583310	1036.392
13	583309.746	583311	1036.343
14	583315.328	583311	1036.188
15	583325.905	583311	1036.043
16	583325.905	583311	1036.043
17	583325.905	583311	1036.043
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96	583325.905	583311	1036.043
97	583325.905	583311	1036.043
98	583325.905	583311	1036.043
99	583325.905	583311	1036.043
100	583325.905	583311	1036.043

Figure 4.3. An example of the downloaded raw data in Microsoft Excel

6.0. FIELD SURVEYS

The methodological approach chosen was an iterative one and it was the most appropriate for supporting engineering and architectural design. The methodological approach encompassed feedback and the recurrent comprehension of requests and suggestions from the survey team which was vital for the usefulness of the survey works.

#### **6.1. Establishment of Benchmarks**

The benchmarks were observed using fast static techniques and each observation time was 180 epochs. Locations for establishing benchmarks were identified prior to building the benchmark and later a rapid static measurement called OCP (Observed Control Point) was made.

#### **6.2. Coordinate System**

The detailed topographic surveys was correlated with the World Geodetic System 1984 (WGS 84 datum and UTM 36 South projection). This was accomplished by utilising the pre-installed datum parameters on Trimble Survey Controller (TSC2) as the origin of the 3D coordinates for the detailed topographic survey works.

#### **6.3. Real Time Kinematic (RTK) Field Surveys**

RTK survey method was used to survey the site and RTK working mode is accurate and precise for engineering surveys, cadastral surveys, construction surveys, detailed topographic site plan mapping, construction stake out, and hydrographic surveying. RTK phase measurements were made between the reference point(base) and remote data collection point (rover) while utilizing coordinate geometry (COGO) stake out functions to determine the site boundary.

GPS adjustment software and equipment firmware is able to compensate for both the variations in the geoid model and variations in the established control benchmarks.

Office and field reconnaissance was conducted prior to the survey to enable smooth execution of the survey works and actualisation of the areas.

#### **6.4. Accuracy of the Survey Works**

The RTK working mode was suitable to interpret the character of the site and the survey works were within the tolerances of prescribed permissible error. The survey data amongst other things will support the design team in the alignment of infrastructure, profile or grade, location of drainage structures/canals/erosion bunds, planning correct

dimensions of structures, orientation of features and occasional earthwork quantities. A fixed ambiguity solution was maintained during data capture to preserve the horizontal accuracy of 10mm + 1ppm and the vertical: 20mm + 1ppm.

#### **7.0. CONCLUSION**

The survey works met the requirements of internationally accredited survey work and the works can be used directly in support of design work.

There were no unusual occurrences during the survey works and the works were completed without any incident that could have negatively affected the work.



## Annex 1 – Photobook



## NCIC consulting land surveyors

## Annex 2 – Drone Images

The two types of drone survey images due to their disk size have been sent as digital image files to the official client's email address.



