RETICULATION STANDARDS FOR ELECTRICITY DISTRIBUTION PLANNING, CONSTRUCTION AND MAINTENANCE

Version VII, February 2026

Rwanda Energy Group
REG

FOREWORD

Rwanda Energy Group is mandated to provide affordable, adequate, reliable, and quality electricity services to the customers through transmission and distribution networks established across the country. In this regard, the REG reticulation standards guide the development and maintenance of electricity infrastructure, ensuring quality compliance and alignment with standard and best engineering practices.

This Electricity Distribution Reticulation Standards, version 7 is an updated version that reflects the technical changes and updates that have occurred since the release of Version 6 in 2020. Its three main parts broadly cover the following core objectives:

- Effective distribution network planning
- Enhancement of power supply reliability
- Strengthened accountability
- Reduction of distribution network losses
- Active stakeholder engagement
- Reinforcement of safety

The development of this document is primarily based on various consultations, including strategic documents, applicable standards, the experience of REG network operators, and perspectives from diverse stakeholders. Given the importance of this document, all relevant personnel are urged to implement it correctly to ensure a more robust safe and efficient electricity distribution network.

The essential contribution of the technical committees, engineers and technicians whose expertise and insights were instrumental in the preparation of this document, are gratefully acknowledged. All stakeholders are encouraged to actively contribute to the ongoing improvement of the standards by providing suggestions and sharing relevant experiences.

The Management of REG

RWANDA ENERGY GROUP LIMITED
Rwanda Energy Group
REG
CHIEF EXECUTIVE OFFICER

DISCLAIMER

This Reticulation standard is the sole property of REG and serves as a guideline for REG staff and stakeholders. Unauthorized actions, including modification or claiming ownership, are strictly prohibited. REG assumes no responsibility for any adverse consequences arising from the improper use of these standards.

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LIST OF ACRONYMS

ABC : Aerial Bundled Cable
ACSR : Aluminium Conductor Steel Reinforced
ADMD: After Diversity Maximum Demand
BDV : Break Down Voltage
BS **:** British Standards
CB **:** Circuit Breaker
CT **:** Current Transformer
CU **:** Copper
DB **:** Distribution Board
GoR **:** Government of Rwanda
GPS **:** Global Positioning System
HV **:** High Voltage
Ka **:** Kilo Ampere
kVA **:** Kilo Volt Ampere
kW **:** Kilo Watt
LV : Low Voltage
MEN **:** Multiple Earthed Neutral
MPa **:** Mega Pascal
MV **:** Medium Voltage
PG **:** Pig Tail
OPGW: Optical Ground Wire
GSW : Ground ShieldWire

PT **:** Potential Transformer

PVC : Polyvinyl Chloride
REG : Rwanda Energy Group
SF6 **:** Sulphur hexafluoride
SWA : Steel Wire Armour
USB **:** Universal Serial Bus
XLPE **:** Cross-linked polyethylen

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INTRODUCTION

The purpose of these Reticulation Standards is to provide clear, consistent guidelines for the design, construction, and maintenance of electrification infrastructure within the Rwanda Energy Group (REG) network. They are intended for use by REG employees, as well as external consultants and contractors involved in the planning, construction, and maintenance of electrification infrastructure on behalf of REG. The standards aim to promote cost-effective solutions without compromising safety or quality using simplified, standardized construction methods, technologies, and equipment.

This standard shall be amended every five years or earlier if end users identify a need for revision and present it to the REG Management. Once the amendments are agreed upon, the existing version of the standard shall be updated and sent to the Chief Executive Officer for approval.

SCOPE

These Reticulation Standards covers electricity distribution lines with Overhead and underground Design and Power Transformers up to 2500 kVA.

The document is divided into three parts, with Part Three specifically dedicated to annexes.

Part One: Distribution Network Planning and Construction Standards and Guidelines

Part Two: Distribution Maintenance Standards

Part Three: ANNEXES:

- **Network Planning and Development Forms**
- **Checklists for Network Distribution Maintenance**
- **Standard drawings**

PART ONE: DISTRIBUTION NETWORK PLANNING AND CONSTRUCTION STANDARDS AND GUIDELINES

1.1. DESIGN CRITERIA

1.1.1. Land use

The land use as per the prevailing master plan is used as a guideline for the calculation of the After Diversity Maximum Demand (ADMD) in different areas. As a guideline, typical land use categories are identified. Every project is verified against this criterion with the approval of the Directors of Planning.

1.1.2. Design After Diversity Maximum Demand

The design household ADMD is calculated as tabled below for new reticulation network. This is calculated at **LV feeder level** and must be diversified for transformer and MV feeder level ADMD.

1.1.2.1. Initial ADMD

Load Category	Initial Load
Rural Residential (Low Income)	30W
Peri-urban (Medium Income)	60W
Urban (High Income)	300W
Urban (Very High Income)	500W (To be assessed)
Schools, Health centers, Workshops, Industries etc.	Calculated per size.

Table 1: Initial Consumer ADMD

1.1.2.2. Saturation consumer ADMD

Load Category	Saturation Load
Rural Residential (Low Income)	100W
Peri-urban (Medium Income)	250W
Urban (High Income)	600W
Urban (Very High Income)	1000W
Schools, Health centers, Workshops, Industries etc.	Calculated per size

Table 2: Saturation Consumer ADMD

1.1.3. Load forecast parameters

The default growth parameters are listed in Table 3 below:

New Distribution transformer capacity shall have margin to accommodate load growth for at least 5 years

Description	Parameter
% connections in start year	30-40% in urban, 40-50% semi-urban and/or rural areas with business centres /productive uses and 50-60 % in isolated rural areas[1]
% connections saturation	90% in rural, 80% in Kigali and Secondary cities
Duration from start to saturation	5 years
Growth in number of houses short term (5 years)	3%
Growth in number of houses long term (>5 years)	2%

Table 3: Load Forecast Parameters

[1] Area outside cities characterized by low population density and small primary economic activities.

1.2. DESIGN PHILOSOPHY

1.2.1. Low voltage network design philosophy

Where possible, the design can be scaled down for initial construction and upgraded later as follows:

- The design Voltage will be 400/230 Volt.
- Initial LV feeder is designed for the calculated long-term saturation load on the feeder. The length of LV feeder within a transformer zone respects the following limitations keeping the voltage within acceptable range:
  - Kigali city: ≤ 0.8km
  - Semi- urban areas and secondary cities: ≤ 1.2km
  - Rural areas: ≤ 1.5km
- LV Networks and transformers must be designed and installed with easy upgrading in mind.
- The maximum permitted Voltage fluctuation at the end of the LV service connection (Customer supply point) shall not be more than +10% and -10% of nominal Voltage with the calculated saturation load.
- The LV network shall be either overhead or underground. For overhead systems, an Aerial Bundle Conductor (ABC) radial configuration with a covered neutral carrier system shall be used. For the case of underground, site condition and other requirements shall be taken into consideration.
- Line design shall be in two definite categories namely:
  - Main line construction normally of three phase construction with ABC shall typically utilize 120mm^2, 95 mm^2, 70 mm^2 or 50 mm^2 conductor. However, weight of 120sqmm and 95sqmm shall be taken into account to select appropriate type of pole/support preferable concrete and steel. However, laterals also called T-offs shall be three phase or single-phase system subject to the design approval and should use ABC conductor with a minimum cross-section of 25 mm^2
- Poles used for network extension shall be 9 m wooden poles. Other pole types and sizes shall be used as per the site requirements: Where enough vertical clearance is required, urban locations, VIP or sensitive areas, locations requiring higher structural strength or durability.
- The neutral conductor of the low voltage systems shall be multiple earthed (MEN System) at the first pole away from the transformer and at every fifth pole from the earthed pole as well as the very last pole on the radial system and spur lines.
- Low Voltage lines can share the same pole with MV to save on construction cost while considering respective span lengths**.**

1.2.2. Service connections

- Service connections are of the overhead type, connected directly from the pole to the house and fixed onto the house's roof structure or the wall by means of a suitable tension clamp with eye bolt or pigtail bolt, bearing in mind that the service connections would also have to support the communications cable of the split pre-payment meter. Options for underground service connection adheres to design requirements: areas with limited space for overhead lines, VIP, government, or sensitive areas where aesthetics or security are critical.

- Metering shall be done through split pre-payment meters where the metering unit will be installed on the pole and the customer interface unit would be installed at the external wall (not exposed to sunlight and rain) of the customer dwelling.
- At each Service Pole[2], the Neutral wire must be earthed via a 16mm^2 copper cable connected to underground spikes and the earth resistance must always be equal or lower than10 Ω.
- Each service connection shall have an appropriate meter as per category of connection and in accordance with the company's energy metering policy.
- Initial LV feeder is designed for the calculated long-term saturation load on the feeder and in consultation with the Master Plan. Line routes must be selected to allow for the anticipated Villages to be connected to the feeder in future.
- The minimum ground clearance for service cables shall be at least 3 meters in normal terrain and 6 meters when crossing a road. If these clearances cannot be maintained, Clearance pole[3] must be installed between the tapping pole and the house. A 9m or 6.5m clearance treated wooden pole shall be used, and if a metallic pole is used, it must be earthed and equipped with suitable insulated clamps.
- Ready boards may be supplied to the selected low-income customers in Villages.

1.2.3. Medium voltage network design philosophy

The REG medium voltage network design philosophy will have the following basic principles:

- The medium voltage lines are of 30kV and 15kV system voltage.
- The medium voltage lines are constructed using a three-wire system with OPGW. However, GSW may also be used subject to the approval of Directors of Planning.

- Recommended Creepage Distance for Insulators should range from 25mm/kV to 33mm/kV
- Both vertical and horizontal pole configurations shall be used. For tension poles, insulators shall be configured horizontally. For suspension poles, insulators shall be arranged in a staggered vertical configuration. However, if greater vertical clearance is required, suspension poles shall adopt a horizontal arrangement with cross-arms to meet the clearance needs.
- For steel structures, any insulators arrangement may be used, provided it meets the design requirements and is suitable for the site conditions.
- Special applications like long conductor spans and critical angles require the H-pole (with 2 or 3 poles) configuration or tower to be used for more strength, ground clearance and conductor spacing. 2.5m, 3m, and 4m steel galvanized cross arms are used in this application.

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[2] Pole with service connection

[3] Pole between Service Pole and Customer Premises.

- Tapping from a single MV wooden poles shall: be made by the shortest possible span not beyond 25m (First span)
- Once the tapping point is a single phase MV line, it is mandatory to upgrade of that single phase to three-phase in the scope of the same project.
- The phasing configuration shall be X, Y and Z (phase**1**, phase**2** and phase**3**) from top to bottom or where horizontal configurations exist, it shall be Y, X and Z from left to right (the middle conductor in vertical arrangement becomes the upper one in horizontal) facing the direction of the power flow.
- Phase labelling shall be done at first pole from the substation, at each and every 0.5 km and the first pole for every T-off and end pole.

  Line design shall be in two definite categories namely:
  - For Main line/new MV feeder, ACSR conductors of 240/40, 150/25, 120/20 and 70/12 mm² shall be used depending on load capacity.
  - For Spur line/ laterals, minimum ACSR 70/12 mm² shall be used.
- ACSR 35/6 mm² shall be used for MV Service connection of one span where the connection is to the end user.
- Low voltage lines can share the same pole with the MV line.
- The line design shall prioritize routing within the road reserve unless site conditions prevent it as per the approval of the directors of Planning.
- Poles used for network extension shall be 12 m wooden poles. Other pole types and sizes shall be used as per the site requirements: Where enough vertical clearance is required, urban locations, VIP or sensitive areas, locations requiring higher structural strength or durability, Industrial parks or special economic zones.
- When a new MV substation or cabin is required, adequate space, room, or structure must be provided for the installation of power equipment, including the transformer, switchgear, LV distribution panel, and other related components
- Provision of a perimeter fence, guard shelter, and toilet/sanitary facilities shall be mandatory at all Medium Voltage substation sites.

1.2.4. Protection and switching devices[4]

- The HV/MV transformer feeding the 30kV and 15kV lines have a secondary star connection or a delta connection with a neutral earth compensator to allow for earth faults to flow and be detected.

[4] Electrical components used to open, close or change the path of an electrical circuit

- The main lines/feeders at substations shall be protected by medium voltage (MV) circuit breakers with appropriate protective relays. A switching device (excluding drop-out fuses) must be installed at the starting point of the main overhead line/feeder (first pole or tower) from the substation.
- Any extension of an MV line shall be equipped with a mechanical load-break switch (air-break switch with a fuse), load break cut-out, drop-out fuse isolator at the tapping point properly rated for the line's load and switching devices without fuses. The "strengthen and extend" philosophy shall be adopted for all MV line extensions and their associated switching devices.
- Any MV line extension/ T-off exceeding 20 km must include an auto-recloser or Automatic Load Break Switch (ALBS) at the tapping point. The device shall be remotely controlled and properly coordinated with existing intelligent protective devices.
- Distribution transformer with capacity up to 400 kVA shall be protected by any of the switching devices with an appropriate protection,
- Distribution transformers with capacities greater than 400 kVA and up to 800 kVA shall be protected using appropriately rated switching devices, excluding drop-out fuses.
- Transformers with capacity greater than 800 kVA shall be protected with medium-voltage (MV) switchgear equipped with a breaker and protection relay, unless an assessment identifies alternative options, subject to Planning Directors 'approval.
- Surge arrestors must be connected at the output of the switching device.
- In areas prone to frequent lightning strikes, combi-units shall be used.
- For the transformer with capacity from 800kVA and above, energy metering system shall be installed on the MV side. The MV switchgear must be equipped with voltage and current transformers for protection and measurement.
- For any installation requiring a powerhouse equipped with disconnectors, switchgear or compact cabin, there must have a spare feeder.

1.3. STANDARDISATION OF DISTRIBUTION EQUIPMENT

To standardize on electrification equipment and material, and to optimize the economics of the design, the standards for use in the electricity access plan are listed below:

1.3.1. Poles.

In the Rwanda network, wooden, concrete, steel poles and pylons are used.
The following information applies for Wooden Poles:

- Wooden poles must be treated with copper-based chemicals such as Chromated Copper Arsenate (CCA).
- Anti-climbing devices must be installed on MV strut poles only.
- Pole numbering must be done on both MV and LV poles.
- Each MV pole must be equipped with a "danger" warning sign in local Language and English.

Poles will have the following minimum base and top diameters:

Application	Pole length	Min Diam. at 1.5m from Butt (mm)	Min Diam. at Pole Top (mm)	Planting Depth	Comment
Service connection use	6.5m	50	50	1	Clearance pole for service cable
LV light use	9m	200	150	1.5m	Intermediate poles
LV medium	9m	230	170	1.5m	Angle poles - supported
LV Stout	9m	285	190	1.5m	Angle pole - unsupported
LV and Street Lights	10m	210	150	1.6m	Road clearance and Street Lights
MV light use	12m	240	180	1.8m	Rural lines, no LV under
MV medium	12m	260	195	1.8m	Angle poles - supported
MV Stout	12m	320	200	1.8m	Unsupported angle
Special use	14m	240	210	2.2m	Special, long span
H-Pole	12m	240	195	1.8m	Special, Extra-long span
H-Pole	14m	260	220	2.2m	Special, Extra-long span

Table 4: Standard Pole Sizes

1.3.2. Stay and assemblies

a. Stay Wire

A guideline for stay wire for medium Voltage and low Voltage installations will be as per **Table 5** below.

Application	Strands/diameter
LV	3/3.35mm
MV	7/3.35mm

Table 5: Standard Stay Wire

b. Stay Rod

Stay rods shall comply with BS 183 Grade 700 and shall be 1100 MPA for both LV and MV stays.

Application	Diameter	Adjustment
LV	16mm	Adjustable
MV	20mm	Adjustable

Table 6: Standard Stay Rod

c. Base Plate

The size of the base plate is determined by the use. Typical use is given in **Table 7** below. It is the duty of the installing Contractor to ensure that the use is applicable. Soil conditions may require 500mm base plates to be used for lighter conductor, or long spans with light conductor may require a bigger stay plate than indicated below. Base plates must be used with a 50mm diameter 4mm round washer at the base of the stay rod.

Application	Size
Low Voltage	400x400x6mm
MV 35mm² Conductor	500x500x6mm
MV 70mm² conductor or more	600x600x6mm

Table 7: Stay Base Plate Size

1.3.3. Distribution transformers

- Distribution transformers can be mounted on H-pole structure, on stand and on ground (indoor installation).
- Once the transformer is mounted on ground (indoor), rail, rollers, cables trench, oil soak pit, and any other approved ground platform shall be required.
- Distribution transformers with a capacity up to 250 kVA shall be installed on an H-pole constructed with concrete or steel poles. For transformers with a capacity above 250kVA, installation shall be on the transformer stand.
- The transformer structure or stand shall be adequately reinforced to safely support the weight and load of the installed transformer. Acceptable construction materials include reinforced masonry (brick or stone) or appropriately rated metallic cross arms.
- Installation of a transformer directly under the line or near the line (like using existing pole together with new pole to create H-pole structure) shall be considered as a last option due to space limitation.
- All outdoor installed transformer locations shall be fenced and/or secured.

- Transformer voltage ratings (No-load): 30kV/400/230V and 15kV/400/230V
- The standard vector group: Dyn11
- Off load 5 position tap changer: 95%-97.5%-100%-102.5%-105%.
- Transformer sizes for 30kV/400V/230V and 15kV/400V/230V are:

Power Rating (kVA)	Phases
10	Single Phase
15	Single Phase
25	Single Phase
25	Three Phase
50	Three Phase
75	Three Phase
100	Three Phase
160	Three Phase
200	Three Phase
250	Three Phase
315	Three Phase
400	Three Phase
450	Three Phase
500	Three Phase
630	Three Phase
800	Three Phase
1000	Three Phase
1250	Three Phase
1600	Three Phase
2000	Three Phase
2500	Three Phase

Table 8: Standard Transformer Sizes

1.3.4. MV Conductor

Aluminium Conductor Steel Reinforced (ACSR) standard conductor is used. The Conductor sizes used with their thermal ratings are listed below. It is important in the design to consider I^2R losses when selecting a conductor size, and not operate the conductor over its economical limits.

Standard Conductor Sizes	Continuous Thermal Rating *
35/6 mm^2 ACSR	150 A
70/12 mm^2 ACSR	206 A
120/20 mm^2 ACSR	280 A
150/ 25 mm^2 ACSR	470 A
240/ 40 mm^2 ACSR	530 A

Table 9: MV Conductor Sizes

* Current ratings are based on 50 Hz AC, 75 ºC conductor temperature, and 0.61 m/s (2 ft/s) wind. 0.5 coefficients of emissivity and absorption, temperature rating: 25 ºC ambient, 1000 watts/sq. meter sun.

1.3.5. LV Conductor

Standard LV Conductor sizes to be used on reticulation networks are listed in **Table 10** below. The typical design continuous thermal ratings are listed with each cable.

Standard Conductor Sizes	Continuous Thermal Rating
1 X 35mm^2 + 1x54.6mm^2 ABC	135 A
1 X 25mm^2 + 1x54.6mm^2 ABC	110 A
3 x 120mm^2 + 1x54.6mm^2 ABC	300 A
3 x 95mm^2 + 1x54.6mm^2 ABC	240 A
3 x 70mm^2 + 1x54.6mm^2 ABC	210 A
3 x 50mm^2 + 1x54.6mm^2 ABC	160 A
3 x 35mm^2 + 1x54.6mm^2 ABC	135 A
3 x 25mm^2 + 1x54.6mm^2 ABC	110 A

Table 10: LV ABC Conductor Sizes

1.3.6. LV Distribution board

- The LV DB shall contain at least the main transformer breaker in the incoming compartment as well as the feeder circuit breakers on the exit compartment and all LV DBs shall allow the installation of energy meter. Additional feeder breakers should be installed based on the number of outgoing feeders required subject to site requirement and design approval.
- The LV DBs shall be equipped with a highly secure and intact locking system.
- A low voltage surge arrester must be installed on the main incoming cable inside the LV DB, rating 10kA.
- The Neutral connection busbar must be isolated from the enclosure to 1000V and have provision of at least 4 connections.
- The main busbars in the DBs shall be insulated at 1kV and rated to the transformer capacity with a safety factor of 1.5. From main busbar to the CB of LV feeder, the insulated LV cables or well sized busbars shall be used.
- Low-voltage bus bars shall be insulated with appropriate insulating materials in compliance with color codes.
- An earth stud, minimum M12 must be provided on the outside of the box for earthing to the transformer structure.
- Knock-out holes must be provided at the bottom for the cable entry. Sufficient cable support must be provided.
- The galvanized enclosure shall be mounted on two lengths of angle iron mounted between the two transformer poles.

1.3.6.1. LV circuit breaker sizes

Circuit breakers for the LV Cables will be rated as per **Table 11** below:

Standard Conductor Sizes	Circuit Breaker
1 X 35 mm² + 54.6 mm² ABC	130 A
1 X 25 mm² + 54.6 mm² ABC	110 A
3 x 120 mm² + 54.6 mm² ABC	300 A
3 x 95 mm² + 54.6 mm² ABC	240 A
3 x 70 mm² + 54.6 mm² ABC	210 A
3 x 50 mm² + 54.6 mm² ABC	160 A
3 x 35 mm² + 54.6 mm² ABC	130 A
3 x 25 mm² + 54. 6mm² ABC	110 A

Table 11: LV ABC Conductor Sizes

1.3.6.2. LV cables to be used on transformer to DB

Low Voltage PVC Copper cables (SWA/unarmoured) to be used from the Transformer LV Bushings to the DB Main Incoming Circuit Breaker for different transformer sizes are listed in **Table 12** below.

Power	Phases	LV Circuit Breaker	Standard Cable Sizes (CU XLPE or equivalent)
10 kVA	Single Phase	50 A	2 x 25 mm^2
15 kVA	Single Phase	80 A	2 x 25 mm^2
25 kVA	Single Phase	125 A	2 x 35 mm^2
25 kVA	Three phases	40 A	4 x 25 mm^2
50 kVA	Three Phases	80 A	4 x 35 mm^2
75 kVA	Three phases	120 A	4 x 50 mm^2
100 kVA	Three Phases	160 A	4 x 70 mm^2
160 kVA	Three Phases	250 A	4 x 95 mm^2
200 kVA	Three Phases	315 A	4 x120 mm^2
250 kVA	Three Phase	400 A	4 x (1x185 mm^2)
315 kVA	Three Phase	500 A	4 x (1x240 mm^2)
400 kVA	Three Phase	630 A	4 x (1x240 mm^2)
450 kVA	Three Phase	800 A	4 x (1x300 mm^2)
500 kVA	Three Phase	800 A	4 x (1x300 mm^2)
630 kVA	Three Phase	1000 A	2 x [4 x (1x240 mm^2)]
800 kVA	Three Phase	1250 A	2 x [4 x (1x300 mm^2)]
1000 kVA	Three Phase	1600 A	3 x [4 x (1x240 mm^2)]
1250 kVA	Three Phase	1800 A	3 x [4 x (1x300 mm^2)]
1600 kVA	Three Phase	2300 A	4 x [4 x (1x300 mm^2)]
2000 kVA	Three Phase	2900 A	4 x [4 x (1x400 mm^2)]
2500 kVA	Three Phase	3600 A	5 x [4 x (1x400 mm^2)]

Table 12: LV Cable Sizes for Transformers according to IEC 60502-1

1.3.6.3. Recommendation for lv conductors colour coding

Phases conductors shall be **Brown**, **Black** and **Grey** from Left to Right, and from top downwards, in vertical configuration. The **Blue** being connected to the Neutral (IEC 60245-1). However, for old cables, the phases configuration will remain **Red, Yellow, Blue** and the Black colour is for the Neutral.

The colours green and yellow, when combined, are recognized exclusively as a means of identification of the core intended for use as earth connection or similar protection

The figure below indicates different cases in Single and Three-phase***:***

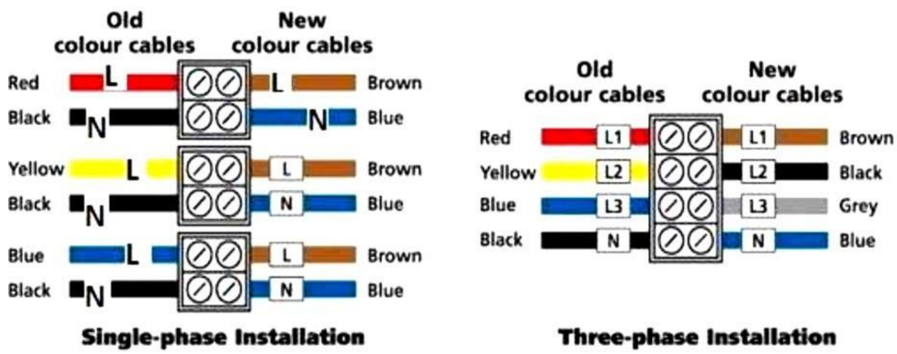

Figure 1:Colour coding

1.3.7. Metering

A smart three-phase electricity meter will be installed in the incoming section of the LV panel to measure all the energy used in the transformer zone.

Meters shall detect and log not limited to:

a) Phase voltage unbalance
b) Phase current unbalance
c) Neutral disturbances
d) Power failures (Outages)
e) Tamper attempts
f) CT reversals
g) Transformer overload
h) Voltage & Current Phase Diagram
i) Cover open detection
j) Reverse connection detection
k) High/Low-voltage detection
l) Over current detection
m) Abnormal phase sequence detection
n) Power-off/on
o) Parameter configuration
p) Terminal cover-opening
q) Energy reset
r) Demand reset

s) Power reverse
t) Under voltage
u) Over voltage
v) Voltage negative sequence
w) Current negative sequence
x) Current imbalance
y) Each kind of event shall store at least 20 latest records
z) Load profile

For the customer with other source of electricity like generator, metering system shall be installed to read only electricity from REG Network.

All access on metering system shall be strictly under control of REG.

1.4. EARTHING

The Multiple Earthed Neutral (MEN) system must be used for LV earthing.

1.4.1. MEN system for LV

- The LV earthing system must be separated from the MV earthing system. The neutral wire in LV DB is not be earthed.
- The LV line shall be earthed on the first pole away from the transformer, and at every fifth pole from the previous earthing, at the end pole, at Spur off feeder and at each service pole.
- All intermediate metallic poles at service connection shall be earthed.

1.4.2. LV Earthing requirements

- LV earthing is done with minimum16mm² stranded copper conductor or 25 mm² steel wire in high theft areas where copper is stolen.
- The earthing busbar in LV DB and earthing system at first pole shall be grounded with at least 25 mm2 stranded copper or equivalent.
- Bi-metal PG clamps must be used for connecting the earth to the overhead ABC conductor.
- The metallic enclosure of the LV DB on the transformer installation is earthed to the MV side. All LV bus bars
  inside the DB, including the neutral bus bar are insulated at 1000V from the DB enclosure.
- The overall LV earthing resistance must be less than 10 ohms, with the earthing at the first pole from the
  transformer required to have a resistance of not greater than 5 ohms.
- The main incoming cable from the transformer must be connected to a 10 kA LV surge arrestor that must be earthed to the LV Neutral.
- Earthing rod shall be copper/copper clad steel with at least 1.5m long and 16mm or 20mm diameter.

1.4.3. MV Earthing requirements

- Overhead earth conductor (GSW or OPGW) must be installed on the lines.
- Earth conductor (GSW/OPGW) is earthed at after every 400m in case of wooden or concrete poles span.
- The shielding angle must be less than 45^0 for structures less than 15m tall with conductor spacing below 2m (reference: IEEE Std 1410). For structures higher than 15m, the shielding angle shall be less or equal 30^0.
- On the Transformer installation, the following items are all commonly earthed to ground.
  - MV Surge arrestors or/and shield wire
  - Transformer bed
  - Transformer earth stud
  - LV DB metal enclosure
- Earthing shall primarily be conducted using a 25mm² stranded copper wire. However, steel may be considered as an alternative in high theft areas where copper is stolen based on the historical records.
- Transformer MV installation is earthed at the transformer structure with 25mm² copper earth spikes. Earthing is done with a continuous earth wire in minimum: 1m deep, 3m long trench from the transformer pole.
- The total earth resistance of the MV structures along the Line shall not exceed 10 Ω.
- The MV earthing resistance at the transformer and any surge arrestors shall not exceed 5 Ω.
- All MV metallic poles must be earthed.

1.5. TRANSFORMER PROTECTION

A main LV breaker with 10kA rupturing capacity is installed in a box mounted on the transformer structure. Feeder circuits shall also be protected by rated circuit breakers or LV fuses.

Transformer Main LV breaker sizes are listed next to the transformer's sizes below:

Power	Phases	LV Breaker[5]	Breaker Poles	MV Fuse (30kV)	MV Fuse (15kV)
10 kVA	Single Phase	50 A	1	1A	1A
15kVA	Single Phase	80 A	1	1A	1A
25 kVA	Single phase	125 A	1	1A	1A

[5] From 75kVA transformer and above, All Circuit Breakers must be adjustable within the range from 50% to 100% of the nominal current.

25kVA	Three Phase	40 A	3	1A	2A
50kVA	Three Phase	80 A	3	2A	4A
75kVA	Three Phase	125A	3	2 A	4A
100kVA	Three Phase	160 A	3	3 A	5 A
160kVA	Three Phase	250 A	3	4 A	8A
200kVA	Three Phase	315 A	3	5 A	10A
250 kVA	Three Phase	400 A	3	6 A	12 A
315 kVA	Three Phase	500 A	3	8 A	16A
400 kVA	Three Phase	630 A	3	8 A	16 A
450 kVA	Three Phase	800	3	10 A	20 A
500 kVA	Three Phase	800 A	3	11 A	21 A
630 kVA	Three Phase	1000 A	3	13 A	26 A
800 kVA	Three Phase	1250 A	3	17 A	33 A
1000 kVA	Three Phase	1600 A	3	20 A	40A
1250 kVA	Three Phase	1800 A	3	25 A	49 A
1600 kVA	Three Phase	2300 A	3	31 A	62 A
2000 kVA	Three Phase	2900 A	3	39 A	77 A
2500 kVA	Three Phase	3600 A	3	49 A	97 A

Table 13: Standard Transformers, LV Breakers and MV Fuse values

Factors Applied:

- For transformers up to 315 kVA: **1.25;**
- For transformers ranging from 400 kVA to 800 kVA: **1.05;**
- For transformers of 1000 kVA and above: **1.00.**

1.6. CONSTRUCTION

1.6.1. Planting of MV and LV poles

- Survey of pole positions must be done by surveyors. Pegged pole positions must be approved by the design engineer before excavation or construction.
- Pole holes must be excavated to the correct width and depth to ensure stability of the poles.
- Foundation dimensions are as listed in **Table 14** below.

Pole height (m)	Hole depth minimum in normal soil (m)	Width Diameter (m)
6	1	0.6
9	1.5	0.8
10	1.8	0.8
12	1.8	1.0
13	2	1.0
14	2.2	1.0
16	2.5	1.0

Table 14: Pole foundation Depth and Width

- Erection of the pole must be done with the aid of a skid board to guide the butt of the pole into the hole.
- Erection must be done with the correct equipment for the safety of workers and for protection of the pole.
- A pole may not be cut at the top or bottom to obtain the desired height. Planting depth must be measured correctly.
- Different soil types must be considered so that the necessary reinforcement can be done.
- Backfilling must be done with good compactable soil. During backfilling, compaction shall be done after every 200mm of backfill.
- Compaction shall be done to a density of at least 95% of the surrounding undisturbed soil for the full depth of the foundation.
- The Contractor must have a relative compaction tester to compare the compaction to that of the undisturbed surrounding ground. The weight-drop tester will suffice to compare compaction densities. Absolute compaction density is not required.

- Compaction must be done with specialized steel compactors with a flat surface (round or square, at least 150mm diameter or 80mm x 150mm). The compactor shall weigh at least 10kg or more.
- The soil shall be filled up higher against the pole, so water flows away from the pole and to prevent damming of water around the pole. Compaction must be done right to the top of the backfill (above normal ground level).
- Open holes, when not attended to, must be covered or enclosed with barrier tape to prevent accidents.
- Special care must be taken when digging close to existing cables or other services.
- When replacing an old pole, the new pole must be planted next to the old pole. The old pole must be uprooted and the hole properly backfilled and compacted to prevent leaning of the new pole towards the old pole position.
- Danger signs shall be installed on all MV poles at 2m above ground level.
- Storing, loading, off-loading, transport and handling of the pole must be done as per international standards and manufacturer's instructions. Poles must not be dragged along the ground. No hooks are used under the ground line.

1.6.2. MV reticulation construction

- Special applications like long conductor spans will require the H-pole configuration to be used for more strength, ground clearance and conductor spacing. For very long spans, three pole structures and longer cross arms are used in this application
- The design span shall be 65 m for wooden poles and 70 m for other poles. The actual span length is determined by type and height of the poles, site condition upon the results of the design calculations with appropriate Software. Longer spans must be done using special structures: H-Poles (2 or 3 Poles), steel and concrete Poles and a long cross-arm for conductor clearance.

Pole Height (m)	Pole type	Conductor size	Design span (m), max
12	Wooden	70/12	65
		120/20	60
	Concrete	70/12	70
		120/20	65
		150/25	60
	Steel	70/12	80
		120/20	70

		150/25	65
14	Wooden	70/12	75
		120/20	65
	Steel	70/12	100
		120/20	80
		150/25	70
16	Steel	70/12	120
		120/20	100
		150/25	80

Table 15: MV Spans

- When wooden poles are used, a concrete or steel pole shall be installed after every five wooden poles.
- The insulators configuration on poles must align with the highlights outlined in the MV design philosophy.
- The required conductor clearances are listed in *Table 16* up to *18.*
- All MV lines must be constructed with the rated insulators:
  - ♦ Composite insulators
  - ♦ 70kN tensile strength for tension insulators
  - ♦ 40kN tensile strength for tension insulators
  - ♦ 10kN tensile strength for suspension insulators
  - ♦ Pole & stay strengths to be a single conductor breaking strength with a doubling safety factor.
- Spur line construction of single phase or three phase construction with conductors normally 70/12mm², 35/6mm² with insulator strength at:
  - ♦ 40kN tensile strength for tension insulators
  - ♦ 10kN tensile strength for suspension insulators
- Very long spans must be supported by stayed H-pole structures on both sides.
- Any long stretches of intermediate poles must have a supported strain structure at every 5 spans and at the tenth spans strong structures (steel, concrete poles) shall be used.
- Lines shall be installed directly from cable drum rollers and un-coiling of the conductor off a drum lying on its side is forbidden, this will lead to rejection of the section of conductor.
- Stringing shall be done with temporary support rollers on each pole. Dragging of the conductor on the ground is not allowed.

- As-built drawings must include the pole number, GPS Coordinate, conductor type and its size, structure type (e.g. intermediate, termination, 90º turn, etc.)

1.6.3. Conductor spacing and clearances

CLEARANCE FROM		MEDIUM VOLTAGE (15 – 30kV)			
		HORIZONTAL CLEARANCE[6] (m)		VERTICAL CLEARANCE (m)	
		Bare conductor	Isolated conductor	Bare conductor	Isolated conductor
Normal terrain or an agriculture area		-	-	6	5.6
Road with agricultural vehicles with a height “h”		-	-	h+1	h+1
Ways open to public circulation		-	-	8	8
Highways		-	-	8	8
Line near silo with H-height		H+5	-	-	-
Trees and various obstacles	Higher than the line	5	5	-	-
	Lower than the line	-	-	3	1
Buildings		3	3	3.2; 10.6 (Non-fire-Resistant roofs and fire sensitive installations like petrol stations, …)	3
Vicinity of river for sailing		-	-	9	9
Telecommunication lines		2	2	2	1
Pyrotechnic plants or installations		20	10	-	-
Vicinity of LV line on separate pole		2	2	1	1
Vicinity of MV line on separate pole		2	2	1.5	1.5
Vicinity of HV line on separate pole		2	2	2	1.5
Vicinity of HV line on the same pole		2	2	2	1.5
Vicinity of educational building or sports equipment		4	4	8	8

Table 15: Clearances from MV lines

[6] For Horizontal clearances, reference must always be made to the Guidelines on Right of Way from RURA

CLEARANCE FROM		LOW VOLTAGE			
		Horizontal[7] clearance (m)		Vertical clearance (m)	
		Bare conductor	Insulated conductor	Bare conductor	Insulated conductor
Normal terrain or an agriculture area		-	-	6	5
Road surface		1.5	1.5	6	6
Trees and various obstacles	Trees Higher than the line	1.5	1.5	-	-
	Trees Lower than the line	-	-	1.5	0.5
Buildings		1	1	2.5	2.5
Vicinity of telecommunication lines		0.5	0.5	1	1
Vicinity of MV line on separate pole		2	2	1	1
Vicinity of HV line on separate pole		2	2	2	2
Vicinity of educational building or sports equipment		4	4	8	8

Table 16: Clearances from LV lines

Design Phase to Phase kV	Phase – To – Phase Clearance in mm	Phase – To – Neutral (Earth) Clearance in mm
15	300.0	250.0
30	450.0	400.0

Table 17: Conductor Clearances

1.6.4. Laying underground cables

- The cable drum shall be properly mounted on jacks (drum lift), or on a cable wheel at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum without failure, and that the spindle is horizontal in the bearings to prevent the drum creeping to one side while rotating.
- The cable shall be pulled over on rollers in the trench steadily and uniformly without jerks and strain. The entire cable length shall as far as possible be laid off in one stretch. Three single core cables forming one three phase circuit shall be laid in open formation as far apart as allowed by the trench (900mm).
- After the cable has been so uncoiled, it shall be lifted slightly over the rollers beginning from one end by helpers standing about 10m apart and drawn straight. The cable shall then be lifted off the rollers and laid in a reasonably straight line.

[7] For Horizontal clearances, reference must always be made to the Guidelines on Right of Way from RURA

- On completion of cable laying, the cable shall be tested for continuity and insulation resistance per testing procedures laid out in the relevant standards before covering the trench.
- Cables laid in trenches in a single tier formation shall have a covering of dry sand of not less than 20cm above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation, after the first cable tier has been laid, a sand cushion of 20cm shall be provided over the top of the lowest cable before the second tier is laid. If additional tiers are formed, each of the subsequent tiers shall also have a sand cushion of 20cm above the top of the cable. Cables in the topmost tiers shall have final sand covering not less than 20cm before the protective cover is laid.
- Whenever more than one cable is laid / run side by side, marker tags as approved, inscribed with cable identification details shall be permanently attached to all the cables in the manholes, cable trenches and entry points into substation plant houses. These shall also be attached to cables laid direct in ground at specified intervals and at proposed cable route marker locations before the trenches are backfilled.

1.6.4.1. Backfilling

- All trenches shall be backfilled with excavated earth, free from stones or other sharp ended debris and shall be rammed and watered, if necessary, in successive layers not exceeding 20cm depth. Unless otherwise specified, a crown of earth not less than 50mm and not exceeding 100mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.
- The temporary re-statements of roadways should be inspected at regular intervals, particularly during wet weather and settlements should be made good by further filling as may be required. After the subsidence has ceased, trenches cut through roadways or other paved areas shall be restored to the same density and materials as the surrounding area and re-paved in accordance with the relevant building specifications to the satisfaction of the Engineer.
- Where road beams or lawns have been cut out of necessity, or kerb stones displaced, the same shall be repaired and made good to the satisfaction of the Engineer and all the surplus earth or rock shall be removed.
- The above requirements for backfilling shall also apply for trenches with pipes/ ducts at road crossings.

1.6.4.2. Cable protection

A layer danger tape marked "**Danger - High voltage cable below**" shall be laid at a depth of 500mm below final ground level to serve as warning when the ground is excavated in future. The danger tape must be laid across the entire width of the trench. Bricks must be laid at 200mm (of soft backfill) from cable laid.

1.6.4.3. Cable route identification

The start and end positions of each cable trench, as well as all turning points, must be clearly marked with a permanent route marker made of metal with engraving, planted in a small concrete foundation. The cable identification must include the "From" and "To" positions of the cable as well as the voltage and depth.

Road crossings shall be clearly and permanently marked on either side of the road by means of a name plate or engraving in the concrete of the curb. The depth of the cable under curb level must be indicated.

1.6.4.4. Section drawings of cable trenches

a. single MV Cable

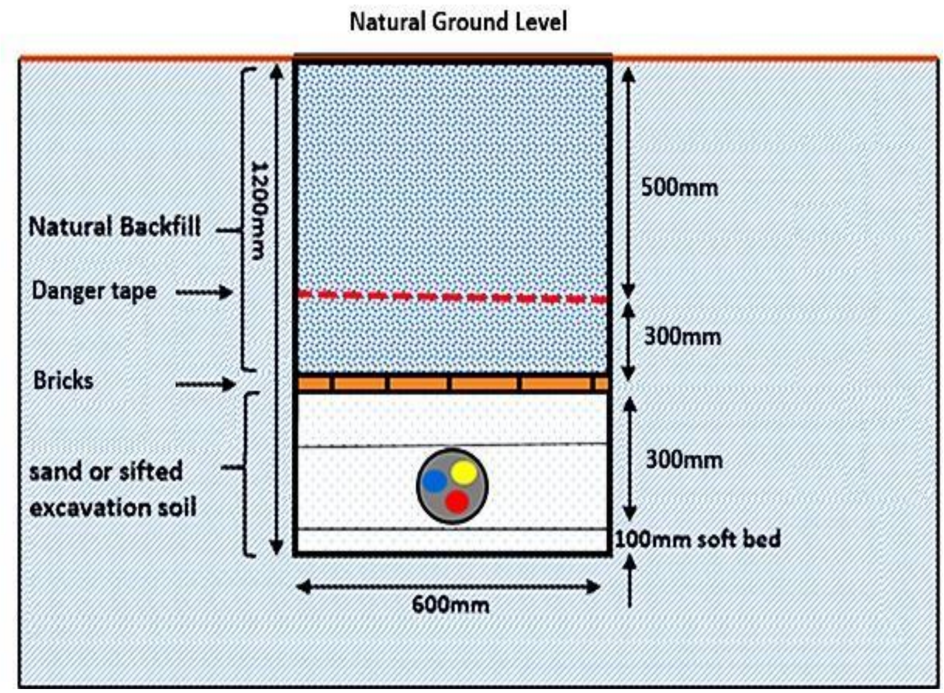

Figure 2:Single MV Cable Laying

b. MV and LV cable

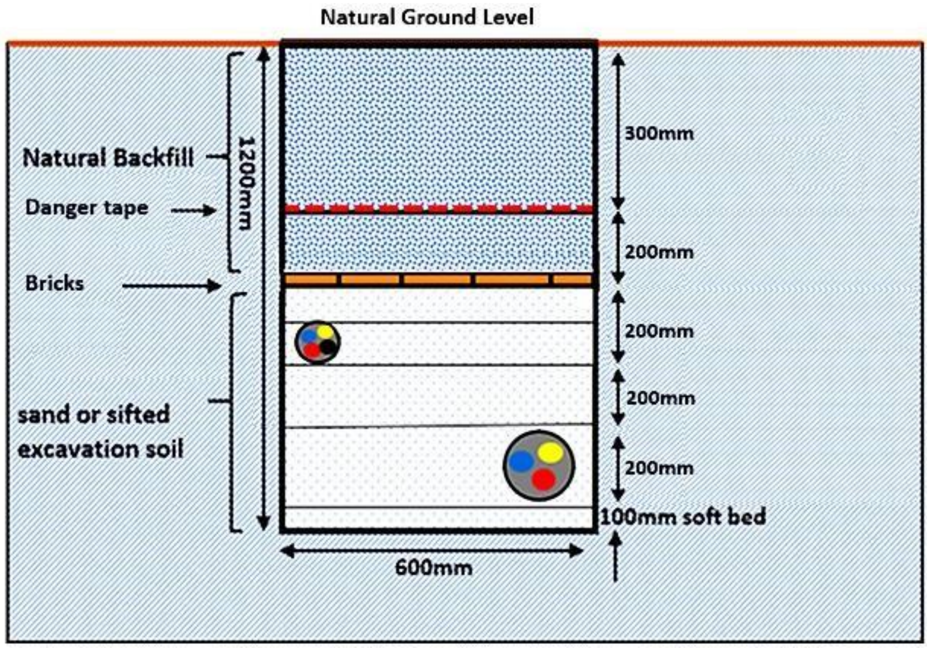

Figure 3:MV and LV Cable Laying

c. Two MV cables

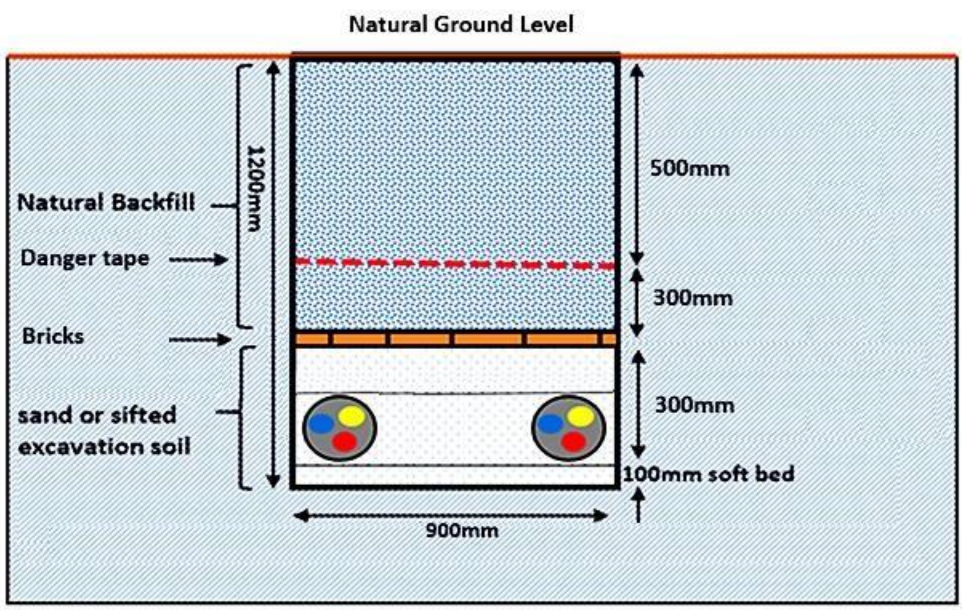

Figure 4:Two MV Cable Laying

d. Single Core MV Cables

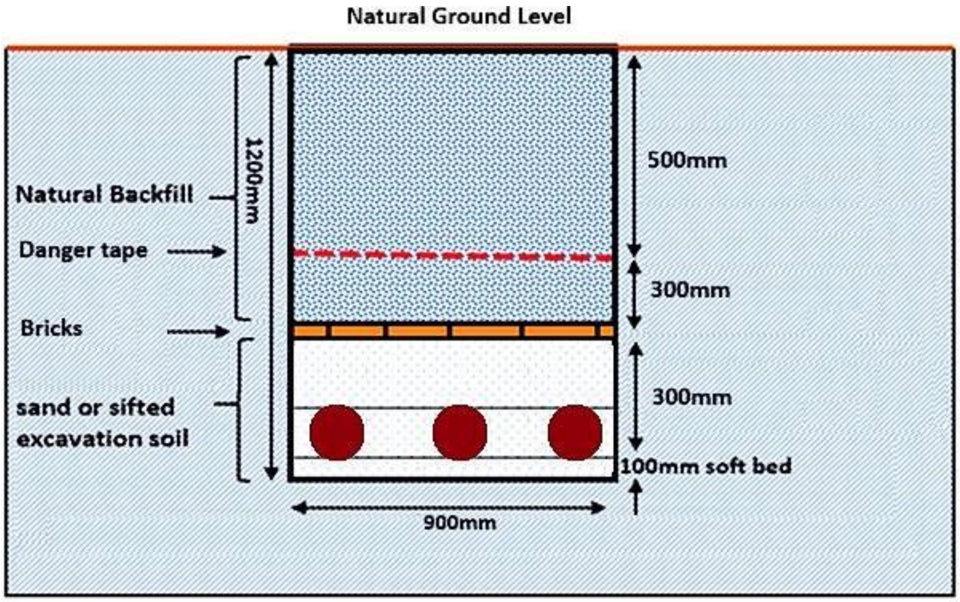

Figure 5:Single Core MV Cables Laying

e. Single Core MV Cables with two circuits

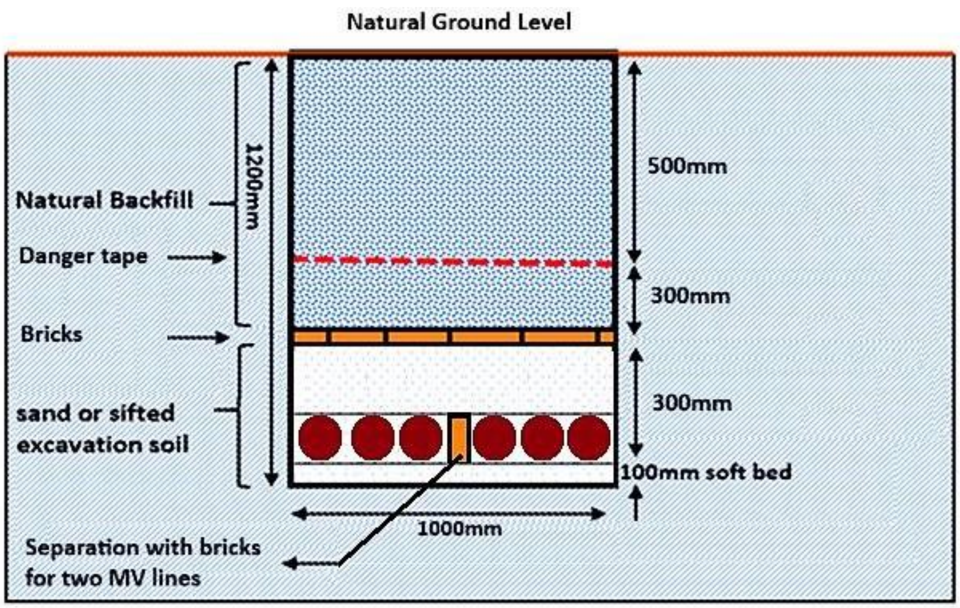

Figure 6:Single Core MV Cables with two circuits

f. LV Cable

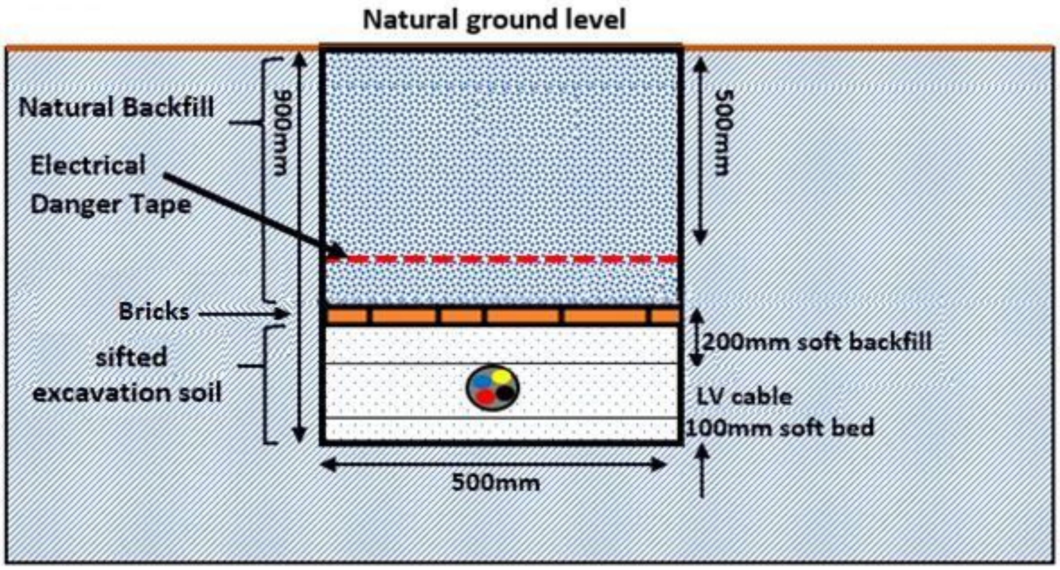

Figure 7:LV Cable Laying

1.6.5. LV reticulation construction

- ABC with insulated neutral carrier shall be used.
- Special care must be taken to handle and install the conductor per the manufacturer's specifications (pulley sizes, no dragging of conductor on the ground, etc.)
- Every pole must be numbered as per specification.
- The average span length for LV ABC construction will be as listed in **Table 25** below. This is mainly to allow for proper ground clearance.

It is the duty of the construction Contractor to verify if the ground clearances are maintained in the allowable range

over roads and other obstacles.

Conductor Used	Span Length (m)
25mm² and 35mm² Single Phase ABC	55
25mm² three phase ABC	50
35mm² three phase ABC	50
50mm² three phase ABC	47
70mm² three phase ABC	44
95mm² three phase ABC	45

120mm² three phase ABC	45

Table 18: LV Span Length

- The poles for 95 mm2 and 120 mm2 LV cable shall be concrete or steel with a span of 45 m.
- If multiple runs are used for a 70mm² three-phase ABC, concrete and steel poles shall be utilized.
- Concrete or steel poles will be used for the LV network in urban areas, unless the design engineer suggests the use of wooden poles.
- Earthing of LV lines shall comply with the guidelines outlined in the Earthing section.
- The LV feeder shall NOT be earthed at the Transformer installation.
- As-built drawings must include the pole number, GPS Coordinate, conductor type, structure type (e.g. Intermediate, termination, 90º turn, etc.)

1.6.6. Service connections construction

The following guidelines for service connections must be followed:

- Three phase domestic connections are done with Stranded copper conductor 10mm² 4 core cable with communication wire.
- • The phase cable on which to connect a single-phase meter must be carefully selected to not cause phase imbalance to the transformer.
- Up to 40m distance, Single-phase connections can be done with 4, 6, and 10 mm² stranded copper cable single core concentric cable or with aluminium cable 10 or 16 mm2 with communication wire. Single-phase connections between 40m to 100m can be done with 10 mm² copper single core concentric conductor or aluminium cable of $10mm^2$ or $16mm^2$. The actual cable size and type shall be selected following the site conditions and design requirements.
- The Consumer has to install a circuit breaker to isolate his internal installation from REG network.
- Where there is no Distribution Board inside the house, an approved Ready Board can be used by the consumer as an electrical installation.
- **A Ready Board consist of**:
  - Earth Leakage Circuit Breaker.
  - Circuit Breaker.
  - Distribution board facilities.
  - Light fitting and switch.
  - Switched socket outlets.
  - Earthing terminals.
- The service cable is attached to the house using either an eye bolt with strain clamp (wedge clamp) on the house wall, or a pole lug with coach screw and strain clamp connected to the roof trusses. See drawing on the attachment for details.

1.7. UPGRANG OF EXISTING NETWORKS

The main objective for network upgrading is to solve problems in the networks at minimum cost to the required design ADMD, and to make the network safe where such risks are evident.

- The Engineer's challenge would be to upgrade existing overloaded networks whilst electrifying the surrounding expansion through the following techniques:
- The approach to addressing the issue of excessively long lines and or overloaded lines or transformers will be based on the principle of load transfer, while also incorporating N-1 redundancy wherever it is optimally applicable.
- Ensure that cable size will be able to carry the load.
- Replace overloaded transformers with bigger ones and upgrade overloaded lines to have a further reach.
- Replace under loaded transformers with units of lower rating to reduce the Iron losses.
- Where an upgrade from single-phase to three-phase is required, the following guidelines shall be followed:
  - The same technology as the existing network shall be used so that all existing poles, conductor and insulators can be re-used while in good condition.
  - Conductor size can be increased where this seems to be the most reliable option. All removed conductor must be carefully rolled on a conductor drum for re-use.

- Strategies such as the installation of appropriate equipment for reactive power compensation and voltage regulation shall be implemented to enhance power quality.

Any planned power outage must be strategically coordinated to minimize its impact on end users, ensuring the outage duration is as short as possible and the affected areas are limited to the smallest extent feasible

PART TWO: NETWORK DISTRIBUTION MAINTENANCE STANDARDS

2.1. INTRODUCTION

The purpose of this standard is to provide service with recommended practices and frequencies that would form the core of a regularly scheduled electrical maintenance program. All maintenance work associated with electric distribution power systems and equipment should be performed in accordance with accepted standards and work practices, following manufacturers 'manuals.
A maintenance plan should be elaborated showing appropriate maintenance strategies for all types of distribution assets and will be updated every time necessary. Implementation of planned maintenance activities that require outages will be authorized by competent authorities per outage management.

2.2. ACTIVITIES IN ELECTRICITY DISTRIBUTION MAINTENANCE

Maintenance activities here below presented concern distribution system and is divided into major components:

A. MV Distribution Lines
B. Distribution Transformers
C. Switching Devices
D. Protective Devices
E. Protective Relay
F. Earthing Equipment
G. Surge Arrestors
H. LV Distribution Boxes
I. LV Distribution Lines
J. Right of Ways

Breakdown/curative maintenance should be dramatically reduced by implementing preventive maintenance through regular inspections.

2.2.1. Distribution lines activities

Electricity distribution lines both overhead and underground requires regular maintenance of their components to avoid disruption of power lines or power outages.

It is therefore essential to undertake regular preventive maintenance activities as described below and a curative maintenance is programmed accordingly:

- Compliance to safety procedures and requirements
- Elaborating maintenance schedule
- Outlining activities to be done
- Defining tools and equipment required to complete activities
- Defining the team to perform the activities

- Risk assessment
- Preparing reports and filing

Overhead conductors and accessories:

- Check distribution line conductors, jumpers. If less than three strands are found broken repair them by using aluminium spiral sleeves, above three broken strands repair shall be done using junction sleeves (al/st). No more than two joints shall be made in one span; in this case, replace all span conductor.
- Check looseness of jumper connections, insulator tie points, etc.
- Maintain proper sag tension and clearances (both vertical and horizontal, ground and internal) of line conductors. The clearance between phases must be equally distributed.
- Maintain the proper bush clearing.
- Check that all clamps, nuts and bolts are intact and in good condition.
- Check conductor bird caging.

Insulators:

- Check all insulators, if cracks are found, replace them.
- Replace cracked, broken line insulators.
- Check insulators alignment
- Measure insulation resistance....

Supporting structures (Poles, Towers):

- Check physical defects and mechanical deformations on pole/tower and cross arms
- Check rot/decay and major cracks for wooden poles
- Check verticality of line supports and associated structures.
- Check tower/poles footings and protect them from land sliding, soil erosion etc.
- Clean bird nests, darts, plants growth, on cross arms and structures.
- Check the corrosion on steel poles/tower and components (cross arms, fittings, etc.
- Check tightness of stay wires.
- Check if the structures are earthed and measure earth resistance as per design.

Underground cables (Underground Cables in Manholes, trenches and ducts)

- Inspect for sharp bends, physical damage, excessive tension, oil leaks in junction boxes, pits, cable movement, soft spots, cracked jackets(insulation), damaged fireproofing, poor ground connections, deteriorated and corroded or weakened cable supports.
- Inspect at entrance point and at supports cables.
- Inspect manhole for spalled concrete, proper ventilation and excessive moisture.
- Inspect potheads for oil or compound leakage.
- Examine the manhole and cable grounding system to ensure its tightness.
- Inspect an open manhole for dangerous animals and insects (snakes, bees)
- Check that erosion has not exposed the cable on surface. If yes, dig and burry the cable to safe depth
- Caution: Check for the smell of dangerous gases before entering any confined space such as a manhole.

At completion of inspection and test remove temporary grounds, restore equipment to serviceable condition and decommission equipment.

- Follow the protocol to re-energize the line
- Compare test results to previous maintenance test results

2.2.2. Distribution transformers

General

- Examine the transformer for signs of overheating, deterioration, arcing, lose or broken parts, or other abnormal conditions
- Check connections of bushings on MV & LV sides and cable between transformer & LV DB
- Check status of powerhouse & Cleanliness in the Substation location/transformer location
- Check earthing system (connection and resistance and ensure a value of 5 ohms or less)
- Check the status of LV distribution panel/ feeders pillar.
- Status of platform or H-pole (for outdoor installed transformer)
- Evaluate the findings on the regular preventive maintenance (status of oil, insulation, etc..) made

Liquid-Filled Transformer

- **Check for physical condition:**
  - Oil leakages
  - Oil level in the conservator tank
  - Breather condition/Silica Gel condition
  - Oil/winding temperature

- **Check the Transformer Protection (Monthly)**
  - MV fuses properly installed and sized
  - LV fuses properly installed and sized
  - LV Circuit breaker properly installed and sized
  - MV surge arrestors properly installed and grounded
- **Tests & Measurement (Once a Year)**
  - Insulation resistance
  - Turns ratio
  - Oil Breakdown Voltage (BDV)
  - Earth resistance measurement
  - Load measurement (for all phases)
  - Secondary Voltage measured
- **Overhaul Maintenance (2 Years)**
  - Dissolved gases analysis
  - Oil regeneration/purification
  - Servicing MV/LV bushings

2.2.3. Switching devices

- Check physical appearance of doors, devices, equipment and lubricate in accordance with manufacturer's instructions.
- Examine all bolts and connecting devices for signs of deterioration, corrosion, or overheating. Ensure that bolts and connecting devices are tight, according to manufacturer's specifications.
- Check the operation of the arc blades, if applicable, and ensure proper wipe of the main contacts.
- Ensure that all moving parts are properly secured and lubricated as specified by the manufacturer. Faulty switch is repaired or replaced as soon as possible.
- Check condition of contacts.
- Check condition of bussing for signs of overheating, moisture or other contamination, for proper torque, and for clearance to ground.
- Inspect insulators and insulating surfaces for cleanliness, cracks, (Check cable and wiring condition, appearance, and terminations.
- Inspect for proper grounding of equipment.
- Check evidence of severe arcing or burning of contacts.

- Check electrical operation of pilot devices, switches, meters, relays, auxiliary contacts, light(sound) indicators devices, flags, interlocks, cell switches, cubicle lighting. Visually inspect arrestors, CT's and PTs for signs of damage.
- Megger test insulators to ground.
- Megger test bus bar phase to ground, and phase to phase.
- Test contact resistance across bolted sections of bus bars.
- Check the cleanliness of the Switching device location
- Where applicable, check arc-quenching assemblies for carbon deposits or other contaminates.

2.2.4. Protective devices (Circuit breakers, Fuses)

Circuit breakers (air, vacuum, moulded-case, oil and SF6 circuit breakers), Fuses and Surge arrestors are important components in the network. They should be properly maintained.

Circuit Breakers

General

- Fundamentals maintenance practices shall always be done as recommended by Original Equipment Manufacturer

- Check physical appearance of the device
- Clean all insulating materials. If it is necessary to use cleaning solvents, use only solvents recommended by the manufacturer.
- Examine all bolts and connecting devices for signs of deterioration, corrosion, or overheating. Ensure that bolts and connecting devices are tight, per manufacturer's specifications.
- Check the operation of the arc blades, if applicable, and ensure proper wipe of the main contacts.
- Examine for excessive wear of moving parts.
- Observe that operating mechanisms function properly without binding, hanging, or without delayed action.
- Ensure any lubrication is done per the manufacture's specifications.
- Ensure that all moving parts are properly secured and lubricated as specified by the manufacturer. Faulty device is repaired or replaced as soon as possible.

- Check condition of contacts.
- Inspect insulating surfaces or bushings for cleanliness, cracks, chips, tracking.
- Check cable and wiring condition, appearance, and terminations.
- Inspect for proper grounding of equipment.
- Check evidence of severe arcing or burning of contacts.

- Check electrical operation of pilot devices, switches, meters, relays, auxiliary contacts, annunciator devices, flags, interlocks, cell switches, cubicle lighting. Visually inspect surge arrestors, CT's and PT's for signs of damage.
- Verify the current rating for circuit breakers and fuses as per the application
- Check the cleanliness of the Protective device location
- Check the insulating fluid measurement (level, density, pressure, temperature, moisture…) indicating devices for calibration and proper operation.
- Conduct a dielectric test of the insulating fluid. Based on the results of this test, filter or replace oil as required (per manufacturer's instruction).
- Where applicable, check arc-quenching assemblies for carbon deposits or other contaminates.
- Circuit breakers should be electrically trip tested to ensure proper operation of the trip elements and trip linkages.
- Check the auxiliary contacts.

Batteries

- The maintenance of each battery will be made according to the manufacturer service manual.
- Check voltage of each battery/cell, voltage for the bank, electrolyte level, specific gravity etc. as applicable to each type of battery
- Thoroughly clean all battery surfaces of dust and/or dirt accumulations.
- Remove any corrosion and tighten all terminal connections
- Clean battery studs and cable ends. On stranded cable, if ends are corroded, cut off ends or separate strands and clean internally.
- Clean all vent openings and ensure that they are free from obstructions
- Check charging and discharging capability of battery bank.

Charger

- If all cells consistently read low, check charger for proper operation.
- Clean all dust and/or dirt accumulations from charger.
- Clean all vent openings and ensure that they are free from obstructions.
- Check terminals and connections for tightness.
- Check all relays, lights, and other indicating devices for proper operation.
- If electrolyte levels are low, check charger rate settings against the manufacturer's specifications. Consistently low levels may indicate the charge rate is too fast.

Fuses

- Check cleanliness and appropriate contact
- Repair or replace as necessary

Surge arrestors

- Check cleanliness
- Check appropriate tightness
- Test the resistance of the surge arrestors
- Repair or replace as necessary

2.2.5. Protective relays

- Inspection, maintenance and testing of protective relays should be done as per the Manufacturer's recommendations
- **Notice**: when working on control circuits, all current transformer (CT) secondary should be shorted to ground and never left open-circuited.
- Inspect relays for physical damage and deterioration.
- Inspect gaskets and covers for damage and/or excessive wear.
- Examine and clean the relay and enclosure of foreign materials, such as dust, dirt, and moisture contamination.
- Check mechanism for freedom of movement, proper travel and alignment, and tightness of mounting hardware and plugs.
- Clean glass inside and out.
- Clean relay compartment as required.
- Clean relay plug in contacts, if applicable, using proper tools.
- Remove dust and foreign materials from interior of relay using small brush or low pressure.
- Remove rust or metal particles from disc or magnet poles with magnet cleaner or brush.
- Inspect for signs of carbon, moisture and corrosion.
- Repair or replace as necessary

Electrical Testing

- Using an appropriate testing instrument, suitable for the relays being tested, conduct electrical testing of the relays in accordance with manufacturer's recommendations
- For overcurrent relays, test the following functions of the relay at the established settings specified by the system engineer or manufacturer:
- The relays should be tested to ensure that operation of the relay will in fact cause a tripping action of the respective concerned elements.
- Pickup contacts should close when a current equal to the relay tap setting is applied to the induction coil. Adjust the spring as needed to allow for proper operation.
- Timing tests should be performed corresponding to two (2) or more points on the relay's time current curves. One of the tests should be done at the specified time dial setting.
- Strictly adhere to required procedures for system switching operations. Switching, de-energizing and energizing shall be performed by authorized personnel only.

- Completely isolate protective relays to be tested and inspected from sources of power.
- Use manufacturer's instructions for information concerning connections, adjustments, repairs, timing, and data for specific relay.
- Tests for typical overcurrent relays include:
- Zero check.
- Induction pick up
- Time-current characteristics.
- Target and seal-in operation.
- Instantaneous pickup.
- Check CT and PT ratios and compare to coordination data.
- Repair or replace as necessary

2.2.6. Earthing equipment

- Earthing and short-circuiting equipment shall be handled with great care and be thoroughly inspected before each application.
- Earthing equipment must be checked regularly per the checklist below to ensure that the tools work safely and reliably.
- An extensive inspection, shall be carried out periodically:
- Check for signs of corrosive damage to contact surfaces online clamps/Earth clamps. If defected, the surfaces must be cleaned. If heavy corrosion is detected the clamps should be replaced.
- Check the cable lug’s connection to the clamp - the screw must be firmly tightened and the cable lug firmly attached.
- Check for breaks on cable lugs. Damaged cable lugs must be replaced. Twisted (not broken) cable lugs can be adjusted to the correct position. After this, check for breaks and check the tightening torque.
- Check that no cable strands are damaged. If a strand is damage the cable should be re-pressed.
- Check for any damage on the cables. A damaged cable (strand breakage) must be replaced.
- Insulating poles must be free of moisture and contamination.

2.2.7. MV Surge arrestors

Periodically visually inspect to ensure that:

- The arrester is set at proper spacing and clearance
- The line lead is securely fastened to the line conductor and the arrester
- The ground lead is securely fastened to the arrester terminal and ground
- Check the earth resistance is below 5 ohms
- The arrester housing is clean and free from cracks, chips, or evidence of external flashover

The arrester is in such a manner as not to be subject to:

- Excessive dirty or other current-conducting deposits
- Excessive humidity, moisture, dripping water, steam, spray abnormal vibrations or shocks
- Where an arrester is composed of two or more individually complete units, test each unit separately to allow bad unit replacement and retaining good units

2.2.8. LV Distribution boxes

- Check physical conditions for dirt and other rubbish, locks, rust
- Check safety conditions for public
- Check the neutral connections and bus bars are insulated from ground
- Check the connections on circuit breakers for loose, burnt conditions
- If installed, LV surge arrestors must be checked and replaced if faulty
- Check cable supports
- Check feeders circuit breaker or/and fuses for correct current ratings and replace the faulty one by the one with correct ratings

2.3. LV DISTRIBUTION NETWORK MAINTENANCE

- Maintain standard clearance of LV ABC Cables to ground, buildings, vegetation, bushes, etc.

- Maintain standard span between poles and their standards pole length
- Check physical deformation of cables
- Check cracks, broken and Rotten poles
- Check of pole foundations and pole's location dangers
- Check Intact of stay assembly and strut poles
- Maintain voltage and current balancing
- Maintain and measure the voltage at the farthest client from transformer.
- Check looseness/tightens all cables connections and their accessories.
- Check the status of all line hardware (clamps, stud bolts, insulators, insulation piercing connectors, etc.)
- Check illegal extensions and connections, Disconnect them
- Check the status and sizes of fuses, CBs, ABC cables and underground cables
- Check operation of metering system
- Check Earthing system for LV DB and for first LV pole

RIGHT OF WAY

- Cut trees and clean bushes & creepers along corridors of distribution lines.
- Check and report the existence of houses and other obstacles inside the Right of Way corridor

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5. RS 370 (EAS 506): Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1.2 kV) up to 30 kV (Um = 36 kV), Part2: Cables for rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV)
6. RS 449:2009 (IEC 61558): Safety of Power transformers, power supply units and similar - General requirements and tests
7. RS 474-1: Power installations exceeding 1 kV ac Part 1: Common rules
8. RS 590:2012 - Concrete poles for telephone, power and lighting purposes – Specifications
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10. RS IEC 60227-1:2006: Polyvinyl chloride insulated cables of rated voltages up to and including 450/750V
11. RS IEC 60433: Insulators for overhead lines with a nominal voltage above 1 000 V — Ceramic insulators for A.C systems — Characteristics of insulator units of the long rod type
12. RS IEC 60826**:** Design criteria of overhead transmission lines
13. RS IEC 61466: Composite string insulator units for overhead lines with a nominal voltage greater than 1 000 V
14. RS IEC 61865: Overhead lines — Calculation of the electrical component of distance between live parts and obstacles — Method of calculation
15. RS IEC 61952: Insulators for overhead lines — Composite line post insulators for AC with a nominal voltage greater than 1000 V
16. SOFRECO, Design Standards and Guidelines for EARP Rural Electrification Projects, 2013
17. IEEE Std 1410TM – 2010, IEEE Guide for Improving the Lightning Performance of Electric Power Overhead Distribution Lin

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PART THREE: ANNEXES

ANNEX 1: NETWORK PLANNING AND DEVELOPMENT FORMS

- Project Survey Form
- Project Design and Appraisal Report
- Site Handover Certificate
- Request for Testing and Commissioning
- Testing and Commissioning Report for Low Voltage Line
- Testing and Commissioning Report for Medium Voltage Line
- Testing and Commissioning Report of Transformers
- Hand-Over Certificate of Low Voltage Line
- Hand-Over Certificate of Mv Voltage Line
- Hand-Over of Transformers
- GISAs-Built Data Forms
- GIS As Built Data of Customer Identification
- MV Line GIS as Built Data of Electricity Network Line and Equipment
- Poles Schedule for MV Line
- Poles Schedule for LV Line

PROJECT SURVEY FORM

Name of Project:		
Project implementer and Owner/beneficiary:	**Name of Implementer:**	**Name of Owner / beneficiary:**
REG Branch name		
Project location (Districts, Sectors, Cells, and Villages etc.)		
Length of surveyed line (MV/LV)		
Estimated Client(s) load in KW/KVA		
Proposed Transformer capacity in KVA		
Name of the main substation that supplies the area		
Main Feeder Name / nearest sub-feeders		
Existing Feeder Conductor type and Size (mm^2)		
Distance of new load from the main substation		
Is this Project in line with the Master Plan Guidelines for Network Development?	Yes/No	

	Will this Project require expropriation?	Yes / No If yes, briefly describe the case
	Is there any potential technical, Environmental and Social risk to be mitigated?	If yes, briefly describe the risk and proposed mitigation measures
	Remarks: …………………………………………………………………………………………… ……………… ……………………………………………………………………………………………	
	SURVEY TEAM	

NAMES	COMPANY	POSITION /CONTACT	SIGNATURE AND DATE

PROJECT DESIGN AND APPRAISAL REPORT	
Name of Project	

High Level Cost Estimates (budget)		
Type of support structures (concrete, wood, steel etc.…)		
Project implementer and Owner/beneficiary	**Name of Implementer:**	**Name of Owner/beneficiary:**
Project Investigation Information		
Name of the main substation that supplies the area		
Main Substation Transformer Capacity (MVA)		
Maximum peak ever recorded on the main Substation/transformer where new load will be connected		
Additional Capacity available to serve the new load (from the main substation/transformer)		
Main Feeder Name		
Feeder Conductor type and Size (mm^2)		
Estimated feeder carrying Capacity (MVA)		
Distance of new load from the main substation		
Estimated Load to be added on the network (MVA)		
Medium Voltage (MV) and Low voltage (LV) line length added to the network (km)	MV (km): LV (km):	

Number of Distribution transformers added to the Network	
Estimated number of customers	Customers: ……. ○ Three phases: …………. ○ Single phase: ……….
New Conductor type and size to be installed (mm^2)	
Load flow studies performed	Yes/No Name of the person who did load flow.
Simulated voltage at load (kV)	
Simulated voltage at end of the MV line	
Substation peak loading with new load (MVA)	
Is this Project in line with the Master Plan Guidelines for network development?	Yes/No
Additional requirements or conditions for technical approval?	○ **EIA Certificate:** Required / Not Required ○ **Construction permit:** Required / Not Required Etc…
Name of Design Engineer	**Position** **Signature and Date**
FOR APPROVAL	
Is this Project technically approved? If no, please highlight what needs to be done prior to approval with recommendations for re-submittal.	**Yes/No** **Required additional details:**

NAME	**POSITION**	**SIGNATURE AND DATE**

SITE HAND OVER CERTIFICATE		
Name Of Project		
Contract Reference		
Name Of Implementer / Contractor		
Expected Date Of Completion		
REG Branch Name		
Brief description of the works (high level project scope).		
Is contractor's site mobilization and quality plans in place?	Yes /no	
Will project require expropriation?	Yes /no	Status of expropriation:
Was environmental impact assessment done?	Yes /no	
Are Land title/construction permits etc. required and available?	Yes /no	
Was a safety briefing done by REG?		

<table>
<tr><td rowspan="3">Are there potential safety risks identified on site? Name those.</td><td>Potential risk</td><td>Mitigation measures</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Were switching procedures explained to the Implementer / Contractor?</td><td colspan="2"></td></tr>
<tr><td colspan="3">Declaration</td></tr>
<tr><td>Parties declare that information provided in this site hand over certificate is true and correct and provide enough information for the purposes of site hand over</td><td colspan="2">Observations (if any)</td></tr>
<tr><td colspan="3">SIGNATURES</td></tr>
<tr><td colspan="3">For REG</td></tr>
<tr><td>NAMES</td><td>POSITION</td><td>SIGNATURE AND DATE</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">For Contractor/REG Project Manager</td></tr>
<tr><td>NAMES</td><td>POSITION</td><td>SIGNATURE AND DATE</td></tr>
</table>

REQUEST FOR TESTING AND COMMISSIONING	
Project Name	
Contract Reference	
Name of Contractor/ Implementer	
Project budget at completion	
REG Branch name	
Date of Works Completion	
Was final inspection done by REG for the works?	
Were the works completed according to specifications and scope	
Were Materials and Labour reconciliation done?	
Are the Works ready for testing and commissioning?	

Will commissioning require an outage?	Yes/No	Where will switching be done?
Feeders /sub-feeders that will be affected		
Estimated outage duration		
Is the site restored/cleared to satisfaction?		
Requested date for Testing and Commissioning?		
Does the Contractor have all test Equipment for testing?		

FOR REG

Request for Testing received by

NAME	POSITION	SIGNATURE AND DATE

Testing & Commissioning approval

Date for Testing & Commissioning
From………………………………..….. / to ………………. …………

NAME	POSITION	SIGNATURE AND DATE

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TESTING AND COMMISSIONING REPORT FOR LOW VOLTAGE LINE	
Name and capacity of MV/LV Transformer:	
PROJECT BASIC DATA	
Project Implementer/Contractor:	
Project location/REG Branch:	
Warranty / guarantee period and start date:	
Three phase or single phase (specify) line	
Length of the line (km)	
Cable type and size (mm^2)	
Are the foundations proper and aligned to support used structures?	
Size of Circuit breaker protecting the cable	
Overall LV Earthing resistance (Value in Ohm $\leq$10 Ohm)	
Before connection or Energizing: Resistance in Mega Ohm	
Phase 1 - Phase 2:	

Phase 1 - Phase 3:	
Phase 2 – Phase 3:	
Phase 1 - Neutral:	
Phase 2 - Neutral:	
Phase 3 - Neutral:	
After Energizing: Voltage measured at the LV DB (Volts)	
Phase 1 - Phase 2:	
Phase 1 - Phase 3:	
Phase 2 – Phase 3:	
Phase 1 - Neutral:	
Phase 2 - Neutral:	
Phase 3 - Neutral:	
After Energizing: On-load Voltage measured at the end of the line (Volts)	
Phase 1 - Phase 2:	
Phase 1 - Phase 3:	
Phase 2 – Phase 3:	
Phase 1 - Neutral:	
Phase 2 - Neutral:	
Phase 3 - Neutral:	

FOR CONTRACTOR / IMPLEMENTER

NAME	POSITION	SIGNATURE AND DATE

PROJECT MANAGEMENT / SUPERVISION / USER		
NAME	**POSITIONS**	**SIGNATURE AND DATE**
REG BRANCH / HUB		
NAME	**POSITIONS**	**SIGNATURE AND DATE**

TESTING AND COMMISSIONING REPORT FOR MEDIUM VOLTAGE LINE	
PROJECT BASIC DATA	
Project Name	
Contract Reference	
Name of Contractor / Implementer	
REG Branch name	
Three phase or single phase (specify):	

Length of the line (km):		
Conductor type and size:		
MV earthing resistance at the transformer (Value in Ohm ≤ 5 Ohm)		
Before Connection or Energizing: Resistance in Mega Ohm		
Phase 1 - Phase 2:		
Phase 1 - Phase 3:		
Phase 2 – Phase 3:		
Phase 1 – Shield wire / Ground:		
Phase 2 - Shield wire / Ground:		
Phase 3 - Shield wire / Ground:		
FOR THE CONTRACTOR / IMPLEMENTER		
NAME	**POSITIONS**	**SIGNATURE AND DATE**
PROJECT MANAGEMENT / SUPERVISION / USER		

NAME	POSITIONS	SIGNATURE AND DATE
REG BRANCH / HUB		
NAME	**POSITIONS**	**SIGNATURE AND DATE**

TESTING AND COMMISSIONING REPORT OF TRANSFORMERS	
Project Name	
Contract Reference	
Name of Contractor/ Implementer	
REG Branch name	
Transformer name	
Manufacturer	

Type of Transformer (Single or Three phase)	
Transformer size (kVA)	
Configuration (H pole mounted/cabin, etc.)	
Transformer tap setting	
INSULATION RESISTANCE TEST Ensure that the earth resistance has been tested and is acceptable **(≤5Ω)**. a) Ensure all electrical connections have been disconnected, including MEN/N-E connections. **b)** Measure the insulation resistance test results after 1 minute of testing.	

Insulation resistance test on the transformer winding			
Test Connection	**Test Voltage**	**Resistance**	**Expected Values**
Primary/high voltage (HV) to tank	2.5 Kv	Ω	>1 GΩ
Primary/HV to secondary/LV	1 kV	Ω	>100 MΩ
Secondary/LV to tank	1 kV	Ω	>100 MΩ
Insulation resistance test on the low voltage (LV) board busbar (LV fuse ways open, including the transformer LV disconnector)			
Phase 1 to Phase 2	1 kV	Ω	>100 MΩ
Phase 1 to Phase 3	1 kV	Ω	>100 MΩ
Phase 2 to Phase 3	1 kV	Ω	>100 MΩ

Phase 1 to Earth	1 kV	Ω	>100 MΩ
Phase 2 to Earth	1 kV	Ω	>100 MΩ
Phase 3 to Earth	1 kV	Ω	>100 MΩ

1. INSTALLATION AND CONSTRUCTION CHECKS	
Item	**YES/NO**
Transformer installed as per construction standards and applicable design drawings.	
Transformer matches system voltage.	
Transformer tap is at the position as per network planning.	
Transformer oil level satisfactory (if visible).	
Transformer bushings and tank in good condition (no oil leaks).	
Primary / HV cables properly terminated and connected.	
Secondary / LV cables properly terminated and connected.	
Neutral connected and earthed and MEN/N-E link connected. (multiple Earthed Neutral/Neutral-earthed)	
2. ENERGIZATION OF TRANSFORMER	
Check the MV Fuses are well calibrated	
Open the LV Breaker (Off position)	
Energize the transformer as per REG procedures	

Secondary voltage measurements off load (Volts)	
Phase 1 - Phase 2:	
Phase 1 - Phase 3:	
Phase 2 – Phase 3:	
Phase 1 - Neutral:	
Phase 2 - Neutral:	
Phase 3 - Neutral:	
Close the LV Circuit Breaker: Secondary voltage measurements on load (Volts)	
Phase 1 - Phase 2:	
Phase 1 - Phase 3:	
Phase 2 – Phase 3:	
Phase 1 - Neutral:	
Phase 2 - Neutral:	
Phase 3 - Neutral:	
Load at commission in Amperes (A):	
I_1	
I_2	
I_3	
Transformers Protection	
MV Earth resistance for Transformer in Ohms (≤5 Ohm):	
MV Earth resistance for Transformer in Ohms (≤5 Ohm):	
Earth resistance for Low voltage distribution board in Ohms (≤5 Ohm):	

Colour of Silica Gel	

CONTRACTOR / IMPLEMENTER		
NAME	**POSITION**	**SIGNATURE AND DATE**
PROJECT MANAGEMENT / SUPERVISION / USER		
NAME	**POSITION**	**SIGNATURE AND DATE**
REG BRANCH / HUB		
NAME	**POSITION**	**SIGNATURE AND DATE**

Rwanda Energy Group REG

HAND-OVER CERTIFICATE OF LOW VOLTAGE LINE						
PROJECT BASIC DATA						
Transformer name and Capacity:						
Project implementer/contractor:						
Project location/REG Branch:						
Warranty/guarantee period and start date:						
Warranty/guarantee period and end date:						
Three phase or single phase (specify):						
Length of the line (km)						
type and size of cable (mm^2)						
Size of Circuit breaker protecting the cable (A)						
Wooden poles (length and number)	Type & length	S100 (9 m)	S140 (9 m)	S190 (9 m)	S225 (9 m)	Other indication
	Nbr					
Concrete poles (length and number)	Type & length	..daN …… m	…daN … m	….daN … m	..daN … m	... daN …… (m)
	Nbr					

Steel poles (length and number)	Type & length	…..daN …… m	...daN … m	...daN … m	..daN … m	... daN …… (m)
	Nbr					
Information on service connections (if applicable)						
Number of three phase connections:						
Number of single-phase connections:						
Number of Households:						
Number of Schools:						
Number of Administrative offices						
Number of Health Centres:						
Number of Business Centres						
Details of low voltage distribution panel:						
Dimension (Length x Width x Height):						
Ratings of LV fuse for outgoing feeder						
Number of outgoing low voltage feeders:						
Rated current for Main Circuit breaker (**A**):						
Current Setting of Circuit breaker (**A**)						

Size of the cable from transformer to Distribution board		
Was As-built drawings with all GIS information submitted?		
Other useful information/ Comments / Observations related to the project:		
CONTRACTOR/IMPLEMENTER		
NAME	**POSITION**	**SIGNATURE AND DATE**
PROJECT MANAGEMENT AND SUPERVISION		
NAME	**POSITION**	**SIGNATURE AND DATE**
REG BRANCH AND HUB		
NAME	**POSITION**	**SIGNATURE AND DATE**

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<table>
<tr><th colspan="6">HAND-OVER CERTIFICATE OF MEDIUM VOLTAGE LINE</th></tr>
<tr><td colspan="6">PROJECT BASIC DATA</td></tr>
<tr><td>Project implementer / contractor:</td><td colspan="5"></td></tr>
<tr><td>Project location / REG Branch:</td><td colspan="5"></td></tr>
<tr><td>Warranty/guarantee period and start date:</td><td colspan="5"></td></tr>
<tr><td>Warranty/guarantee period and end date:</td><td colspan="5"></td></tr>
<tr><td>Voltage level (kV):</td><td colspan="5"></td></tr>
<tr><td>Length of the MV line (km)</td><td colspan="5"></td></tr>
<tr><td>Size of conductor (s)</td><td colspan="5"></td></tr>
<tr><td rowspan="2">Wooden poles (length and number)</td><td>Type & Length</td><td>S….
....m</td><td>S….
…..m</td><td>S….
…..m</td><td>S….
…..m</td></tr>
<tr><td>Nbr</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Concrete poles (length and number)</td><td>Type & Length</td><td>…daN
… m</td><td>…. daN
…. m</td><td>….daN
… m</td><td>... daN
… m</td></tr>
<tr><td>Nbr</td><td></td><td></td><td></td><td></td></tr>
</table>

Steel poles (length and number)	Type & Length	…daN … m	…. daN …. m	….daN … m	... daN … m
	Nbr				
Pylon/Tower structures length and number	Type				
	Nbr				
Ground Shield wire installed (yes/No):					
Number of Transformers installed (complete list attached for each transformer)					
Number of three phase transformers installed					
Number of single phase Transformers installed					
List of switching/protective devices installed and number (i.e. auto re-closer, line disconnector, Drop out fuse, surge arrestors etc…) (use a separate list if more):					
1					
2					
3					
4					

5	
Details of the main feeder:	
Main feeder: (where the line is connected)	
HV/MV substation where the main line is supplied from:	
Conductor type and size of the main line/feeder:	
Actual load of the main line	
Was As-built drawings with all GIS information submitted?	
Other useful information	
FOR CONTRACTOR/IMPLEMENTER/USER APPROVAL	

NAME	POSITION	SIGNATURE AND DATE
FOR REG APPROVAL		

NAME	POSITION	SIGNATURE AND DATE
REG BRANCH AND HUB		
NAME	**POSITION**	**SIGNATURE AND DATE**

HAND-OVER OF TRANSFORMER	
Transformer name	
Transformer Phases	
Transformer size (kVA)	
Size of LV Breaker (A)	
Current setting of LV Breaker (A)	
Configuration (pole mounted/cabin, etc.)	
Manufacturer	
Serial Number	

Cooling System (ONAN/ONAF/OFAF)	
Manufacturing Date	
Commissioning Date	
Vector Group	
Number of Taps	
Tap positions available (%)	

FOR CONTRACTOR/IMPLEMENTER/USER APPROVAL

NAME	POSITION	SIGNATURE AND DATE

FOR REG APPROVAL

NAME	POSITION	SIGNATURE AND DATE

GIS AS-BUILT DATA FORMS

To keep the REG GIS Database update, all Contractors and all Departments who touch on the Network must submit as-built data (in GIS format: Shape file and/or GDB) after completion of project in addition to all other required documents. These data should be reported to the Unit in charge of Geographical Information System (GIS). The following projection should be respected as it is the one used in the REG ArcGIS system:

- Coordinate system: GCS_ITRF_2005 or GCS WGS 1984 (as indicated in the contract)
- Projection: Transverse Mercator
- Datum: D_ITRF_2005 or WGS 1984 (as indicated in the contract)

- False Easting: 500,000.0000
- False Northing: 5,000,000.0000
- Central Meridian: 30.0000
- Scale Factor: 0.9999
- Latitude of origin: 0.0000
- Units: Meter

Information to be collected on new assets or lines introduced in Network shall include. But not limited to the following

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REG

CUSTOMER IDENTIFICATION	
Location	District: …………………….. Sector: ……………….. Cell: ………………………… Village: ……………..
Landlord Name	
Landlord contact (phone)	
Landlord ID	
Tenant Name	
Tenant contact (phone)	
Plot Number	
House number	
Street number	
Customer Segmentation (mark which is appropriate)	Residential
	Commercial
	Hotel
	Apartment
	Public services
	Small industry
	Large industry

	Diplomat
Meter Number	
POC Number	
Meter Type	Electromechanical
	Electronic
Meter Category	Single phase
	Three phase
	High current
	Connected via current/voltage transformers
Payment Method	Prepaid
	Post-paid
Transformer Name	
POC Label	
GPS Coordinates of the customer	
POC (POINT OF CONNECTION)	
Pole Type	LV MV HV
Pole Number	

Pole Structure	Wood Steel Concrete Pylon Local wood Local tube Other
Cable Underground	Yes No
Transformer Name	
POC Label	
GPS Coordinates of the POC	

GIS AS BUILT

TEMPLATE FOR THE DISTRIBUTION NETWORK COMPONENTS

Network Component	Attribute	Data type	Domain
Transformers	Substation	Text	
	MV Feeder	Text	
	Name TRF	Text	
	Pole/Pylon Number	Text	
	Capacity (kVA)	Float	
	Phases	Text	Single phase Bi-phase

			Three phase
	Support TRF	Text	Single Steel
			Single Wooden
			Single Concrete
			PH Steel
			PH Wooden
			PH Concrete
			Soclet
			Ground Concrete
			Pylon
			Cabin
	Serial No	Text	
	Barcode /Tag number	Text	
	Primary Voltage (kV)	Float	
	Secondary Voltage (kV)	Float	
	Primary Current (Amp)	Float	
	Secondary Current (Amp)	Float	
	LV_CB(Amp)	Float	
	Type of Switch	Text	Sectionnaire
			Dropout
			MV switchgear
	Owner	Text	
	Manufacturer	Text	
	Country Manufacturer	Text	

	OIL_INDICATOR	Text	Yes
			No
	Number of tap position	Text	3
			5
	Total mass	Float	
	OIL_WEIGHT	Float	
	Smart meter	Text	Yes
			No
	Smart meter S/N	Text	
	COOLING_SY	Text	ONAN
			OFAN
			Not
	VIDANGE_VA	Text	Yes
			No
	S_SILCAGEL	Text	Yes
			No
	Year_Manufacturer	Text	
	Maintenance Date	Date	
	Branch Name	Text	
	Notes	Text	
	Photo_TRF		

	X		
	Y		
	Attribute	**Data type**	**Domain**
Medium_Voltage_Lines	Substation Name	Text	
	Feeder Name	Text	
	Voltage (kV)	Float	30
			15
			17.32
			6.6
	Conductor type	Text	ACSR
			AAAC
			CU
	Conductor Size ASCR_AAAC	Text	120_20
			70_12
			35_6
			35_5
	Conductor Size AAAC	Text	54.6
	Phases	Text	Single phase
			Bi-phase
			Three phase
	Type	Text	Overhead
			Underground

	Currying capacity (A)	Text	170
			175
			290
			410
	Fiber optical	Text	OPGW
			ADSS
	Branch name	Text	
	Construction date	Date	
	Commissioning date	Date	
	Maintenance date	Date	
	Feeder Smart meter	Text	Yes
			No
	Feeder meter S/N	Text	
	Length	Float	
	Notes	Text	
	X		
	Y		
LV_Lines	**Attribute**	**Data type**	**Domain**
	Substation Name	Text	
	Feeder Name	Text	
	Transformer Name	Text	
	Voltage (kV)	Float	400

			242
			230
	Type	Text	Overhead
			Underground
	Conductor Size OH	Text	2*16mm2,
			2*25mm2,
			2*35mm2,
			4*16mm2
			4*25mm2,
			4*35mm2,
			4*50mm2
			4*70mm2
			4*75mm2
			4*95mm2
			4*120mm2
	Conductor size UG	Text	4*50mm2
			4*70mm2
			4*95mm2
			4*120mm2
	Conductor type	Text	Al twisted
			Cu
	Phases	Text	Single phase

			Biphase
			Three phase
	Branch name	Text	
	Length	Float	
	Year of commissioning	Date	
	Construction date	Date	
	Maintenance date	Date	
	Fiber type (ADSS only)	Text	Yes
			No
	Notes	Text	
	X		
	Y		
Optical joint closure support	**Attribute**	**Data type**	**Domain**
	Pole number	Text	
	Feeder name	Text	
	Fiber owner	Text	MTN
			LIQUID
			ORN
	Feeder type	Text	HV
			MV
			LV
	Fiber type	Text	OPGW

			ADSS
	X		
	Y		
Medium_Voltage_Support	**Attribute**	**Data type**	**Domain**
	Feeder Name	Text	
	Substation Name	Text	
	Transformer Name	Text	
	Pole Number	Text	
	Type	Text	Pylon
			Pole
	Pole Structure	Text	Wooden
			Steel
			Concrete
			Not traited wooden
			Local tube
			Others
	Conductor Size ASCR	Text	120_20
			70_12
			35_6
			35_5
	Conductor Size AAAC	Text	54.6
	Pylon structure	Text	Alignment A,

			Alignment A+2,
			Alignment A+4,
			Alignment A+6,
			Angle TA,
			Angle TA1,
			Angle TA2,
			Angle TAT,
			Special TAS,
			Special TAS+2,
			Special TAS+4,
	Dressing type/Insulator	Text	Suspension
			Strain
			Terminal
			T-off from strain
			T-off from suspension
			Cross from strain
			Cross from suspension
	Pole Height (m)	Integer	
	Smart meter	Text	Yes
			No
	DMS Centraliser (default detector)	Text	
	Manufacturer	Text	

	Year of Installation	Integer	
	Appended Cable	Text	Fiber
			Earthing
			Stay
			Flying stay
	Construction type	Text	Horizontal
			Vertical
			Flat Spacing Arrangement (Nappe Voûte)
	Country of Manufacturer	Text	
	Year of Manufacturer	Integer	
	Construction date	Date	
	Maintenance date	Date	
	X		
	Y		
LV_Support	**Attribute**	**Data type**	**Domain**
	Substation Name	Text	
	Feeder Name	Text	
	Name TRF	Text	
	Type	Text	Wooden
			Steel
			Concrete

			Pylon
			Not treated wooden
			Local tube
			MV Pole
			Others
	Structure	Text	Single wooden
			Single concrete
			Single steel
			HP wooden
			HP concrete
			HP steel
	Conductor size	Text	2*16mm2,
			2*25mm2,
			2*35mm2,
			4*16mm2
			4*25mm2
			4*35mm2
			4*50mm2
			4*70mm2
			4*75mm2
			4*95mm2
			4*120mm2

	Dressing type/Insulator	Text	Suspension
			Strain
			Terminal
			T-off from strain
			T-off from suspension
			Cross from strain
			Cross from suspension
	Height (m)	Integer	9
			10
			12
			Other
	Appended Cable	Text	Fiber
			Earthing
			Stay
			Flying stay
	Manufacturer	Text	
	Year_Manufacturer	Integer	
	Country Manufacturer	Text	
	X		
	Y		
	Notes	Text	
Distribution box	**Attribute**	**Data type**	**Domain**

	Distributer name (end user) 1	Text	
	Distributer name (end user) 2	Text	
	Distributer name (end user) 3	Text	
	Distributer name (end user) 4	Text	
	Transformer name	Text	
	LV CB (Amp) /Disjoncteur	Float	
	Pole Number	Float	
	Notes	Text	
	X		
	Y		
POC LV Pole	**Attribute**	**Data type**	**Domain**
	Pole Type	Text	Wooden
			Steel
			Concrete
			Not traited wooden
			Local tube
			Others
	Pole Structure	Text	Single wooden
			Single concrete
			Single steel
			HP wooden
			HP concrete

			HP steel
	Conductor size	Text	2*16mm2
			2*25mm2
			2*35mm2
			4*16mm2
			4*25mm2
			4*35mm2
			4*50mm2
			4*70mm2
			4*75mm2
			4*95mm2
			4*120mm2
	Conductor type	Text	Al twisted
			CU
	Service cable type	Text	Overhead
			Underground
	Service cable size	Text	
	Transformer Name	Text	
	POC Label	Text	
	Installation date	Text	
	Notes	Text	
	Y		

	X		
MV Protection and MV switching	**Attribute**	**Data type**	**Domain**
	Site name	Text	
	Substation Name	Text	
	Feeder Name	Text	
	Device Type	Text	Autorecloser
			Disconnector
			Cutout
			Load breaker switches
			MV circuit breaker
	Phases	Text	Single phase
			Biphase
			Three phase
	Rated Current (Amp)	Float	
	Support Type	Text	Tower
			HP Poles
			Single Pole
	Point of reconfiguration/switching element	Text	yes
			Not
	Pole number	Integer	
	Manufacturer	Text	
	Country of Manufacture	Text	

	Year of installation	Date	
	Notes	Text	
	X		
	Y		
Substation	**Attribute**	**Data type**	**Domain**
	Substation Name	Text	
	Substation type	Text	Switching
			T-OFF
	Number of Transformers	Integer	
	Weight of transformer 1 (Ton)	Float	
	Weight of transformer 2	Float	
	Weight of transformer 3	Float	
	Configuration of transformer 1	Text	
	Configuration of transformer 2	Text	
	Configuration of transformer 3	Text	
	Serial number 1	Text	
	Serial number 2	Text	
	Serial number 3	Text	
	Smart meter transformer 1 (S/N)	Text	
	Smart meter transformer 2 (S/N)	Text	
	Smart meter transformer 3 (S/N)	Text	
	Smart meter line 1 (S/N)	Text	

	Smart meter line 2 (S/N)	Text	
	Smart meter line 3 (S/N)	Text	
	Capacity of TRF /Power rating (MVA)	Integer	
	Primary Voltage Transformer 1(kV)	Float	
	Secondary Voltage Transformer 1(kV)	Float	
	Primary Voltage Transformer 2(kV)	Float	
	Secondary Voltage Transformer 2(kV)	Float	
	Primary Voltage Transformer 3(kV)	Float	
	Secondary Voltage Transformer 3(kV)	Float	
	Transformer maintenance date	Date	
	Year of Commissioning	Date	
	Year of Manufacturer 1	Date	
	Year of Manufacturer 2	Date	
	Year of Manufacturer 3	Date	
	Manufacturer 1	Text	
	Manufacturer 2	Text	
	Manufacturer 3	Text	
	Country of Manufacture 1	Text	
	Country of Manufacture 2		
	Country of Manufacture 3		
	MV switchgears	Text	Single busbar
			double busbar

	Busbar	Text	conductor
			tubular
	Auxilliaire supply	Text	transformer
			earthing transformer
	Incoming feeder (Names & number) 1	Text	
	Incoming feeder (Names & number) 2	Text	
	Incoming feeder (Names & number) 3	Text	
	Outgoing feeder (Names & number) 1	Text	
	Outgoing feeder (Names & number) 2	Text	
	Outgoing feeder (Names & number) 3	Text	
	Switchgear maintenance date	Date	
	SCADA	Text	RTU
			PLC
	Optical fiber	Text	BG20
			NPT
	ODF	Integer	
	ODF Used	Integer	
	ODF Users	Text	
	Transformer tap changer	Text	On load
			Off load
	Tap changer manufacturer	Text	
	Tap changer serial number	Text	

	Tap changer year of manufacturer	Date	
	Tap changer number of positions	Integer	
	Transformer mass oil	Float	
Street light Pole	**Attribute**	**Data type**	**Domain**
	Transformer name	Text	
	Feeder name	Text	
	Type of pole street light pole	Text	Steel
			Wooden
			Concrete
	Conductor type of street light	Text	Al twisted
			Cu
	Conductor size of street light	Text	2*16mm2,
			2*25mm2,
			2*35mm2,
			4*16mm2
			4*25mm2,
			4*35mm2,
			4*50mm2
			4*70mm2
			4*75mm2
			4*95mm2
			4*120mm2

		Text	4*50mm2
			4*70mm2
			4*95mm2
			4*120mm2
	Power of LED	Integer	
	Notes	Text	
	X		
	Y		
Capacitor bank / DMS	**Attribute**	**Data type**	**Domain**
	Name	Text	
	Id	Float	
	Phase	Text	Single phase
			Bi-phase
			Three phase
	Rated kV	Float	
	Base kV	Float	
	Connection Type		
	Nominal kVAR1	Integer	
	Nominal kVAR2	Integer	
	Nominal kVAR3	Integer	
Regulator tap change	**Attribute**	**Data type**	**Domain**

	Name	Text	
	ID	Float	
	Phase	Text	Single phase
			Bi-phase
			Three phase
	Rated KV	Float	
	Base KV	Float	
	Rated Amps	Float	
	Connection Type		
	Delta Open Phase	Text	
	Standard Rotation	Text	
	Regulation Type	Text	
	Bidirectional	Text	
	Control Phase	Text	
	Desired Voltage	Text	
	Tap Side	Text	
	Initial Tap1	Text	
	Initial Tap2	Text	
	Initial Tap3	Text	
	Bandwidth	Text	

ANNEX 2: CHECKLISTS FOR NETWORK DISTRIBUTION MAINTENANCE

- Inspection check list for MV concrete poles
- Inspection check list for MV steel poles
- Inspection check list for MV pylon/Latticed towers
- Inspection check list for MV wooden poles
- Inspection check list for MV conductors
- Inspection check list for MV/LV distribution transformers
- Inspection check list for disconnect switch, drop out, fuse, auto-recloser
- LV Distribution line

INSPECTION CHECKLIST FOR MV CONCRETE POLES

Name of Main feeder/Location: …………………………………

T-Off Location: ……………………………………………………………….................................

Size and type of Conductor: ………………………………………

Length of the feeder…………………………………………………….

REG Branch: ………………………………………………………….

Sn	Pole Number / Identification	Length of poles	Apparent defects (Broken, cracked, Steel bars exposed...)	Foundation status (Cracks broken, etc.)	Pole Straightness, bending	Stay wire status (Normal position, Loosened, Broken	Insulators and accessories (Broken or cracked, Missing disc, Not well fitted, Not aligned, Burnt…)	Cross arm apparent defects (Rusted, Not well positioned, loose of bolts & nuts, Rust, Bent)	Surge arrestors (Loose connection, Not grounded…)	Other comments/ recommendations
1										
2										
3										

DATA COLLECTED BY:

Names	**Position**	**Signature and date**

APPROVED BY:

Names	**Position**	**Signature and date**

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INSPECTION CHECKLIST FOR MV STEEL POLES

Name of Main feeder/Location: ……………………………………..…

T-Off Location: ……………………………………………………….

Size and type of Conductor: ………………………………………..

Length of the feeder………………………………………………..

.REG Branch: ………………………………………………………..

Sn	Pole Number/Identification	Pole/Type Length (S140, S190, S255, S315…)	Apparent, defects (Rusted, sheltered by bees and covered by creepers etc.)	Pole Foundation status (Cracks, broken, etc.)	Pole Straightness, bending	Stay wire status (Normal position, Loosened, Broken)	Cross arm apparent defects (Rusted, Not well positioned, loose of bolts & nuts, Bent)	Status of Insulators and accessories (Broken or cracked, Missing disc, Not well fitted, Not aligned, Burnt, etc.)	Other Comment/ Recommendations
1									
2									
3									

DATA COLLECTED BY:

Names	**Position**	**Signature and date**

APPROVED BY:

Names	**Position**	**Signature and date**

INSPECTION CHECKLIST FOR MV PYLON/Latticed towers

Name of Main feeder/Location: ……………………………………………

T-Off Location: ………………………………………………………..

Size and type of Conductor: ……………………………………………..

Length of the feeder……………………………………………………

REG Branch: ………………………………………………………..

Sn	Pylon Number/ Identification	Pole//Type Length	Apparent defects (vandalized, bird nest, steel bar exposed, cross arms stolen, rusted, covered by creepers, loose of bolts….)	Pole Foundation status	Pole Straightness, bending	Shield wire status (Not installed not grounded)	Status of Insulators and accessories (Broken or cracked, Missing disc, Not well fitted, Not aligned, Burnt, etc.)	Surge arrestors (loose of connection, not grounded….)	Other Comment / Recommendations
1									
2									
3									

DATA COLLECTED BY:

Names	**Position**	**Signature and date**

APPROVED BY:

Names	**Position**	**Signature and date**

INSPECTION CHECKLIST FOR MV WOODEN POLES

Name of Main feeder/Location: ………...............……………………

T-Off Location: ……………………………………………………

Rwanda Energy Group REG

Size and type of Conductor: ……………………………….............

Length of the feeder…………………………………………………

REG Branch: ……………………………………………………

Sn	Pole Number/ Identification	Pole/Type Length (S140,S190 S255,S315, Etc.)	Apparent defects (Broken, Cracks, Rotten, etc.)	Pole Footing status	Pole Straightness, bending	Stay wire status(Normal position, Loosened, Broken)	Cross arm apparent defects (Rusted, Not well positioned, loose of bolts & nuts, Bent)	Status of Insulators and accessories (Broken or cracked, Missing disc, Not well fitted, Not aligned, Burnt, etc.)	Other Comment/ Recommendations
1									
2									
3									
4									

DATA COLLECTED BY:

Names	**Position**	**Signature and date**

APROVED BY:

Names	**Position**	**Signature and date**

INSPECTION CHECKLIST FOR MV CONDUCTORS

Length of MV Feeder: ....

Name of MV Feeder: ....

Location: ……………………………………………………

Size and type of Conductor: ....

REG Branch name:………………….....................................

Sn	Conductor Location	Apparent defects (Strands Broken, bird caging, etc.)	Number of Junctions	Conductor on insulator status (Not well fitted, Loosen,	Status of jumpers (Not well fitted, Loosen,	Status of conductor /internal Clearances (Normal, Below normal)	Status of Conductor to ground/external clearance (Normal, Below normal)	Right of way (Bush cleared, bush around lines, bush below lines,)	Other Comment/ Recommendations
1									
2									
3									
4									

DATA COLLECTED BY:

Names	Position	Signature and date

APROVED BY:

Names	Position	Signature and date

INSPECTION CHECKLIST FOR MV/LV DISTRIBUTION TRANSFORMER

Substation / Transformer Name: ……………………………………… ……………………………………..

Transformer Capacity & Type: ………kVA, /............... kV, (Indoor or Outdoor)

Transformer Serial / Number: ………………Name ……………………………………….

Manufacturer & Year of Manufacture: ………………………......................... Year of Installation: ………

REG Branch /Location……………………………………………………………………………………..

	Item to be inspected	Good	Fair	Bad	Statement	Action to be taken	Date of Action
A	**CHECK FOR PHYSICAL CONDITION**						
1	General upkeep and overall cleanliness of substation						
2	Fencing & gate of the substation/ doors & Windows						
3	Danger plate						
4	Status of platform or H-pole (for outdoor installed transformer) checked						
5	Inside & Outside lighting						
6	Condition of insulators/ Condition of MV&LV bushings checked						
7	Condition of conductors						
8	Condition of cables,						
9	Cable Lugs						
10	Arching Horn						
11	Radiator						
12	MT terminals						
13	LV terminals						
14	Oil level in the conservator tank checked						
15	Silica Gel condition checked/described by the manufacturer						
16	Oil/winding temperature checked						
17	The status of LV distribution panel/feeders pillar checked						
18	The status of cable between transformer and LV distribution panel checked						
		Non-Existing	Existing	Insignificant			

19	Oil leakages checked						
20	Breather condition checked						
21	Others						

B	**TRANSFORMER PROTECTION**	**Ref REG reticulation standards**	**Statement/Existing conditions/values/sizes**	**Action to be taken**	**Date of Action**
1	MV fuses properly installed and sized				
2	Check if earthing system is proper & intact				
3	LV CB/fuses properly installed and sized				
4	MV surge arrestors properly installed and grounded				
C	**TESTS & MEASUREMENT**	**Reference REG reticulation standards**	**Actual measured values**	**Action to be taken**	**Date of Action**
1	Insulation Resistance value	Phases HV-HV Phases LV-LV HV - LV HV - Tank LV - Tank			
2	Load (Amps)	Peak Hours	A-phase B-phase C-phase		
		Off-Peak Hours	A-phase B-phase C-phase		
3	Secondary Voltage measured		Phase1 –phase2		

			Phase1 –phase3 Phase2 –phase3 Phases1,2,3 - N		
4	Earth resistance measurement	MV: 5 Ohm LV:10 Ohm			
5	Turns ratio tested/ref manufacturer indications	▪ Tap 1: ▪ Tap 2: ▪ Tap 3: ▪ Tap 4: ▪ Tap 5			
6	Oil BDV tested/ref Oil technical description	15 kV			
		30 kV			

D	**OVERHAUL MAINTENANCE**	**Last/previous action**	**Statement/Existing conditions**	**Action to be taken**	**Date of Action**
1	Dissolved gases analysis				
2	Oil regeneration/purification				
3	Servicing HV/LV bushings				

DATA COLLECTED BY:

Names	**Position**	**Signature and date**

APPROVED BY:

Names	**Position**	**Signature and date**

INSPECTION CHECKLIST FOR DISCONNECT SWITCH, DROP OUT FUSE, AUTO RECLOSER

Name of MV Feeder: ……………… ………………………. Length of MV Feeder: …………………………

Size and type of Conductor: …………… ……………………

Sn	Name of switching/protecting equipment (either disconnect switch, dropout or auto-recloser)	Switching/ protecting equipment location or identification	Disconnector/ support defects (Rusted, Not well positioned, loose of bolts & nuts, Bent)	Cable terminations and connections (Dirty, loosen, etc…)	Status of Switch operating mechanism, blades & contacts, fuse clips (Not well positioned, loose of bolts & nuts, Bent)	Status of Insulators (Broken or cracked, Not aligned, Burnt, etc.)	Status of fuse (Normal, bypassed, defected, etc.)	Status of surge arrestor (Normal, defected, Not well positioned, not earthed, etc)	Other Comment/ Recommendations
1									
2									

DATA COLLECTED BY:

Names	**Position**	**Signature and date**

APPROVED BY:

Names	**Position**	**Signature and date**

Rwanda Energy Group

REG

INSPECTION CHECKLIST FOR LV DISTRIBUTION LINES

Transformer Name: ………………………………………………. Name of Outgoing LV Feeder: …………………

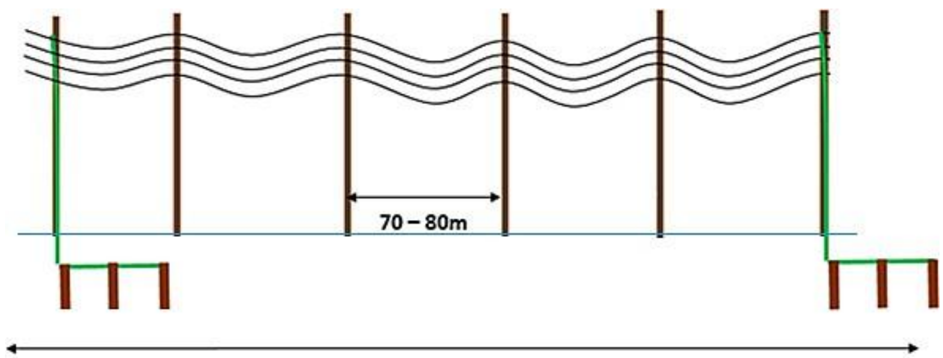
Size & Type of Main Cable/Conductor: ………………………… Number of Poles per Type: Wooden.........Concrete ……. Steel…

Sn	Activities	Yes or No	Remarks/Observations	Date of Action
1	Status of conductor/cable checked			
2	Status of poles checked			
3	Status of pole foundations			
4	Status of stay wires checked			
5	The voltage at the farthest client from transformer measured			
6	All connections checked			
7	All line hardware (clamps, stud bolts, insulators, etc) checked			
8	Trees and bushes cleared			
9	The size of underground cable from LV distribution panel to the first pole of LV feeders checked			
10	Earth resistance for first LV pole			
11	Balance of three phase voltages			
12	Rotten poles			
13	Cable clearance to ground checked			
Check Value of Voltage, Current and Earth resistance				
	Activities	**Yes**	**Remarks/Observations**	**Recommendation**

14	Voltage (V): ▪ Phase to phase Ph1–Ph2; Ph1–Ph3; Ph2– Ph3 ▪ Phased to neutral Ph1 –N; Ph2 – N; Ph3 – N			Voltage tolerance -10% to +5% of rated value
15	Load (A): Each Phase: Ph1, Ph2, Ph3			95% of rated current
16	Earth resistance			Acceptable value ≤ **5 Ω**
17	Illegal extensions and connections checked			Disconnect illegal connection
DATA COLLECTED BY:				
Names		**Position**		**Signature and date**
APPROVED BY:				
Names		**Position**		**Signature and date**

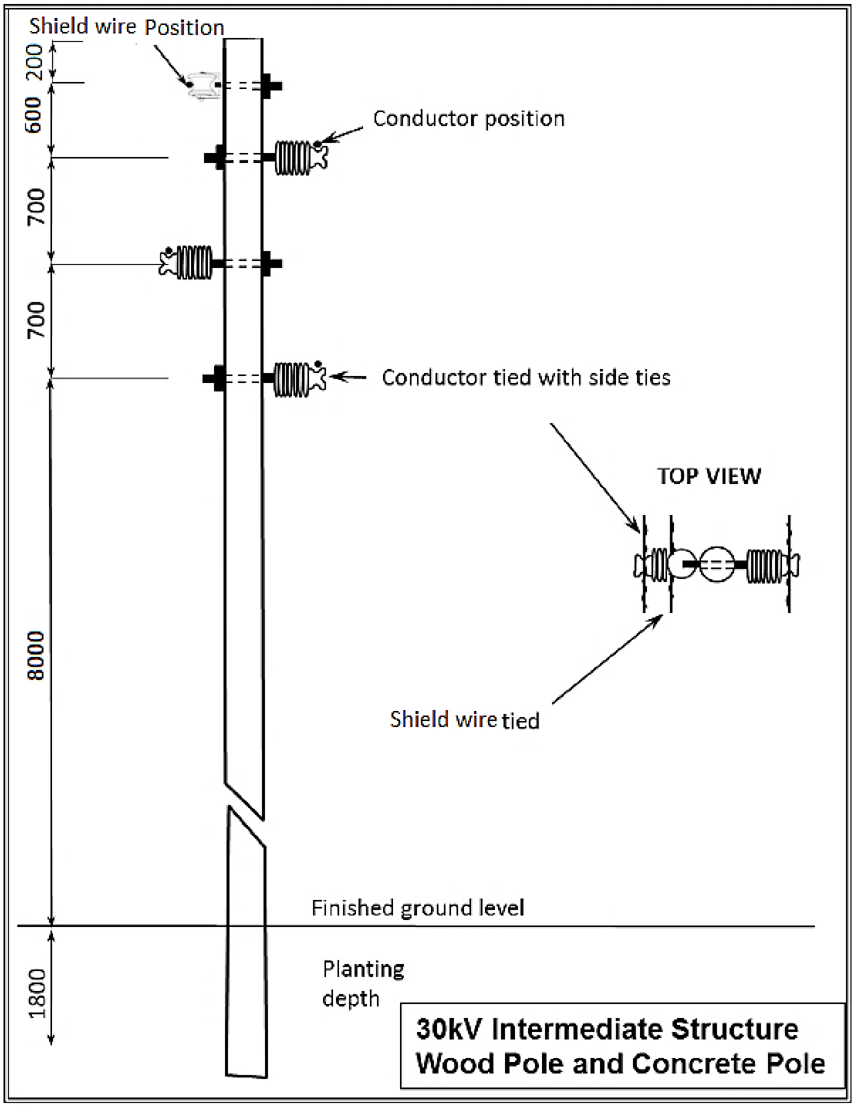
ANNEX 3: STANDARDS DRAWINGS

3.1 MEDIUM VOLTGE STRUCTURES

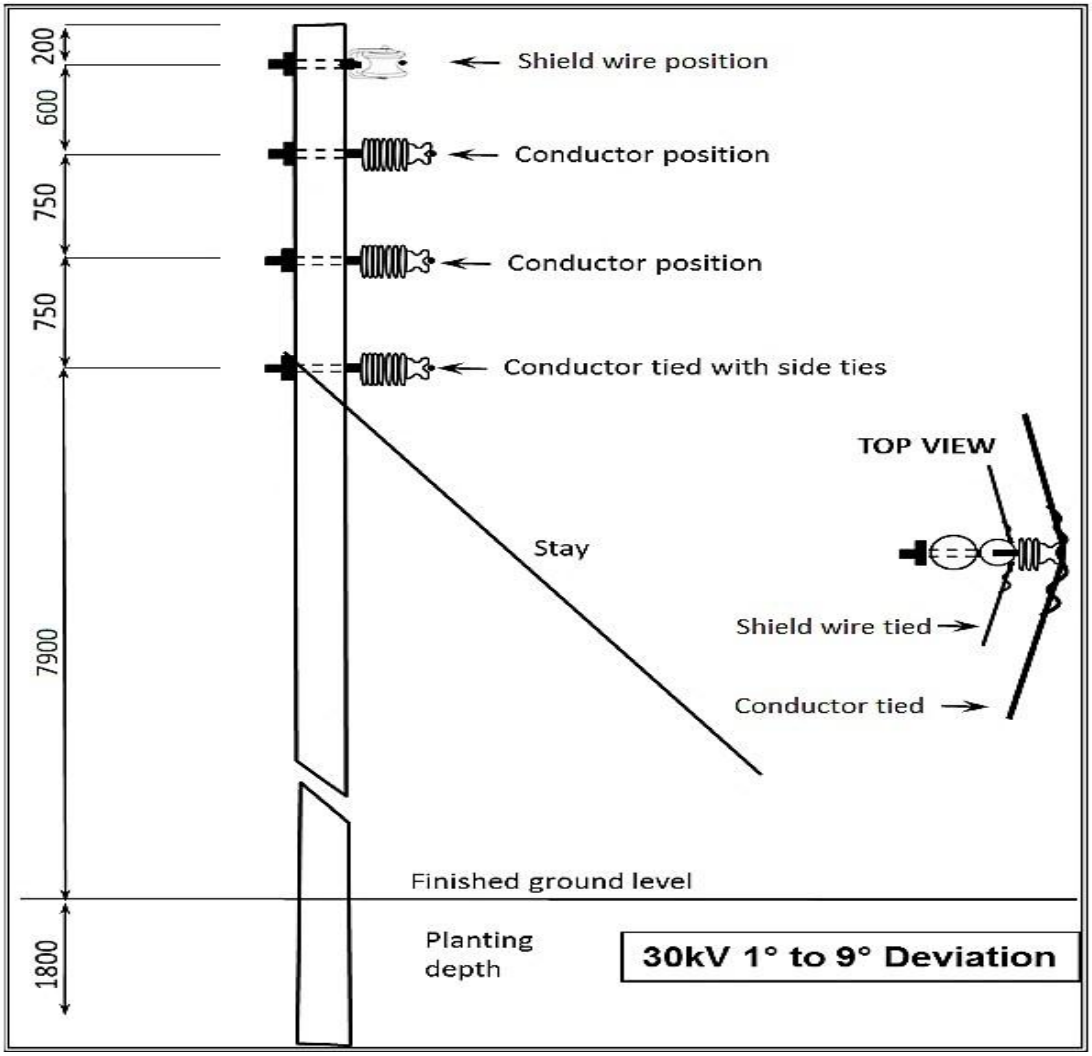


The shield wire is earthed at every first, terminal and tapping pole and every steel pole is earthed

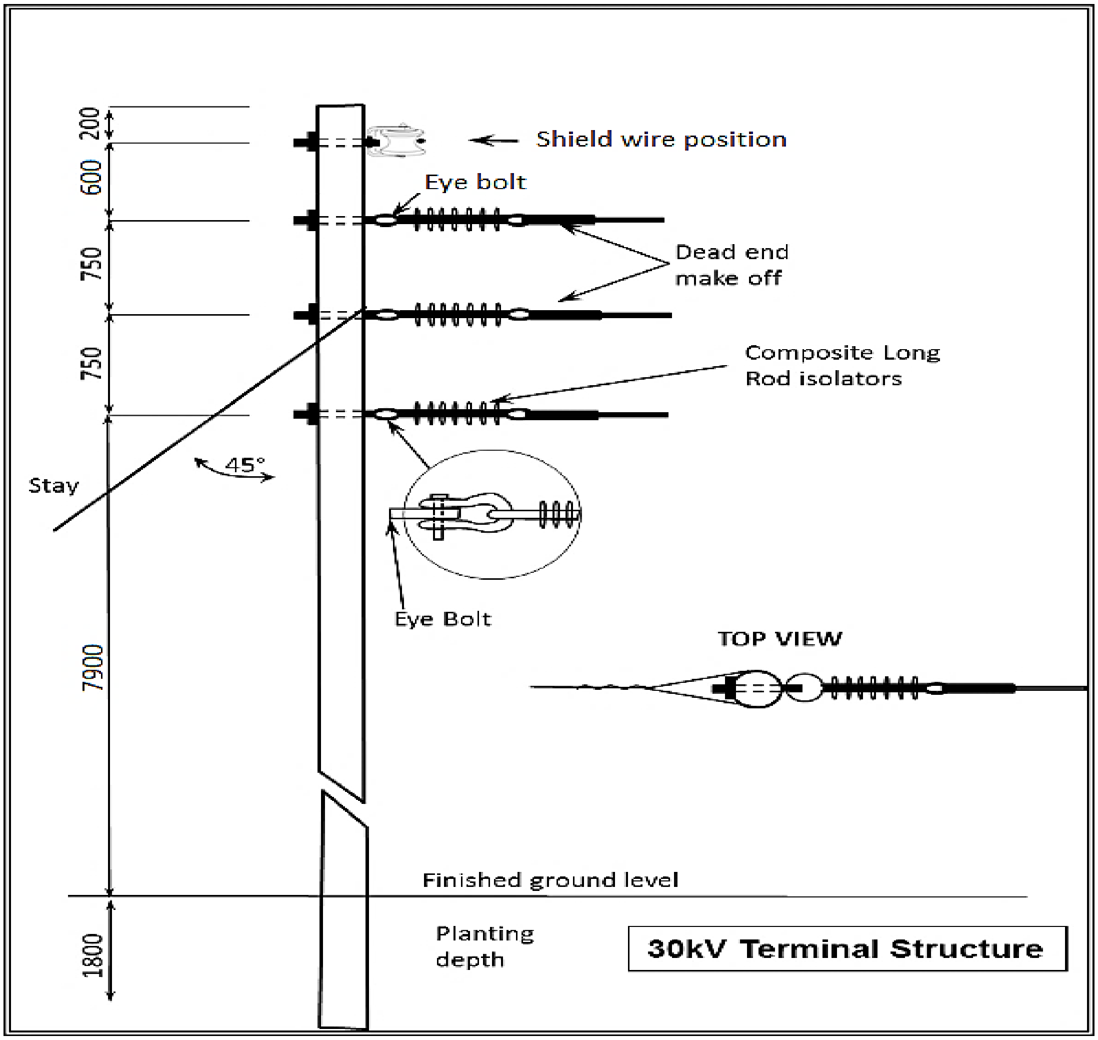
STRUCTURE TYPE A: 30 kV SUSPENSION STRUCTURE



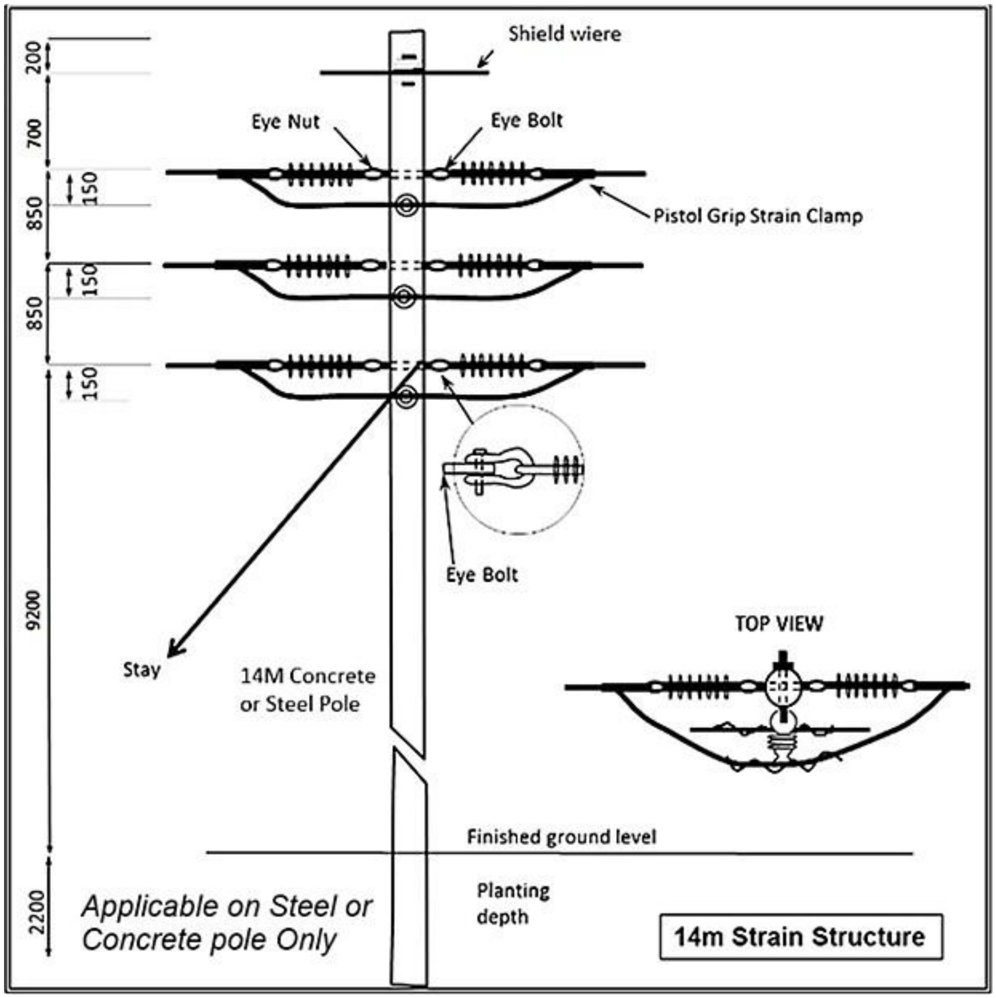
STRUCTURE TYPE B: 30KV 1º TO 9º DEVIATION



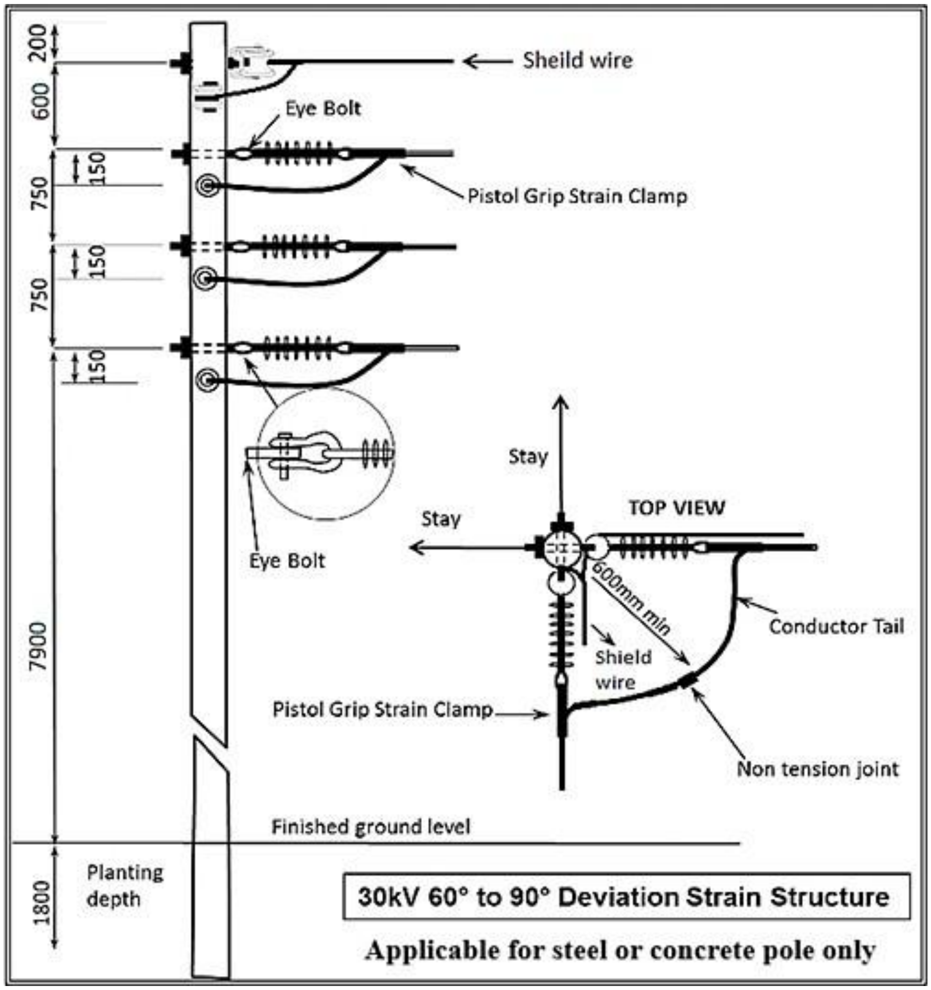
STRUCTURE TYPE C: 30KV TERMINATION STRUCTURE



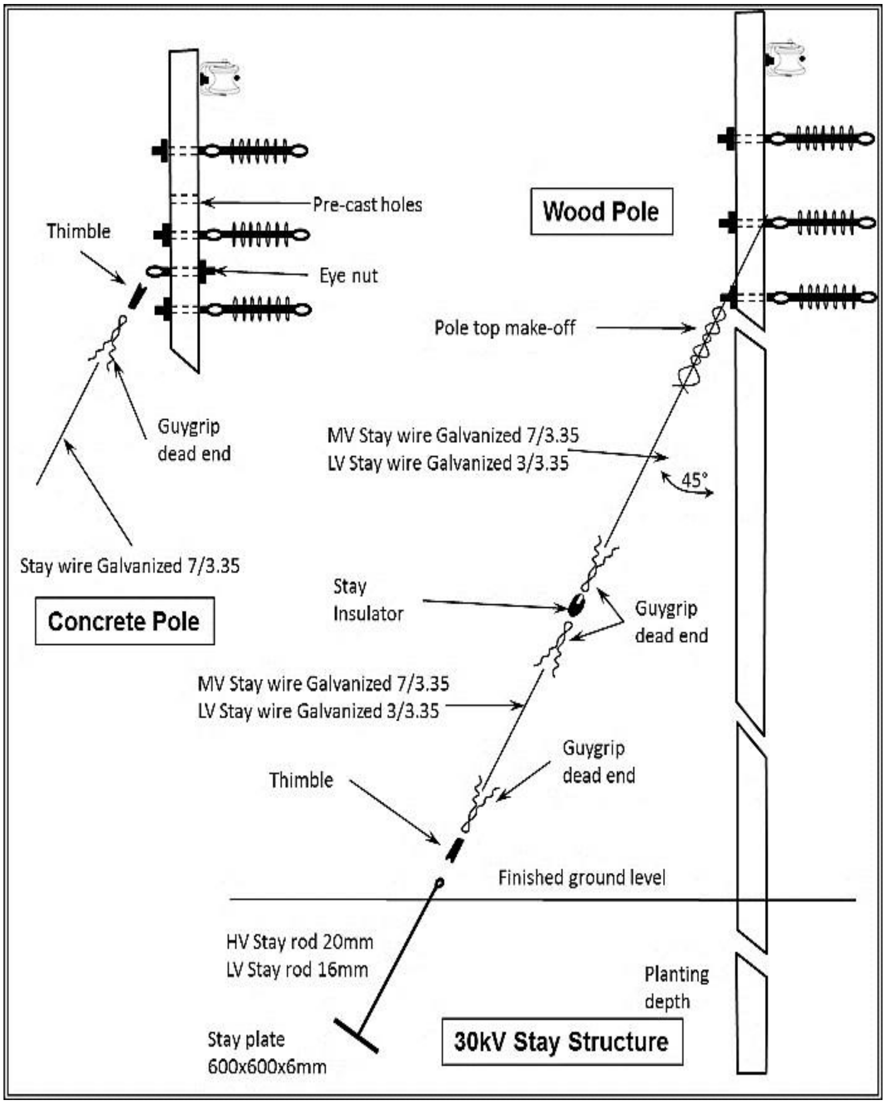
STRUCTURE TYPE D: 14M POLE STRUCTURE



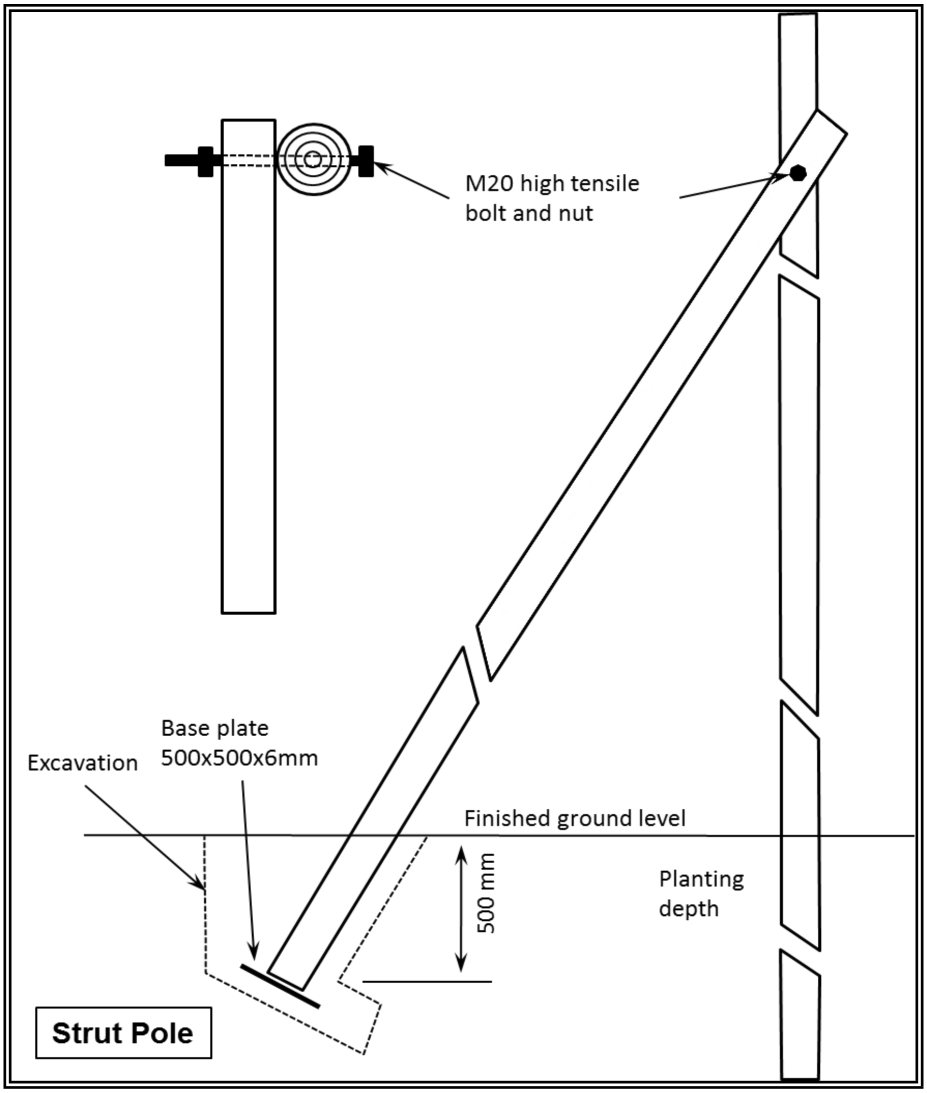
STRUCTURE TYPE E: 30º - 90º DEVIATION STRUCTURE



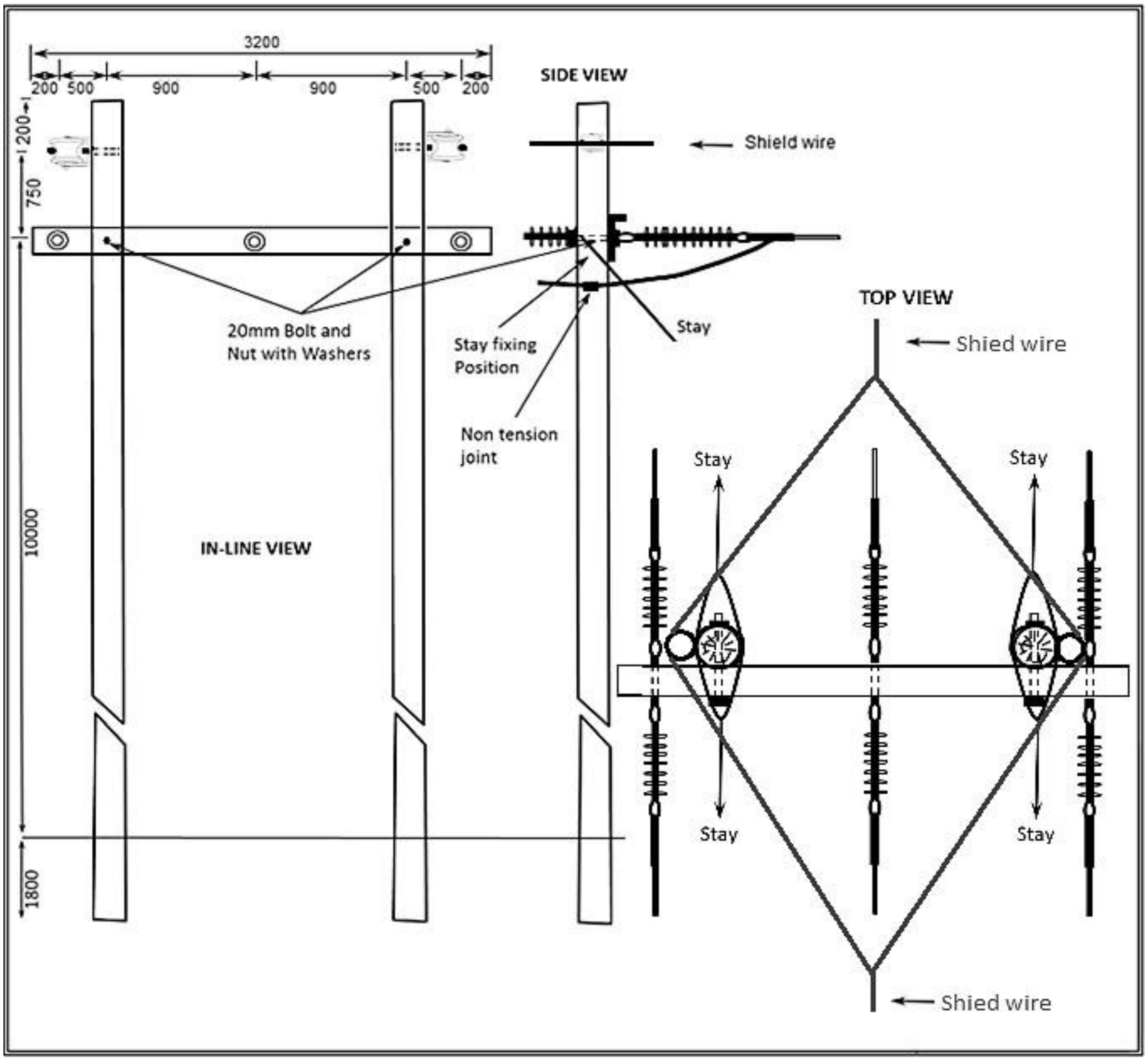
STRUCTURE TYPE F: MV STAY STRUCTURE



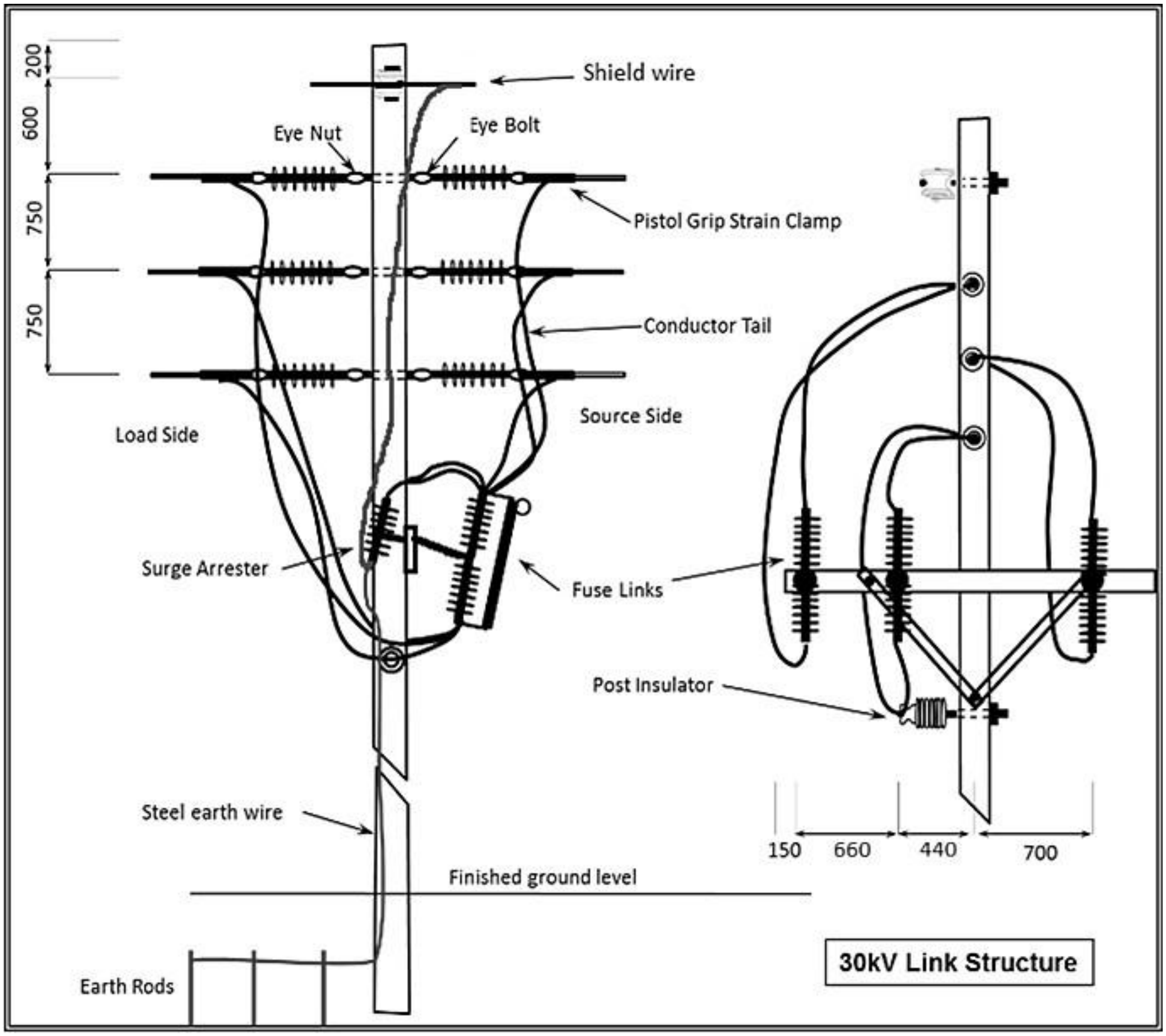
STRUCTURE TYPE G: STRUT POLE STRUCTURE



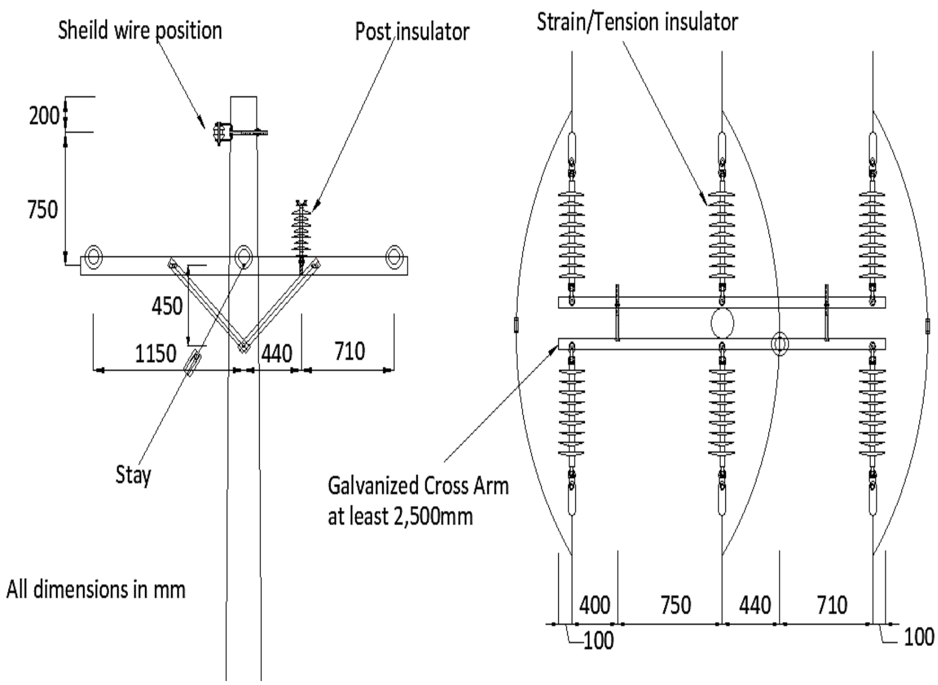
STRUCTURE TYPE H: H-POLE STRUCTURE



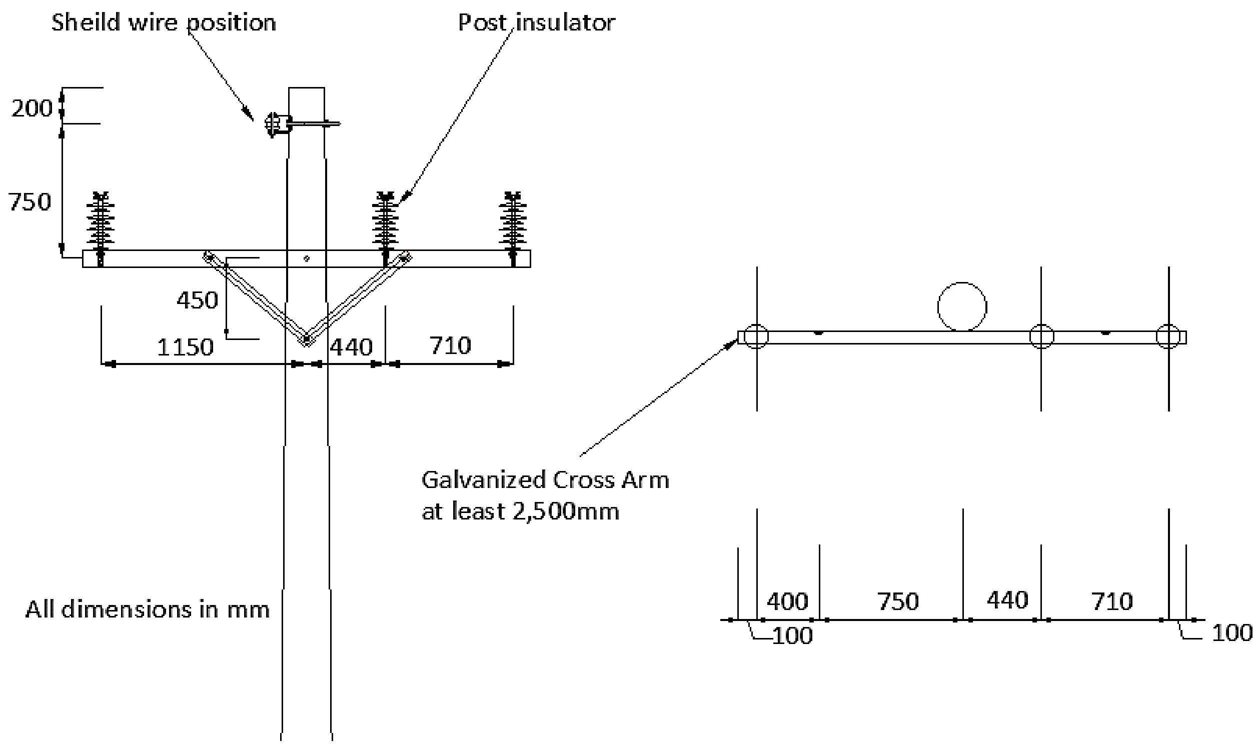
STRUCTURE TYPE I: LINK STRUCTURE



STRUCTURE TYPE J: ANGLE POLE STRUCTURE WITH CROSS ARM

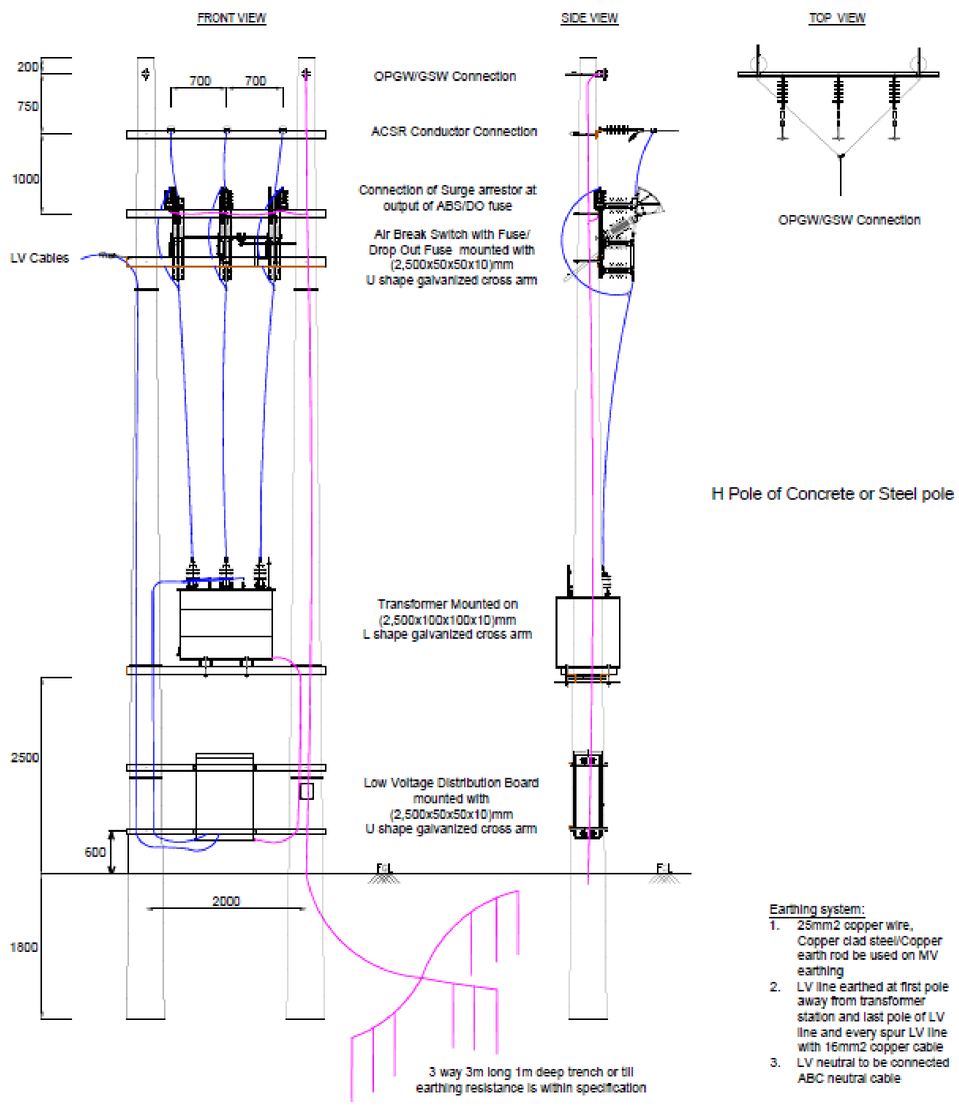


STRUCTURE TYPE K: SUSPENSION POLE STRUCTURE WITH CROSS ARM



STRUCTURE TYPE L: TRANSFORMER STRUCTURE

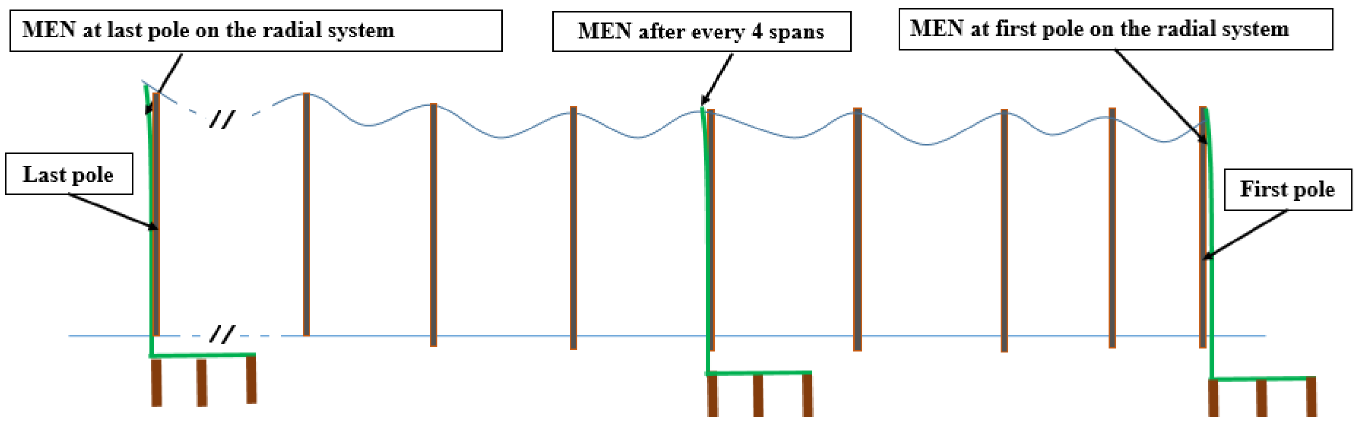
TRANSFORMER STRUCTURE WITH AIR BREAK SWITHCH WITH FUSE



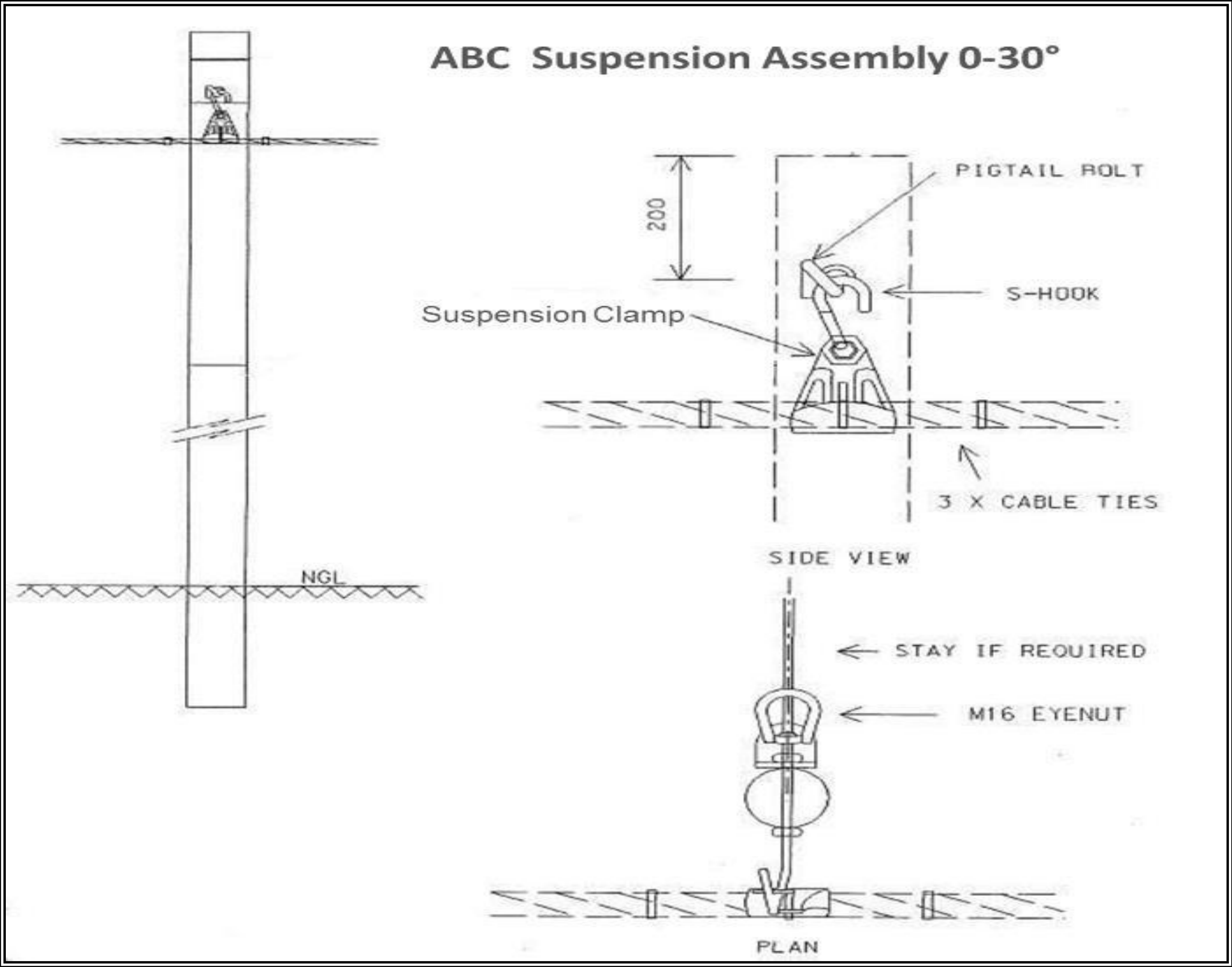
Earthing system:

1. 25mm2 copper wire, Copper clad steel/Copper earth rod be used on MV earthing
2. LV line earthed at first pole away from transformer station and last pole of LV line and every spur LV line with 16mm2 copper cable
3. LV neutral to be connected ABC neutral cable

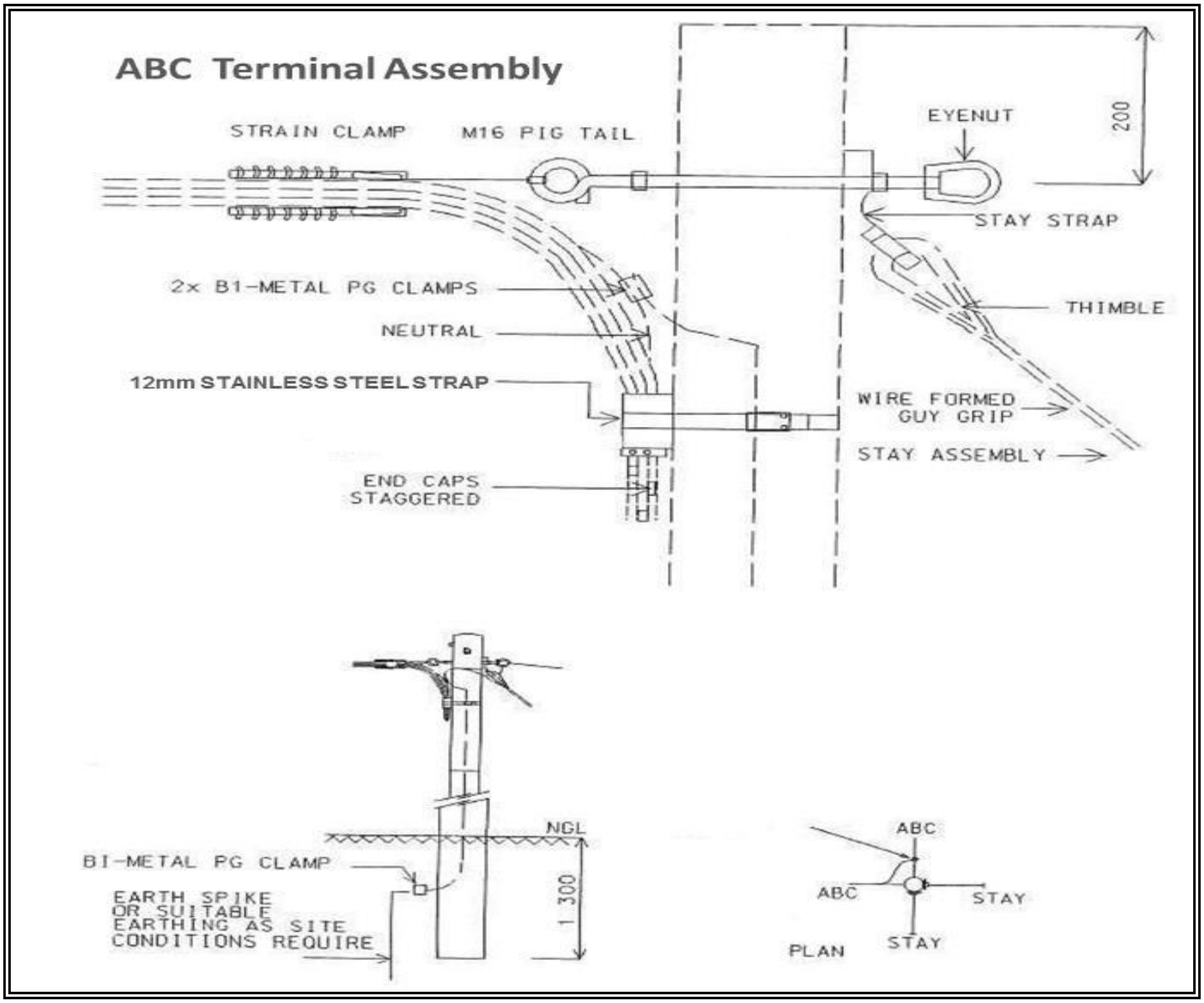
3.2 LOW VOLTAGE STRUCTURES



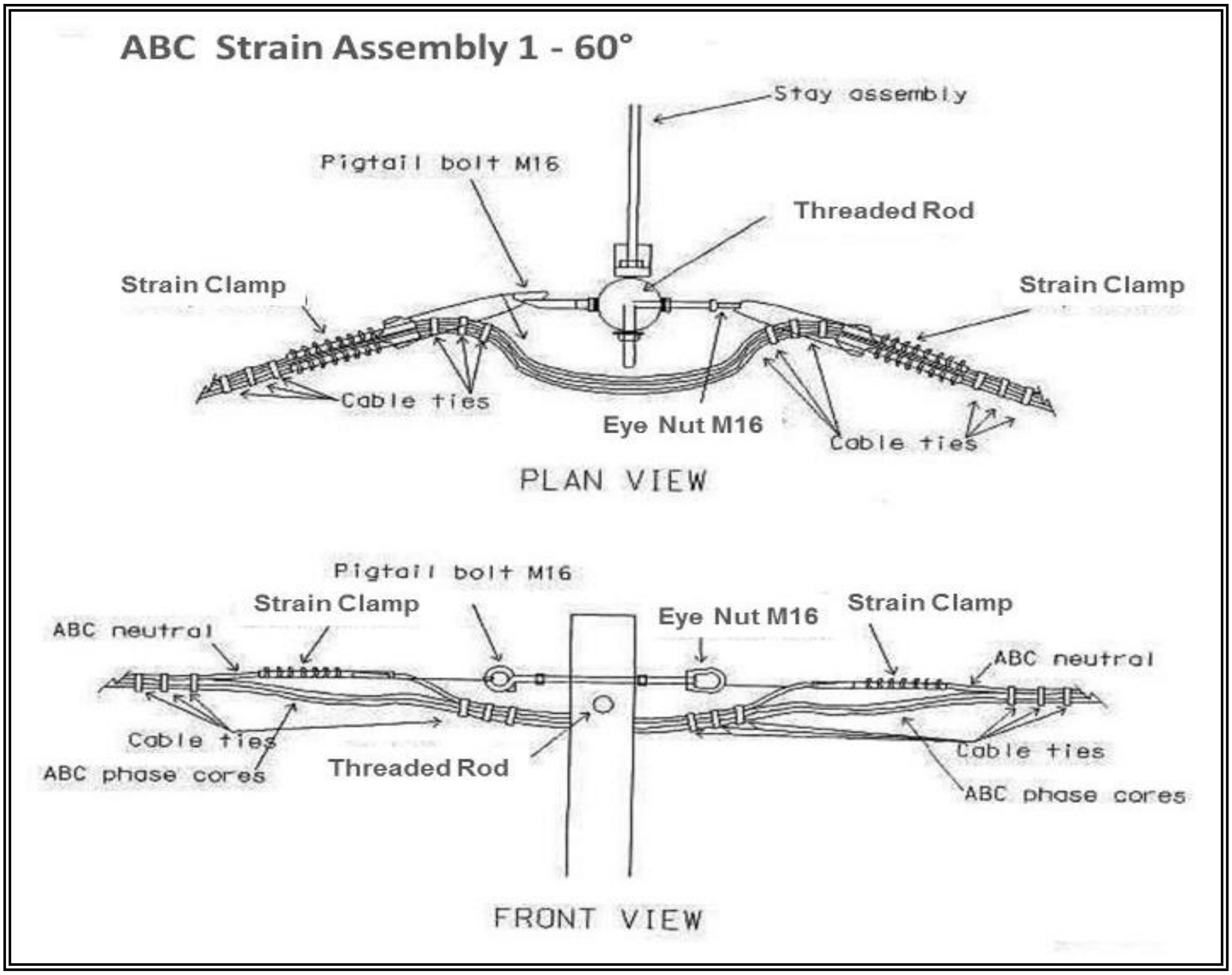
ABC SUSPENSION ASSEMBLY.



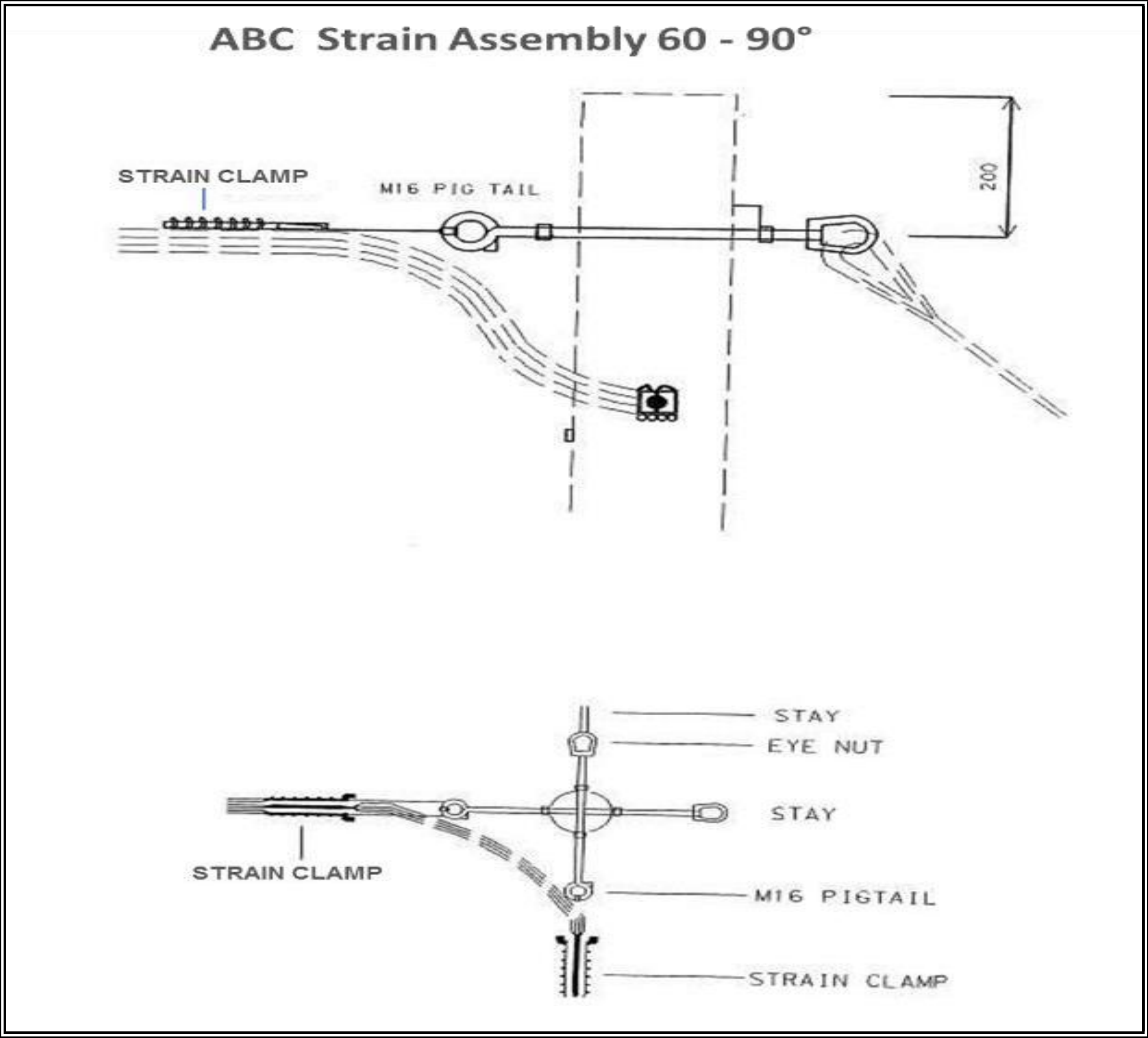
ABC TERMINAL ASSEMBLY



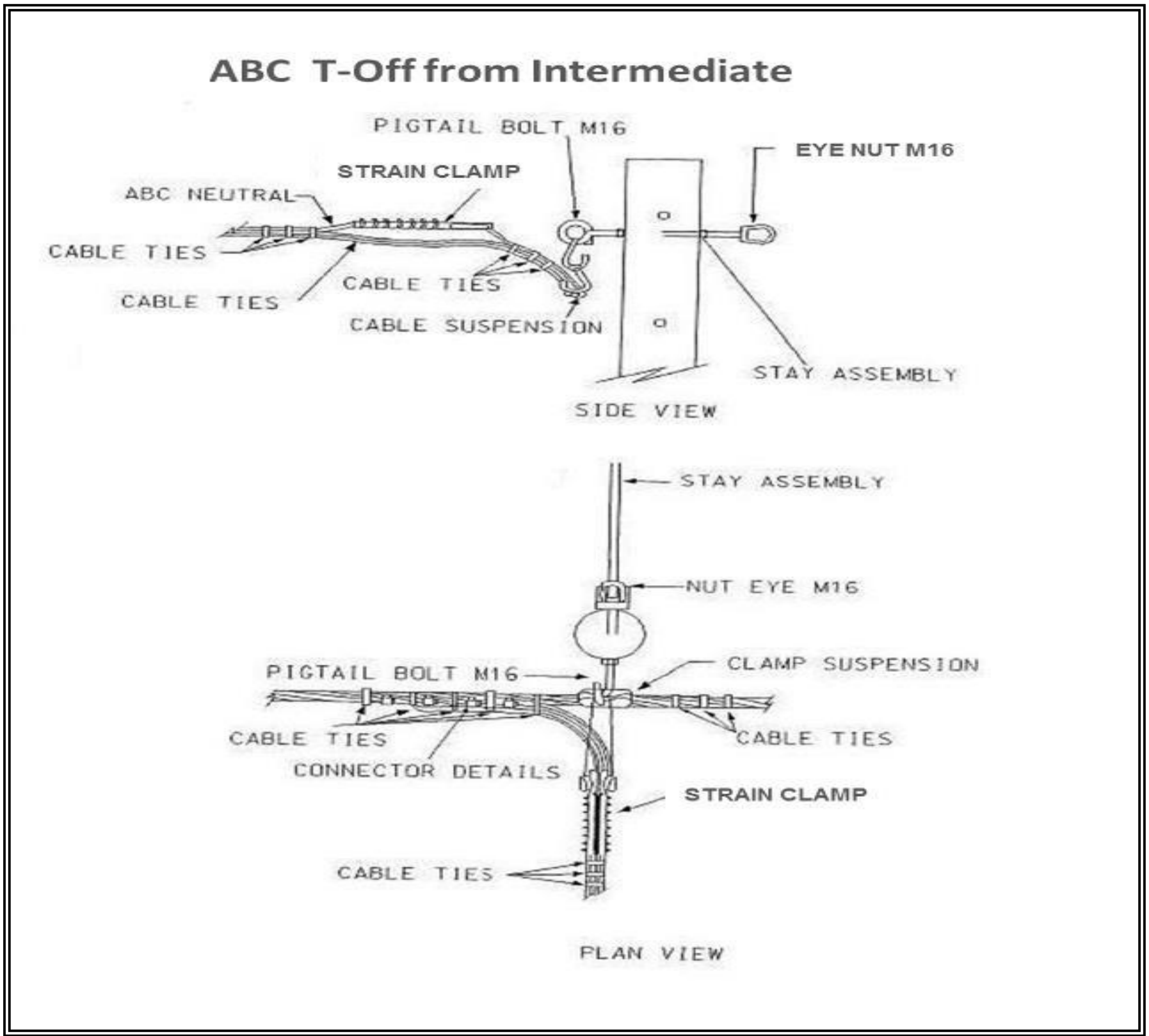
ABC STRAIN ASSEMBLY 1-60º



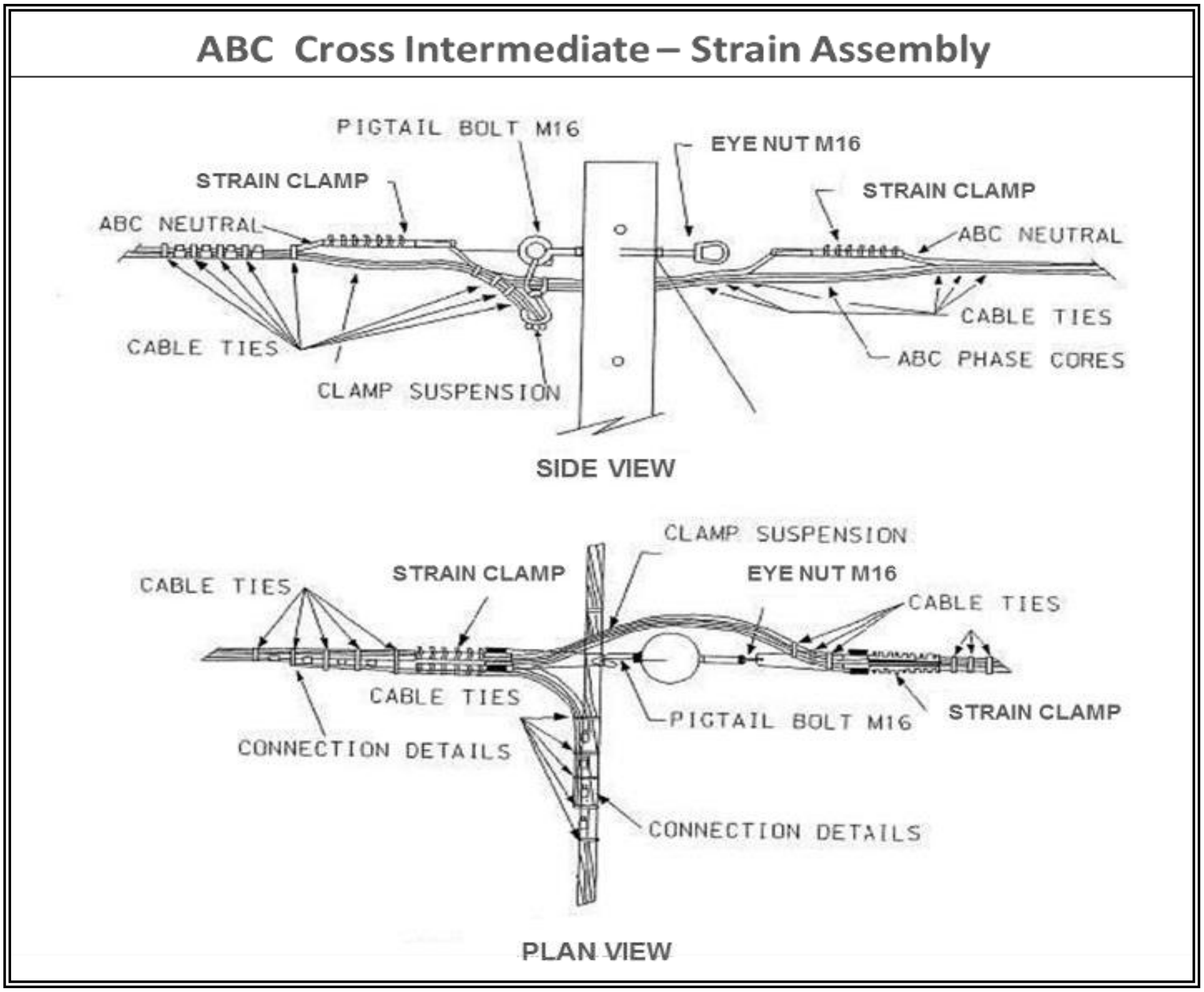
ABC STRAIN ASSEMBLY 60º - 90º



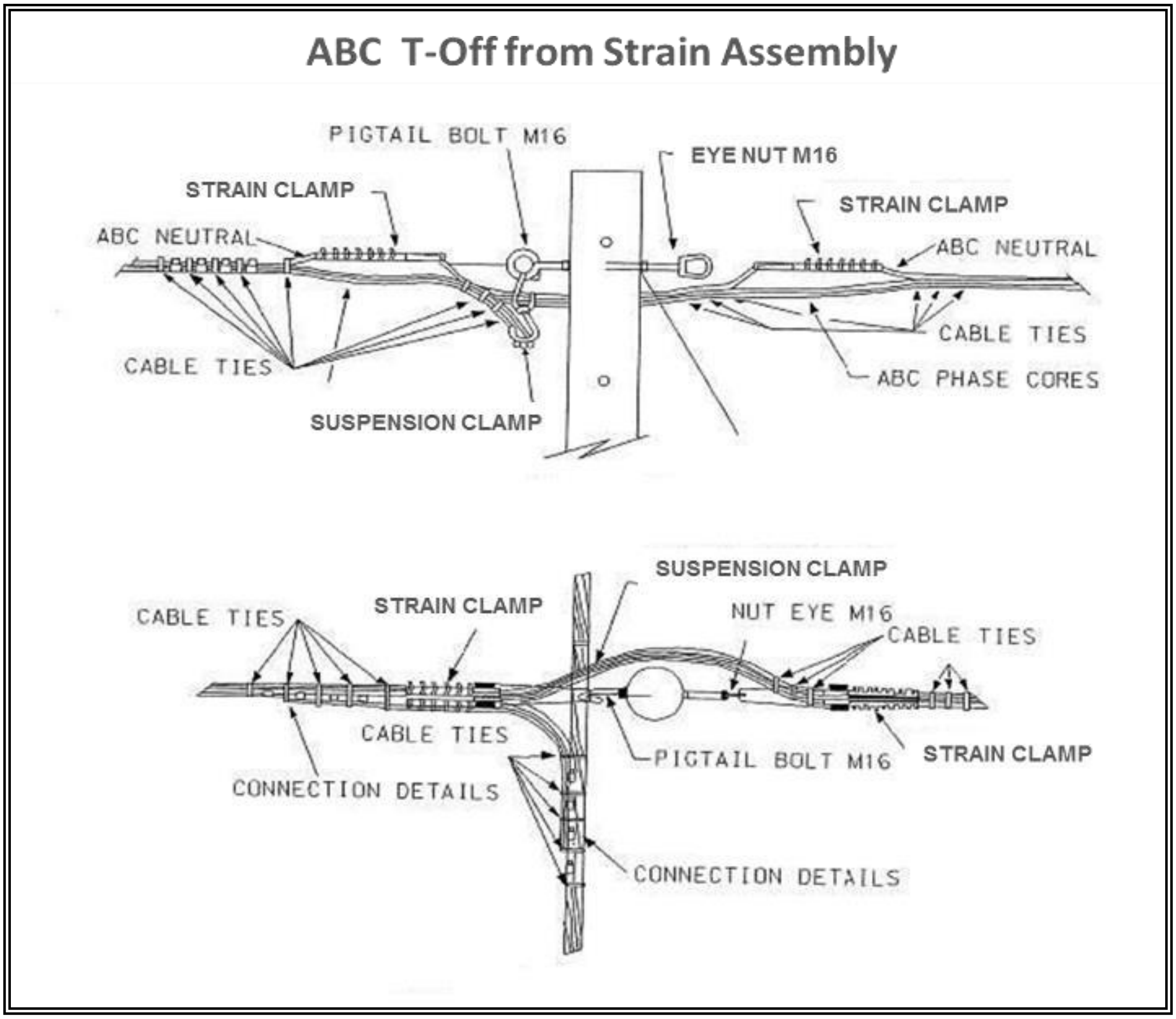
ABC T-OFF FROM INTERMEDIATE



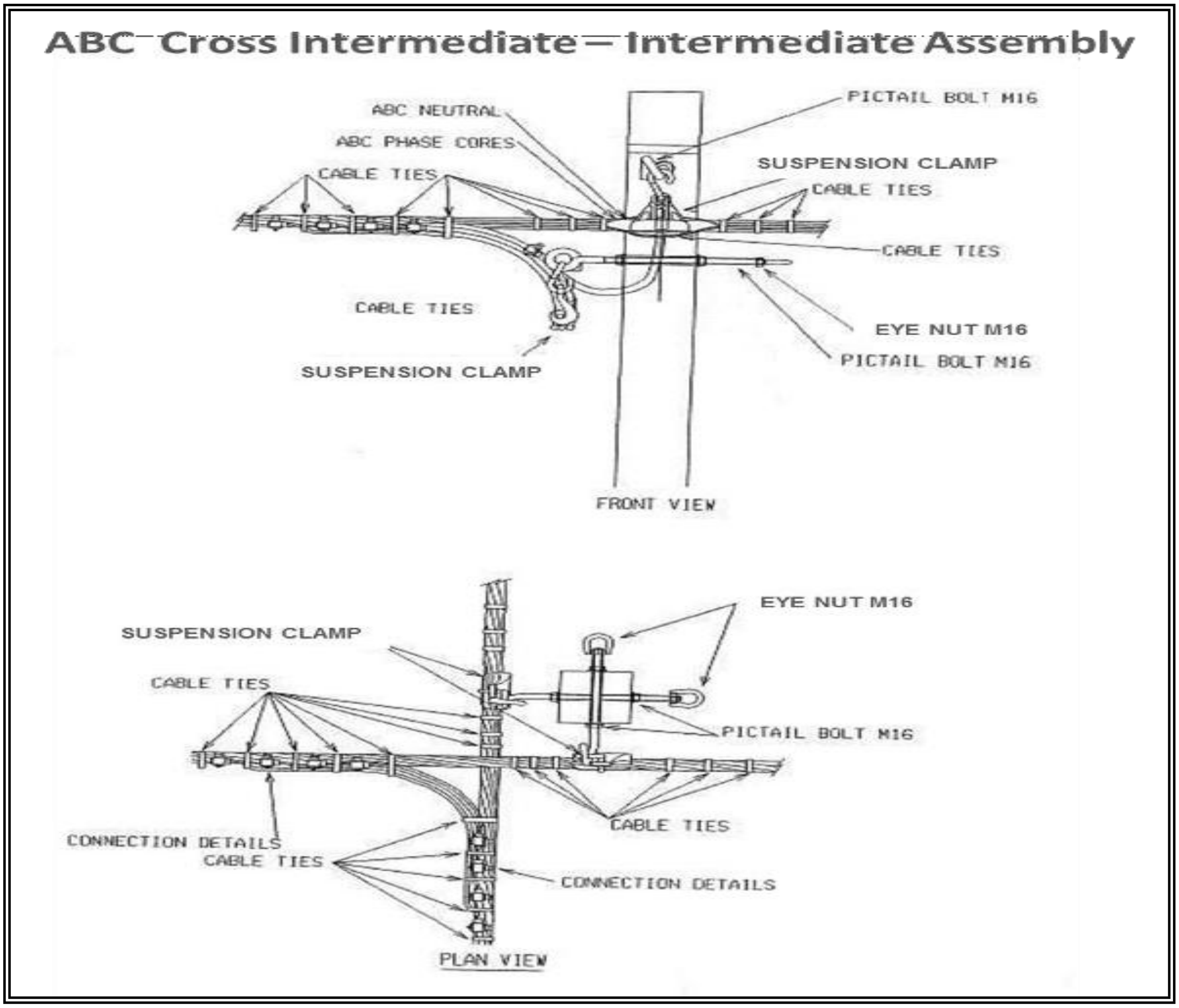
ABC CROSS INTERMEDIATE – STRAIN ASSEMBLY



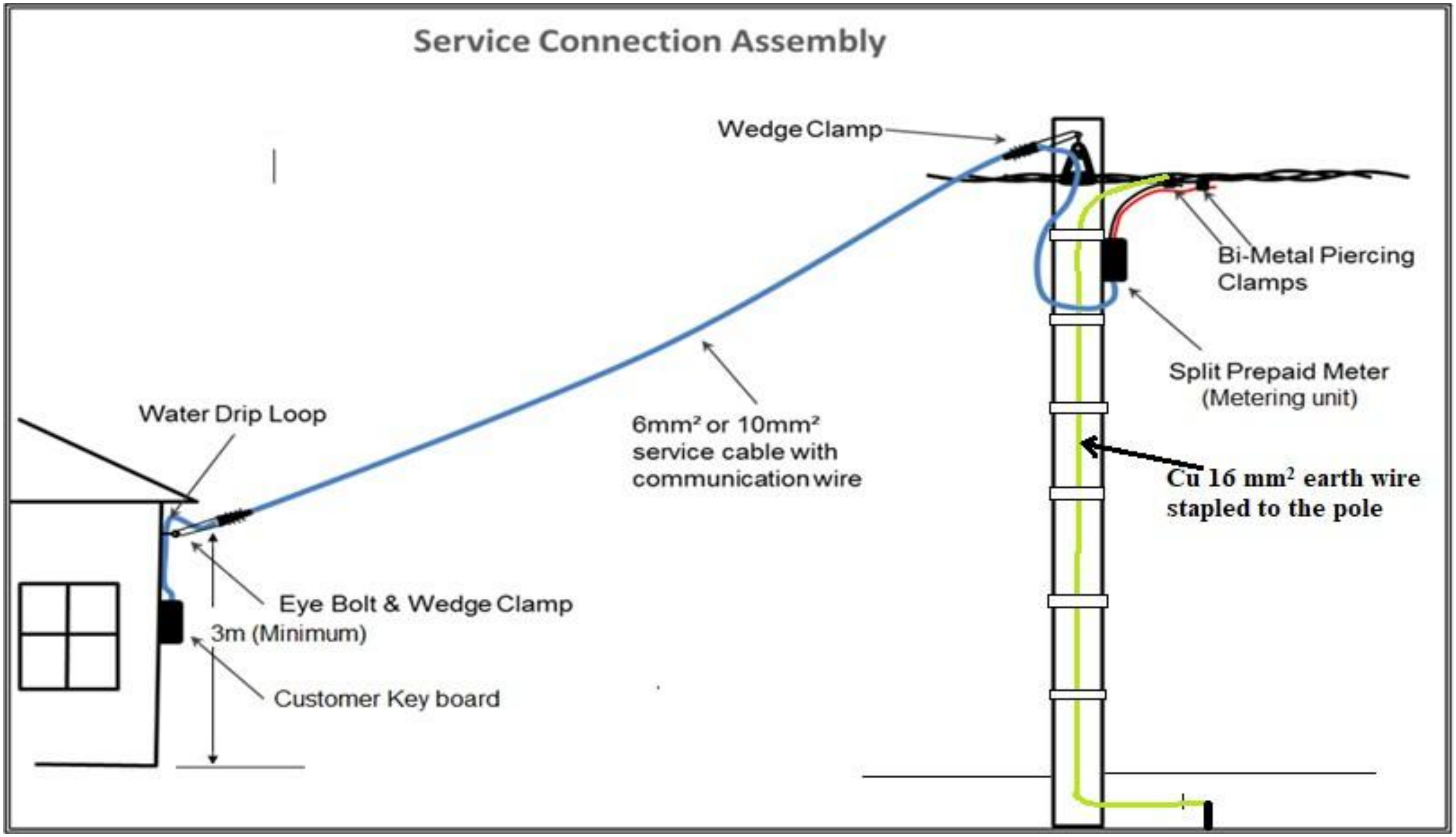
ABC T-OFF FROM STRAIN ASSEMBLY



ABC CROSS INTERMEDIATE – INTERMEDIATE ASSEMBLY



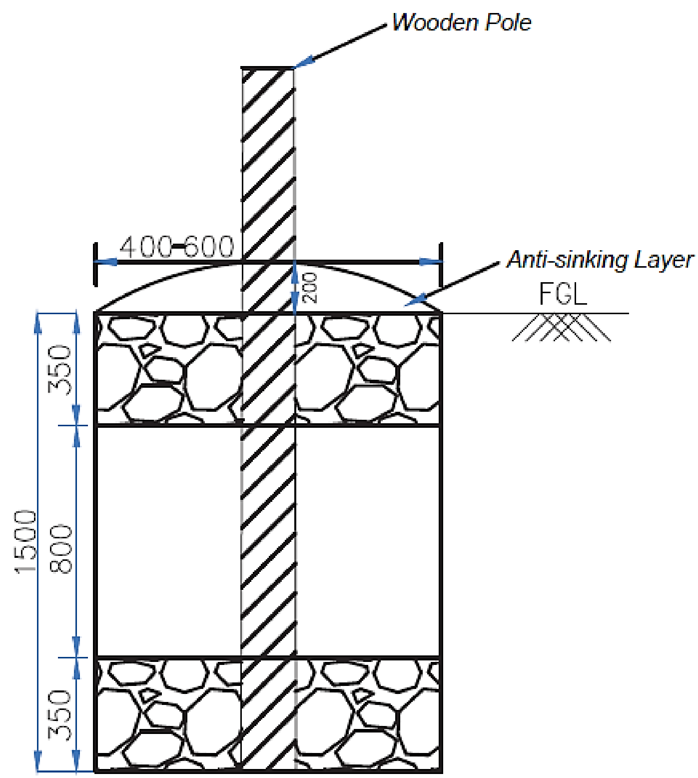
3.3. SERVICE CONNECTION



POLES FOUNDATIONS

LV Wooden Poles

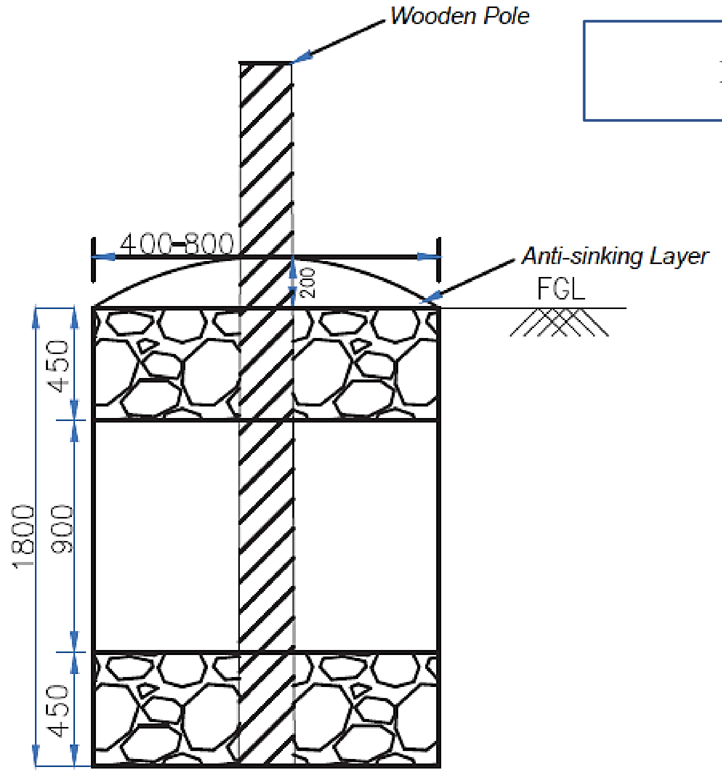
- Pole backfilling shall be done using stone wedging as shown in the figure.
- Stones must be wedged in by using a hand compactor.
- Backfill between wedging will be done with excavated materials and consolidated firmly in layers of not more than 20cm at a time



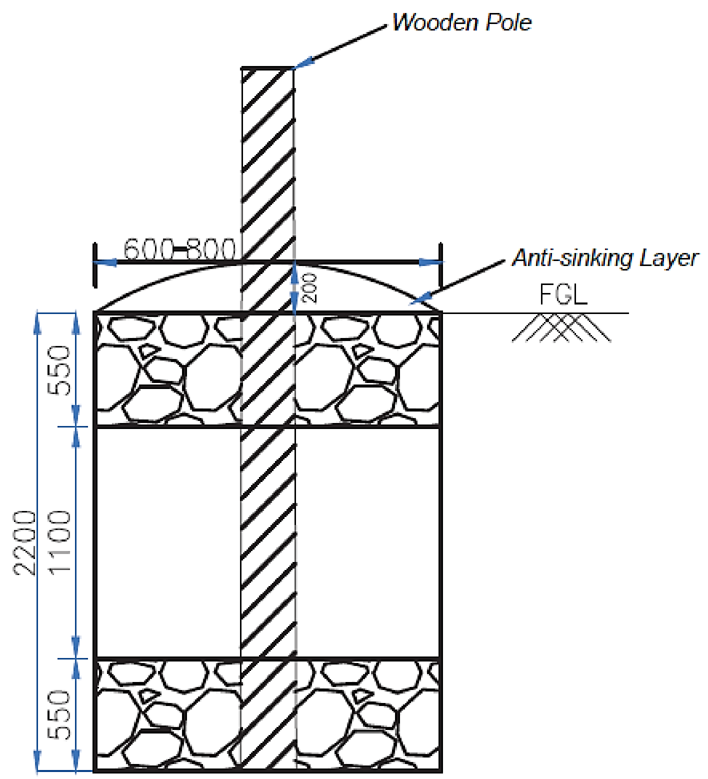
For 9m Wooden Poles

All dimensions are in mm

MV Wooden Poles



For 12m Wooden Poles

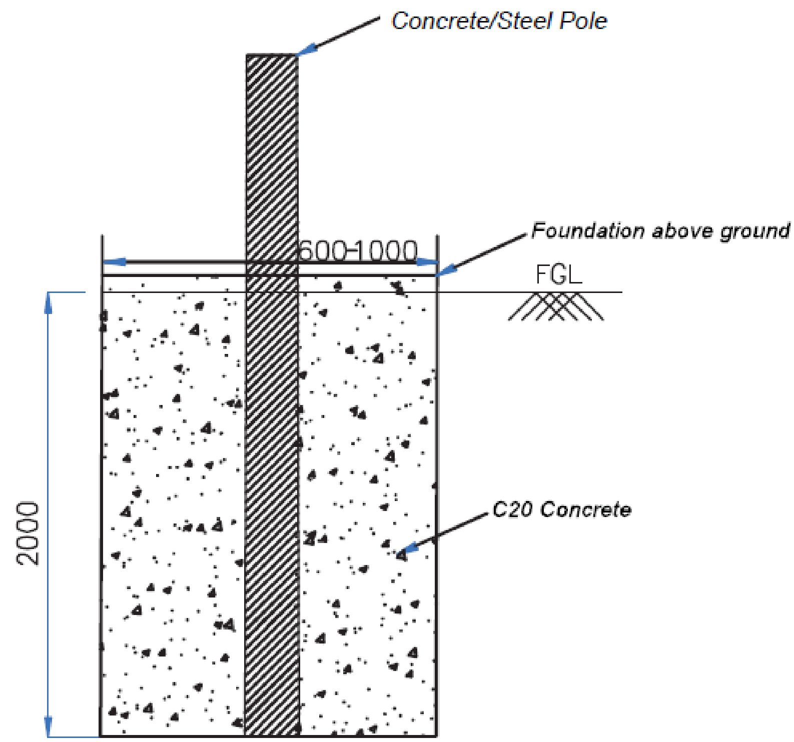


For 14m Wooden Poles

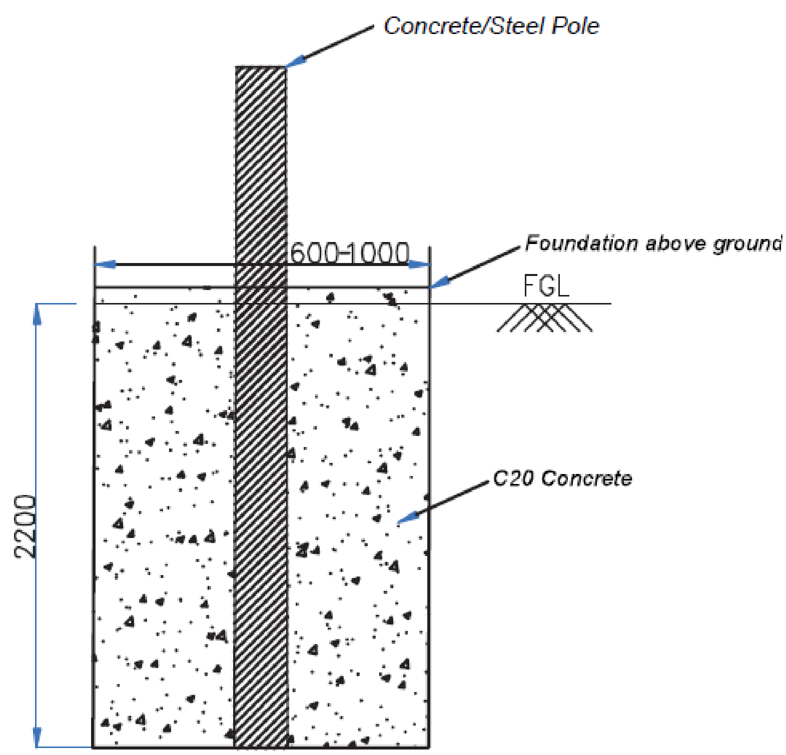
All dimensions are in mm

Concrete and Steel Poles

- Concrete mix shall be minimum 20MPA strength.
- Air shall be removed from concrete mix by use of a suitable vibrator.
- Cement/sand/crushed stone ratio shall be 1/3/4 or as required to achieve the required strength
- All dimensions are in mm

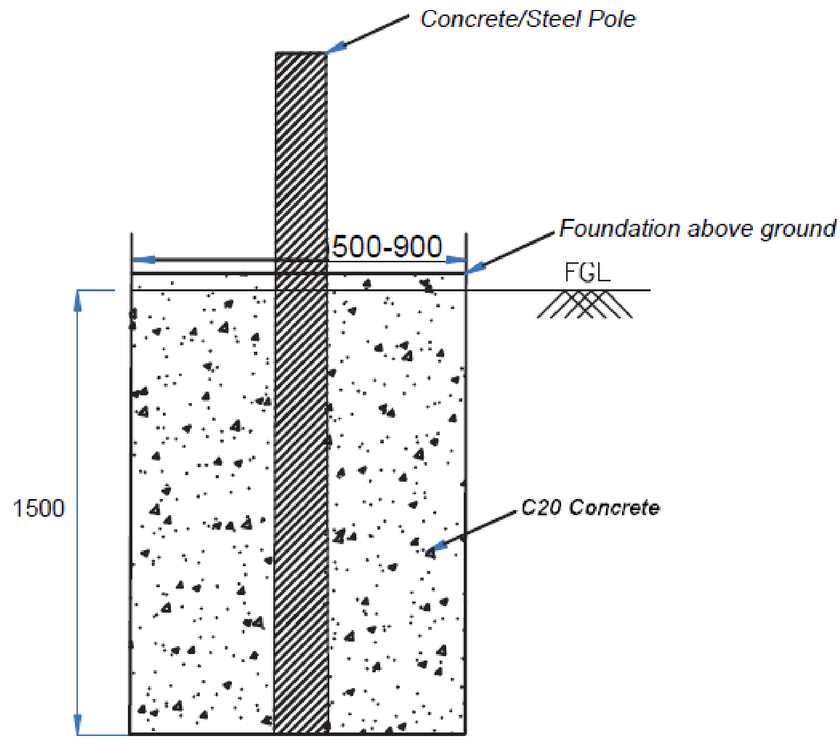


For 12m Concrete/Steel pole



For 14m Concrete/Steel Pole

All dimensions are in mm



For 9m Concrete/Steel Pole

All dimensions are in mm