PART 2 - EMPLOYER'S REQUIREMENTS

UNDERGROUND CABLES (UGC)

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Abbreviations and Acronyms

%	Percentage
R	Resistivity
°C	Degrees Celsius
°F	Degrees Fahrenheit
A	Amperes
AC	Alternating Current
ACSR	Aluminium Conductor Steel Reinforced
AIS	Air-Insulated Substations
ANSI	American National Standards Institute
AWG	American Wire Gage
BIL	Basic Impulse Insulation Level
BSL	Basic Switching Impulse Insulation Level
CB	Circuit Breaker
Cm	Centimeter
CPU	Central Processing Unit
CT	Current Transformer
Cu	Copper
CVT	Capacitor Voltage Transformer
dB	Decibels
DC	Direct Current
F	Frequency
FO	Fiber Optic
Ft	Feet
GFI	Geothermal Fond Cole Interconnection
GIS	Gas-Insulated Substations
GLI	Geothermal Laudat Interconnection
GTI	Geothermal Trafalgar Interconnection
HIS	Hybrid Insulation Switchgear
HMI	Human–Machine Interface
HDPE	High Density Polyethylene Pipe
HSE	Health and Safety Executive
HV	High Voltage

HVAC	Heating, Ventilating, and Air Conditioning
Hz	Hertz (cycles per second)
IEC	International Electrotechnical Association
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronics Engineers
in.	Inch
kA	Kiloamperes (1,000 amperes)
kcmil	Kilocircular mils (1,000 circular mils)
kg	Kilogram (1,000 grams)
kHz	Kilohertz (1,000 hertz or cycles per second)
km	Kilometers (1,000 meters or 1,608 feet)
kN	Kilonewtons
kNm	Kilonewton meters
kPa	Kilopascals (1,000 Pascals)
ksi	KIP (1000lbs) per square inch
kV	Kilovolt (1,000 volts)
kVA	Kilovolt-amperes (1,000 volt-amperes)
kVAR	Kilovolt-amperes reactive (1,000 volt-amperes reactive)
kWh	Kilowatt-hour
L	Liter
LAN	Local Area Network
LMDPE	Linear Medium Density Polyethylene
LV	Low voltage
M	Meter(s)
m^2	Square meter
mA	Milliamperes (0.001 ampere)
mm	Millimeter (0.001 meter)
mV	Millivolt
MV	Medium Voltage
MVA	Megavolt-amperes (1,000,000 volt-amperes)
MVAR	Megavolt-amperes reactive (1,000,000 volt-amperes)
MW	Megawatt (1,000,000 watts)
N	Newton
N/m	Newtons per meter

O&M	Operations and Maintenance
ODF	Optical Distribution Frame
OHL	Overhead Line
OPGW	Optical Ground Wire
PC	Personal computer
PE	Polyethylene
PF	Power Factor
PFI	Padu Fond Cole Interconnection
PT	Potential Transformer
PVC	Polyvinyl Chloride
PP	Power Plant
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SF6	Sulfur Hexaflouride
Std.	Standard
SS	Substation
SVL	Sheath Voltage Limiter
TPI	Trafalgar Padu Interconnection
UGC	Underground Cable
UTM	Universal Transverse Mercator Grid system
UV	Ultra violet
V	Volts
VA	Volt-amperes
VAC	Volts Alternating Current
VAR	Volt-amperes reactive
VDC	Volts Direct Current
VT	Voltage Transformer
XLPE	Cross-Linked Polyethylene

1. Scope Of Design, Supply And Installation for the UNDERGROUND CABLE (UGC)

This section applies to the underground cables links, (69kV, 33kV and 11kV) of this project, intended to be connected to the existing transmission system located in Roseau Valley, in order to obtain a resilient transmission system.

The resilient transmission line routes have been identified as the ones avoiding as much as possible all the exposed areas to landslides, and flooding hazards.

This section specifies the design criteria to be taken into account for the dimensioning of the civil engineering works intended to accommodate the interconnection cables and determines the requirements to be met in terms of implementation of the civil engineering works.

It indicates also all the tests to be carried out on the civil engineering works.

The various underground interconnection of this project are:

- **GLI 11kV UGC** → 11kV UGC from Geothermal substation (69/33/11 kV) to the hydraulic power station Laudat, (approximately 0.55Km**)**
- **GFI 33 KV** → From the Geothermal substation (69/33/11 kV) to the Fond Cole substation (69/33/11 kV). This Link can be divided to 3 major parts defined as follow:

  GTI: From Geothermal substation to Trafalgar substation:
  - ✓ Part 1: 33kV UGC from Geothermal substation (69/33/11 kV) to the Terminal monopoles at the upper level of Trafalgar cliff (approximately 1.5 Km)
  - ✓ Part 2: 33kV OHL link all over the Trafalgar Cliff (approximately 0.32 Km),
  - ✓ Part 3: 33kV UGC from the Terminal monopoles at the bottom level of Trafalgar Cliff to Trafalgar substation (2.2/33 kV), (approximately 0.3 Km).

  TPI: From Trafalgar to Padu substation

  33kV UGC from Trafalgar (2.2/33 kV) to Padu (33/11 kV) (approximately 2 Km)

  PFI: From Padu to Fond Cole substation

  33kV UGC from Padu (33/11 kV) to Fond Cole (69/33/11 kV) (approximately 7 Km)
- **GFI 69 KV** → From Geothermal substation (69/33/11 kV) to the Fond Cole substation. This link can be divided into 3 major parts defined as follow:
  - ✓ 69kV UGC from Geothermal substation to the Terminal monopoles (#at bend "B14")**, located at the level of a secondary road near the upper level of Trafalgar Cliff (approximately 1.5 Km)
  - ✓ 69kV OHL from the Terminal monopoles (#at bend "B1")* till the Terminal monopoles (#at bend "B14") (approximately 4.8 Km)
  - ✓ 69kV UGC from the Terminal monopoles (#at bend "B1") to the new substation of Fond Cole (approximately 2.5 Km)

* bend B1 is defined according to the Universal Transverse Mercator Grid system (UTM Zone 20) by the following: X= 675033.169 Y= 1693918.627

** bend B14 is defined according to the Universal Transverse Mercator Grid system (UTM Zone 20) by the following: X= 678642.000 Y= 1695414.000

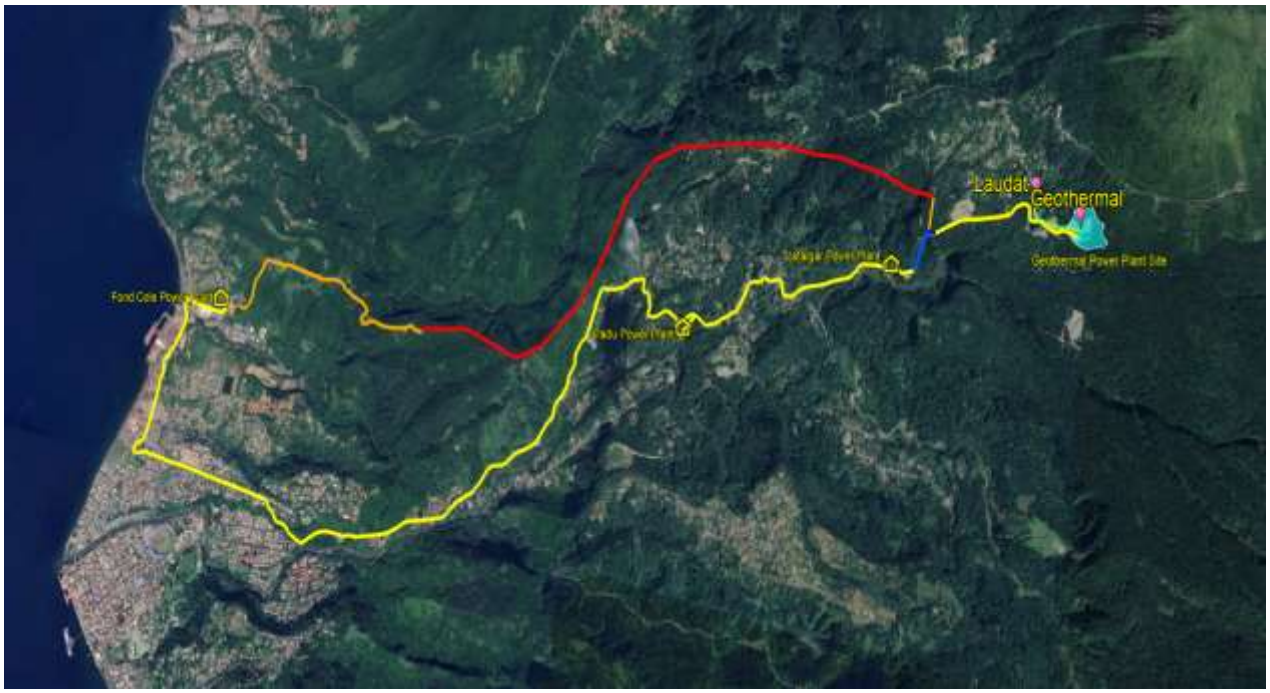


Figure 1: 69kV, 33kV, 11kV Links

N.B.:

Before any commencement of work, a photographical inventory must be made all along the routing, showing the initial state of the working zone.

Then, following the execution phase, another on-site inspection must take place, and if some impacts have been detected, **the Contractor would be responsible for all the necessary repair work**.

2. Summary of Contractor's obligations for the UNDERGROUND CABLES (UGC)

The works related to the project will be executed on a turnkey basis, design, supply, installation and commissioning. Therefore, the works shall include, among others, calculations, design, manufacture, assembly and acceptance testing in the Contractor's workshop (manufacturer's facility**)** as well as the supply, customs clearance, delivery, unloading, storage**,** installation, adjusting, painting, identification, commissioning, acceptance and testing of new equipment to be installed, complete in every respect and suitable for satisfactory operation.

This section details the main items of plant to be supplied and installation works to be carried out under this contract. However, the Contractor is required to ascertain himself whether any additional plant or installation works are necessary so as to make the Facility in working order on completion and in accordance with the requirements of the contract. Any additional equipment, plant or works, not specified but intrinsically required for the proper operation of the facility, are deemed to be included in the bid. Any quantities which may be set out in the price schedules shall be considered as indicative quantities.

From the commencement date up to the signing of the completion of the Facilities, the Contractor shall - at his own costs – store and secure the equipment and materials as well as protect them against damages, weathering, removal or destruction. It shall be the Contractor's obligation to construct fences and shelters, lighting, security services and all relevant measures to fulfil these duties.

The scope of this contract described in below sections and elsewhere in the bid documents shall cover all supplies and services required to meet the purpose of the plant, safe, reliable and contractual intended use of the facilities, even if these are not expressly mentioned in detail in the subsequent sections.

All works not expressly called for in this Employers Requirements/ Specification, but necessary for the complete and proper installation and operation of the Facility /equipment and accessories at the discretion of the Engineer shall be supplied and installed by the Contractor at no additional cost to the Employer.

Any terminal points which are not specified / included in the Employers Requirement/Specification, but required for safe and reliable operation of the Facility shall be deemed to be included in the scope of works and the Contractor shall carry out such terminal connection works at no extra cost to the Employer. All preparatory works for terminal point connections, such as drawings, shall be under the directives of the Employer/ Engineer. Supply of necessary equipment, clean up etc. will be the Contractor’s responsibility. The Employer should not be required to utilize its resources for such work.

The requirements detailed in the following paragraphs shall be read in conjunction with the detailed technical specifications and technical schedules. The final quantities shall be determined from the final design.

All temporary works and equipment, necessary to keep the substation in operation during the execution of the works, are included in the scope of supply and services. The Contractor who will be wholly responsible for ensuring that all materials used in the work and temporary works comply with the approved standards, and that all processes of workmanship are carried out with a high degree of efficiency, in accordance with an approved program an in compliance with the contract requirements.

In case discrepancies occur between the items of scope of supply and services stated hereby and the ones derived from the respective drawings and in case certain items of scope of supply are identified hereby but not in the respective drawings or vice versa, the Contractor is requested to interpret the project requirements by considering this document and all its parts in conjunction and collectively. The same principle applies with the price schedules. The contract is Lumpsum type. The most stringent requirements shall apply in case of deviations other than which qualifies under GCC 39 – Change in the Facilities

The itemized relevant unit prices in the price schedules shall include all costs of all supply and services, which are required for the function of the facility, but not exclusively mentioned elsewhere in the specification.

3. Specific works information for UNDERGROUND CABLES (UGC) links

3.1 Specific Works Information for GFI 69kV UGC link

The 69 KV GFI link can be divided into 3 major parts defined as follow:

- **69kV UGC** from Geothermal substation to the Terminal monopoles (#at bend B14) located at the level of a secondary road near the upper level of Trafalgar Cliff, (approximately 1.5Km)

- **69kV OHL** from the Terminal monopole (#at bend B1) till the other terminal monopole (#at bend B14) (approximately 4.8Km).
- **69kV UGC** from the terminal monopole (#at bend B1) till the new substation of Fond Cole (approximately 2.5Km).

3.1.1 Localization

The 69 KV link between Geothermal substation and the Terminal monopoles (#at bend B14) located at the level of a secondary road near the upper level of Trafalgar Cliff, consists of a UGC-Link, defined by ~1.5Km of Length approximately.

Figure 2: Routing of the 69 KV UGC link between Geothermal SS and terminal monopoles (#at bend B14)

3.1.2 Scope of supply

The Contract scope of works for the new 69kV UGC link between Geothermal substation and Fond Cole substation, is the design, construction, supply, installation, connection, testing, pre-commissioning and final commissioning of all civil and electrical works, as well as the provision of drawings and documentation and any other requirements as defined in this specification.

The overall deliverables, at site, for this Link are:

First 69kV GFI UGC Portion: From Geothermal substation outdoor switchyard to the terminal monopoles (#at bend B14) located at the level of a secondary road near the upper level of Trafalgar cliff (approximately 1.5km)

- Three (03) 69kV outdoor composite cable termination with integrated (03) surge arresters, to be installed in the Geothermal substation at the entry of the line with all needed accessories, fittings and pedestal metallic structure to ensure an overhead connection from cable termination to the adjacent Surge arresters.
- 1.5km of 69kV underground XLPE single core aluminium 240mm² (transit of 22MVA) cable from Geothermal substation till terminal monopoles (#at bend B14) of 69kV GFI line (Geothermal side).

- 1.5km of Fiber Optical underground cable (48F) from Geothermal substation till Terminal monopoles (#at bend B14) of 69kV GFI line (Geothermal side).
- Three (03) 69kV cable joints (within one cable junction manhole) which divide the first 1,5km into two portions (650m and 850m approximately).
- One (01) cross-bonding box with SVL (Sheath Voltage Limiter) and necessary accessories (cables lugs,…)
- Two (02) earthing box with necessary accessories (cables lugs,…)
- One (01) splice box for splicing Fiber Optical underground cable and OPGW mounted on the terminal monopoles (Geothermal side).
- Three (03) 69kV outdoor composite cable termination with integrated (03) surge arresters, to be mounted on the terminal monopoles of the OHL line or separate pedestal column (Geothermal side) with all needed accessories, fittings and metallic structure to ensure a connection to overhead conductor of the line (ACSR/AW, Guinea 85 mm²). This cable termination should be connected to the adjacent Surge arresters mounted on the same Terminal monopoles (more details of monopoles specifications are in annexes).
- All HDPE ducts and warning grid for UGC and FO cable as detailed in the specification.

Second 69 kV GFI UGC Portion: From the Terminal monopoles (#at bend B1) of 69kV GFI Line the new Fond Cole substation (2.5km approximately)

- Three (03) 69kV outdoor composite cable termination with integrated (03) surge arresters, to be mounted on the Terminal monopoles of the OHL line or separate pedestal column (Fond Cole side) with all needed accessories, fittings and metallic structure to ensure a connection to overhead conductor of the line (ACSR/AW, Guinea 85 mm²). This cable termination should be connected to the adjacent Surge arresters mounted on the same Terminal monopoles (more details of monopoles specifications are in annexes).
- 2.5km of 69kV underground XLPE single core aluminium 240mm² (transit of 22MVA) cable from Fond Cole substation till Terminal monopoles (#at bend B1) (Fond Cole side).
- 2.5km of Fiber Optical underground cable (48F) from Fond Cole substation till Terminal monopoles (#at bend B1) (Fond Cole side).
- One (01) splice box for splicing Fiber Optical underground cable and OPGW mounted on the terminal monopoles (Fond Cole side).
- Three (03) dry plug-in SF6 gas immersed sealing end for connection to 69kV GIS at Fond Cole substation.
- Six (06) 69kV cable joints (within 02 cable junction manholes) which divide the 2.5km into 3 portions (each portion of 800m approximately).
- One (01) FO splice box to connect two portions of FO underground cable (within 01 FO junction manhole).
- Two (02) cross-bonding box with SVL (Sheath Voltage Limiter) and necessary accessories (cables lugs,…)
- Two earthing boxes with all necessary accessories (cables lugs,…).
- Two anchoring boxes
- All HDPE ducts and warning grid for UGC and FO cable as detailed in the specification.

<u>The services to be performed by the Contractor include, but are not limited to:</u>

- All the services and supplies as described in this specification,
- The complete design studies of the cable system including all the additional technical studies that the contractor would need for the dimensioning of the cable system, soil investigations, Georadar passage, topographic surveys, identification of all existing buried networks, geotechnical studies, site installation, etc.
- All administrative procedures, obtaining work permits, etc.
- Compliance with environmental constraints of the project region
- The management and control of its activities, its subcontractors, the implementation of its quality system,
- Participation in project meetings,

- Compliance with the documentation provided before and after work
- The implementation of all its services in accordance with the requirements of this bid file until perfect completion.

N.B.:

All along the UGC part of this link, we will have 3 power junction boxes, one FO Junction box, with two anchoring boxes, no directional drilling and no special civil work to be done.

3.1.3 Scope of construction works

The construction scope of work to be performed by the Contractor consist of:

Electrical construction works:

First 69kV GFI UNDERGROUND CABLES (UGC) Portion: From Geothermal substation outdoor switchyard to the Terminal monopoles (#at bend B14) located on a secondary road near the upper level of Trafalgar cliff (1.5km approximately)

- Pulling and connection of 1.5km of 69kV underground XLPE cable from outdoor cable termination in Geothermal substation till Terminal monopoles (#at bend B14) (Geothermal side).
- Installation of three (03) 69kV outdoor composite cable termination with integrated (03) surge arresters, to be mounted on pedestal column in the Geothermal substation at the entry of the line with all needed accessories, fittings and metallic structure to ensure an overhead connection from cable termination to the adjacent equipment.
- Pulling and connection of 1.5km of Fiber Optical underground cable (48F) from Geothermal substation telecom room till Terminal monopoles (#at bend B14) (Geothermal side). The FO cable should be spliced to the substation ODF and to the FO junction box at the terminal monopoles (#at bend B14) Geothermal side.
- Installation and splicing of One (01) splice box for splicing Fiber Optical underground cable and OPGW connection on the terminal monopoles (#at bend B14) (Geothermal side).
- Installation and connection of three (03) 69kV cable joints (within one cable junction manhole) which divide the first 1.5km into two portions (650m and 850m approximately).
- Installation and connection of one cross-bonding box with necessary SVL (Sheath Voltage Limiter).
- Installation and connection of earthing boxes
- Installation and connection of one (01) junction box for Fiber Optical underground cable and OPGW connection on the terminal monopoles (#at bend B14) (Geothermal side).
- Installation and connection of three (03) 69kV outdoor composite cable termination with integrated (03) surge arresters, to be mounted on the terminal monopoles of the OHL line or separate pedestal column (Geothermal side) with all needed accessories, fittings and metallic structure to ensure a connection to overhead conductor of the line.
- Testing and commissioning of the whole installed equipment (power cables, FO cable and all accessories).

Second 69 kV GFI UNDERGROUND CABLES (UGC) Portion: From the Terminal monopoles (#at bend B1) of 69kV GFI Line the new Fond Cole substation (2.5km approximately)

- Installation and connection of three (03) 69kV outdoor composite cable termination, with integrated (03) surge arresters, to be mounted on the Terminal monopoles of the OHL line or separate pedestal column (Fond Cole side) with all needed accessories, fittings and metallic structure to ensure a

connection to overhead conductor of the line. This cable termination should be connected to the adjacent Surge arresters mounted on the same Terminal monopoles.

- Installation and connection of one (01) junction box for Fiber Optical underground cable and OPGW connection on the Terminal monopoles (Fond Cole side).
- Pulling and connection of 2.5km of 69kV underground XLPE cable from Fond Cole substation till Terminal monopoles (#at bend B1) of 69kV GFI line.
- Pulling and connection of 2.5km of Fiber Optical underground cable (48F) from Fond Cole substation telecom room till Terminal monopoles (#at bend B1) (Fond Cole side). The FO cable should be spliced to the substation ODF and to the FO junction box at the Terminal monopoles (#at bend B1) Fond Cole side.
- Installation and connection of six (06) 69kV cable joints (within 02 cable junction manholes) which divide the 2.5km into 3 portions (each portion of 800m approximately).
- Installation and splicing of one (01) FO splice box to connect two portions of FO underground cable (within 01 FO junction manhole).
- Installation and connection of two (02) cross-bonding box with SVL (Sheath Voltage Limiter) and necessary accessories (cables lugs,…)
- Installation and connection of two earthing boxes with all necessary accessories (cables lugs,…).
- Installation of two anchoring boxes and cable anchoring.
- Installation and splicing of One (01) splice box for splicing Fiber Optical underground cable and OPGW connection on the Terminal monopoles (#at bend B1) (Fond Cole side).
- Installation and connection of three (03) dry plug-in SF6 gas immersed sealing end for connection to 69kV GIS line bay at Fond Cole substation.
- Testing and commissioning of the whole installed equipment (power cables, FO cable and all accessories).

Civil construction works:

The Contractor refers to the General Civil Engineering specification in section14 for all the civil engineering services for which it is responsible.

In particular, the contractor should carry out:

- All the necessary steps to carry out its work (relations with the owners, search for authorizations, reports, etc.)
- The detection of buried networks near the works on which the Contractor will have to intervene
- All earthworks, civil engineering, and handling work allowing the installation of the cable system, in particular:
  - ✓ Cable trench opening (Excavation)
  - ✓ Ducts installation and laying
  - ✓ Concrete encasement when passing under roadways
  - ✓ Warning Grid
  - ✓ Backfilling and compacting work
  - ✓ Cable trench closing
  - ✓ The repair of any coating impacted by the work
  - ✓ Identical restoration of land after finalization of works.
  - ✓ The creation of a traffic plan throughout the duration of the works for local residents affected by the prohibited access to the work area, like diversions for vehicles, Safety markings, Signage of restricted access, and any additional safety measure guaranteeing the safety of the public around the site.

Site preparation:

The contractor will be responsible of the following:

- The setting up of site facilities for the construction of the links

- The transmission of the declaration of works (plans, schedules) to the local authorities to obtain authorization to open the trenches.
- All the preparation work before the opening of the trenches including:
  - ✓ Site installation that respects all the requirements detailed in the general technical specifications in the section14 below of this document.
  - ✓ Protection of trees located near the route
  - ✓ Supply of all the necessary markup

(When passing under roadways, at least one lane will remain functional during the work execution)

Substations works:

The Contractor must coordinate with the substations Contractor and the Employer for the installation of the ducts within the enclosure of the substation.

The Contractor shall submit for approval to the contracting authority a system guaranteeing the sealing of penetrations in the underground passage near the exit from the enclosure of the Geothermal, Trafalgar, Padu, and Fond Cole substations).

The Contractor should restore any work of the substations impacted by the installation of its cable systems.

In the Geothermal substation, the 69 KV link will be connected to HIS switchgear, and in Fond Cole substation this link will be connected to GIS switchgear.

Works relating to the 69kV GFI:

General:

The plans in the appendixes detail the route of the 69 kV GFI link from the Geothermal substation till the Terminal monopoles (#at bend B14) located at the level of a secondary road near the upper level of Trafalgar cliff, and from the other terminal monopole (#at bend B1) till the new substation of Fond Cole, will be made by underground connections, with a total length of (1.5+2.5) = approximately 4km.

The general characteristics of the ducts set are given below for information only:

- Single trench width = approx. 0.6 m, depth 1.5 m.
- Ducts for the 3*69 KV phases (3 HDPE ø140-160 mm) laid with an HDPE 50mm duct for FO cable.
- No Horizontal directional drilling and no special civil work to be done all along this link
- 3 Power junction boxes
- 1 underground FO junction box
- 2 anchoring boxes

Cable trenches:

Trenches works are detailed in the General Civil Engineering Specification.

The related works to the cable's trenches passage are:

- Excavation and shielding
- Installation of ducts (with or without a concrete encasement depending on the localization of the trench)
- Backfilling and compacting works with a maximum layer of 15 cm
- Installing the warning grid
- Repairing work on any impacted area by the work

For the 69 kV GFI link, the cable trench will be dimensioned minimum as follow:

- Width 0.6 m
- Depth = 1.5 m

Cable Junction Manhole, Earth/Cross Bonding pit and FO junction Manhole:

As mentioned before, all along this UNDERGROUND CABLES (UGC) parts of the 69 kV link, we will have 03 power junction manhole and three earthing/cross bonding pit.

The installation of an earthing box or a Cross bonding box near the power junction manhole will be confirmed according to the electrical study.

The 69 kV power junction manhole has the following minimum dimensions:

- Length = 9 m
- Width = 2.5 m
- Height =0.7 m

And they will be placed at 1.5 m minimum of depth

Directional Drilling:

- No directional drilling to be done all along this link

3.1.4 Scope of design works

The Contractor must also provide supporting documentation, calculations, system studies, drawings, descriptions, manuals, quality control systems, progress reports and meetings with the project owner representative as set out in this Specification. Required supporting documentations may include but is not limited to the following:

- HV Cable Rating Study,
- Soil Thermal Resistivity Test Results,
- Geotech Survey,
- All Site Surveying work,
- All needed drawings and calculation notes for electrical and civil works dimensioning:
    - General arrangements (plan and elevation), layouts and sections drawings for the route,
    - Civil works detailed drawings and calculation notes: Cable duct arrangement, elevation and dimensions, sections views, etc.
    - Cable section, rating current, derating factors, cable laying, etc.
    - Joints and terminations
    - Primary Plant Schedule for Procurement (8 weeks from date of Contract award)

The Contractor must perform a site visit prior to undertaking detailed design in order to determine site-specific conditions.

Please refer to the drawings given in the annexes as guidance for the contractor to achieve the civil work design. A typical section of the 69 kV cable trench and the 69 kV power junction manhole are provided in the appendices A3-1 and A3-4. In addition an indicative 69kV line route is provided in the appendix A3-6-3.

These plans are given for information only in order to inform the Contractor about the consistency of the works that he is responsible for.

This does not release the Contractor from its responsibility for the design of all the civil engineering works of the project.

Especially:

- The Contractor should design the works in such a way as to respect the needs in transit and to ensure the safety of the public
- The dimensions of the ducts set will be optimized so as to respect the transit in all the configurations encountered on the route
- The thickness of the concrete encasement all around the ducts if it exists must guarantee the containment of any fault (short-circuit, etc.) that may occur during the operation of the connections
- The telecommunication FO junction box must be installed in a separate manhole outside of the power junction manhole.

3.1.4.1 Civil works design

As mentioned in the section above, the 69 kV Geothermal – Fond Cole UNDERGROUND CABLES (UGC) link consists of an underground passage by a simple cable trench all along ~4km approximately.

Three power cable ducts will be used for the passage of the 3 phases of the 69 kV cable, with another duct for the passage of the FO telecommunication link and backfilled according to the mentioned requirements of the general Civil works technical specifications of civil work, section 14.4, and the technical specifications of materials, section 14.2, part “Backfilling”, below.

All the relative plans and cross-sections of the civil engineering work to accommodate the cable systems are available in the appendixes.

Three junction manholes are needed for the 69KV, along with earth or cross bonding pits, with two anchoring boxes and one junction box for the FO cables all along the UNDERGROUND CABLES (UGC) part of this link and 2 FO junction boxes will be needed at the start and end of the OHL part.

In addition, no horizontal directional drilling to be done.

Soil investigations:

The Contractor carries out the necessary studies and investigations for the dimensioning of all the civil engineering works for which he is responsible.

The Topographical studies must include:

- The research for the various existing network concessionaires and the requests for defining and representing their existing networks.
- Surveys and detection of buried networks by appropriate means (Georadar passage where the Lidar Technology is preferred),
- Definition and detection of all obstacles, or any kind of networks encountered on the proposed route of the link,
- The production of engineering and execution plans (plan views, longitudinal profiles, assembly plans, sections, etc.)

After the topographical surveys that will be carried out by the contractor, all the plans will be georeferenced. The requested Projected Coordinate System for this project is: **Universal Transverse Mercator Grid system (UTM Zone 20)**

During the geotechnical studies, the Contractor will perform electrical and thermal resistivity measurements as well soil temperature measurements.

In addition, the contractor is responsible to make a relative hydrological study and hydrogeological study.

Ducts set:

Each duct set will include:

- Three HDPE ducts, one for each of the three phases of the 69 KV cables, (D=140-160 mm)
- One HDPE duct for the fiber optic cable (D=50 mm)

Horizontal directional drilling:

No horizontal directional drilling to be done all along this 69 KV UNDERGROUND CABLES (UGC) link from the new Geothermal substation to Fond Cole substation.

Civil engineering structures:

Cable Junction Manhole, Earth/Cross Bonding pit and FO junction Manhole:

Three power Junction Manholes to be done all along this 69 KV UNDERGROUND CABLES (UGC) link of GFI. Near each junction box an earth or a Cross bonding visitable pit will be installed according to the detailed cable transit study.

One FO junction box to be done all along the UNDERGROUND CABLES (UGC) part, 2 FO junction Boxes will be needed at the level of the Terminal monopoles at the start and end of the OHL part.

In addition 2 anchoring boxes with take place on the second UNDERGROUND CABLES (UGC) part of the GFI link (69 kV) (from the terminal monopole (#at bend B1) till the new Fond Cole substation)

The 69 kV power junction boxes are dimensioned minimum with the following:

- Length = ~9 m
- Width = ~2.5 m
- Height =~0.7 m

And they will be placed at 1.5 m minimum of depth

In order to allow the permutation or earthing of the screens of each circuit, earth or cross bonding visitable pits, (1.5*1.5 m2), will be installed near the junction boxes when they exist. Each of these manhole will have a cast iron cover. The upper level of these manholes will be the same of the natural ground level. The chosen pits type will be based on the transit cable design.

Cable Trench:

For the 69 kV GFI link, the cable trench will be dimensioned minimum as follow:

- Width =~ 0.6 m
- Depth = ~1.5 m

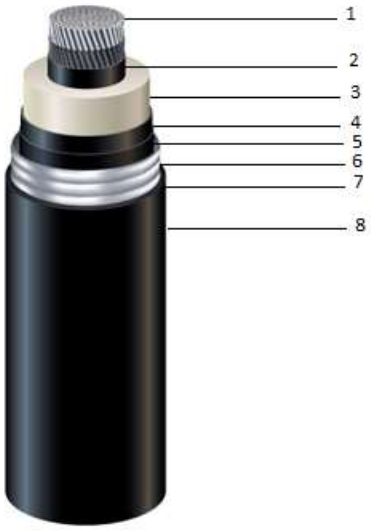
3.1.4.2 Electrical design

69kV Cable:

The selected 69kV UNDERGROUND CABLES (UGC) which should transit a maximum power of 22MVA is 3 x 1core x 240mm² aluminium conductor. A calculation note for 69kV must be elaborated proving that this selected cross section is efficient to transit the requested energy while applying all derating factors (ground temperature, ground thermal resistivity, depth of laying, in a buried duct)

Please refer to section “69kV XLPE Cable” for more details.

Technical requirements for 69kV cable are detailed in Annex A2-1



1: Aluminium Conductor Core

2: Conductor screen (extruded semi-conductor)

3: XLPE Insulation

4: Insulation screen (extruded semi-conductor)

5: Watertight layer

6: Corrugated aluminium sheath

7: Outer sheath (PE Jacket)

8: Marking

Figure 3: Typical 69kV single core cable with corrugated aluminium sheath

69kV Plug-In SF6 gas Cable termination for GIS switchgear:

Please refer to section "69kV UNDERGROUND CABLES (UGC) accessories" for more details.

Technical requirements for 69kV Plug-In SF6 gas cable terminations are detailed in Annex A2-2

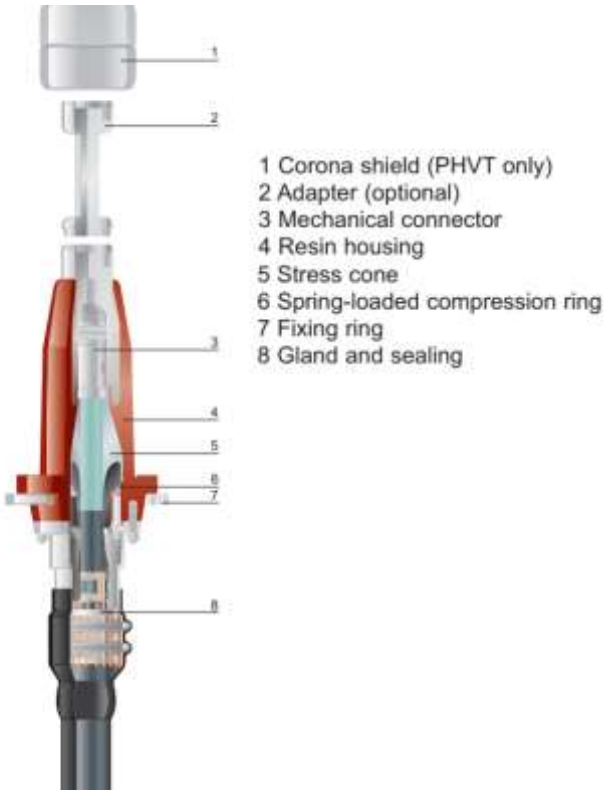


Figure 4: Typical 69kV dry type plug in termination for GIS switchgear

69kV Outdoor composite Cable termination with integral surge arresters:

Please refer to section "69kV UNDERGROUND CABLES (UGC) accessories" for more details.

Technical requirements for 69kV outdoor composite cable terminations with integral surge arresters are detailed in Annex A2-3

Figure 5: Typical Outdoor sealing end with integral surge arrestor

69kV Cable Joint:

Please refer to section "69kV UNDERGROUND CABLES (UGC) accessories" for more details.

Technical requirements for 69kV cable joints are detailed in Annex A2-4

69kV Cable Cross-bonding Boxes:

Please refer to section "69kV UNDERGROUND CABLES (UGC) accessories" for more details.

Technical requirements for 69kV cable cross-bonding are detailed in Annex A2-10

3.2 Specific Works Information for GFI 33kV UNDERGROUND CABLES (UGC) link

The 33kV GFI link from Geothermal substation to Fond Cole substation will be divided into three sub-links: GFI = GTI + TPI + PFI

GTI: From Geothermal substation to Trafalgar substation:

- ✓ Part 1: 33kV UGC from Geothermal substation (69/33/11 kV) to the Terminal monopoles at the upper level of Trafalgar cliff (approximately 1.5 Km)
- ✓ Part 2: 33kV OHL link all over the Trafalgar Cliff (approximately 0.32 Km),

- ✓ Part 3: 33kV UGC from the Terminal monopoles at the bottom level of Trafalgar Cliff to Trafalgar substation (2.2/33 kV) (approximately 0.3 Km).

TPI: From Trafalgar to Padu substation

- ✓ 33kV UGC from Trafalgar (2.2/33 kV) to Padu (33/11 kV) (approximately 2 Km)

PFI: From Padu to Fond Cole substation

- ✓ 33kV UGC from Padu (33/11 kV) to Fond Cole (69/33/11 kV) (approximately 7 Km)

N.B.:

The Contractor would be responsible for ensuring the secure passage between the underground and the OHL cable at the level of the Terminal monopoles, as well as all along the OHL link at the level of Trafalgar cliff, with all the necessary connection accessories.

So, the Contractor shall bear full responsibility that the relative design is in accordance with all standards and applicable regulations.

The Contractor shall provide the Employer with a detailed line route survey, which is subject to approval before any construction activities may commence.

The line route survey shall consist of a center line survey covering at least 15m to each side conducted in person on foot, or a LiDAR survey.

The Contractor shall provide the Employer with a full and detailed list of all above ground obstacles, buildings, structures, property, goods and crops that are required to be demolished or removed to permit the construction and erection of the Works.

The OHL line must be able to carry the maximum capacity of the underground cable.

All towers shall be hot dip galvanized and protected against corrosion under service conditions. The protection shall also prevent corrosion during transport, storage and erection.

Damage to the protection during transport, erection etc. and jointing shall be repaired to the same quality as specified for the object.

Galvanizing shall be applied by the hot-dip process and shall consist of a continuous coating to minimum thickness 95 μm*.*

3.2.1 Localization

The 33 KV link between Geothermal and Fond Cole substations, (GFI), consists of the following UNDERGROUND CABLES (UGC) portions:

- 33kV UGC from Geothermal substation to the upper level of Trafalgar Cliff (**approximately 1.5 kilometers of length).**
- 33kV OHL all over the Trafalgar Cliff **(approximately 0.32km)**
- 33kV UGC from the bottom level of Trafalgar Cliff to Fond Cole going through Trafalgar and Padu substations → **~0.3+2+7 = ~9.3km in length approximately**

Figure 6: Routing of the 33 KV UGC link between Geothermal and Fond Cole Substations

The route of this link pass near the following areas:

1. People's Pentecostal Family Church
2. Dominica-China Friendship Hospital Parking Lot - Free parking lot
3. Bull's eye pharmacy
4. Papillote Tropical Gardens
5. Waterfall at Papillote
6. Geothermal production well
7. Dominica, Karibik - Resting Place on the Cable Car
8. Dominica, Karibik - Valley Station Cable Car Rainforest
9. Etc.…

3.2.2 Scope of supply

The Contract scope of works for the new 33kV UNDERGROUND CABLES (UGC) link between Geothermal substation and Fond Cole substation, is the design, construction, supply, installation, connection, testing, pre-commissioning and final commissioning of all civil and electrical works, as well as the provision of drawings and documentation and any other requirements as defined in this specification.

The overall deliverables, at site, for this Link are:

First 33kV GFI UNDERGROUND CABLES (UGC) Portion: From Geothermal substation 33kV switchgear to the 33kV tower in the upper level of Trafalgar cliff (1.5km approximately)

- One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Geothermal substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Trafalgar Feeder)
- 1.5km of 33kV underground XLPE three core copper 240mm² (transit of 22MVA) cable from Geothermal substation till the tower in the upper level of Trafalgar cliff of 33kV GFI line (Geothermal side).
- 1.5km of Fiber Optical underground cable (48F) from Geothermal substation till the tower in the upper level of Trafalgar cliff of 33kV GFI line (Geothermal side).

- One (01) **three phases** joint kit for 33kV cable (within one cable junction manhole) which divide the first 1.5km into two portions (750m and 750m approximately).
- One (01) cross-bonding box with SVL (Sheath Voltage Limiter) and necessary accessories (cables lugs,…)
- Two earthing boxes with all necessary accessories (cables lugs,…).
- One (01) splice box for Fiber Optical underground cable and OPGW connection on the tower in the upper level of Trafalgar cliff of 33kV GFI line
- One (01) 33kV outdoor cold-shrinkable cable terminations kit (**for three phases**) with (03) surge arresters, to be mounted on the Terminal monopoles of the 33kV OHL line portion or separate pedestal column (Geothermal side) with all needed accessories, fittings and metallic structure to ensure a connection to overhead conductor of the line (conductor: ACSR/AW, Guinea 127mm²) and steel monopoles (more details of monopoles specifications are in annexes).
- All HDPE ducts and warning grid for UGC and FO cable as detailed in the specification.

Second 33kV GFI UNDERGROUND CABLES (UGC) Portion: From the 33kV tower in the bottom level of Trafalgar cliff to Trafalgar substation 33kV switchgear (0.3km approximately)

- One (01) 33kV outdoor cold-shrinkable cable terminations kit (**for three phases**) with (03) surge arresters, to be mounted on the Terminal monopoles of the 33kV OHL line portion or separate pedestal column (Trafalgar side) with all needed accessories, fittings and metallic structure to ensure a connection to overhead conductor of the line (conductor: ACSR/AW, Guinea 127mm²) and steel monopoles (more details of monopoles specifications are in annexes).
- One (01) splice box for Fiber Optical underground cable and OPGW connection on the tower in the upper level of Trafalgar cliff of 33kV GFI line
- 0.3km of 33kV underground XLPE three core copper 240mm² (transit of 22MVA) cable from the tower in the button level of Trafalgar cliff of 33kV GFI line (Trafalgar side) to Trafalgar substation.
- 0.3km of Fiber Optical underground cable (48F) from the tower in the bottom level of Trafalgar cliff of 33kV GFI line (Trafalgar side) to Trafalgar substation.
- One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Trafalgar substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Geothermal Feeder)
- Two earthing boxes with all necessary accessories (cables lugs,…).
- All HDPE ducts and warning grid for UGC and FO cable as detailed in the specification.

Third 33kV GFI UNDERGROUND CABLES (UGC) Portion: From Trafalgar substation 33kV switchgear to Padu substation 33kV switchgear (2km approximately)

- One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Trafalgar substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Padu Feeder)
- 2km of 33kV underground XLPE three core copper 240mm² (transit of 22MVA) cable from Trafalgar substation to Padu substation.
- 2km of Fiber Optical underground cable (48F) from Trafalgar substation to Padu substation.
- One (01) **three phases** joint kit for 33kV cable (within one cable junction manhole) which divide the 2km into two portions (1000m and 1000m approximately).
- One (01) cross-bonding box with SVL (Sheath Voltage Limiter) and necessary accessories (cables lugs,…)
- Two earthing boxes with all necessary accessories (cables lugs,…).
- One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Padu substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Trafalgar Feeder)
- All HDPE ducts and warning grid for UGC and FO cable as detailed in the specification.

Fourth 33kV GFI UNDERGROUND CABLES (UGC) Portion: From Padu substation 33kV switchgear to Fond Cole substation 33kV switchgear (7km approximately)

- One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Padu substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Fond Cole Feeder)
- 7km of 33kV underground XLPE three core copper 240mm² (transit of 22MVA) cable from Padu substation to Fond Cole substation.
- 7km of Fiber Optical underground cable (48F) from Padu substation to Fond Cole substation.
- Six (06) **three** joint kits for 33kV cable (within 06 cable junction manholes) which divide the 7km into 7 portions (each portion of 1000m approximately).
- Three (03) FO splice boxes to connect each two portions of 2km FO underground cable (within 03 FO junction manholes).
- Six (06) cross-bonding box with SVL (Sheath Voltage Limiter) and necessary accessories (cables lugs,…)
- Two earthing boxes with all necessary accessories (cables lugs,…).
- One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Fond Cole substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Padu Feeder)
- All HDPE ducts and warning grid for UGC and FO cable as detailed in the specification.

N.B.:

All along this link, we will have 8 power junction boxes, 2 FO boxes at the level of the Terminal monopoles before and after the OHL link, and 3 FO Junction boxes will be needed all over the GFI underground link.

No directional drilling and no special civil work to be done.

The services to be performed by the Contractor include, but are not limited to:

- All the services and supplies described in the General specification of the section 14.4
- The complete design studies of the cable system including all the additional technical studies that the contractor would need for the dimensioning of the cable system, soil investigations, Georadar passage, topographic surveys, identification of all existing buried networks, geotechnical studies, site installation, etc.
- All administrative procedures, obtaining work permits, etc.
- Compliance with environmental constraints of the project region
- The management and control of its activities, its subcontractors, the implementation of its quality system,
- Participation in project meetings,
- Compliance with the documentation provided before and after work
- The implementation of all its services in accordance with the requirements of this bid file until perfect completion

3.2.3 Scope of construction works

The construction scope of work to be performed by the Contractor consist of:

Electrical construction works:

First 33kV GFI UNDERGROUND CABLES (UGC) Portion: From Geothermal substation 33kV switchgear to the 33kV tower in the upper level of Trafalgar cliff (1.5km approximately)

- Installation and connection of One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Geothermal substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Trafalgar Feeder)
- Pulling and connection of 1.5km of 33kV underground XLPE three core copper 240mm² cable from Geothermal substation 33kV switchgear cabinet (outgoing Trafalgar Feeder) till the tower in the upper level of Trafalgar cliff of 33kV GFI line (Geothermal side).
- Pulling and connection of 1.5km of Fiber Optical underground cable (48F) from Geothermal substation Telecom room till the terminal monopoles in the upper level of Trafalgar cliff of 33kV GFI line (Geothermal side). The FO cable should be spliced to the substation ODF and to the FO junction box at the Terminal monopoles of 33kV GFI line Geothermal side.
- Installation and connection of One (01) **three phases** joint kit for 33kV cable (within one cable junction manhole) which divide the first 1.5km into two portions (750m and 750m approximately).
- Installation and connection of one cross-bonding box with necessary SVL (Sheath Voltage Limiter).
- Installation and connection of two earthing boxes with all necessary accessories (cables lugs,…).
- Installation and splicing of One (01) splice box for Fiber Optical underground cable and OPGW connection on the tower in the upper level of Trafalgar cliff of 33kV GFI line
- Installation and connection of One (01) 33kV outdoor cold-shrinkable cable terminations kit (**for three phases**) with (03) surge arresters, to be mounted on the Terminal monopoles of the 33kV OHL line portion or separate pedestal column (Geothermal side) with all needed accessories, fittings and metallic structure to ensure a connection to overhead conductor of the line (conductor: ACSR/AW, Guinea 85 mm²) and steel monopoles (more details of monopoles specifications are in annexes).
- Testing and commissioning of the whole installed equipment (power cables, FO cable and all accessories).

Second 33kV GFI UNDERGROUND CABLES (UGC) Portion: From the 33kV tower in the bottom level of Trafalgar cliff to Trafalgar substation 33kV switchgear (0.3km approximately)

- Installation and connection of One (01) 33kV outdoor cold-shrinkable cable terminations kit (**for three phases**) with (03) surge arresters, to be mounted on the Terminal monopoles of the 33kV OHL line portion or separate pedestal column (Trafalgar side) with all needed accessories, fittings and metallic structure to ensure a connection to overhead conductor of the line (conductor: ACSR/AW, Guinea 85 mm²) and steel monopoles (more details of monopoles specifications are in annexes).
- Installation and splicing of One (01) splice box for Fiber Optical underground cable and OPGW connection on the tower in the upper level of Trafalgar cliff of 33kV GFI line
- Pulling and connection of 0.3km of 33kV underground XLPE three core copper 240mm² cable from the tower in the button level of Trafalgar cliff of 33kV GFI line (Trafalgar side) to Trafalgar substation 33kV metal-clad switchgear cabinet (outgoing Geothermal Feeder).
- Pulling and connection of 0.3km of Fiber Optical underground cable (48F) from the tower in the bottom level of Trafalgar cliff of 33kV GFI line (Trafalgar side) to Trafalgar substation telecom room. The FO cable should be spliced to the substation ODF and to the FO junction box at the Terminal monopoles of 33kV GFI line Trafalgar side.
- Installation and connection of two earthing boxes with all necessary accessories (cables lugs,…).
- Installation and connection of One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Trafalgar substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Geothermal Feeder)
- Testing and commissioning of the whole installed equipment (power cables, FO cable and all accessories).

Third 33kV GFI UNDERGROUND CABLES (UGC) Portion: From Trafalgar substation 33kV switchgear to Padu substation 33kV switchgear (2km approximately)

- Installation and connection of One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Trafalgar substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Padu Feeder)
- Pulling and connection of 2km of 33kV underground XLPE three core copper 240mm² cable from Trafalgar substation 33kV metal-clad switchgear cabinet (outgoing Padu Feeder) to Padu substation 33kV metal-clad switchgear cabinet (outgoing Trafalgar Feeder).
- Pulling and connection of 2km of Fiber Optical underground cable (48F) from Trafalgar substation telecom room to Padu substation telecom room. The FO cable should be spliced to the Trafalgar and Padu substations ODFs.
- Installation and connection of One (01) **three** joint kit for 33kV cable (within one cable junction manhole) which divide the 2km into two portions (1000m and 1000m approximately).
- Installation and connection of one cross-bonding box with necessary SVL (Sheath Voltage Limiter).
- Installation and connection of two earthing boxes with all necessary accessories (cables lugs,…).
- Installation and connection of One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Padu substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Trafalgar Feeder)
- Testing and commissioning of the whole installed equipment (power cables, FO cable and all accessories).

Fourth 33kV GFI UNDERGROUND CABLES (UGC) Portion: From Padu substation 33kV switchgear to Fond Cole substation 33kV switchgear (7km approximately)

- Installation and connection of One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Padu substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Fond Cole Feeder)
- Pulling and connection of 7km of 33kV underground XLPE three core copper 240mm² cable from Padu substation 33kV metal-clad switchgear cabinet (outgoing Fond Cole Feeder) to Fond Cole substation 33kV metal-clad switchgear cabinet (outgoing Padu Feeder).
- Pulling and connection of 7km of Fiber Optical underground cable (48F) from Padu substation telecom room to Fond Cole substation telecom room. The FO cable should be spliced to the Padu and Fond Cole substations ODFs.
- Installation and connection of Six (06) **three** joint kits for 33kV cable (within 06 cable junction manholes) which divide the 7km into 7 portions (each portion of 1000m approximately).
- Installation and splicing of Three (03) FO splice boxes to connect each two portions of 2km FO underground cable (within 03 FO junction manholes).
- Installation and connection of Six (06) cross-bonding box with necessary SVL (Sheath Voltage Limiter).
- Installation and connection of two earthing boxes with all necessary accessories (cables lugs,…).
- Installation and connection of One (01) 33kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Fond Cole substation with all needed accessories, fittings to ensure the connection from cable termination to the 33kV metal-clad switchgear cabinet (outgoing Padu Feeder)
- Testing and commissioning of the whole installed equipment (power cables, FO cable and all accessories).

Civil construction works:

The Contractor refers to the General Civil Engineering specification in section14 for all the civil engineering services for which it is responsible.

In particular, the contractor should carry out:

- All the necessary steps to carry out its work (relations with the owners, search for authorizations, reports, etc.)
- The detection of buried networks near the works on which the Contractor will have to intervene
- All earthworks, civil engineering, and handling work allowing the installation of the cable system, in particular:
  - ✓ Cable trench opening (Excavation)
  - ✓ Ducts installation and laying
  - ✓ Concrete encasement when passing under roadways
  - ✓ Warning Grid
  - ✓ Backfilling and compacting work
  - ✓ Cable trench closing
  - ✓ The repair of any coating impacted by the work
  - ✓ Identical restoration of land after finalization of works.
  - ✓ The creation of a traffic plan throughout the duration of the works for local residents affected by the prohibited access to the work area, like diversions for vehicles, Safety markings, Signage of restricted access, and any additional safety measure guaranteeing the safety of the public around the site.

Site preparation:

The contractor will be responsible of the following:

- The setting up of site facilities for the construction of the links
- The transmission of the declaration of works (plans, schedules) to the local authorities to obtain authorization to open the trenches.
- All the preparation work before the opening of the trenches including:
  - ✓ Site installation that respects all the requirements detailed in the general technical specifications in the section 14.4 below of this document.
  - ✓ Protection of trees located near the route
  - ✓ Supply of all the necessary markup

(When passing under roadways, at least one lane will remain functional during the work execution)

Substations works:

The UNDERGROUND CABLES (UGC) Contractor must coordinate with the Substation Contractor for the installation of the ducts within the enclosure of the substation.

The Contractor shall submit for approval to the contracting authority a system guaranteeing the sealing of penetrations in the underground passage near the exit from the enclosure of the Geothermal, Trafalgar, Padu, and Fond Cole substations).

The Contractor should restore any work of the substations impacted by the installation of its cable systems.

In all the substations Geothermal, Fond Cole, Padu, and Trafalgar, the 33 KV link will be connected to metal clad switchgear.

Works relating to the 33kV Geothermal – Fond Cole UNDERGROUND CABLES (**UGC) link:**

General:

The plans in the appendixes detail the route of the 33 kV Geothermal – Fond Cole underground connections to be made, with a total length of approximately 10.6km approximately.

The general characteristics of the ducts set are given below for information only:

- Single trench width = approx. 0.4 m, depth = 0.9 m approximately
- Ducts for the 3*33 KV phases (1 HDPE ø200 mm) laid with an HDPE 50mm duct for FO cable.
- No Horizontal directional drilling and no special civil work to be done all along this link
- 08 Power junction manholes, 2 FO boxes at the level of the Terminal monopoles before and after the OHL link, and 3 FO Junction manholes will be needed all along the PFI underground link.

Cable trenches:

Trenches works are detailed in the General Civil Engineering Specification.

The related works to the cable's trenches passage are:

- Excavation and shielding
- Installation of ducts (with or without a concrete encasement depending on the localization of the trench)
- Backfilling and compacting works with a maximum layer of 15 cm
- Installing the warning grid
- Repairing work on any impacted area by the work

For the 33 kV GFI link, the cable trench will be dimensioned minimum as follow:

- Width =~0.4 m
- Depth =~ 0.9 m

Cable Junction Manhole, Earth/Cross Bonding pit and FO junction Manhole:

All along this UNDERGROUND CABLES (UGC) 33 KV GFI link, we will have 08 power cable junction manholes, 2 FO boxes at the level of the Terminal monopoles before and after the OHL link and 3 FO Junction manholes.

The 33 kV power junction manholes will have the following minimum dimensions:

- Length = ~5 m
- Width = ~2.5 m
- Height =~0.7 m

And they will be placed at 1.5 m minimum of depth

The 3 FO junction manholes all along the GFI link, will be of L3T type, and will be at the same level of the natural ground. *(Please refer to annex A2-15)*

Directional Drilling:

No directional drilling to be done all along this link.

3.2.4 Scope of design works

The Contractor must also provide supporting documentation, calculations, system studies, drawings, descriptions, manuals, quality control systems, progress reports and meetings with the project owner representative as set out in this Specification. Required supporting documentations may include but is not limited to the following:

- HV Cable Rating Study,
- Soil Thermal Resistivity Test Results,
- Geotech Survey,
- All Site Surveying work,

- All needed drawings and calculation notes for electrical and civil works dimensioning:
    - General arrangements (plan and elevation), layouts and sections drawings for the route,
    - Civil works detailed drawings and calculation notes: Cable duct arrangement, elevation and dimensions, sections views, etc.
    - Cable section, rating current, derating factors, cable laying, etc.
    - Joints and terminations
    - Primary Plant Schedule for Procurement (8 weeks from date of Contract award)

The Contractor must perform a site visit prior to undertaking detailed design in order to determine site-specific conditions.

Please refer to the drawings given in the annexes as guidance for the contractor to achieve the civil work design. A typical section of a 33 kV cable trench and the 33 kV power junction manhole are provided in the appendices A3-3 and A3-5. In addition an indicative 33kV line route is provided in the appendix A3-6-2.

These drawings are given for information only in order to inform the Contractor about the consistency of the works that he is responsible for.

This does not release the Contractor from its responsibility for the design of all the civil engineering works of the project.

Especially:

- The Contractor should design the works in such a way as to respect the needs in transit and to ensure the safety of the public
- The dimensions of the ducts set will be optimized so as to respect the transit in all the configurations encountered on the route
- The thickness of the concrete encasement all around the ducts if it exists must guarantee the containment of any fault (short-circuit, etc.) that may occur during the operation of the connections
- The telecommunication boxes must be installed outside of the power junction boxes if they exist.

3.2.4.1 Civil works design

As mentioned in the section above, the 33 kV Geothermal – Fond Cole UNDERGROUND CABLES (UGC) link consists of an underground passage by a simple cable trench all along ~10.6km approximately.

One power cable duct will contain the 3 phases of the 33 kV cable, with another duct for the passage of the telecommunication link and backfilled according to the mentioned requirements of the general Civil works technical specifications of civil work section 14.4, and the general technical specifications of materials – section 14.2 – Part Backfilling.

All the relative plans and cross-sections of the civil engineering work to accommodate the cable systems are available in the appendixes.

All along this UNDERGROUND CABLES (UGC) 33 KV GFI link, we have 08 power cable junction manholes, 2 FO boxes at the level of the Terminal monopoles before and after the OHL link and 3 FO Junction manholes.

In addition, no horizontal directional drilling to be done.

Soil investigations:

The Contractor carries out the necessary studies and investigations for the dimensioning of all the civil engineering works for which he is responsible.

<u>The Topographical studies must include:</u>

- The research for the various existing network concessionaires and the requests for defining and representing their existing networks.

- Surveys and detection of buried networks by appropriate means (Georadar passage where the Lidar Technology is preferred),
- Definition and detection of all obstacles, or any kind of networks encountered on the proposed route of the link,
- The production of engineering and execution plans (plan views, longitudinal profiles, assembly plans, sections, etc.)

After the topographical surveys that will be carried out by the contractor, all the plans will be georeferenced. The requested Projected Coordinate System for this project is: **Universal Transverse Mercator Grid system (UTM Zone 20)**

During the geotechnical studies, the Contractor will perform electrical and thermal resistivity measurements as well soil temperature measurements.

In addition, the contractor is responsible to make a relative hydrological study and hydrogeological study.

Ducts set:

Each duct set will include:

- One HDPE duct for the three phases of the 33 KV cables, (D=200 mm)
- One HDPE duct for the fiber optic cable (D=50 mm)

Horizontal directional drilling:

No horizontal directional drilling to be done all along this 33 KV UNDERGROUND CABLES (UGC) link from the new Geothermal substation to Fond Cole substation.

Civil engineering structures:

Cable Junction Manhole, Earth/Cross Bonding pit and FO junction Manhole:

08 power Junction manholes to be done all along this 33 KV UNDERGROUND CABLES (UGC) link of 10.6km of length approximately. 2 FO boxes at the level of the Terminal monopoles before and after the OHL link, and 3 FO Junction manholes will be done all along the PFI underground link.

The 33 kV power junction boxes are dimensioned minimum with the following:

- Length = ~5 m
- Width = ~2.5 m
- Height = ~0.7 m

And they will be placed at 1.5 m minimum of depth

The 3 FO junction manholes all along the GFI link, will be of L3T type, and will be at the same level of the natural ground.

(Please refer to the technical Data sheet in the appendix A2-15 of this document)

Cable Trench:

The cable trench will be dimensioned minimum as follow:

- Width = ~0.4 m
- Depth = ~0.9 m

3.2.4.2 Electrical design

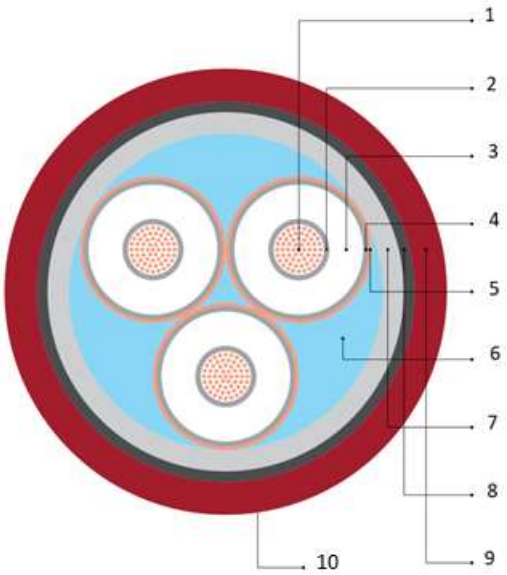
33kV Cable:

The selected 33kV UNDERGROUND CABLES (UGC) which should transit a maximum power of 22MVA is 1 x 3cores x 240mm² copper conductor.

A calculation note for 33kV UGC must be elaborated proving that this selected cross section is efficient to transit the requested energy while applying all derating factors (ground temperature, ground thermal resistivity, depth of laying, in a buried duct)

Please refer to section "33kV XLPE Cable" for more details.

Technical requirements for 33kV cable are detailed in Annex A2-5



1: Copper Conductor Core

2: Conductor screen (extruded semi-conductor)

3: XLPE Insulation

4: Insulation screen (extruded semi-conductor)

5: metallic screen (Flat plain copper tape helically)

6: Filler (Non-hygroscopic EPR/PP)

7: Bedding (PVC)

8: Armouring (galvanized steel)

9: Outer sheath (PVC-ST2 Jacket)

10: Marking

Figure 7: Typical section view of 33 KV cable

33kV Cable termination:

Please refer to section "33kV UNDERGROUND CABLES (UGC) accessories" for more details.

Technical requirements for 33kV cable terminations are detailed in Annex A2-6

33kV Cable Joint Boxes:

Please refer to section "33kV UNDERGROUND CABLES (UGC) accessories" for more details.

Technical requirements for 33kV cable are detailed in Annex A2-7

33kV Cable Cross-bonding Boxes:

Please refer to section "33kV UNDERGROUND CABLES (UGC) accessories" for more details.

Technical requirements for 33kV cross-bonding boxes are detailed in Annex A2-10

3.3 Specific Works information for GLI 11kV UNDERGROUND CABLES (UGC) link

The purpose of this section is to define the 11 kV UNDERGROUND CABLES (UGC) link to be executed between the new Geothermal substation (69/33/11 kV) and the existing 11 kV substation of Laudat.

In this specification, the GLI 11 KV UNDERGROUND CABLES (UGC) link will include but is not limited to, power cables, telecom fiber optic cables, junctions, earthing system equipment, telecommunications equipment, all civil engineering works, and monitoring system.

The Contractor refers to the General specification for the technical, environmental, social, health, and safety requirements to be complied with during the construction works.

All the given specifications in this document should be considered as a minimum.

However, this imposition does not relieve the Contractor of its responsibility in terms of sizing and management of the interfaces of all the supplied systems.

If certain elements seem imprecise or incomplete, the contractor must report this to the client and request any additional information it deems useful.

N.B.:

All the mentioned lengths must be considered as approximate and indicative lengths, and the contractor would be responsible for doing his own design study to have the fixed lengths of the various routes.

3.3.1 Localization

The 11 kV GLI link, from the new Geothermal substation to the existing Laudat substation, consists of an UNDERGROUND CABLES (UGC) link, of about ~0.55 kilometres in length approximately.

Figure 8: Routing of the 11 KV UGC link between Geothermal and Laudat Substations

The route of this link pass near the following areas:

- Geothermal production well
- River crossing near the existing substation of Laudat
- Etc.

N.B.:

All along this link, we will not have any power or telecommunication junction box because of its short length, (0.55km approximately).

3.3.2 Scope of supply

The Contract scope of works for the new 11kV UNDERGROUND CABLES (UGC) link between Geothermal substation and Laudat substation, is the design, construction, supply, installation, connection, testing, pre-commissioning and final commissioning of all civil and electrical works, as well as the provision of drawings and documentation and any other requirements as defined in this specification.

The overall deliverables, at site, for this Link are:

11kV GLI UNDERGROUND CABLES (UGC): From Geothermal substation 33/11kV transformer secondary windings to the 11kV switchgear cabinet in Laudat substation (0.55km approximately)

- One (01) 11kV outdoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Geothermal substation with all needed accessories, fittings to ensure the connection from cable termination to the secondary windings of 33/11kV transformer.
- 0.55km of 11kV underground XLPE three core aluminium 185mm² (transit of 5MVA) cable from Geothermal substation till the 11kV metal-clad switchgear in Laudat substation.
- 0.55km of Fiber Optical underground cable (48F) from Geothermal substation telecom room till the Laudat substation telecom room.
- One (01) 11kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Laudat substation with all needed accessories, fittings to ensure the connection to the 11kV Laudat metal-clad switchgear (Geothermal outgoing feeder)
- Two (02) earthing boxes with all necessary accessories (cables lugs,…).
- All HDPE ducts and warning grid for UGC and FO cable as detailed in the specification.

<u>The services to be performed by the Contractor include, but are not limited to:</u>

- All the services and supplies described in the General specification of civil works – section 14.4
- The complete design studies of the cable system including all the additional technical studies that the contractor would need for the dimensioning of the cable system, soil investigations, Georadar passage, topographic surveys, identification of all existing buried networks, geotechnical studies, site installation, etc.
- All administrative procedures, obtaining work permits, etc.
- Compliance with environmental constraints of the project region
- The management and control of its activities, its subcontractors, the implementation of its quality system,
- Participation in project meetings,
- Compliance with the documentation provided before and after work

The implementation of all its services in accordance with the requirements of this bid file until perfect completion

3.3.3 Scope of construction works

The construction scope of work to be performed by the Contractor consist of:

Electrical construction works:

11kV GLI UNDERGROUND CABLES (UGC): From Geothermal substation 33/11kV transformer secondary windings to the 11kV switchgear cabinet in Laudat substation (0.55km approximately)

- Installation and connection of One (01) 11kV outdoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Geothermal substation with all needed accessories, fittings to ensure the connection from cable termination to the secondary windings of 33/11kV transformer.
- Pulling and connection of 0.55km of 11kV underground XLPE three core aluminium 185mm² (transit of 5MVA) cable from Geothermal substation secondary windings of 33/11kV transformer till the 11kV metal-clad switchgear in Laudat substation (Geothermal outgoing feeder).
- Pulling and connection of 0.55km of Fiber Optical underground cable (48F) from Geothermal substation telecom room till the Laudat substation telecom room. The FO cable should be spliced to Geothermal and Laudat substations ODFs.
- Installation and connection of One (01) 11kV indoor cold-shrinkable cable terminations kit (**for three phases**) to be installed in the Laudat substation with all needed accessories, fittings to ensure the connection to the 11kV Laudat metal-clad switchgear (Geothermal outgoing feeder)
- Installation and connection of two earthing boxes with all necessary accessories (cables lugs,…).
- Testing and commissioning of the whole installed equipment (power cables, FO cable and all accessories).

Civil construction works:

The Contractor refers to the General Civil Engineering specification in section14 for all the civil engineering services for which it is responsible.

In particular, the contractor should carry out:

- All the necessary steps to carry out its work (relations with the owners, search for authorizations, reports, etc.)
- The detection of buried networks near the works on which the Contractor will have to intervene
- All earthworks, civil engineering, and handling work allowing the installation of the cable system, in particular:
  - ✓ Cable trench opening (Excavation)
  - ✓ Ducts installation and laying
  - ✓ Concrete encasement when passing under roadways
  - ✓ Warning Grid
  - ✓ Backfilling and compacting work
  - ✓ Cable trench closing
  - ✓ The repair of any coating impacted by the work
  - ✓ Identical restoration of land after finalization of works.
  - ✓ The creation of a traffic plan throughout the duration of the works for local residents affected by the prohibited access to the work area, like diversions for vehicles, Safety markings, Signage of restricted access, and any additional safety measure guaranteeing the safety of the public around the site.

Site preparation:

The contractor refers to the General specifications for all site preparation services for which he is responsible.

Especially

- The setting up of site facilities for the construction of the links

- The transmission of the declaration of works (plans, schedules) to the local authorities to obtain authorization to open the trenches.
- All the preparation work before the opening of the trenches including:
  - ✓ Site installation that respects all the requirements detailed in the general technical specifications in the section 14.4 of this document.
  - ✓ Protection of trees located near the route
  - ✓ Supply of all the necessary markup
  - ✓ Etc.

Substations works:

The UNDERGROUND CABLES (UGC) Contractor must coordinate with the Substation Contractor and the Employer for the installation of the ducts within the enclosure of the substation.

The Contractor shall submit for approval to the contracting authority a system guaranteeing the sealing of penetrations in the underground passage near the exit from the enclosure of the Geothermal or Laudat power plant.

The Contractor should restore any work of the substations impacted by the installation of its cable systems.

In the existing Laudat substation, the underground 11 KV cable will be connected to an 11 KV metal clad enclosure. However in the new Geothermal substation this cable will be connected to the secondary of a new 33/11kV transformer (11kV cable box).

The new power 33/11kV transformer will be supplied and installed by the Geothermal substation contractor. However, the UNDERGROUND CABLES (UGC) Contractor will be responsible of this Link and must ensure all supports, fittings, tools, and adequate end sealings, up to the connection to the two 11 kV ends, in Laudat and Geothermal substations.

The two contractors must cooperate with each other to ensure well-harmonized progress of both: Substations and links.

Regarding the connection at Laudat substation, the GLI cable will pass under an existing hydraulic pipe then under the existing fence surrounding the substation, then it continues by a parallel path to this pipe until it reaches the existing trench below 11 kV MV room. The UNDERGROUND CABLES (UGC) Contractor will be in charge of pulling the 11kV inside the substation and connecting it to the existing 11kV cabinet.

This cable would then be connected in place of the current Trafalgar connection 11 KV.

The contractor would be responsible for all the required supports, fittings, and sealing terminations for this connection.

In addition, the cable will pass under a river that exists next to the Laudat substation. This river must be exceeded manually by a trench passing below.

Works relating to the 11kV Geothermal – Laudat UNDERGROUND CABLES (UGC) link:

General:

The plans in the appendixes detail the route of the 11 kV Geothermal - Laudat underground connections to be made, with a total length of approximately 550 m.

The general characteristics of the ducts set are given below for information only:

- Single trench width = approx. 0.4 m approximately, depth = 0.9 m approximately
- Ducts for the 3*11 KV phases (1 HDPE duct, ø140-160 mm) laid with an HDPE 50mm fiber optic cable duct
- No Horizontal directional drilling and no joint box to be done all along this link

Cable trenches:

Trench works are detailed in the General Civil Engineering Specification.

The related works to the cable's trenches passage are:

- Excavation and shielding
- Installation of ducts (with or without a concrete encasement depending on the localization of the trench)
- Backfilling and compacting works
- Repairing work on any impacted area by the work

All along the GLI passage, the cable trench will be dimensioned minimum as follow:

- Width =~ 0.4 m approximately
- Depth = ~0.9 m approximately

3.3.4 Scope of design works

The Contractor must also provide supporting documentation, calculations, system studies, drawings, descriptions, manuals, quality control systems, progress reports and meetings with the project owner representative as set out in this Specification. Required supporting documentations may include but is not limited to the following:

- HV Cable Rating Study,
- Soil Thermal Resistivity Test Results,
- Geotech Survey,
- All Site Surveying work,
- All needed drawings and calculation notes for electrical and civil works dimensioning:
    - General arrangements (plan and elevation), layouts and sections drawings for the route,
    - Civil works detailed drawings and calculation notes: Cable duct arrangement, elevation and dimensions, sections views, etc.
    - Cable section, rating current, derating factors, cable laying, etc.
    - Joints and terminations
    - Primary Plant Schedule for Procurement (8 weeks from date of Contract award)

The Contractor must perform a site visit prior to undertaking detailed design in order to determine site-specific conditions.

Please refer to the drawings given in the annexes as guidance for the contractor to achieve the civil work design. A typical section of the 11 kV cable trench in provided in the appendix A3-2. In addition an indicative 11kV line route is provided in the appendix A3-6-1.

These plans are given for information only in order to inform the Contractor about the consistency of the works that he is responsible for.

This does not release the Contractor from its responsibility for the design of all the civil engineering works of the project.

Especially:

- The Contractor should design the works in such a way as to respect the needs in transit and to ensure the safety of the public
- The dimensions of the ducts set will be optimized so as to respect the transit in all the configurations encountered on the route

- The thickness of the concrete encasement all around the ducts if it exists must guarantee the containment of any fault (short-circuit, etc.) that may occur during the operation of the connections
- The telecommunication boxes must be installed outside of the power junction boxes if they exist.

All along this UNDERGROUND CABLES (UGC) 11 KV link, no power cable junction manholes and no FO junction manhole to be done.

3.3.4.1 Civil works design

The 11 kV Geothermal - Laudat UNDERGROUND CABLES (UGC) link consists of an underground passage by a simple cable trench.

One power cable duct will contain the 3 phases of the 11 kV cable, with another duct for the passage of the telecommunication link and backfilled according to the mentioned requirements of the general Civil works technical specifications of material – section 14-2 “Backfilling“.

All the relative plans and cross-sections of the civil engineering work to accommodate the cable systems are available in the appendixes.

No junction box neither for the 11KV nor for FO cables to be done all along this link of about 0.55km in length approximately.

In addition, no horizontal directional drilling to be done.

Soil investigations:

The Contractor carries out the necessary studies and investigations for the dimensioning of all the civil engineering works for which he is responsible.

The Topographical studies must include:

- The research for the various existing network concessionaires and the requests for defining and representing their existing networks.
- Surveys and detection of buried networks by appropriate means (Georadar passage where the Lidar Technology is preferred),
- Definition and detection of all obstacles, or any kind of networks encountered on the proposed route of the link,
- The production of engineering and execution plans (plan views, longitudinal profiles, assembly plans, sections, etc.)

After the topographical surveys that will be carried out by the contractor, all the plans will be georeferenced. The requested Projected Coordinate System for this project is: **Universal Transverse Mercator Grid system (UTM Zone 20)**

During the geotechnical studies, the Contractor will perform electrical and thermal resistivity measurements as well soil temperature measurements.

In addition, the contractor is responsible to make a relative hydrological study and hydrogeological study.

Ducts set:

Each duct set will include:

- One HDPE duct for the three phases of the 11 KV cables, (D=140 to 160 mm)
- One HDPE duct for the fiber optic cable (D=50 mm)

Horizontal directional drilling:

No horizontal directional drilling to be done all along this 11 KV UNDERGROUND CABLES (UGC) link from the new Geothermal substation to the existing Laudat substation.

Civil engineering structures:

(Power and FO) Junction Box:

No power or FO Junction manholes to be done all along this 11 KV UNDERGROUND CABLES (UGC) link of 0.55km of length approximately.

Cable Trench:

The cable trench will be dimensioned minimum as follow:

- Width =~0.4 m approximately
- Depth = ~0.9 m approximately

3.3.4.2 Electrical design

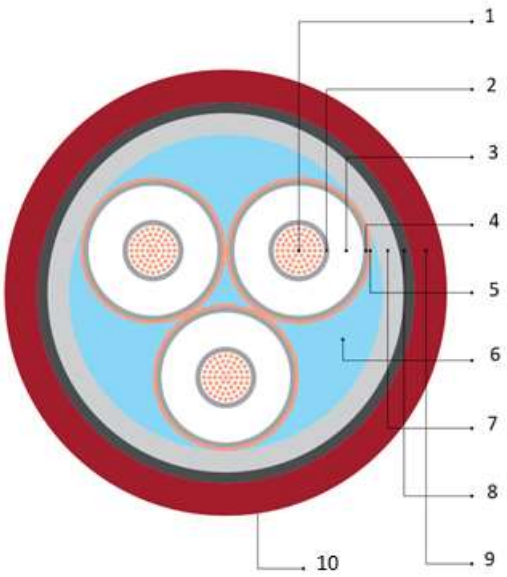
11kV Cable:

The selected 11kV UNDERGROUND CABLES (UGC) which should transit a maximum power of 5MVA is 1 x 3cores x 185mm² aluminium conductor.

A calculation note for 11kV UGC must be elaborated proving that this selected cross section is efficient to transit the requested energy while applying all derating factors (ground temperature, ground thermal resistivity, depth of laying, in a buried duct)

Please refer to section “11kV XLPE Cable” for more details.

Technical requirements for 11kV cable are detailed in Annex A2-8



1 : Aluminium Conductor Core

2: Conductor screen (extruded semi-conductor)

3: XLPE Insulation

4: Insulation screen (extruded semi-conductor)

5: metallic screen (Flat plain copper tape helically)

6: Filler (Non-hygroscopic EPR/PP)

7: Bedding (PVC)

8: Armouring (galvanized steel)

9: Outer sheath (PVC-ST2 Jacket)

10: Marking

Figure 9: Typical section view of 11 kV cable

11kV Cable termination:

Please refer to section "11kV UNDERGROUND CABLES (UGC) accessories" for more details.

Technical requirements for 11kV cable terminations are detailed in Annex A2-9

3.4 Further Services to be provided

The Contractor has to ensure the training of the Employer's main personnel regarding installation, commissioning, maintenance and operation of the UGC and FO cable for all voltages levels and their corresponding accessories (termination, joint boxes, sealing end, etc.) including test equipment and tools. The following Local/on-site training has to be provided:

#	Subject	Description	Number of participants	Training venue	Objectives
1	69kV, 33kV and 11kV UGC	Ampacity and engineering aspects of power cables Ageing, quality assurance, testing, diagnostics, failures and maintenance of power cables	10 persons/ 1 week	Project Site	Capacity building to personnel working in operation and maintenance of underground cables
2	UGC accessories : Hot and Cold-shrinkable Cable Termination, SF6 gas immersed sealing end, joint	Installation, Testing , commissioning and maintenance	10 persons/ 1 week	Project Site	Knowledge transfer to client personnel in relation to specific equipment to be

#	Subject	Description	Number of participants	Training venue	Objectives
	boxes, cross-bonding boxes				supplied under the project
3	FO cables: splicing boxes, splicing procedure, ODTR testing	Installation and commissioning Ageing, quality assurance, testing, diagnostics and failures of power cables	10 persons/ 1 week	Project Site	Knowledge transfer to client personnel in relation to specific equipment to be supplied under the project

4. General Technical Requirements for the UNDERGROUND CABLES (UGC)

4.1 General

The electro-mechanical devices and equipment of this project shall be in compliance with the requirements and conditions of the specification. IEC-Recommendations/Publications standard has priority. The equipment shall be manufactured not more than one year prior to its delivery to the respective final destination.

The offer shall reflect the major requirements like largest possible uniformity of all major components, easy replacement and repair, highest degree of maintenance free equipment, service safety and availability.

The equipment and devices shall be factory-assembled and tested at the manufacturers' works. All equipment, accessory, measuring devices and materials which have to be supplied must be new, not previously used and have to be of the standard design of the Manufacturer. They shall be developed with respect to the latest requirements of the applicable standards and have to be manufactured based on the use of the latest technologies.

Unless otherwise specified, current and voltage values and ratings shall include a 10 % safety margin. The supplier has to submit all related data and documents like short-circuit calculations, reduction factors and maximum admissible service data, weather data, like maximum admissible temperature and relative air humidity, and other relevant factors.

In addition to the risks and liabilities in accordance to DAP delivery conditions, the Contractor will bear all costs and risks associated with off-loading at site, storage at site and transportation on site to the installation of plant and equipment.

4.2 Earthing

Earthing shall be carried out by using tinned copper soft drawn concentric strands conductor.

The earthing systems shall be designed in compliance with the latest applicable standards and regulations.

The grounding conductors sizes shall be checked at the short circuit current withstand capability.

The earthing conductor and cable lug connections shall be done using hydraulic crimping tools.

The connections / joints of different metals shall be done by suitable materials or by protective coating.

The rehabilitated grounding systems have to be tested by measurements, certified and proved to suitability.

4.3 Designation Labels (Nameplates)

All new equipment designation labels shall be in English language, weather-proof and fitted to the lifetime of the devices. Additionally, all new devices shall be equipped with designation number plates and plates with new operational names of the equipment.

All apparatus, plant and equipment shall be clearly and permanently labelled in English and to be approved of the Employer. Where labels are provided for making clear the method of operation of equipment they shall be concise and preferably diagrammatic in form. They shall be of suitable size as to be readable at normal operating positions.

Each item of plant or equipment covered by this Specification shall be supplied, complete with an identification nameplate, clearly engraved or stamped with the Manufacturer's name, plant number and date, together with any other such information that will assist future maintenance and the purchase of spare parts. The Contractor shall submit for approval to the Employer, details of the labels indicating the identification and the type of label being supplied prior to the labels being ordered.

All equipment shall be provided with permanently engraved labels and/or number plates secured by fixing screws, to facilitate replacement.

Nameplates, labels and their fixing screws shall be of stainless steel or other corrosion resistant material.

Where the use of vitreous enamelled labels is approved, the whole surface including the back and edges shall be properly covered and protective washers shall be provided in front and at the back of the fixing screws.

Labels to match existing equipment shall be of uniform appearance and size. The use of double - sided tape will not be permitted to secure labels on indoor or outdoor equipment.

Danger labels shall have red lettering on a white background. All other labels shall have black lettering on a white background.

Before production of labels, the Contractor shall submit to the Employer full-scale drawings of the proposed labels for the necessary approval.

The labels and indications are very important for use during references in case there is any malfunctioning part, either during or after installation.

4.4 Warning Signs (moveable and fixed)

Supply of new warning signs (movable and fixed) weather-proof in English language according the EDM with pictogram. All warning signs shall be in a sufficient number for use during the rehabilitation measures and later the operation of the substation.

- Movable warnings signs should be supplied and positioned in order to mark and secure on-going work in the substation (by the Contractor and/or Employer). All moveable warning signs shall include all necessary stands/racks and/or re-attachable fixing material.

- Fixed warning signs shall be supplied and installed including durable fixing material.

4.5 Padlock System for Electric Switchboards

It has to be adapted to existing standard system. When it is needed for protecting equipment, locking shall be provided with a padlock system of high-quality anti-corrosive. Sufficient numbers of spare keys shall be provided.

4.6 Steel Structures, Bolts, Screws and Nuts

Blank, non anti-corrosive steel, screw and connection material are not allowed. All provided materials are:

- hot-dip galvanised steel structures
- hot-dip galvanised screw material for all outdoor devices and installations
- Non-ferrous screw material like brass, bronze etc. according the suppliers' standard

The proposed metallic structures are to be provided by the Contractor for cable raising and equipment supports.

Any steel part presenting a punching crack will be directly evacuated from the site.

The Contractor is responsible to submit for the approval of the project owner all the calculation notes and manufacturing plans that concerns all the used metallic structures.

The contractor will be responsible to ensure their perfect insertion and all compatibility of the assembly.

These structures must be designed for a service life of 50 years minimum, relatively to the climate conditions and supposed loads.

Screwed connections at steel structures shall principally be fitted at both sides (screw and nut) with washers. For non-restressed screwed connections (tension without torque key) additionally a spring washers between nut and washer shall be provided.

Holes must be clean and free of all kinds of residues.

4.7 Degrees of Protection and boxes sealing

For boxes exposed to the common outdoor conditions like:

Sun, rain, wind, dust, heat, humidity etc. All these climatic elements shall not affect the operation safety and availability of the devices.

Degree of protection for outdoor boxes: IP 55

The outdoor boxes shall be double-walled (shields) to prevent from direct sun rays heating.

All bottom holes and cable openings shall be sealed fire-proof. Cables shall always enter via screwed cable glands made out of corrosion free metal (stainless steel, no plastic etc.).

5. Detailed Technical Requirements for UGC, FO cables and their accessories

5.1 General

All equipment and installations shall be constructed and designed for durability and continuous operation with high economic efficiency and low maintenance costs.

All workmanship has to be throughout of the highest quality. The design, dimensions and materials of all equipment parts have to be carried out in a way that the stress to which they will be exposed do not cause any distortion or damage under the most severe conditions during their entire service lifetime. Welding, filling or plugging of damaged parts will not be permitted without the written approval of the Employer.

The design shall be carried out in a way that it shall facilitate inspection, cleaning, repairs, operation, and maintenance. All equipment shall be designed in order to ensure reliable operation at the atmospheric conditions in the areas where the substations are located and under the variations of load and voltages as they may occur under the working conditions of the respective power system. The design of all substation equipment shall be carried out in a way that it minimizes the risk of damage due to deterioration, or damage within in operation of all parts of the substation. The design shall incorporate all reasonable precaution and provision for the safety of those involved in the maintenance of the contract works and all associated works supplied and executed within other contracts.

All corresponding parts shall be interchangeable wherever possible throughout the contract works, and they have to be carried out in a way, that it will facilitate the installation of replacement parts.

For design and construction strict attention shall be paid in order to satisfying the specified operational requirements which are indicated below.

The Contractor shall submit his proposal for approval by the Employer.

Even if not especially mentioned under the respective chapter, all delivered/installed material shall be suitable for unrestricted use in temperate climate.

The Contractor is bound to provide complete works, even if the equipment or services which have to be provided are not specifically mentioned in the specification.

5.2 Voltage Levels and Characteristic Data

Frequency

Rated frequency of all equipment shall be 50 Hz.

Voltage Levels

The following voltage levels have to be considered in the project:

- HV 3-phase 69kV and MV 3-phase 33kV (Transmission voltage levels)
- MV 3-phase 11 kV (Distribution voltage levels)

Electrical Characteristic Data for HV and MV Equipment IEC 62271-1

Nominal operating voltage	U_n [$kV_{r.m.s}$]	69	33	11
Rated voltage	U_m [$kV_{r.m.s}$]	72	36	12
Standard short time power-frequency withstand voltage	U_{pf} [$kV_{r.m.s}$]	140	70	28
Standard lightning impulse withstand voltage	U_{li} [kV_{peak}]	325	170	75
Rated frequency	[Hz]	50	50	50
Minimum insulator creepage distance: phase-to-earth	[$mm/kV_{(r.m.s.)}$]	31.5	31.5	31.5
Rated short time (3 sec. withstand current)	[$kA_{(r.m.s}$]	25	25	25
Starpoint		Solidly earthed	Solidly earthed	None. Earthed Through earthing transformer (ZigZag)

6. 69kV XLPE UGC Cable

6.1. Regulations and Standards

The latest edition of the following Codes and Standards shall be applicable for the equipment/material covered in this section.

IEC 60228	Conductors of Insulated Cables
IEC 60840	Power Cables with Extruded Insulation and Their Accessories for Rated Voltages Above 30kV (Um=36kV) up to 150kV (Um=170kV) - Test Methods and Requirements.
IEC 60949	Calculation of Thermally Permissible Short-Circuit Currents, Taking into Account Non-Adiabatic Heating Effects
ICEA P-45-482	Short Circuit Performance of Metallic Shields and Sheaths of Insulated Cable
AEIC CS7	Specifications for Cross Linked Polyethylene Insulated Shielded Power Cables Rated 69 through 138kV
IEC 60229	Tests on cable over-sheaths which have a protective function and are applied by extrusion
IEC 60230	Impulse tests on cables and their accessories
IEC 60287-Parts 1&2	Electric cables – Calculation of the current rating – Part 1: Current rating equations and calculation of losses – Part 2: Thermal resistance
IEC 60684	Flexible insulating sleeving
IEC 60811-1-1	Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section1: Measurement of thickness and overall dimensions – Tests for determining the mechanical properties
IEC 60811-1-2	Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section 2: Thermal ageing methods
IEC 60811-1-3	Insulating and sheathing materials of electric cables – Common test methods - Part 1: General application – Section 3: Methods for determining the density - Water absorption tests – Shrinkage test
IEC 60811-1-4	Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Four: Tests at low temperature
IEC 60811-2-1	Insulating and sheathing materials of electric and optical cables – Common test methods - Part 2-1: Methods specific to elastomeric compounds –Ozone resistance, hot set and mineral oil immersion tests
IEC 60811-4-1	Common test methods for insulating and sheathing materials of electric cables – Part 4: Methods specific to polyethylene and polypropylene compounds –Section One: Resistance to environmental stress cracking – Wrapping test after thermal ageing in air – Measurement of the melt flow index – Carbon black and/or mineral content measurement in PE
IEC 60885-3	Electrical test methods for electric cables – Part 3: Test methods for partial discharge measurements on lengths of extruded power cables
IEC 60287	Calculation of Continuous Current Rating of Cables (100% LF)
IEC 60793-2	Optical fibres – Part 2 – Product specification for multimode fibres
ISO 48	Rubber, vulcanised or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)
ISO 9001	Quality systems - Model for quality assurance in production, installation and servicing
ISO 14644-1	Cleanrooms and associated controlled environments – Part 1 – Classification of air cleanliness

6.2. Service Conditions

General Operating Conditions
The conditions under which the cables will be required to operate are:

- Installed in a separate trefoil arrangement in a single way duct/phase comprised of HDPE conduit in concrete encasement
- at a nominal depth of around 1,500mm
- Cable ends rising up concrete, timber, or metal poles and exposed to direct sunlight;
- Ambient air temperature not exceeding 40°C summer day time and 15°C winter night time as determined by a shaded thermometer;
- Ambient soil temperature not exceeding 35°C;
- An altitude not exceeding 1,500m above sea level;
- A high humidity (90%) combined with a high temperature (40°C); followed by a sudden drop in temperature of up to 10°C;
- Soil thermal resistivity 1,5 K m/W
- An area in which the cables may be installed is home to subterranean termite, Mastotermes Darwiniesis and the coastal brown ant, Pheidole Megacephala.
- High Seismicity conditions
- Both end bonding

Operating Conditions – Exposed Cable
Exposed sections of cable will be subject to the following additional service conditions:

- Solar radiation intensity of 1,100W/m²;
- Tropical summer storms with high winds upto 288km/h and an annual rainfall in excess of 1,500mm;
- Areas of coastal salt spray and/or industrial pollution with equivalent salt deposits densities in the range of 2.0 - 3.0g/m².
- Maximum wind pressure 700 N/m2
- Level of pollution, very high

Regarding short-circuit rating adiabatic and non-adiabatic values shall be calculated using the
Following conditions:

- Conductor initial temperature 90 °C
- Conductor operating temperature at emergency conditions 130 °C
- Conductor final temperature at short circuit conditions 250 °C
- Aluminium screen initial temperature 80 °C
- Aluminium screen final temperature 180 °C
- Short-circuit duration: 1 s

69kV Systems
The power cables required are for use on 69kV, three phase, and 50Hz systems.
The neutral points of the 69kV transformers system are directly earthed.
The maximum system voltage (phase to phase) on the systems is 72 kV and the required impulse insulation level is 350 kVp.

The specified cables shall be designed to meet a 22.56kA (1s) earth fault duties for 69kV level.

6.3. Design and construction requirements

Unless otherwise specified, the cable shall be manufactured in accordance with AEIC CS7 and tested in accordance with AEIC CS7 or IEC 60840.

The power cable shall be designed for ambient temperature conditions.

The cable shall be designed to withstand a conductor temperature of 130°C without any detrimental effects on any of its components. However, the cable sizing shall be based on a maximum permissible continuous temperature of 90°C and emergency loading temperature of 105°C.

The construction of the cable shall be essentially as described below. The ratings and dimensions shall be as indicated in the Data Schedule.

The power cable shall meet or exceed the requirements of this Specification in all respects.

Manufacturer's drawings shall show the outline of the power cable, together with all pertinent dimensions. Any variations in these dimensions due to manufacturing tolerances shall be indicated.

The 69kV cables shall be designed and manufactured to comply with the test requirements set out in IEC standard.

During the contract period, the Bidder shall not change the design, supplier, manufacturing process or compounding of the materials without the written approval of the Purchaser.

The conductor screen, insulation and insulation screen shall be manufactured using a 3 in 1 extruder head with all three layers applied in the same extruder head.

The conductor shield, cross-linked polyethylene insulation and insulation shield shall be extruded by the simultaneous triple extrusion method to assure homogeneity between the insulation and the semiconducting shields.

The insulation shield shall be bonded firmly and continuously to the insulation.

The cross-linking process shall be by the dry cure dry cooling or dry cure wet cooling method.

It is desirable that the process has facilities at the point of extrusion to monitor and control the thickness of the extruded screens and the insulation and the concentricity of the cable (this may be done by X-Ray scanning and control or similar techniques).

The Bidder must state in the bid submission how they will control the concentricity of the cable and the thickness of the extruded cable screens and the cable insulation. This will be considered in assessing bids.

The Bidder must provide details of cable accessories that the manufacturer used for the compliance testing of bided cables to requirements and is requested to advise of any other accessories used by the manufacturer with demonstrated compatibility with the bided or similar cable construction.

Cables shall be capable of satisfactory operation under a power supply system frequency variation of ±5% voltage variation of ±10 % and combined frequency voltage variation shall be +10 % & - 15%.
Cable shall be suitable for laying in ducts underground.
Cable shall have heat and moisture resistance properties. These shall be of type and design with proven record on transmission network service.

The power cable shall be free of material and manufacturing defects which would prevent it from meeting the requirements of this Specification.

Conductors

The aluminium conductors shall be stranded compacted circular class 2, complying all the features specified herein and in standard IEC 60228. Conductor material shall be AAC-1350, i.e. 99,5% aluminium content.

The aluminium conductors' cross-sectional areas for 69kV cable should be 1core x 240mm² per phase.

Longitudinal water barriers must be applied to all conductors to avoid water penetration.

Electrical resistance in direct current at 20ºC for 69kV conductor, measured as indicated on IEC60228:2004 Annex A, shall be equal or smaller to 0.125Ω/km.

The individual wires shall be of the same nominal diameter before stranding into the compacted circular formation. Successive layers of wires shall have opposite directions of lay.

Any lubricants used during compaction of the conductor shall be removed from the conductors prior to application of the core screen. Greasing of the conductors is not permitted.

Conductor Screen

It shall consist of a fully bonded layer of black semi-conductive cross-linked compound. It shall be extruded over the conductor to provide a smooth surface without causing any damage to the conductor or insulation and ensuring material compatibility.
The conductor screen nominal thickness shall be 1.5 mm.
The conductor screen minimum thickness measured and accepted at any point shall not be less than 1.2 mm. In addition, the average of all the measures shall not be less than the nominal thickness (1.5 mm).

The resistivity of extruded semi-conducting screens applied over the conductor shall not exceed 1.000W·m.

Insulation

The insulation shall be super clean grade cross-linked polyethylene complying with the requirements of IEC 60840, IEC 60811 Parts 1 to 4 inclusive and IEC 60885-3 applied by an extrusion process; simultaneously with the semi-conductive conductor and insulation screens within one crosshead.

The insulation shall be free from faults and imperfections larger than the resultant values given by the maximum extruder filter mesh size stated by the Bidder.

All manufacturing rooms and areas where PE, additives and peroxides are handled and mixed shall be suitably sealed and provided with air-dryers and filtering systems corresponding to clean room conditions in accordance ISO 14644-1 Class 5 to Class 6 or the equivalent provisions in the USA Fed. Gov. Standard 209a (Class 1,000 to 10,000) as applicable.

The Bidder is required to submit, with the biding documentation, copies of manufacturing and purchasing specifications of raw materials and detailed quality procedures in relation to sampling and testing conditions and requirements. The Principal shall have access to inspect the manufacturers' works should he elect to do so.

Insulation thickness and concentricity requirements shall be in accordance with the requirements.

The XLPE insulation must allow maximum conductor temperatures of 90 °C in normal operation and 250 °C under short circuit condition by at least 1 seconds.
The insulation minimum thickness measured and accepted at any point of the cable shall not be less than 90% of the nominal value: *tmin = 0.9 tn*

Nominal and minimum thickness for XLPE insulated cables are:
- Nominal (tn): 9mm
- Minimum (tmin): 8.1mm

Alternatively, the nominal insulation thickness may be based on a design stress as agreed between the supplier and the purchaser. For an agreement of this nature to be considered the Bidder must provide evidence of accelerated testing carried out to demonstrate the expected life of the cable

The expected service life of the cable under the specified environmental conditions shall be stated.

De-gassing of the insulation shall be effected before the metallic sheath is applied to the cables. The cable cores shall be dry nitrogen cured and de-gassed to the manufacturer's recommendations, but in any case as a minimum, at ambient temperature for 1 day per millimetre of insulation thickness prior to the further laying up of the cable core.

The Bidder shall provide details with the bid documentation of the de-gassing process, stating the temperatures and periods of time that manufactured core material of the cable is exposed to allow gasses to ventilate.

At the end of the de-gassing process the residual gases shall be identified and quantified by measuring the cross-linking by-product concentration in cable samples using the tests conducted in a thermo gravimetric analyser (TGA) in accordance with the procedure and meeting the requirements of Clause 2.4.15 of CENELEC Document HD 632 S2:2008 Part 2.

Insulation Screen

A black layer of cross-linked semi-conductive compound shall be applied over the insulation. Such layer shall be compatible with insulation temperatures in normal operation and during short circuit.
The insulation screen shall be adhered to the insulation.
Unless otherwise indicated in the Local Sections, the insulation screen minimum thickness measured and accepted at any point shall not be less than 1.2 mm. In addition, the average of all the measures shall not be less than the nominal thickness 1.5 mm.

The resistivity of extruded semi-conducting screen applied over the insulation shall not exceed 500W·m.

Water Blocking of the Insulation Screen

Non-biodegradable, water-swellable semi-conductive tape(s) shall be applied over the insulation screen.

Such tape shall be applied without harming the adjacent layers and could work as additional separator layer as well. The swelling tape shall be applied with a minimum overlap same as 10%.

The Bidder shall submit with their bid submission the results of tests carried out demonstrating the effectiveness of water blocking method and materials proposed.

Corrugated Aluminium Sheath

The Aluminium sheath comprising the moisture barrier shall provide an impervious barrier.

Corrugated sheaths shall be extruded in a continuous process from rolls of sheet metal without joins in any one drum length.

Annular corrugations are requested to assist with the prevention of water permeation along the cable and to facilitate the cutting and removal of the metallic sheath without damage to the core of the cable.

The following instructions must be fulfilled for the corrugated aluminium earth screen:

- Material shall be aluminium of 99.6% minimum purity having an elongation of 16% minimum.
- The corrugated sheath shall be of uniform thickness, homogeneous construction, seamless, free from defects, porosity and intercrystalline fracture. A layer of bitumen or other suitable compound, incorporating corrosion inhibitors, shall be applied over the aluminium sheath for corrosion protection and to provide a moisture seal with the oversheath.
- Nominal thickness of aluminium sheath must be equal or greater than 2.0 mm.
- The minimum thickness of the corrugated aluminium sheath measured and accepted at any point of the cable shall not be less than 85% of the nominal value minus 0,1 mm: $t_{min}=0,85t_n-0,1$ Where:
  t_{min}: minimum thickness in millimetres and t_n: nominal thickness in millimetres
- The maximum electric resistance at 20ºC shall be equal or less than 0,5Ω/km

IEC 60949 or ICEA Publication P-45-482 shall be used by the manufacturer to determine the effective cross-sectional area of the metallic shield and its short circuit current carrying capability.

Protective Layers, Over-Sheaths and Outer-Sheaths

An extruded over-sheath shall be applied to the cable. The over-sheath shall be comprised of a layer of black LMDPE complying with the requirements of IEC 60840 and IEC 60229 and have the properties specified below.

The outer sheath shall be resistant to moisture, abrasion, and UV.

The compound shall have a minimum of 2% carbon black and shall be capable of operating continuously at 900C.

A graphite coating shall be applied on the over-sheath to allow for present and future testing of the integrity of the cable sheath. The Bidder shall give details of the graphite coating being offered.

For the purposes of this specification the term LMDPE (linear medium density polyethylene) refers to an over sheath that shall have the following properties:

- Density: 0.930 – 0.950 g/cm3
- Hardness - Shore D 54 – 58

The Bidder shall provide sample test results of shrinkage tests carried out on the LMDPE outer sheath insulation using the test procedure and meeting the requirements of IEC standard.

The minimum thickness of the outer sheath measured and accepted at any point of the cable shall not be less than 85% of the nominal value minus 0,1 mm: $t_{min}=0,85\ t_n-0,1$ (Where: t_{min}: minimum thickness in millimetres and t_n: nominal thickness in millimetres)

Minimum thickness at any point of the outer sheath is 3mm

A conductive layer shall be applied over the jacket to serve as an electrode for testing the integrity of the jacket.

The thickness of the conductive layer shall be sufficient so that the jacket integrity test can be done successfully

Marking

The marking must be indelible paint, easily legible and carried out by indenting or embossing above the surface of the outer sheath in a continuous way.

Durability shall be checked by the test given in sub-clause 4.4 of standard IEC 60794-1-21.

The jacket for all the cables shall be embossed marked in English at intervals not exceeding one meter with the following minimum information:

a. Electric Cable

b. Voltage designation, 69kV

c. Type of insulation, XLPE

d. Insulation thickness, mm

e. Conductor cross-sectional area, mm² and material

f. The manufacturer's name or trademark

g. Year of manufacture

h. Cumulative length at every one meter with the highest length mark on the outer end of the cable.

The print will be made every 0.5 meters and with a font size of not less than 10 mm

Marking by matrix print is not acceptable

Ampacity and Short-circuit rating

The ampacity and short-circuit rating **estimated** values shall be given for network design purposes and should comply with the requested values in annexes.
Unless otherwise indicated in local sections, such ampacity values shall be calculated in steady state condition, for single core laying, when installed in buried duct using the operational conditions listed above.

6.4. Testing

Acceptance tests

Acceptance tests (routine tests and sample tests) shall be carried out in the Supplier's facilities.

Type tests

Type tests shall be performed before supplying a type of cable covered by this standard in order to demonstrate satisfactory performance characteristics to meet the intended application.
When type tests have been successfully performed on one type of cable covered herein with a specific cross-section, rated voltage and construction characteristics, the type approval could be accepted as valid for as long as the following conditions are met:

- The conductor cross-section is not larger than that of the tested cable.
- The cable has similar constructions as that of the tested cable, i.e. utilizes same materials, (conductor, screens, insulation, earth screen, outer sheath) and the same manufacturing process.
- The rated voltage does not exceed that of the tested cable.
- The calculated nominal electrical stress and the impulse voltage stress calculated using nominal dimensions at the cable conductor screen do not exceed the respective calculated stresses of the tested cable by more than 10 %.
- The calculated nominal electrical stress at the cable insulation screen and the impulse voltage stress calculated using nominal dimensions do not exceed the respective calculated stresses of the tested cable.

When the design or the materials of the cable are changed (which might affect the performance characteristics of the cable), the relevant type tests shall be repeated.

Cables shall undergo type tests after having passed all the acceptance tests gathered in routine and sample tests lists.

All samples needed for the type tests shall be taken from the same production length.

The type tests shall comprise the electrical tests on the complete cable system and the non-electrical test on cable components and complete cable as specified in 7.7.5 and 7.7.6. For cables with Umax = 170 kV, calculated nominal electrical stress at the conductor screen not higher than 8.0 kV/mm and calculated nominal electrical stress at the insulation screen not higher than 4,0 kV/mm the electrical tests should be performed on cables alone.

The type tests on cable components only need to be carried out on samples from cables of different voltage ratings and/or conductor cross-sectional areas if different materials and/or different manufacturing processes are used to produce them. However, repetition of the ageing tests on pieces of completed cable to check compatibility of materials may be required if the combination of materials applied over the screened core is different from that of the cable on which type tests have been carried out previously.

Electrical Type Test list

i) Bending test IEC 60840 sub-clause 12.4.3 and IEC 62067 sub-clause 12.4.4
ii) Tan d measurement: IEC 60840 clause 12.4.5
iii) Heating cycle voltage test: IEC 60840 clause 12.4.6
iv) Partial discharge test at ambient and high temperature: IEC 60840 clause 12.4.4
v) Lightning impulse voltage test followed by a power frequency voltage test: IEC 60840 clause 12.4.7
vi) Partial discharge test at ambient and high temperature: IEC 60840 clause 12.4.4
vii) Examination of cable: IEC 60840 clause 12.4.8
viii) Resistivity of cable semi-conducting screens: IEC 60840 clause 12.4.9

Non-Electrical Type Test list

i) Check of cable construction: IEC 60840 clause 12.5.1
ii) Mechanical properties of insulation before and after ageing: IEC 60811-501 and IEC 60811-401 and IEC 60840 clause 12.5.2
iii) Mechanical properties of oversheath before and after ageing: IEC 60840 clause 12.5.3, IEC 60811-501 and IEC 60811-401.
iv) Ageing tests on pieces of complete cable to check compatibility of materials: IEC 60840 clause 12.5.4, IEC 60811-501 and IEC 60811-401.
v) Pressure test at high temperature on oversheath: IEC 60811-508
vi) Test for LSHF oversheaths at low temperature: IEC 60811-505 and IEC 60811-506
vii) Hot set test for XLPE insulation: IEC 60811-507
viii) Measurement of carbon black content of black PE oversheaths: IEC 60811-605
ix) Test under fire conditions: IEC 60332-1-2
x) Water penetration: IEC 60840 Annex E
xi) Tests on components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath: IEC 60840 clause 12.5.15
xii) Shrinkage test for XLPE insulation: IEC 60811-502
xiii) Shrinkage test for PE and LSHF oversheaths: IEC 60811-503
xiv) Oversheath halogen acid content: IEC 60754-1

Routine test list

Routine tests shall be performed at 100% of delivered spools to demonstrate product integrity as per standard IEC 60840.

i) Partial discharge test
ii) Voltage test
iii) Electrical test on oversheath of the cable
iv) Measurement of electrical resistance of conductor and metal screen
v) Measurement of capacitance

Sample Test list

Sample tests are carried out over samples taken from each batch (manufacturing series) in order to verify that the finished product meet the design specifications.
The sample tests shall be carried out on one length from each batch (manufacturing series) of the same type and cross-section of cable, but shall be limited to not more than 10 % of the number of lengths in any contract, rounded to the nearest whole number.
If the sample from any length selected for the tests fails in any of the tests, further samples shall be taken from two further lengths of the same batch and subjected to the same tests as those in which the original sample failed. If both additional samples pass the tests, the other cables in the batch from which they were taken shall be regarded as having complied with the requirements of this standard. If either fails, this batch of cables shall be regarded as having failed to comply.
Test are:
i) Cable examination
ii) Measurement of thickness of cable insulation and oversheath: IEC 60811-201, IEC 60811-202
iii) Measurement of thickness of metal sheath: IEC 608410
iv) Measurement of diameters: IEC 60811-203
v) Hot set test for XLPE insulation: IEC 60811-507
vi) Lightning impulse voltage test: IEC 62067 clause 10.12
vii) Water penetration test: IEC 60840 Annex E
viii) Tests on components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath: IEC 60840 Annex F
ix) Measurement of thickness of conductor and insulation screens: IEC 60811-202
x) Mechanical properties of XLPE insulation: IEC 60811-507
vi) Lightning impulse voltage test: IEC 62067 clause 10.12
vii) Water penetration test: IEC 60840 Annex E
viii) Tests on components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath: IEC 60840 Annex F
ix) Measurement of thickness of conductor and insulation screens: IEC 60811-202
x) Mechanical properties of XLPE insulation: IEC 60811-501
xi) Mechanical properties of sheath: IEC 60811-501
xii) Abrasion resistance of cable markings: IEC 60794-1-21 sub clause 4.4

Prequalification Test list

Prequalification tests shall be performed before supplying a type of cable covered by this standard in order to demonstrate satisfactory long-term performance of the complete cable system.
The prequalification test shall be performed on cable systems where the calculated nominal electrical stresses at the conductor screen will be higher than 8.0 kV/mm and/or at the insulation screen higher than 4,0 kV/mm.
The prequalification test shall be performed except if cable systems with the same construction and accessories of the same family have been prequalified for a higher rated voltage.
Prequalification test must be performed on a cable system, using a cable of a large conductor cross-section in order to cover thermo-mechanical aspects. General conditions for these tests and their extension are those indicated in IEC 62067 clause 13 for cables with U_0=127 kV and IEC 60840 clause 13 for cables with U_0<127 kV.
i) Heating cycle voltage test: IEC 60840 clause 13.2.4
ii) Lightning impulse voltage test: IEC 60840 clause 13.2.5
iii) Examination of the cable system after completion of the tests above: IEC 60840 clause 13.2.6

Development Test list

These are tests made during the development of a cable design and shall be performed before supplying a type of cable covered by this standard in order to demonstrate satisfactory performance of the complete cable system.

i) Impact test: IEC TR 61901 clause 4.1.1
ii) Sidewall loading test: IEC TR 61901 clause 4.1.3
iii) Long term ageing of adhesive bonds of components of laminated covering: IEC TR 61901 clause 4.1.4
iv) Mechanical properties of the welding: IEC TR 61901 clause 4.1.5
v) Short circuit test: IEC TR 61901 clause 4.1.5

6.5. Packing and shipping

The samples needed for tests shall be taken from additional lengths of the same batch included in the supply order. Thereby, the lengths in any contract could not be diminished in order to perform any test. The allowed tolerance of the cable length provided on each drum is -0%, +1% of the nominal length required.

In addition to the applicable items as per IEC standard, packing and shipping of the cable shall conform to the following:

- A pulling eye attached to the conductor shall be provided at the outside cable end of each cable shipping length.
- The cable ends shall be sealed with a waterproof, heat shrinkable plastic or elastomeric end cap with adhesive type sealing compound. Cable ends shall be properly secured to the reel.
- The cable shall be delivered without splices, on standard sized non-returnable steel drums of sturdy construction properly packed and lagged externally to prevent the cable from possible damage during transport. Wood lagging shall be used and have a minimum thickness of 50mm.

Cable reels/drums shall be marked in legible and indelible letters giving the following particulars:

a. Cable voltage and conductor size
b. Type of cable
c. Length and weight of cable on reel
d. Gross weight
e. Dimensions of reel
f. Manufacturer's name and country of origin
g. Purchase Order number
h. Contract number
i. Serial number of reel
j. TBU stock number in 10 cm high bold numerals.
k. Direction of rolling of reel

All markings shall appear on both sides of the reel
Cable reel identification shall include any additional information as required by shipping instructions.

6.6. Technical data for 69 kV XLPE cable

The 69 kV XLPE cable to be supplied shall comply with guaranteed technical particulars as indicated in Annex A2-1.

7. 69kV UGC Accessories

This specification is for cable joints and terminations for single core XLPE insulated aluminium cables (with a corrugated aluminium metallic sheath for operation at 50Hz ac voltages of 38.1 kV between any conductor and sheath or earth, 69kV between phase conductors, having a maximum sustained power frequency voltage between phase conductors of 72.5kV.

The specification also covers inspection and testing of the cable accessories as well as schedule of Guaranteed Technical Particulars to be filled, signed by the manufacturer, and submitted for bid evaluation.

The specification stipulates the minimum requirements for cable accessories acceptable for use, and it shall be the responsibility of the Supplier to ensure adequacy of the design, good workmanship, adherence to standards and the specification as well as ensuring good engineering practice in the manufacture of the cable accessories for the Employer.

7.1. Regulations and Standards

The following standards contain provisions which, through reference in this text constitute provisions of this specification. Unless otherwise stated, the latest editions (including amendments) apply.

IEC 60840	Power cables with extruded insulation and their accessories for rated voltages above 30kV (Um = 36kV) up to 150kV (Um = 70kV) - Test methods and requirements.
IEC 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions.
IEEE 48	Standard for Test Procedures and requirements for Alternating-Current Cable Terminations Used on Shielded Cables having Laminated Insulation Rated 2.5kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEC 61238-1	Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um= 36 kV) -Part 1: Test methods and requirements

The design and construction of the termination shall essentially meet the latest requirements of IEC 60141-1, IEC 60840, IEC 62067 or IEEE 48.
The dimensions of cable termination interfaces for SF6 Gas Insulated Switchgear (GIS) shall meet the requirements of IEC TS60859 or IEEE 1300. Any variations in these dimensions due to manufacturing tolerances shall be indicated.
All components of the splice or termination shall perform without distress under normal cyclic loading and fault conditions. When the dielectric strength of the cable termination is dependent upon taping or the use of auxiliary insulation, such insulation shall be used when any design (type) tests are performed.
The termination shall be Class 1 per IEEE 48 or equivalent. For apparatus terminations, the temperature of the medium in direct contact with the termination (ambient inside enclosure) shall not exceed 55ºC. Oil used in indoor terminations shall be preferably silicone oil.
All terminations to Low Pressure Oil Filled (LPOF) power cable and GIS shall employ, as a minimum, a double sealing method per IEC 60859 to prevent leakage of SF6 gas and oil. Details of the sealing method shall be submitted by the bidder for review and approval. The seals shall have a life expectancy of not less than 30 years.
Cable termination manufacturer shall provide and install the non-linear resistance/surge arresters, symmetrically between the GIS-side flange and ground, at the cable termination with GIS having shield break insulation to bypass very fast transients generated in GIS per IEC 60859 or IEEE 1300

7.2. Terms and Definitions

For the purpose of this specification the definitions given in the reference standards shall apply.

7.3. Requirements

7.3.1. Service and System Conditions

a. The cable accessories shall be suitable for use in outdoors installations and tropical conditions with a temperature range of -1°C to +40°C and humidity of up to 90%.
b. The cable shall be laid in cable ducts.
c. Permissible continuous loading operating temperature shall be 90°C.
d. Permissible emergency loading temperature shall be 130°C for at least 8 hours.
e. Permissible short circuit temperature shall be 250°C (for short-circuit duration of 5 s as per IEC 60840).
f. The cable and cable accessories shall be connected to underground system operating at a nominal voltage of 69kV, 50Hz and maximum system voltage of 72.5kV and are solidly earthed at the transformer neutrals.

7.3.2. Materials Design and Construction

a. The cable accessories (termination and jointing kits) shall be designed and manufactured to IEC 60840 and IEEE 48 and the requirements of this specification.
b. All materials used shall be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 seconds duration).
c. The cable accessories shall be suitable for 69kV single core XLPE insulated Aluminium cable that has a corrugated Aluminium sheath.

No	Item	Technical data for 69kV accessories
1	Nominal voltage (U)	69kV
2	Max. service voltage (Um)	72kV
3	Power frequency voltage withstand test	120kV/30 min. No breakdown no flashover
4	Room temperature partial discharge test	Test voltage 72kV, Partial discharge < 5pC
5	Thermal cycle test	96 kV heating for 8 hours, cooling for 16 hours, Conductor's temperature is 95-100 °C (20 cycles)
6	High temperature partial discharge test	Test Voltage 72kV Test temperature 95-100°C, Partial discharge <5pC
7	Lightning impulse voltage test	450 kV positive and negative polarities each 10 times, No breakdown, No flashover.
8	After the impulse voltage withstand voltage test	120 kV/15min. No breakdown. No flashover
9	Outdoor joint / termination short-term power frequency voltage test	Rain status, at 120kV, for 1 min. No flashover, No breakdown.
10	Short circuit current for 3 seconds	25kA

11	Outdoor joint/termination radio interference test	61kV generated 1MHHz interference voltage shall not be greater than 450 pV
12	Pressure leak test	No gas shall escape at 0.2 MPa for 1 hour

Table 1: Technical requirements for test of 69kV cable joints and terminations as per IEEE 48.

Cable Jointing Kits

Cable jointing kits shall be suitable for connecting the cables specified in Table 2 and the design requirements for each type of joint (straight through joint, transition joint,) shall be:

a. A joint insulation which meets the same performance standards as the cable as specified in IEC 60840 and IEEE 48 standards.
b. A high current connection to permit the flow of short circuit current between the two cable sheaths or screen wires.
c. A screen connection electrically insulated from earth potential to match the insulating integrity of the cable over-sheath.
d. Protection of the joint and cable insulation against the ingress of water.
e. Protection against corrosion of the joint metal work, flame retardant protection, anti-termite protection, etc.
f. Each cable jointing kit shall contain the following:
   - Separate stress control tubing for smoothing the electrical field over the cable screen ends.
   - Stress control tubing for smoothing the electrical field over the connector. This shall be moulded together with the insulation and screen tubing used for insulation and insulation screen on the outer layer (triple extrusion)
   - Metallic shielding (copper mesh) for continuing the correct shield across the joint area and making electrical contact with insulation screen.
   - Outer shielding heat shrink/cold shrink outer sleeve forming a barrier against moisture and corrosion.
   - Mechanical joint connector with stepless shear bolts that stretches axially and breaks off immediately the shear torque is achieved. Its contact technology shall be type- tested electrically and mechanically to IEC 61238-1.
   - Earth braids and connectors.
   - Push on devices to be used in installation of pre-moulded tubes if necessary.
   - Heat shrinkable cable caps for sealing off moisture on cut cables. The cable caps shall shrink when heated and tightly fit the cable.
g. The joints shall be designed and manufactured to ensure that all components and materials shall be suitable for use in the service conditions specified.
h. The complete components and materials shall be free from defects, which would likely cause them to be unsatisfactory in service.
i. The components and materials shall be manufactured to ensure high moisture sealing capacity, resistance to fungal and insect attack.

Outdoor cable terminations with integral surge arrestor

The terminations required in this specification shall have the following characteristics:

a. Shall be of dry type and suitable for use in terminating XLPE cables with stranded compacted round aluminium conductors.
b. The 69kV outdoor cable termination shall have an integral surge arrestor, for mounting onto a suitable pedestal column, (to be provided), or onto a suitable bracket (to be provided), for

attachment onto the transmission line terminal structure, and shall include all necessary supporting clamps.

c. Shall have a stress control tubing component with proper electrical stress control at the operating voltage over the insulated cable cores at the termination.
d. Shall have anti-tracking tubing with resistance to tracking and erosion of the material.
e. Shall be designed and manufactured to ensure that all components and materials are suitable for use in the specified service conditions.
f. The complete components and materials shall be free from defects which would be likely to cause them to be unsatisfactory in service.
g. The components and materials shall be manufactured to ensure high moisture sealing capacity, resistance to fungal and insect attack.

h. Outdoor terminations shall be of specific creepage distance of 31.5 mm/kV, pollution level IV conforming and tested to IEC 60815 and shall be provided with sheds for creepage extension.

i. Terminal lugs shall be of tinned high conductivity copper with step-less mechanical shear off bolts.
   - Lugs shall be supplied in pairs complete with a pair of assembly bolts of similar materials.
   - Lugs shall be tested in accordance with BS EN 61238-1 (Class A-Short circuit Test).

The bolts shall have extruded profile. When completely tightened, the shears shall be flush with connector body

Indoor Dry plug-in SF6 termination for 69kV GIS connection

The dimensions of cable termination interfaces for SF6 Gas Insulated Switchgear (GIS) shall meet the requirements of IEC TS60859 or IEEE 1300. Any variations in these dimensions due to manufacturing tolerances shall be indicated.

The termination shall be Class 1 per IEEE 48 or equivalent. For apparatus terminations, the temperature of the medium in direct contact with the termination (ambient inside enclosure) shall not exceed 55ºC.

All terminations for GIS shall employ, as a minimum, a double sealing method per IEC 60859 to prevent leakage of SF6 gas. Details of the sealing method shall be submitted by the bidder for review and approval. The seals shall have a life expectancy of not less than 30 years.
Cable termination manufacturer shall provide and install the non-linear resistance/surge arresters, symmetrically between the GIS-side flange and ground, at the cable termination with GIS having shield break insulation to bypass very fast transients generated in GIS per IEC 60859 or IEEE 1300.

The terminations required in this specification shall have the following characteristics:

a. The dry compact switchgear termination for rated voltage of 69 kV must be designed to be installed in gas-insulated switchgear (GIS). It complies with IEC 62271-209 standard, which essentially specifies the interfaces between the termination and the switchgear. Therefore, the termination will fit into all GIS that comply with IEC 62271-209.
b. Dry interfaces, no oil-filling
c. Dimensions comply with IEC 62271-209
d. Pressure-tight resin housing
e. Operates in SF6 and insulating liquids
f. Pre-fabricated and factory-tested silicone-rubber stress cone
g. Torque-controlled or wedge-type multi-contact conductor bolt
h. No special tools required to install the termination
i. Insulated cable gland for sectionalisation
j. Type tested according to IEC 60840, IEC 62067 and IEC 62271-209 standards

Cross-Bonding box with SVL

For underground circuits longer than 1km, the losses on the metallic sheaths can be minimized making in each joint a cross bonding of the cable shields. This method consists in dividing the cable length into three approximately equal sections with the sheaths connected and grounded at the ends of the circuit. Thus, the vectorial sum of the induced voltage is practically null. The natural points to establish the crossings are the joints, where appropriate cross bonding boxes to the sheaths. These boxes include SVL

To a cross bonding system implementation the following equipment are applied:

a) **Cross bonding boxes** to execute the crossing of the sheaths. These boxes include SLV and each box should have an earth electrode itself for create an earth return circuit in each divided section of the line.
These boxes should be watertight and capable of containing the effects of the thermal or electrical failures of any element inside the box, including a possible internal short circuit.
To facilitate its maintenance, these boxes should be installed in joints boxes with easy access (for example through the placement of manholes) and they should not be at more than one meter below the ground level [3].

b) **Direct bonding boxes** are usually applied on the ends of the line to connect the sheath directly to earth. These boxes include earth electrode but, unlike cross bonding boxes, they do not include SLV.

c) **Kits for shield interruption:** it is necessary for each phase joint to introduce an additional kit to remove the shield outside the respective box and to connect a concentric cable. Is this coaxial cable that will connect the sheaths to the cross bonding boxes.

d) **Cables to the sheaths connection to cross bonding boxes**: should be coaxial cables insulated with XLPE (cross linked polyethylene) or flexible monopole conductors. The section of these cables is determined by the maximum value of short circuit current of the power line.
Considering the monopole conductors solution, instead of the coaxial cables one, it is not necessary to include the additional kits for shield interruption. Thus, the monopole conductors are directly connected to the cross bonding boxes.
The sheaths connections should be designed to minimise the cable length, which should not exceed the 10 meters.

The contractor should provide all necessary accessories to fulfil the installation and connection of the cross-bonding boxes with SVL to specified underground cable. Technical requirement of the cross-bonding boxes are detailed in Annex A2-10.

Specialized tools

Specialised tools that are required during the terminating process shall be provided for both the joints and the terminations.

Installation Instructions

The supplier shall provide the installation procedures and instructions for the pre-moulded straight through joints, indoor dry plug-in and outdoor termination kits to be used as accessories of the cable specified below.

7.3.3. Sizes and Characteristics of the Cables

The cable terminations and jointing kits specified shall be suitable for cables of sizes and technical data as per Table below:

Conductor nominal cross-sectional area	mm²	240mm²
Voltage Designation Uo/U (Um)	kV	38.1/69(72.5)
Conductor shape		stranded, compacted round

Impulse withstand voltage & power frequency withstand voltage for cable	Vpeak Vans	1.2/50ps dry: 325kV peak 50Hz wet (60s): 140kV rms
Impulse withstand voltage & power frequency withstand voltage for terminations	Vpeak Vmis	1.2/50ps dry: 380kV peak 50Hz wet (60s): 150kV rms
Maximum resistance of conductor at 20°C	ohms/km	0.12

Table 2: ***Electrical characteristics of the 69kV cables as per IEC 60840***

7.3.4. Quality Management System

a. The bidder shall submit a quality assurance programme (QAP) that will be used to ensure that the cable accessories design, material, workmanship, tests, service capability, maintenance, and documentation, will fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001:2008.
b. The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2008 certificate shall be submitted with the bid for evaluation.
c. The bidder shall indicate the delivery time of the cable termination and jointing kits, manufacturer's monthly & annual production capacity and experience in the production of the type and size of cable accessories being offered.
d. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers outside the country of manufacture for exact or similar size of cable accessories sold in the last five years shall be submitted with the bid for evaluation.

7.4. Tests and Inspection

7.4.1. Conformance to Specifications

The cable termination and jointing kits shall be inspected and tested in accordance with the requirements of this specification and IEC 60840, IEC 60815 and IEEE 48 standards. It shall be the responsibility of the manufacturer to perform or to have performed all the relevant tests.

All termination kits shall be tested per IEC 60141-1, IEC 60840, IEC 62067 or IEEE Std. 48. Cable termination interfaces for GIS shall also be tested per IEC TS 60859 or IEEE 1300.

7.4.2. Type tests

Copies of previous Type Tests Reports issued by a third-party testing laboratory that is accredited to ISO/IEC 17025 shall be submitted with the bid for the purpose of technical evaluation. The accreditation certificate to ISO/IEC 17025 for the same third-party testing laboratory used shall also be submitted with the bid (all in English Language).

Copies of Type Test Reports to IEC 60840, IEC 60815 and IEEE 48 to be submitted with the bid for evaluation shall include the following:

a) Thermal cycle voltage test.

b) Partial discharge tests:
- At ambient temperature, and
- At high temperature.

The tests shall be carried out after the final cycle of item a) above or, alternatively, after the lightning impulse voltage test in item d) below:

c) Lightning impulse voltage test followed by a power frequency voltage test.
d) Partial discharge tests, if not previously earned out in item c) above.
e) Tests of outer protection for buried joints.
f) Pressure leakage tests.
g) Radio interference tests.
h) Adhesive tests on the silicone rubber.

Test voltages shall be in accordance with this specification, IEC 60840 and IEEE 48

7.4.3. Range of type approval as per IEC Standards

When type tests have been successfully performed on one or more accessories with one or more cable(s) of specific cross-section(s), and of the same rated voltage and construction, the type approval shall be considered as valid for accessories within the scope of this specification with other rated voltages, constructions and with other cables, provided that all the following conditions are met:

a. The voltage group is not higher than that of the tested accessory (ies); NOTE: In this context, accessories of the same rated voltage group are those of rated voltages having a common value of Um, highest voltage for equipment, and the same test voltage levels. For example, tests on an accessory of rated voltage U = 69 kV would also cover accessories of rated voltages U= 60 kV and U = 69 kV.
b. The cable with another conductor cross-section, rated voltage and construction is within the range of type approval as per IEC 60840 and IEEE 48. When the calculated nominal electrical stress at the cable insulation screen does not exceed 2.5kV/mm, the type approval shall be considered as valid for accessories on all cables in this range.
c. The accessories have the same or a similar construction as that of the tested accessory (ies). NOTE: Accessories of similar construction are those of the same type and manufacturing process of insulation and semi-conducting screens.
d. The calculated nominal electrical stresses within the main insulation parts of the accessory and at the cable and accessory interfaces do not exceed those of the tested accessory (ies).
e. A type test certificate signed by the representative of a competent witnessing body, or a type test certificate issued by an independent test laboratory accredited to ISO/IEC 17025 shall be acceptable as evidence of type testing.

7.4.4. Routine and sample tests

Routine and Sample test reports to this specification, IEC 60840, IEC 60815 and IEEE 48 for the cable accessories shall be submitted by the supplier to the Employer for approval before shipment of the goods.

The Employer's Engineer will witness routine tests and the following sample tests as per IEC 60840, IEC 60815 and IEEE 48 at the factory before shipment:

Tests on components:

The characteristics of each component shall be verified in accordance with the specifications of the accessories manufacturer through tests. The manufacturer of a given accessory shall provide a list of the tests to be performed on each component, indicating the frequency of each test. The components shall be inspected against their drawings. There shall be no deviations outside the declared tolerances.

Tests on complete accessory:

The following electrical tests shall be carried out as per this specification, IEC 60840, IEC60815 and IEEE 48 and by the manufacturer on a fully assembled accessory:

a. Partial discharge tests
   - At ambient temperature
   - At high temperatures
b. Voltage tests - Power frequency tests
c. Pressure leak test
d. Examination of the accessories after completion of the above tests.

The above tests shall be performed on one accessory of each type per contract.

If the sample fails either of the above two tests, two further samples of the same accessory type shall be taken from the contract and subjected to the same tests. If both additional samples pass the tests, the other accessories of the same type from the contract shall be regarded as having complied with the requirements of this specification. If either fails, this type of accessory of the contract shall be regarded as having failed to comply.

During acceptance testing, the manufacturer shall demonstrate that the accessories are mechanically and electrically fit for the cable size specified.

7.4.5. Delivery

During delivery of the cable accessories, The Employer will inspect them and may perform or have performed any of the relevant tests to verify compliance with the specification. The supplier shall replace/rectify without charge to The Employer, cable accessories which upon examination, test or use fail to meet any of the requirements in the specification

7.5. Marking, Labelling and Packaging

7.5.1. Marking

All accessories shall be clearly and indelibly marked by the manufacturer to indicate the following:

a. The manufacturer’s identification mark and reference/catalogue number (visible on the completed accessory).
b. The accessory range (visible on the accessory packaging)
c. The manufacturer’s identification mark and a part number (visible on all components forming part of an accessory). This part number shall be referenced in the bill of materials.
d. Components that are physically impossible to mark shall be individually packed and the packaging shall be marked.
e. The expiry date (visible on the packaging of all components or consumables that are subjected to a shelf-life limitation). These components or consumables shall be individually packed.

A suitable nameplate shall be provided in the termination kit giving the following information:

- Manufacturer's name

- Type of termination
- Designation no.
- IEEE terminator class no.
- Insulation class
- Maximum design voltage to ground
- Maximum and Minimum cable conductor size
- Maximum and Minimum cable insulation diameter
- BIL
- Rated internal pressure, kPa
- Date of Manufacture

7.5.2. Packaging of Individual Parts

Each accessory shall be packed in a strong cardboard container to protect it from mechanical damage. Individual parts shall be packed in strong sealed plastic bags to protect them from ingress of dirt and moisture. The cardboard container shall have:

a. Installation instructions in English Language.
b. All necessary components and consumables required to complete the installation as per the instructions, i.e. accessory components, cleaning kit and earthing kit as well as connectors.
c. It shall not be left to the jointer to decide the quantity to use in each application.
d. A bill of materials referenced according to the component part numbers.
e. Packing shall be such as to permit easy identification of the components without their removal from the packaging.

7.5.3. Management of Material with Limited Shell Life

The supplier shall indicate measures taken to ensure prudent management of material with limited shell life. These measures may include staggered delivery of such material.

7.5.4. Detailed Safe Procedure for Decommissioning

The manufacturer shall provide a detailed safe procedure for decommissioning and disposal of the termination and jointing kits. This may include retrieval of decommissioned kits by the manufacturer from the Employer for safe disposal.

Note: The characters used in marking shall be at least 3mm high.

7.6. Documentation

7.6.1. Bid Documentation to be Submitted

The bidder shall submit its bid complete with technical documents as required by Annex (Guaranteed Technical Particulars) for bid evaluation.

7.6.2. Successful Bidder (Supplier) Shall Submit the Following Documents/Details

The successful bidder (supplier) shall submit the following documents/details to The Employer for approval before manufacture:

a. Guaranteed Technical Particulars.
b. Design manufacturer's drawings showing outline of joints, terminations and accessories together with all pertinent dimensions. Any variation in these dimensions due to manufacturing tolerances shall be indicated.
c. Catalogue for all the components used. Catalogue numbers for the offered items shall be high-lighted.
d. Construction and method of assembly of joints and terminations shall be clearly set out in illustrated installation instructions supplied at the time of biding and included in every product kit during delivery. All documentation shall be in English Language.
e. Duly completed attached technical data schedule for each offered item.
f. Complete list of items contained in each joint and termination kit along with the price for each item of kit contents.
g. Quality Assurance Plan (QAP) that will be used to ensure that the joints and terminations design, material, workmanship, tests, service capability, maintenance and documentation will fulfil the requirements stated in the contract documents, standards, specifications and regulations.
h. Test Program to be used after manufacture.
i. Marking details and method to be used in marking of the joints and terminations,
j. Supplier’s undertaking to ensure adequacy of the design, good workmanship, good engineering practice and adherence to applicable standards in the manufacture of the joints and terminations for THE EMPLOYER.
k. Packaging details (including packaging materials, total number of joints/terminations per packaging).

7.6.3. Recommendations for Use, Care, Storage and Routine Inspection/Testing Procedures

The supplier shall submit recommendations for use, care, storage and routine inspection/testing procedures, all in the English Language, during delivery of the joints/terminations to THE EMPLOYER stores

7.7. Technical data for 69 kV XLPE cable accessories

The 69 kV XLPE cable accessories to be supplied shall comply with guaranteed technical particulars as indicated in Annex A2-2 (Plug-In SF6 gas Cable terminations), Annex A2-3 (Outdoor composite Cable terminations with integrated surge arresters), Annex A2-4 (cable Joints) and Annex A2-10 (Cross-bonding boxes).

8. 33kV XLPE Cables

The materials shall be of first class quality and designed for continuous satisfactory operation as continuity of supply is of prime importance and to operate satisfactorily under variation of load, voltage and short circuit or other conditions which may occur on the system provided that these variations are within the assigned rating of the apparatus. The materials used shall be suitable for the climatic and soil conditions listed below.

8.1. Regulations and Standards

Unless otherwise specified elsewhere in this specification, the rating as well as performance and testing of the XLPE power cables shall conform to the latest revisions available at the time of placement of order of all the relevant standards as listed, but not limited to specified.

IEC 60228	Conductors of Insulated Cables
IEC60502 Part – 2	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) – Part 2: Cables for rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV)
IEC61442	Test methods for accessories for power cables with rated voltages from 6kV (7.2kV) up to 30kV (Um=36kV)
IEC 60949	Calculation of Thermally Permissible Short-Circuit Currents, Taking into Account Non-Adiabatic Heating Effects
IEC 60229	Tests on cable over-sheaths which have a protective function and are applied by extrusion
IEC 60230	Impulse tests on cables and their accessories
IEC 60287-Parts 1&2	Electric cables – Calculation of the current rating – Part 1: Current rating equations and calculation of losses – Part 2: Thermal resistance
IEC 60684	Flexible insulating sleeving
IEC 60811-1-1	Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section1: Measurement of thickness and overall dimensions – Tests for determining the mechanical properties
IEC 60811-1-2	Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section 2: Thermal ageing methods
IEC 60811-1-3	Insulating and sheathing materials of electric cables – Common test methods - Part 1: General application – Section 3: Methods for determining the density - Water absorption tests – Shrinkage test
IEC 60811-1-4	Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Four: Tests at low temperature
IEC 60811-2-1	Insulating and sheathing materials of electric and optical cables – Common test methods - Part 2-1: Methods specific to elastomeric compounds –Ozone resistance, hot set and mineral oil immersion tests
IEC 60811-4-1	Common test methods for insulating and sheathing materials of electric cables – Part 4: Methods specific to polyethylene and polypropylene compounds –Section One: Resistance to environmental stress cracking – Wrapping test after thermal ageing in air – Measurement of the melt flow index – Carbon black and/or mineral content measurement in PE

IEC 60853-1	Calculation of the cyclic and emergency current rating of cables. Part 1: Cyclic rating factor for cables up to and including 18/30(36) kV
BS 7835	Electric cables - Armoured cables with thermosetting insulation for rated voltages from 3.8/6.6 kV to 19/33 kV having low emission of smoke and corrosive gases when affected by fire - Requirements and test methods
IEEE 48-2000	Testing standard for joints and terminations
IEC 60754-1	Test on gases evolved during combustion of materials from cables – Part 1: Determination of the halogen acid gas content
IEC 60332-1-2	Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame

8.2. Service conditions

General Operating Conditions
The conditions under which the cables will be required to operate are:

- Installed in a separate trefoil arrangement in a single way duct/phase comprised of HDPE conduit in concrete encasement
- at a nominal depth of around 1,500mm
- Cable ends rising up concrete, timber, or metal poles and exposed to direct sunlight;
- Ambient air temperature not exceeding 40°C summer day time and 15°C winter night time as determined by a shaded thermometer;
- Ambient soil temperature not exceeding 35°C;
- An altitude not exceeding 1,500m above sea level;
- A high humidity (90%) combined with a high temperature (40°C); followed by a sudden drop in temperature of up to 10°C;
- Soil thermal resistivity 1,5 K m/W
- An area in which the cables may be installed is home to subterranean termite, Mastotermes Darwiniesis and the coastal brown ant, Pheidole Megacephala.
- High Seismicity conditions
- Both end bonding

Operating Conditions – Exposed Cable
Exposed sections of cable will be subject to the following additional service conditions:

- Solar radiation intensity of 1,100W/m²;
- Tropical summer storms with high winds upto 288km/h and an annual rainfall in excess of 1,500mm;
- Areas of coastal salt spray and/or industrial pollution with equivalent salt deposits densities in the range of 2.0 - 3.0g/m².
- Maximum wind pressure 700 N/m2
- Level of pollution, very high

Regarding short-circuit rating adiabatic and non-adiabatic values shall be calculated using the Following conditions:

- Conductor initial temperature 90 °C
- Conductor operating temperature at emergency conditions 130 °C
- Conductor final temperature at short circuit conditions 250 °C
- Metallic screen initial temperature 80 °C
- Metallic screen final temperature 180 °C
- Short-circuit duration: 1 s

33kV Systems
The power cables required are for use on 33kV, three phase, 50Hz systems.
The neutral points of the 33kV transformers system are directly earthed.
The maximum system voltage (phase to phase) on the systems is 36 kV and the required impulse insulation level is 170 kVp.

The specified cables shall be designed to meet a 25kA (1s) earth fault duties for 33kV level.

8.3. Design and construction requirements

33kV cable shall be suitable for high ambient, high humid tropical Climatic conditions. Cables shall be designed to withstand the mechanical, electrical and thermal stresses under the unforeseen steady state and transient conditions and shall be suitable for proposed method of installation.

The cable shall be designed to withstand a conductor temperature of 130°C without any detrimental effects on any of its components. However, the cable sizing shall be based on a maximum permissible continuous temperature of 90°C and emergency loading temperature of 105°C.

Maximum continuous operating temperature shall be 90 °C under normal operation and 250°C under short circuit condition. Armouring shall be provided consisting of galvanized strip steel wires conforming to IEC 60502 Part – 2, BS: 6622, BS: 7835. (amended up to date) and over the armouring a tough outer sheath of PVC compound shall be extruded. The PVC compound for the outer sheath shall conform to type ST-2, FRLS as per IEC 60502 Part – 2, the colour of the outer sheath shall be black. The cable shall be manufactured strictly conforming to IEC standard.

The construction of the cable shall be essentially as described below. The ratings and dimensions shall be as indicated in the Data Schedule.

The power cable shall meet or exceed the requirements of this Specification in all respects.

Manufacturer's drawings shall show the outline of the power cable, together with all pertinent dimensions. Any variations in these dimensions due to manufacturing tolerances shall be indicated.

The 33kV cables shall be designed and manufactured to comply with the test requirements set out in IEC standard.

During the contract period, the Bidder shall not change the design, supplier, manufacturing process or compounding of the materials without the written approval of the Purchaser.

The insulation (XLPE) screening shall be provided consisting of extruded semi-conducting cross link material in combination with a metallic layer of copper tapes. Such screened cores shall be laid up together with fillers and/or binder tapes where necessary and provided with extruded inner sheathing of heat resistant PVC conforming to type ST-2 of PVC ST 2 as per IEC:60502 Part – 2, BS:6622, LSOH to BS:7835.

The conductor shield, cross-linked polyethylene insulation and insulation shield shall be extruded by the simultaneous triple extrusion method to assure homogeneity between the insulation and the semiconducting shields.

The insulation shield shall be bonded firmly and continuously to the insulation.

The cross-linking process shall be by the dry cure dry cooling or dry cure wet cooling method.

It is desirable that the process has facilities at the point of extrusion to monitor and control the thickness of the extruded screens and the insulation and the concentricity of the cable (this may be done by X-Ray scanning and control or similar techniques).

The Bidder must state in the bid submission how they will control the concentricity of the cable and the thickness of the extruded cable screens and the cable insulation. This will be considered in assessing bids.

The Bidder must provide details of cable accessories that the manufacturer used for the insulation screen shall be an extruded layer of black semi-conducting compound and continuously covers the whole area of insulation. The semiconducting screens should be effectively cross linked to achieve 90°C cable rating. The contact surface between insulation and insulation screen shall be smooth and free from protrusion and irregularities compliance testing of bided cables to requirements and is requested to advice of any other accessories used by the manufacturer with demonstrated compatibility with the bided or similar cable construction.

Cables shall be capable of satisfactory operation under a power supply system frequency variation of ±5% voltage variation of ±10 % and combined frequency voltage variation shall be +10 % & - 15%.
Cable shall be suitable for laying in ducts underground.
Cable shall have heat and moisture resistance properties. These shall be of type and design with proven record on transmission network service.

The power cable shall be free of material and manufacturing defects which would prevent it from meeting the requirements of this Specification.

Power medium voltage cables shall be provided with watertight screen. The water barrier shall be performed by a water-swellable semi-conducting.

Repaired cables shall not be acceptable

Conductor

The 33kV cables shall be 3cores XLPE insulated, stranded compacted round copper conductor complying the requirement of flexibility Class-2 of IEC 60228/BS 6360. The wires shall be made of high conductivity copper and shall be stranded mid compacted. The copper used for the conductor shall be of highest purity. Conductor shall be of uniform, of good quality, free from defects copper.

The nominal area of conductor shall be 240mm².

Conductor screen

The conductor screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface of the conductor. The screen shall be firmly bonded to XLPE insulation. The minimum thickness of conductor screen shall be 0.8 mm. (approx.)

A non-hygroscopic semi conducting tape may be applied over the conductor surface under extruded layer. The outer surface of the conductor screen shall be circular and free from irregularities.

Conductor screen and insulation screen shall both be extruded, semi-conducting compound and shall be applied along-with XLPE insulation in a single operation by triple extrusion process. Method of curing for 33 kV cable shall be "Dry curing/ gas curing" only.

Extruded Semi-conducting screening and metallic screening of copper tape shall be generally as per IEC 60502 Part – 2 standard. The semi conducting compound shall be suitable for the operating temperature of the cable and compatible with the insulating material.

Insulation

The insulation shall be cross-linked polyethylene (XLPE) as per IEC 60502 Part –2, BS: 6622, BS: 7835 standards. The insulation shall be applied by extrusion and vulcanisation to form a compact homogenous body free from micro voids and contaminants.

The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The extrusion method shall give very smooth interface between semi – conducting screen and insulation. The insulation of the cables shall be of high standard quality and conform to IS: 7098 (Part-II) 1985 or latest amendment thereof. The insulation shall be so applied that it fit closely on the conductor or conductor screening and it shall be possible to remove it without damaging the conductor. The insulating material shall be Cross Linked Polyethylene (XLPE) cured by dry curing process i.e. nitrogen gas curing CCV line method and applied by extrusion process. The insulating material shall have excellent electrical properties with regard to resistivity, dielectric constant and loss factor and shall have high tensile strength and resistance to abrasion.

This shall not deteriorate at elevated temperatures or when immersed in water. The insulation shall be preferably fire resistant and resistant to chemicals like acids, alkalis, oils and ozone. The insulation properties shall be stable under thermal conditions arising out of continuous operation at conductor temperature of 90ºC rising momentarily to 250ºC under short circuit conditions. It shall be free from any foreign material or porosity visible to the unaided eye. The quality of insulation should be good and insulation should not be deteriorated when exposed to the climatic conditions. The average thickness of insulation shall not be less than the nominal value of 8.0 mm

Insulation screen

The insulation screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface area of insulation. It shall be firmly bonded to the insulation. Semi-conducting swelling tape with suitable overlap over the extruded semi-conducting layer of compound shall be applied.

The non-metallic semi- conducting shield shall be put over the insulation of each core. The insulation shield shall be extruded in the same operation as the conductor shield and insulation by dry curing process i.e. nitrogen gas curing CCV line method. The insulation shield shall be bonded and strippable on adequate heat treatment. The bidders are requested to elaborate the manufacturing technique adopted by their manufacturers to achieve this motive.

The minimum thickness of insulation screen shall be 0.5 mm.

The interface between insulation and insulation screen shall be free of any voids.

Metallic screen

The insulation metallic screen shall consist of plain annealed copper conductor capable to withstands the short-circuit current values specified in the specification.

A combination of copper wires with copper counter spiral tape shall be applied over the non-metallic insulation screen. The equivalent total cross sectional area of metallic screen shall be not less than 35mm² for cables having a conductor size more than 150mm².

Fillers / Separation Sheath

The three cores then laid up with a suitable extruded material fillers to provide a substantially circular cross section before the inner covering is applied and bedded with a layer of extruded P.V.C. The filler material should be non-hygroscopic, easy to be removed and good flexibility material, suitable for the operating temperature and compatible with the insulating material (to be mentioned with the offer such as (EPR) or (PP)). The materials shall be new, unused and of finest quality. The minimum thickness of shall be 2 mm.

Inner sheath/Bedding

All armoured cables shall have distinct extruded inner PVC sheath of black colour.

The PVC inner covering then extruded over the circular assembly with a thickness proportional to the fictitious diameter over laid-up cores as specified in IEC 60502-2/Clause 8.1.3.

Waterproof tape

A layer of suitable tape (swelling tape) for water proofing to be laid over the armour layer.

Armour

The three cores then armoured with double, low carbon, galvanized steel tapes of thickness not less than 0.5 mm and the gap between adjacent turns of each tape shall not exceed 50 % of the width of the tape. The metallic armour shall confirm to IEC 60502 clause 12.4 standard with latest addendums and amendments.

Steel wire armor has high short circuit current handling capacity and has higher mechanical strength.

Armouring shall have minimum 90% coverage. Breaking Load of the joints shall be minimum 95% of the normal armour.

Outer Sheath

Over all extruded PVC seamless sheath to prevent moisture from penetrating and provides good corrosion protection thickness not less than 3 mm.

The over sheath of the MV cables shall be of PVC and flame retardant FRLS (Flame Retardant Low Smoke)

It shall be of black or red colour PVC (type ST2) with Cable size and Voltage grade embossed on it. Sequential marking shall be at every 1 Meter distance. Word "FRLS" (Flame Retardant Low Smoke) shall also be embossed on it at every 5 meter distance.

Outer sheath shall have the following properties:

- Acid Gas Generation – Max 20% (as per IEC 754-1)
- Smoke density rating: 60% (As per ASTMD 2843)
- Flammability test - As per Swedish chimney test F3 As per IEC 332 part-3 (Category B)
- Minimum bending radius shall be 10 D

The thickness shall be checked and meet the following formula as minimum: Ts = 0.035D+1mm

where D = Fictitious diameter immediately after the sheath and Ts = thickness in mm

8.4. Testing

Type Tests:

All the type tests in accordance with IEC: 60502, BS: 6622, BS: 7835 and amended up to date, shall be performed on cable samples drawn by purchaser.

Type tests are required to be carried out from the lot of supply on a sample of any one size of cable ordered for each voltage grade. In case facilities of any of the type tests are not available at the works of the supplier, then such type test shall be carried out by the supplier at the independent laboratory at the cost of supplier.

Sample for the type test will be drawn by the purchaser's representative and the type test will be witnessed by him.

The following shall constitute type tests:

a) Tests of Conductor:

i) Annealing test (for copper)

ii) Tensile test (for aluminium)

ii) Wrapping test (for aluminium)

iii) Conductor Resistance test

b) Tests for armouring wires/strips.

c) Tests for thickness of insulation and sheath.

d) Physical tests for insulation:

i) Tensile strength and elongation at break.

ii) Ageing in air oven.

iii) Hot test

iv) Shrinkage test.

v) Water absorption (gravimetric).

e) Physical test for outer sheath:

i) Tensile strength and elongation at break.

ii) Ageing in air oven.

iii) Shrinkage test.

iv) Hot deformation,

f) Partial discharge test.

g) Bending test.

h) Dielectric power factor test:

i) As a function of voltage.

ii) As a function of temperature.

i) Insulation resistance (volume resistivity test).

j) Heating cycle test.

k) Impulse withstand test.

l) High voltage test.

m) Flammability test.

Routine Tests:

All the Routine tests as per IEC standard and amended up to date shall be carried out on each and every delivery length of cable. The result should be given in test report. Partial discharge test must be carried out in a fully screened test cell. It is, therefore, absolutely essential that the manufacturer should have the appropriate type of facility to conduct this test which is routine test.

The details of facility available in the manufacturer's works in this connection should be given in the bid.

The following shall constitute routine tests:

a) Conductor resistance test

b) Partial discharge test

c) High voltage test.

The contractor shall also undertake to arrange for the short circuit test as a type test on any one size of each voltage grade i.e. on one size of 11 kV and one size of 33 kV earthed grade shielded XLPE cables. If facilities for carrying out short circuit tests are available at the works of the supplier, and provided the certification procedure is approved by the Purchaser, testing at the supplier's works will be acceptable. Short Circuit test shall be witnessed by the purchaser's representative.

The short circuit test shall be preceded and followed by the following tests so as to ensure that the characteristics of the cable remain within the permissible limits even after it is subjected to the required short circuit rating.

a) Partial Discharge Test.

b) Conductor Resistance Test.

c) High Voltage Test.

The manufactured cable will be acceptable only after such a sample test is successfully carried out at CPRI or at suppliers works and approved by the Purchaser.

8.5. Packing and Marking

The following particulars shall be properly legible embossed on the cable sheath at the intervals of not exceeding one meter throughout the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

a) Manufactures name and/or Trade name.

b) Voltage grade.

c) Year of manufacture.

d) Type of insulation, XLPE

e) Successive Length.

f) Conductor cross-sectional area, mm² and material

The cable shall be supplied in continuous standard length of 1000 running meters with plus minus 5% tolerance wound on non-returnable wooden drum of good quality and non-standard lengths not less than 100 meters up to 5% of the ordered quantity shall be accepted. Alternately cable can be supplied wound on non-returnable steel drum without any extra cost to the purchaser. Packing and marking shall be as per IEC standard

The cable shall be packed in non-returnable wooden drums. The following information shall be marked on each drum.

a) Drum identification number.

b) Manufacturer's name, Trade name / Trade mark, if any.

c) Nominal sectional area of the conductor of the cable.

d) Number of cores

e) Type of cable and voltage grade with cable code

f) Length of cable in cable drum

g) Direction of rotation of drum (by means of an arrow)

h) Appox. Weight: bare: gross:

i) Year and country of manufacture

j) Purchase order number

k) Date of delivery

l) Name of the purchaser.

Drum shall be proofed against attack by white ant or termite conforming to standard.

8.6. Technical data for 33 kV XLPE cable

The 33 kV XLPE cable to be supplied shall comply with guaranteed technical particulars as indicated in Annex A2-5.

9. 33kV UGC accessories

This specification is for cable joints and terminations for three cores XLPE insulated copper cables (with galvanized metallic sheath for operation at 50Hz Ac voltages of 19 kV between any conductor and sheath or earth, 33kV between phase conductors, having a maximum sustained power frequency voltage between phase conductors of 36kV.

The specification also covers inspection and testing of the cable accessories as well as schedule of Guaranteed Technical Particulars to be filled, signed by the manufacturer, and submitted for bid evaluation.

The specification stipulates the minimum requirements for cable accessories acceptable for use, and it shall be the responsibility of the Supplier to ensure adequacy of the design, good workmanship, adherence to standards and the specification as well as ensuring good engineering practice in the manufacture of the cable accessories for the Employer.

9.1. Regulations and Standards

The following standards contain provisions which, through reference in this text constitute provisions of this specification. Unless otherwise stated, the latest editions (including amendments) apply.

IEC 60502-2	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) - Part 2: Cables for rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV).
IEC 60502-4	Test requirements on accessories for cables with rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV)
IEC 61442	Test methods for accessories for power cables with rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV)
HD 629.1 S2 + A1 CENELEC	Test requirements on accessories for use on power cables rated voltage from 3.6/6(7.2) kV up to 20.8/36(42) kV - Part 1
IEC 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions.
IEEE 48	Standard for Test Procedures and requirements for Alternating-Current Cable Terminations Used on Shielded Cables having Laminated Insulation Rated 2.5kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEC 60228	Conductors of insulated cables
IEC 61238-1	Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um= 36 kV) -Part 1: Test methods and requirements
BS 6622	Electric cables - Armoured cables with thermosetting insulation for rated voltages from 3.8/6.6 kV to 19/33 kV - Requirements and test methods
IEEE 404	Standards for Extruded and Laminated Dielectric shielded cable

joints rated 2.5 kV to 500 kV

All components of the splice or termination shall perform without distress under normal cyclic loading and fault conditions. When the dielectric strength of the cable termination is dependent upon taping or the use of auxiliary insulation, such insulation shall be used when any design (type) tests are performed.
The termination shall be Class 1 per IEEE 48 or equivalent. For apparatus terminations, the temperature of the medium in direct contact with the termination (ambient inside enclosure) shall not exceed 55ºC.

9.2. Terms and Definitions

For the purpose of this specification the definitions given in the reference standards shall apply.

9.3. REQUIREMENTS

9.3.1. Service and System Conditions

a. The cable accessories shall be suitable for use in outdoors installations and tropical conditions with a temperature range of -1°C to +40°C and humidity of up to 90%.
b. The cable shall be laid in cable ducts.
c. Permissible continuous loading operating temperature shall be 90°C.
d. Permissible emergency loading temperature shall be 130°C for at least 8 hours.
e. Permissible short circuit temperature shall be 250°C (for short-circuit duration of 5 s as per IEC 60502-2).
f. The 33kV cable and cable accessories shall be connected to underground system operating at a nominal voltage of 33kV, 50Hz and maximum system voltage of 36kV and are solidly earthed at the transformer neutrals.

9.3.2. Materials Design and Construction

a. The cable accessories (termination and jointing kits) shall be designed and manufactured to IEC 60502-2 and IEEE 48 and the requirements of this specification.
b. All materials used shall be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 seconds duration).
c. The 33kV cable accessories shall be suitable for 33kV three core XLPE insulated Copper cable that has a copper wire screen.

No	Item	Technical data for 33kV accessories
1	Nominal voltage (U)	33kV
2	Max. service voltage (Um)	36kV
3	Power frequency voltage withstand test	70kV/1 min. No breakdown no flashover
4	Room temperature partial discharge test	Test voltage 36kV, Partial discharge < 5pC
5	Thermal cycle test	Heating: 100°C for 4 hours Cooling: -25°C for 4 hours Holding: 20°C for 1 hour

6	High temperature partial discharge test	Test Voltage 36kV Test temperature 95-100°C, Partial discharge < 5pC
7	Lightning impulse voltage test	170 kV positive and negative polarities each 10 times, No breakdown, No flashover.
8	After the impulse voltage withstand voltage test	Wet, at 95kV, for 15 min. No flashover, No breakdown.
9	Outdoor joint / termination short-term power frequency voltage test	34.3kA
10	Short circuit current for 3 seconds	10.1kA
11	Outdoor joint / termination radio interference test	5 microvolts at 10 kHz 50 microvolts at 100 kHz 250 microvolts at 1 MHz
12	Pressure leak test	No gas shall escape at 0.2 MPa for 1 hour

Table 3: Technical requirements for test of 33kV cable joints and terminations as per IEEE 48.

Cable Jointing Kits (for Three phases)

Cable jointing kits shall be suitable for connecting the cables specified in Table above and the design requirements for each type of joint (straight through joint, transition joint,) shall be:

a. A joint insulation which meets the same performance standards as the cable as specified in IEC 60502-2 and IEEE 48 standards.
b. A high current connection to permit the flow of short circuit current between the two cable sheaths or screen wires.
c. A screen connection electrically insulated from earth potential to match the insulating integrity of the cable over-sheath.
d. Protection of the joint and cable insulation against the ingress of water.
e. Protection against corrosion of the joint metal work, flame retardant protection, anti-termite protection, etc.
f. Each cable jointing kit shall contain the following:
   - Separate stress control tubing for smoothing the electrical field over the cable screen ends.
   - Stress control tubing for smoothing the electrical field over the connector. This shall be moulded together with the insulation and screen tubing used for insulation and insulation screen on the outer layer (triple extrusion)
   - Metallic shielding (copper mesh) for continuing the correct shield across the joint area and making electrical contact with insulation screen.
   - Outer shielding heat shrink/cold shrink outer sleeve forming a barrier against moisture and corrosion.
   - Mechanical joint connector with stepless shear bolts that stretches axially and breaks off immediately the shear torque is achieved. Its contact technology shall be type- tested electrically and mechanically to IEC 61238-1.
   - Earth braids and connectors.
   - Push on devices to be used in installation of pre-moulded tubes if necessary.
   - Cold shrinkable cable caps for sealing off moisture on cut cables.
g. The joints shall be designed and manufactured to ensure that all components and materials shall be suitable for use in the service conditions specified.

h. The complete components and materials shall be free from defects, which would likely cause them to be unsatisfactory in service.
i. The components and materials shall be manufactured to ensure high moisture sealing capacity, resistance to fungal and insect attack.

Cable terminations: Outdoor mounted on tower with surge arrestor/ indoor for metal-clad switchgear

Outdoor and indoor termination shall be done by cold shrinkable type termination kits suitable for three cores copper 240mm² cable. Termination for cable shall be provided in sufficient quantities for complete installations of substations.

The kits should have satisfactory performance record of minimum 5 years supported with proof of customers having had satisfactory use of these kits.

The Joints and terminations should have been type tested and type test reports made available.

The Kits should generally consist of:

(a) Heat shrinkable clear insulating tubes

(b) Stress control tubing where necessary,

(c) Ferrule insulating tubing for joints,

(d) Conductive cable break outs for terminations, non-tracking, erosion and weather resistant tubing both outer / inner

(e) Non tracking erosions and weather resistant outdoor sheds in case of terminations.

(f) High permittivity mastic wedge

(g) Insulating mastic.

(h) Aluminium crimping lugs.

(i) Tinned copper braids

(j) Wrap around mechanical protection for joints.

(k) Cleaning solvents, abrasive strips.

(l) Plumbing metal.

(m) Binding wire etc. adequate in quantity and dimensions to meet the service and test conditions.

The kit shall have installation instructions and shall be properly packed with shelf life of over 3 years.

The contractor should provide and connect 33kV outdoor cold-shrinkable cable terminations with adequate surge arresters, to be mounted on the Terminal monopoles of the 33kV OHL line portion (both sides) or separate pedestal column

Cross-Bonding box with SVL

For underground circuits longer than 1km, the losses on the metallic sheaths can be minimized making in each joint a cross bonding of the cable shields. This method consists in dividing the cable length into three approximately equal sections with the sheaths connected and grounded at the ends of the circuit. Thus, the vectorial sum of the induced voltage is practically null. The natural points to establish the crossings are the joints, where appropriate cross bonding boxes to the sheaths. These boxes include SVL

To a cross bonding system implementation the following equipment are applied:

a) **Cross bonding boxes** to execute the crossing of the sheaths. These boxes include SLV and each box should have an earth electrode itself for create an earth return circuit in each divided section of the line.
   These boxes should be watertight and capable of containing the effects of the thermal or electrical failures of any element inside the box, including a possible internal short circuit.
   To facilitate its maintenance, these boxes should be installed in joints boxes with easy access (for example through the placement of manholes) and they should not be at more than one meter below the ground level [3].
b) **Direct bonding boxes** are usually applied on the ends of the line to connect the sheath directly to earth. These boxes include earth electrode but, unlike cross bonding boxes, they do not include SLV.
c) **Kits for shield interruption:** it is necessary for each phase joint to introduce an additional kit to remove the shield outside the respective box and to connect a concentric cable. Is this coaxial cable that will connect the sheaths to the cross bonding boxes.
d) **Cables to the sheaths connection to cross bonding boxes**: should be coaxial cables insulated with XLPE (cross linked polyethylene) or flexible monopole conductors. The section of these cables is determined by the maximum value of short circuit current of the power line.
   Considering the monopole conductors solution, instead of the coaxial cables one, it is not necessary to include the additional kits for shield interruption. Thus, the monopole conductors are directly connected to the cross bonding boxes.
   The sheaths connections should be designed to minimise the cable length, which should not exceed the 10 meters.

The contractor should provide all necessary accessories to fulfil the installation and connection of the cross-bonding boxes with SVL to specified underground cable. Technical requirement of the cross-bonding boxes are detailed in Annex A2-10.

Specialized tools

Specialised tools that are required during the terminating process shall be provided for both the joints and the terminations.

Installation Instructions

The supplier shall provide the installation procedures and instructions for the pre-moulded straight through joints and heat/cold shrinkable termination kits to be used as accessories of the cable specified below.

9.3.3. Sizes and Characteristics of the Cable

The cable terminations and jointing kits specified shall be suitable for cables of sizes and technical data as per Table below:

Conductor nominal cross-sectional area	mm^2	$240mm^2$

Voltage Designation Uo/U (Um)	kV	19/33(36)
Conductor shape		Three core copper stranded, compacted.
Impulse withstand voltage & power frequency withstand voltage for cable	Vpeak Vans	1.2/50ps dry: 170kV peak 50Hz wet (60s): 70kV rms
Impulse withstand voltage & power frequency withstand voltage for terminations	Vpeak Vmis	1.2/50ps dry: 170kV peak 50Hz wet (60s): 70kV rms
Maximum resistance of conductor at 20°C	ohms/km	0.075

Table 4: ***Electrical characteristics of the 33kV cables as per IEC*** **60502-2**

9.3.4. Quality Management System

a) The bidder shall submit a quality assurance programme (QAP) that will be used to ensure that the cable accessories design, material, workmanship, tests, service capability, maintenance, and documentation, will fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001:2008.
b) The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2008 certificate shall be submitted with the bid for evaluation.
c) The bidder shall indicate the delivery time of the cable termination and jointing kits, manufacturer's monthly & annual production capacity and experience in the production of the type and size of cable accessories being offered.
d) A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers outside the country of manufacture for exact or similar size of cable accessories sold in the last five years shall be submitted with the bid for evaluation.

9.4. Tests and Inspection

9.4.1. Conformance to Specifications

The cable termination and jointing kits shall be inspected and tested in accordance with the requirements of this specification and IEC 60502-2, IEC 60502-4, IEC 61442, IEC 60815 and IEEE 48 standards. It shall be the responsibility of the manufacturer to perform or to have performed all the relevant tests.

9.4.2. Type tests

Copies of previous Type Tests Reports issued by a third-party testing laboratory that is accredited to ISO/IEC 17025 shall be submitted with the bid for the purpose of technical evaluation. The accreditation certificate to ISO/IEC 17025 for the same third-party testing laboratory used shall also be submitted with the bid (all in English Language).

Copies of Type Test Reports to IEC 60502-2, IEC 60502-4, IEC 61442, IEC 60815 and IEEE 48 to be submitted with the bid for evaluation shall include the following:

a) Thermal cycle voltage test.

b) Partial discharge tests:
- At ambient temperature, and
- At high temperature.

The tests shall be carried out after the final cycle of item a) above or, alternatively, after the lightning impulse voltage test in item d) below:

c) Lightning impulse voltage test followed by a power frequency voltage test.
d) Partial discharge tests, if not previously earned out in item c) above.
e) Tests of outer protection for buried joints.
f) Pressure leakage tests.
g) Radio interference tests.
h) Adhesive tests on the silicone rubber.

Test voltages shall be in accordance with this standards listed above.

9.4.3. Range of type approval as per IEC Standards

When type tests have been successfully performed on one or more accessories with one or more cable(s) of specific cross-section(s), and of the same rated voltage and construction, the type approval shall be considered as valid for accessories within the scope of this specification with other rated voltages, constructions and with other cables, provided that all the following conditions are met:

f. The voltage group is not higher than that of the tested accessory (ies); NOTE: In this context, accessories of the same rated voltage group are those of rated voltages having a common value of Um, highest voltage for equipment, and the same test voltage levels. For example, tests on an accessory of rated voltage U = 33 kV would also cover accessories of rated voltages U= 30 kV and U = 36 kV.
g. The cable with another conductor cross-section, rated voltage and construction is within the range of type approval as per IEC standards. When the calculated nominal electrical stress at the cable insulation screen does not exceed 2.5kV/mm, the type approval shall be considered as valid for accessories on all cables in this range.
h. The accessories have the same or a similar construction as that of the tested accessory (ies). NOTE: Accessories of similar construction are those of the same type and manufacturing process of insulation and semi-conducting screens.
i. The calculated nominal electrical stresses within the main insulation parts of the accessory and at the cable and accessory interfaces do not exceed those of the tested accessory (ies).
j. A type test certificate signed by the representative of a competent witnessing body, or a type test certificate issued by an independent test laboratory accredited to ISO/IEC 17025 shall be acceptable as evidence of type testing.

9.4.4. Routine and sample tests

Routine and Sample test reports as per IEC standards for the cable accessories shall be submitted by the supplier to the Employer for approval before shipment of the goods.

The Employer's Engineer will witness routine tests and the following sample tests at the factory before shipment:

Tests on components:

The characteristics of each component shall be verified in accordance with the specifications of the accessories manufacturer through tests. The manufacturer of a given accessory shall provide a list of the tests to be

performed on each component, indicating the frequency of each test. The components shall be inspected against their drawings. There shall be no deviations outside the declared tolerances.

Tests on complete accessory:

The following electrical tests shall be carried out as per this specification, IEC 60502-2, IEC 60502-4, IEC 61442, IEC 60815 and IEEE 48 and by the manufacturer on a fully assembled accessory:

a. Partial discharge tests
   - At ambient temperature
   - At high temperatures
b. Voltage tests - Power frequency tests
c. Pressure leak test
d. Examination of the accessories after completion of the above tests.

The above tests shall be performed on one accessory of each type per contract.

If the sample fails either of the above two tests, two further samples of the same accessory type shall be taken from the contract and subjected to the same tests. If both additional samples pass the tests, the other accessories of the same type from the contract shall be regarded as having complied with the requirements of this specification. If either fails, this type of accessory of the contract shall be regarded as having failed to comply.

During acceptance testing, the manufacturer shall demonstrate that the accessories are mechanically and electrically fit for the cable size specified.

9.4.5. Delivery

During delivery of the cable accessories, The Employer will inspect them and may perform or have performed any of the relevant tests to verify compliance with the specification. The supplier shall replace/rectify without charge to The Employer, cable accessories which upon examination, test or use fail to meet any of the requirements in the specification

9.5. Marking, Labelling and Packaging

9.5.1. Marking

All accessories shall be clearly and indelibly marked by the manufacturer to indicate the following:

a. The manufacturer’s identification mark and reference/catalogue number (visible on the completed accessory).
b. The accessory range (visible on the accessory packaging)
c. The manufacturer’s identification mark and a part number (visible on all components forming part of an accessory). This part number shall be referenced in the bill of materials.
d. Components that are physically impossible to mark shall be individually packed and the packaging shall be marked.
e. The expiry date (visible on the packaging of all components or consumables that are subjected to a shelf-life limitation). These components or consumables shall be individually packed.

A suitable nameplate shall be provided in the termination kit giving the following information:

- Manufacturer's name
- Type of termination
- Designation no.
- IEEE terminator class no.

- Insulation class
- Maximum design voltage to ground
- Maximum and Minimum cable conductor size
- Maximum and Minimum cable insulation diameter
- BIL
- Rated internal pressure, kPa
- Date of Manufacture

9.5.2. Packaging of Individual Parts

Each accessory shall be packed in a strong cardboard container to protect it from mechanical damage. Individual parts shall be packed in strong sealed plastic bags to protect them from ingress of dirt and moisture. The cardboard container shall have:

a. Installation instructions in English Language.
b. All necessary components and consumables required to complete the installation as per the instructions, i.e. accessory components, cleaning kit and earthing kit as well as connectors.
c. It shall not be left to the jointer to decide the quantity to use in each application.
d. A bill of materials referenced according to the component part numbers.
e. Packing shall be such as to permit easy identification of the components without their removal from the packaging.

9.5.3. Management of Material with Limited Shell Life

The supplier shall indicate measures taken to ensure prudent management of material with limited shell life. These measures may include staggered delivery of such material.

9.5.4. Detailed Safe Procedure for Decommissioning

The manufacturer shall provide a detailed safe procedure for decommissioning and disposal of the termination and jointing kits. This may include retrieval of decommissioned kits by the manufacturer from the Employer for safe disposal.

Note: The characters used in marking shall be at least 3mm high.

9.6. Documentation

9.6.1. Bid Documentation to be Submitted

The bidder shall submit its bid complete with technical documents required by Annex (Guaranteed Technical Particulars) for bid evaluation.

9.6.2. Successful Bidder (Supplier) Shall Submit the Following Documents/Details

The successful bidder (supplier) shall submit the following documents/details to The Employer for approval before manufacture:

a. Guaranteed Technical Particulars.
b. Design manufacturer's drawings showing outline of joints, terminations and accessories together with all pertinent dimensions. Any variation in these dimensions due to manufacturing tolerances shall be indicated.
c. Catalogue for all the components used. Catalogue numbers for the offered items shall be high-lighted.
d. Construction and method of assembly of joints and terminations shall be clearly set out in illustrated installation instructions supplied at the time of biding and included in every product kit during delivery. All documentation shall be in English Language.
e. Duly completed attached technical data schedule for each offered item.
f. Complete list of items contained in each joint and termination kit along with the price for each item of kit contents.
g. Quality Assurance Plan (QAP) that will be used to ensure that the joints and terminations design, material, workmanship, tests, service capability, maintenance and documentation will fulfil the requirements stated in the contract documents, standards, specifications and regulations.
h. Test Program to be used after manufacture.
i. Marking details and method to be used in marking of the joints and terminations,
j. Supplier’s undertaking to ensure adequacy of the design, good workmanship, good engineering practice and adherence to applicable standards in the manufacture of the joints and terminations for THE EMPLOYER.
k. Packaging details (including packaging materials, total number of joints/terminations per packaging).

9.6.3. Recommendations for Use, Care, Storage and Routine Inspection/Testing Procedures

The supplier shall submit recommendations for use, care, storage and routine inspection/testing procedures, all in the English Language, during delivery of the joints/terminations to THE EMPLOYER stores

9.7. Technical data for 33 kV XLPE cable accessories

The 33 kV XLPE cable accessories to be supplied shall comply with guaranteed technical particulars as indicated in Annex A2-6 (Outdoor and Indoor Cable terminations), Annex A2-7 (cable Joints) and Annex A2-10 (Cross-bonding boxes).

10. 11kV XLPE Cables

The materials shall be of first class quality and designed for continuous satisfactory operation as continuity of supply is of prime importance and to operate satisfactorily under variation of load, voltage and short circuit or other conditions which may occur on the system provided that these variations are within the assigned rating of the apparatus. The materials used shall be suitable for the climatic and soil conditions listed below.

10.1. Regulations and Standards

Unless otherwise specified elsewhere in this specification, the rating as well as performance and testing of the XLPE power cables shall conform to the latest revisions available at the time of placement of order of all the relevant standards as listed, but not limited to specified.

IEC 60228	Conductors of Insulated Cables
IEC60502 Part – 2	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) – Part 2: Cables for rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV)
IEC61442	Test methods for accessories for power cables with rated voltages from 6kV (7.2kV) up to 30kV (Um=36kV)
IEC 60949	Calculation of Thermally Permissible Short-Circuit Currents, Taking into Account Non-Adiabatic Heating Effects
IEC 60229	Tests on cable over-sheaths which have a protective function and are applied by extrusion
IEC 60230	Impulse tests on cables and their accessories
IEC 60287-Parts 1&2	Electric cables – Calculation of the current rating – Part 1: Current rating equations and calculation of losses – Part 2: Thermal resistance
IEC 60684	Flexible insulating sleeving
IEC 60811-1-1	Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section1: Measurement of thickness and overall dimensions – Tests for determining the mechanical properties
IEC 60811-1-2	Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section 2: Thermal ageing methods
IEC 60811-1-3	Insulating and sheathing materials of electric cables – Common test methods - Part 1: General application – Section 3: Methods for determining the density - Water absorption tests – Shrinkage test
IEC 60811-1-4	Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Four: Tests at low temperature
IEC 60811-2-1	Insulating and sheathing materials of electric and optical cables – Common test methods - Part 2-1: Methods specific to elastomeric compounds –Ozone resistance, hot set and mineral oil immersion tests
IEC 60811-4-1	Common test methods for insulating and sheathing materials of electric cables – Part 4: Methods specific to polyethylene and polypropylene compounds –Section One: Resistance to environmental stress cracking – Wrapping test after thermal ageing in air – Measurement of the melt flow index – Carbon black and/or mineral content measurement in PE

IEC 60853-1	Calculation of the cyclic and emergency current rating of cables. Part 1: Cyclic rating factor for cables up to and including 18/30(36) kV
BS 7835	Electric cables - Armoured cables with thermosetting insulation for rated voltages from 3.8/6.6 kV to 19/33 kV having low emission of smoke and corrosive gases when affected by fire - Requirements and test methods
IEEE 48-2000	Testing standard for joints and terminations
IEC 60754-1	Test on gases evolved during combustion of materials from cables – Part 1: Determination of the halogen acid gas content
IEC 60332-1-2	Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame

10.2. Service conditions

General Operating Conditions
The conditions under which the cables will be required to operate are:

- Installed in a separate trefoil arrangement in a single way duct/phase comprised of HDPE conduit in concrete encasement
- at a nominal depth of around 1,500mm
- Cable ends rising up concrete, timber, or metal poles and exposed to direct sunlight;
- Ambient air temperature not exceeding 40°C summer day time and 15°C winter night time as determined by a shaded thermometer;
- Ambient soil temperature not exceeding 35°C;
- An altitude not exceeding 1,500m above sea level;
- A high humidity (90%) combined with a high temperature (40°C); followed by a sudden drop in temperature of up to 10°C;
- Soil thermal resistivity 1,5 K m/W
- An area in which the cables may be installed is home to subterranean termite, Mastotermes Darwiniesis and the coastal brown ant, Pheidole Megacephala.
- High Seismicity conditions
- Both end bonding

Operating Conditions – Exposed Cable
Exposed sections of cable will be subject to the following additional service conditions:

- Solar radiation intensity of 1,100W/m²;
- Tropical summer storms with high winds upto 288km/h and an annual rainfall in excess of 1,500mm;
- Areas of coastal salt spray and/or industrial pollution with equivalent salt deposits densities in the range of 2.0 - 3.0g/m².
- Maximum wind pressure 700 N/m2
- Level of pollution, very high

Regarding short-circuit rating adiabatic and non-adiabatic values shall be calculated using the Following conditions:

- Conductor initial temperature 90 °C
- Conductor operating temperature at emergency conditions 130 °C
- Conductor final temperature at short circuit conditions 250 °C
- Metallic screen initial temperature 80 °C
- Metallic screen final temperature 180 °C
- Short-circuit duration: 1 s

11kV Systems
The power cables required are for use on 11kV, three phase, 50Hz systems.
The 11kV system will have an artificial earthing point through earthing transformer (ZigZag) connected to power transformer secondaries.
The maximum system voltage (phase to phase) on the systems is 12 kV and the required impulse insulation level is 75 kVp.

The specified cables shall be designed to meet a 17.39kA (1s) earth fault duties for 11kV level.

10.3. Design and construction requirements

11kV cable shall be suitable for high ambient, high humid tropical Climatic conditions. Cables shall be designed to withstand the mechanical, electrical and thermal stresses under the unforeseen steady state and transient conditions and shall be suitable for proposed method of installation.

The cable shall be designed to withstand a conductor temperature of 130°C without any detrimental effects on any of its components. However, the cable sizing shall be based on a maximum permissible continuous temperature of 90°C and emergency loading temperature of 105°C.

Maximum continuous operating temperature shall be 90 °C under normal operation and 250°C under short circuit condition. Armouring shall be provided consisting of galvanized strip steel wires conforming to IEC: 60502 Part – 2, BS: 6622, BS: 7835. (amended up to date) and over the armouring a tough outer sheath of PVC compound shall be extruded. The PVC compound for the outer sheath shall conform to type ST-2, FRLS as per IEC: 60502 Part – 2, The colour of the outer sheath shall be black. The cable shall be manufactured strictly conforming to IEC standard.

The construction of the cable shall be essentially as described below. The ratings and dimensions shall be as indicated in the Data Schedule.

The power cable shall meet or exceed the requirements of this Specification in all respects.

Manufacturer's drawings shall show the outline of the power cable, together with all pertinent dimensions. Any variations in these dimensions due to manufacturing tolerances shall be indicated.

The 11kV cables shall be designed and manufactured to comply with the test requirements set out in IEC standard.

During the contract period, the Bidder shall not change the design, supplier, manufacturing process or compounding of the materials without the written approval of the Purchaser.

The insulation (XLPE) screening shall be provided consisting of extruded semi-conducting cross link material in combination with a metallic layer of copper tapes. Such screened cores shall be laid up together with fillers and/or binder tapes where necessary and provided with extruded inner sheathing of heat resistant PVC conforming to type ST-2 of PVC ST 2 as per IEC:60502 Part – 2, BS:6622, LSOH to BS:7835.

The conductor shield, cross-linked polyethylene insulation and insulation shield shall be extruded by the simultaneous triple extrusion method to assure homogeneity between the insulation and the semiconducting shields.

The insulation shield shall be bonded firmly and continuously to the insulation.

The cross-linking process shall be by the dry cure dry cooling or dry cure wet cooling method.

It is desirable that the process has facilities at the point of extrusion to monitor and control the thickness of the extruded screens and the insulation and the concentricity of the cable (this may be done by X-Ray scanning and control or similar techniques).

The Bidder must state in the bid submission how they will control the concentricity of the cable and the thickness of the extruded cable screens and the cable insulation. This will be considered in assessing bids.

The Bidder must provide details of cable accessories that the manufacturer used for the insulation screen shall be an extruded layer of black semi-conducting compound and continuously covers the whole area of insulation. The semiconducting screens should be effectively cross linked to achieve 90°C cable rating. The contact surface between insulation and insulation screen shall be smooth and free from protrusion and irregularities compliance testing of bided cables to requirements and is requested to advise of any other accessories used by the manufacturer with demonstrated compatibility with the bided or similar cable construction.

Cables shall be capable of satisfactory operation under a power supply system frequency variation of ±5% voltage variation of ±10 % and combined frequency voltage variation shall be +10 % & - 15%.
Cable shall be suitable for laying in ducts underground.
Cable shall have heat and moisture resistance properties. These shall be of type and design with proven record on transmission network service.

The power cable shall be free of material and manufacturing defects which would prevent it from meeting the requirements of this Specification.

Power medium voltage cables shall be provided with watertight screen. The water barrier shall be performed by a water-swellable semi-conducting.

Repaired cables shall not be acceptable

Conductor

The 11kV cables shall be 3cores XLPE insulated, stranded compacted round aluminium conductor complying the requirement of flexibility Class-2 of IEC 60228/BS 6360. The wires shall be made of high conductivity copper and shall be stranded mid compacted. The copper used for the conductor shall be of highest purity. Conductor shall be of uniform, of good quality, free from defects copper.

The nominal area of conductor shall be 185 mm².

Conductor screen

The conductor screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface of the conductor. The screen shall be firmly bonded to XLPE insulation. The minimum thickness of conductor screen shall be 0.3 mm. (approx.)

A non-hygroscopic semi conducting tape may be applied over the conductor surface under extruded layer. The outer surface of the conductor screen shall be circular and free from irregularities.

Conductor screen and insulation screen shall both be extruded, semi-conducting compound and shall be applied along-with XLPE insulation in a single operation by triple extrusion process. Method of curing for 11 kV cable shall be "Dry curing/ gas curing" only.

Extruded Semi-conducting screening and metallic screening of copper tape shall be generally as per IEC: 60502 Part – 2 standard. The semi conducting compound shall be suitable for the operating temperature of the cable and compatible with the insulating material.

Insulation

The insulation shall be cross-linked polyethylene (XLPE) as per IEC: 60502 Part –2, BS: 6622, BS: 7835 standards. The insulation shall be applied by extrusion and vulcanisation to form a compact homogenous body free from micro voids and contaminants.

The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The extrusion method shall give very smooth interface between semi – conducting screen and insulation. The insulation of the cables shall be of high standard quality and conform to IS: 7098 (Part-II) 1985 or latest amendment thereof. The insulation shall be so applied that it fit closely on the conductor or conductor screening and it shall be possible to remove it without damaging the conductor. The insulating material shall be Cross Linked Polyethylene (XLPE) cured by dry curing process i.e. nitrogen gas curing CCV line method and applied by extrusion process. The insulating material shall have excellent electrical properties with regard to resistivity, dielectric constant and loss factor and shall have high tensile strength and resistance to abrasion.

This shall not deteriorate at elevated temperatures or when immersed in water. The insulation shall be preferably fire resistant and resistant to chemicals like acids, alkalis, oils and ozone. The insulation properties shall be stable under thermal conditions arising out of continuous operation at conductor temperature of 90ºC rising momentarily to 250ºC under short circuit conditions. It shall be free from any foreign material or porosity visible to the unaided eye. The quality of insulation should be good and insulation should not be deteriorated when exposed to the climatic conditions. The average thickness of insulation shall not be less than the nominal value of 3.4 mm

Insulation screen

The insulation screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface area of insulation. It shall be firmly bonded to the insulation. Semi-conducting swelling tape with suitable overlap over the extruded semi-conducting layer of compound shall be applied.

The non-metallic semi- conducting shield shall be put over the insulation of each core. The insulation shield shall be extruded in the same operation as the conductor shield and insulation by dry curing process i.e. nitrogen gas curing CCV line method. The insulation shield shall be bonded and strippable on adequate heat treatment. The bidders are requested to elaborate the manufacturing technique adopted by their manufacturers to achieve this motive.

The minimum thickness of insulation screen shall be 0.3 mm.

The interface between insulation and insulation screen shall be free of any voids.

Metallic screen

The insulation metallic screen shall consist of plain annealed copper conductor capable to withstands the short-circuit current values specified in the specification.

A combination of copper wires with copper counter spiral tape shall be applied over the non-metallic insulation screen. The minimum thickness of metallic screen shall be 0.05 mm.

Fillers / Separation Sheath

The three cores then laid up with a suitable extruded material fillers to provide a substantially circular cross section before the inner covering is applied and bedded with a layer of extruded P.V.C. The filler material should be non-hygroscopic, easy to be removed and good flexibility material, suitable for the operating temperature and compatible with the insulating material (to be mentioned with the offer such as (EPR) or (PP)). The materials shall be new, unused and of finest quality. The minimum thickness of shall be 1 mm.

Inner sheath/Bedding

All armoured cables shall have distinct extruded inner PVC sheath of black colour.

The PVC inner covering then extruded over the circular assembly with a thickness proportional to the fictitious diameter over laid-up cores as specified in IEC 60502-2/Clause 8.1.3.

Waterproof tape

A layer of suitable tape (swelling tape) for water proofing to be laid over the armour layer.

Armour

The three cores then armoured with double, low carbon, galvanized steel tapes of thickness not less than 0.5 mm and the gap between adjacent turns of each tape shall not exceed 50 % of the width of the tape. The metallic armour shall confirm to IEC 60502 clause 12.4 standard with latest addendums and amendments.

Steel wire armor has high short circuit current handling capacity and has higher mechanical strength.

Armouring shall have minimum 90% coverage. Breaking Load of the joints shall be minimum 95% of the normal armour.

Outer Sheath

Over all extruded PVC seamless sheath to prevent moisture from penetrating and provides good corrosion protection thickness not less than 3 mm.

The over sheath of the MV cables shall be of PVC and flame retardant FRLS (Flame Retardant Low Smoke)

It shall be of black colour PVC (type ST2) with Cable size and Voltage grade embossed on it. Sequential marking shall be at every 1 Meter distance. Word "FRLS" (Flame Retardant Low Smoke) shall also be embossed on it at every 5 meter distance.

Outer sheath shall have the following properties:

- Acid Gas Generation – Max 20% (as per IEC 754-1)
- Smoke density rating: 60% (As per ASTMD 2843)
- Flammability test - As per Swedish chimney test F3 As per IEC 332 part-3 (Category B)
- Minimum bending radius shall be 10 D

The thickness shall be checked and meet the following formula as minimum: Ts = 0.035D+1mm

where D = Fictitious diameter immediately after the sheath and Ts = thickness in mm

10.4. Testing

Type Tests:

All the type tests in accordance with IEC: 60502, BS: 6622, BS: 7835 and amended up to date, shall be performed on cable samples drawn by purchaser.

Type tests are required to be carried out from the lot of supply on a sample of any one size of cable ordered for each voltage grade. In case facilities of any of the type tests are not available at the works of the supplier, then such type test shall be carried out by the supplier at the independent laboratory at the cost of supplier.

Sample for the type test will be drawn by the purchaser's representative and the type test will be witnessed by him.

The following shall constitute type tests:

a) Tests of Conductor:

i) Annealing test (for copper)

ii) Tensile test (for aluminium)

ii) Wrapping test (for aluminium)

iii) Conductor Resistance test

b) Tests for armouring wires/strips.

c) Tests for thickness of insulation and sheath.

d) Physical tests for insulation:

i) Tensile strength and elongation at break.

ii) Ageing in air oven.

iii) Hot test

iv) Shrinkage test.

v) Water absorption (gravimetric).

e) Physical test for outer sheath:

i) Tensile strength and elongation at break.

ii) Ageing in air oven.

iii) Shrinkage test.

iv) Hot deformation,

f) Partial discharge test.

g) Bending test.

h) Dielectric power factor test:

i) As a function of voltage.

ii) As a function of temperature.

i) Insulation resistance (volume resistivity test).

j) Heating cycle test.

k) Impulse withstand test.

l) High voltage test.

m) Flammability test.

Routine Tests:

All the Routine tests as per IEC standard and amended up to date shall be carried out on each and every delivery length of cable. The result should be given in test report. Partial discharge test must be carried out in a fully screened test cell. It is, therefore, absolutely essential that the manufacturer should have the appropriate type of facility to conduct this test which is routine test.

The details of facility available in the manufacturer's works in this connection should be given in the bid.

The following shall constitute routine tests:

a) Conductor resistance test

b) Partial discharge test

c) High voltage test.

The contractor shall also undertake to arrange for the short circuit test as a type test on any one size of each voltage grade i.e. on one size of 11 kV and one size of 33 kV earthed grade shielded XLPE cables. If facilities for carrying out short circuit tests are available at the works of the supplier, and provided the certification procedure is approved by the Purchaser, testing at the supplier's works will be acceptable. Short Circuit test shall be witnessed by the purchaser's representative.

The short circuit test shall be preceded and followed by the following tests so as to ensure that the characteristics of the cable remain within the permissible limits even after it is subjected to the required short circuit rating.

a) Partial Discharge Test.

b) Conductor Resistance Test.

c) High Voltage Test.

The manufactured cable will be acceptable only after such a sample test is successfully carried out at CPRI or at suppliers works and approved by the Purchaser.

10.5. Packing and Marking

The following particulars shall be properly legible embossed on the cable sheath at the intervals of not exceeding one meter throughout the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

a) Manufactures name and/or Trade name.

b) Voltage grade.

c) Year of manufacture.

d) Type of insulation, XLPE

e) Successive Length.

f) Conductor cross-sectional area, mm² and material

The cable shall be supplied in continuous standard length of 500 running meters with plus minus 5% tolerance wound on non-returnable wooden drum of good quality and non-standard lengths not less than 100 meters up to 5% of the ordered quantity shall be accepted. Alternately cable can be supplied wound on non-returnable steel drum without any extra cost to the purchaser. Packing and marking shall be as per IEC standard

The cable shall be packed in non-returnable wooden drums. The following information shall be marked on each drum.

a) Drum identification number.

b) Manufacturer's name, Trade name / Trade mark, if any.

c) Nominal sectional area of the conductor of the cable.

d) Number of cores

e) Type of cable and voltage grade with cable code

f) Length of cable in cable drum

g) Direction of rotation of drum (by means of an arrow)

h) Appox. Weight: bare: gross:

i) Year and country of manufacture

j) Purchase order number

k) Date of delivery

l) Name of the purchaser.

Drum shall be proofed against attack by white ant or termite conforming to standard.

10.6. Technical data for 11 kV XLPE cable

The 11 kV XLPE cable to be supplied shall comply with guaranteed technical particulars as indicated in Annex A2-8.

11. 11kV UGC accessories

This specification is for cable joints and terminations for three cores XLPE insulated aluminium cables (with galvanized metallic sheath for operation at 50Hz Ac voltages of 6,35 kV between any conductor and sheath or earth, 11kV between phase conductors, having a maximum sustained power frequency voltage between phase conductors of 12kV.

The specification also covers inspection and testing of the cable accessories as well as schedule of Guaranteed Technical Particulars to be filled, signed by the manufacturer, and submitted for bid evaluation.

The specification stipulates the minimum requirements for cable accessories acceptable for use, and it shall be the responsibility of the Supplier to ensure adequacy of the design, good workmanship, adherence to standards and the specification as well as ensuring good engineering practice in the manufacture of the cable accessories for the Employer.

11.1. Regulations and Standards

The following standards contain provisions which, through reference in this text constitute provisions of this specification. Unless otherwise stated, the latest editions (including amendments) apply.

IEC 60502-2	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) - Part 2: Cables for rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV).
IEC 60502-4	Test requirements on accessories for cables with rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV)
IEC 61442	Test methods for accessories for power cables with rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV)
HD 629.1 S2 + A1 CENELEC	Test requirements on accessories for use on power cables rated voltage from 3.6/6(7.2) kV up to 20.8/36(42) kV - Part 1
IEC 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions.
IEEE 48	Standard for Test Procedures and requirements for Alternating-Current Cable Terminations Used on Shielded Cables having Laminated Insulation Rated 2.5kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEC 60228	Conductors of insulated cables
IEC 61238-1	Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um= 36 kV) -Part 1: Test methods and requirements
BS 6622	Electric cables - Armoured cables with thermosetting insulation for rated voltages from 3.8/6.6 kV to 19/33 kV - Requirements and test methods
IEEE 404	Standards for Extruded and Laminated Dielectric shielded cable

joints rated 2.5 kV to 500 kV

All components of the splice or termination shall perform without distress under normal cyclic loading and fault conditions. When the dielectric strength of the cable termination is dependent upon taping or the use of auxiliary insulation, such insulation shall be used when any design (type) tests are performed.
The termination shall be Class 1 per IEEE 48 or equivalent. For apparatus terminations, the temperature of the medium in direct contact with the termination (ambient inside enclosure) shall not exceed 55ºC.

11.2. Terms and Definitions

For the purpose of this specification the definitions given in the reference standards shall apply.

11.3. Requirements

11.3.1. Service and System Conditions

a. The cable accessories shall be suitable for use in outdoors installations and tropical conditions with a temperature range of -1°C to +40°C and humidity of up to 90%.
b. The cable shall be laid in cable ducts.
c. Permissible continuous loading operating temperature shall be 90°C.
d. Permissible emergency loading temperature shall be 130°C for at least 8 hours.
e. Permissible short circuit temperature shall be 250°C (for short-circuit duration of 5 s as per IEC 60502-2).
f. The 11kV cable and cable accessories shall be connected to underground system operating at a nominal voltage of 11kV, 50Hz and maximum system voltage of 12kV and are earthed through earthing transformer.

11.3.2. Materials Design and Construction

a. The cable accessories (termination and jointing kits) shall be designed and manufactured to IEC 60502-2 and IEEE 48 and the requirements of this specification.
b. All materials used shall be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 seconds duration).
c. The 11kV cable accessories shall be suitable for 11kV three core XLPE insulated Aluminium cable that has a galvanized steel armour.

No	Item	Technical data for 33kV accessories
1	Nominal voltage (U)	11kV
2	Max. service voltage (Um)	12kV
3	Power frequency voltage withstand test	24kV/1min. No breakdown no flashover
4	Room temperature partial discharge test	Test voltage 12kV, Partial discharge < 10pC
5	Thermal cycle test	Heating: 100°C for 4 hours Cooling: -25°C for 4 hours Holding: 20°C for 1 hour

6	High temperature partial discharge test	Test Voltage 12kV Test temperature 95-100°C, Partial discharge < 10pC
7	Lightning impulse voltage test	95kV positive and negative polarities each 10 times, No breakdown, No flashover.
8	After the impulse voltage withstand voltage test	Wet, at 42kV, for 15 min. No flashover, No breakdown.
9	Outdoor joint / termination short-term power frequency voltage test	17.5kA
10	Short circuit current for 3 seconds	10.1kA
11	Outdoor joint / termination radio interference test	5 microvolts at 10 kHz 50 microvolts at 100 kHz 100 microvolts at 1 MHz
12	Pressure leak test	No gas shall escape at 0.2 MPa for 1 hour

Table 5: Technical requirements for test of 11kV cable terminations as per IEEE 48.

Cable terminations: Outdoor mounted on secondary power transformer / indoor for metal-clad switchgear

Outdoor and indoor termination shall be done by cold shrinkable type termination kits suitable for three cores Aluminium 185 mm² cable. Termination for cable shall be provided in sufficient quantities for complete installations of substations.

The kits should have satisfactory performance record of minimum 5 years supported with proof of customers having had satisfactory use of these kits.

The Joints and terminations should have been type tested and type test reports made available.

The Kits should generally consist of:

(a) Heat shrinkable clear insulating tubes

(b) Stress control tubing where necessary,

(c) Ferrule insulating tubing for joints,

(d) Conductive cable break outs for terminations, non-tracking, erosion and weather resistant tubing both outer / inner

(e) Non tracking erosions and weather resistant outdoor sheds in case of terminations.

(f) High permittivity mastic wedge

(g) Insulating mastic.

(h) Aluminium crimping lugs.

(i) Tinned copper braids

(j) Wrap around mechanical protection for joints.

(k) Cleaning solvents, abrasive strips.

(l) Plumbing metal.

(m) Binding wire etc. adequate in quantity and dimensions to meet the service and test conditions.

The kit shall have installation instructions and shall be properly packed with shelf life of over 3 years.

The contractor should provide and connect 11kV outdoor cold-shrinkable cable terminations, to be mounted on the secondries of power transformers.

Indoor cable terminated must be suitable for 11kV metal-Clad connection.

Specialized tools

Specialised tools that are required during the terminating process shall be provided for both the joints and the terminations.

Installation Instructions

The supplier shall provide the installation procedures and instructions for the pre-moulded straight through joints and heat/cold shrinkable termination kits to be used as accessories of the cable specified below.

11.3.3. Sizes and Characteristics of the Cable

The cable terminations and jointing kits specified shall be suitable for cables of sizes and technical data as per below Table:

Conductor nominal cross-sectional area	mm²	185mm²
Voltage Designation Uo/U (Um)	kV	6,35/11(12)
Conductor shape		Three core Aluminium stranded, compacted.
Impulse withstand voltage & power frequency withstand voltage for cable	Vpeak Vans	1.2/50ps dry: 75kV peak 50Hz wet (60s): 21kV rms
Impulse withstand voltage & power frequency withstand voltage for terminations	Vpeak Vmis	1.2/50ps dry: 75kV peak 50Hz wet (60s): 21kV rms
Maximum resistance of conductor at 20°C	ohms/km	0.164

Table 6: ***Electrical characteristics of the 11kV cables as per IEC*** **60502-2**

11.3.4. Quality Management System

a. The bidder shall submit a quality assurance programme (QAP) that will be used to ensure that the cable accessories design, material, workmanship, tests, service capability, maintenance, and documentation,

will fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001:2008.

b. The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2008 certificate shall be submitted with the bid for evaluation.
c. The bidder shall indicate the delivery time of the cable termination and jointing kits, manufacturer's monthly & annual production capacity and experience in the production of the type and size of cable accessories being offered.
d. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers outside the country of manufacture for exact or similar size of cable accessories sold in the last five years shall be submitted with the bid for evaluation.

11.4. Tests and Inspection

11.4.1. Conformance to Specifications

The cable termination and jointing kits shall be inspected and tested in accordance with the requirements of this specification and IEC 60502-2, IEC 60502-4, IEC 61442, IEC 60815 and IEEE 48 standards. It shall be the responsibility of the manufacturer to perform or to have performed all the relevant tests.

11.4.2. Type tests

Copies of previous Type Tests Reports issued by a third-party testing laboratory that is accredited to ISO/IEC 17025 shall be submitted with the bid for the purpose of technical evaluation. The accreditation certificate to ISO/IEC 17025 for the same third-party testing laboratory used shall also be submitted with the bid (all in English Language).

Copies of Type Test Reports to IEC 60502-2, IEC 60502-4, IEC 61442, IEC 60815 and IEEE 48 to be submitted with the bid for evaluation shall include the following:

a) Thermal cycle voltage test.
b) Partial discharge tests:
    - At ambient temperature, and
    - At high temperature.

The tests shall be carried out after the final cycle of item a) above or, alternatively, after the lightning impulse voltage test in item d) below:

c) Lightning impulse voltage test followed by a power frequency voltage test.
d) Partial discharge tests, if not previously earned out in item c) above.
e) Tests of outer protection for buried joints.
f) Pressure leakage tests.
g) Radio interference tests.
h) Adhesive tests on the silicone rubber.

Test voltages shall be in accordance with this standards listed above.

11.4.3. Range of type approval as per IEC Standards

When type tests have been successfully performed on one or more accessories with one or more cable(s) of specific cross-section(s), and of the same rated voltage and construction, the type approval shall be considered

as valid for accessories within the scope of this specification with other rated voltages, constructions and with other cables, provided that all the following conditions are met:

a. The voltage group is not higher than that of the tested accessory (ies); NOTE: In this context, accessories of the same rated voltage group are those of rated voltages having a common value of Um, highest voltage for equipment, and the same test voltage levels. For example, tests on an accessory of rated voltage U = 11 kV would also cover accessories of rated voltages U= 10 kV and U = 12 kV.
b. The cable with another conductor cross-section, rated voltage and construction is within the range of type approval as per IEC standards. When the calculated nominal electrical stress at the cable insulation screen does not exceed 2.5kV/mm, the type approval shall be considered as valid for accessories on all cables in this range.
c. The accessories have the same or a similar construction as that of the tested accessory (ies). NOTE: Accessories of similar construction are those of the same type and manufacturing process of insulation and semi-conducting screens.
d. The calculated nominal electrical stresses within the main insulation parts of the accessory and at the cable and accessory interfaces do not exceed those of the tested accessory (ies).
e. A type test certificate signed by the representative of a competent witnessing body, or a type test certificate issued by an independent test laboratory accredited to ISO/IEC 17025 shall be acceptable as evidence of type testing.

11.4.4. Routine and sample tests

Routine and Sample test reports as per IEC standards for the cable accessories shall be submitted by the supplier to the Employer for approval before shipment of the goods.

The Employer's Engineer will witness routine tests and the following sample tests at the factory before shipment:

Tests on components:

The characteristics of each component shall be verified in accordance with the specifications of the accessories manufacturer through tests. The manufacturer of a given accessory shall provide a list of the tests to be performed on each component, indicating the frequency of each test. The components shall be inspected against their drawings. There shall be no deviations outside the declared tolerances.

Tests on complete accessory:

The following electrical tests shall be carried out as per this specification, IEC 60502-2, IEC 60502-4, IEC 61442, IEC 60815 and IEEE 48 and by the manufacturer on a fully assembled accessory:

a. Partial discharge tests
   - At ambient temperature
   - At high temperatures
b. Voltage tests - Power frequency tests
c. Pressure leak test
d. Examination of the accessories after completion of the above tests.

The above tests shall be performed on one accessory of each type per contract.

If the sample fails either of the above two tests, two further samples of the same accessory type shall be taken from the contract and subjected to the same tests. If both additional samples pass the tests, the other

accessories of the same type from the contract shall be regarded as having complied with the requirements of this specification. If either fails, this type of accessory of the contract shall be regarded as having failed to comply.

During acceptance testing, the manufacturer shall demonstrate that the accessories are mechanically and electrically fit for the cable size specified.

11.4.5. Delivery

During delivery of the cable accessories, The Employer will inspect them and may perform or have performed any of the relevant tests to verify compliance with the specification. The supplier shall replace/rectify without charge to The Employer, cable accessories which upon examination, test or use fail to meet any of the requirements in the specification

11.5. Marking, Labelling and Packaging

11.5.1. Marking

All accessories shall be clearly and indelibly marked by the manufacturer to indicate the following:

a. The manufacturer's identification mark and reference/catalogue number (visible on the completed accessory).
b. The accessory range (visible on the accessory packaging)
c. The manufacturer's identification mark and a part number (visible on all components forming part of an accessory). This part number shall be referenced in the bill of materials.
d. Components that are physically impossible to mark shall be individually packed and the packaging shall be marked.
e. The expiry date (visible on the packaging of all components or consumables that are subjected to a shelf-life limitation). These components or consumables shall be individually packed.

A suitable nameplate shall be provided in the termination kit giving the following information:

- Manufacturer's name
- Type of termination
- Designation no.
- IEEE terminator class no.
- Insulation class
- Maximum design voltage to ground
- Maximum and Minimum cable conductor size
- Maximum and Minimum cable insulation diameter
- BIL
- Rated internal pressure, kPa
- Date of Manufacture

11.5.2. Packaging of Individual Parts

Each accessory shall be packed in a strong cardboard container to protect it from mechanical damage. Individual parts shall be packed in strong sealed plastic bags to protect them from ingress of dirt and moisture. The cardboard container shall have:

a. Installation instructions in English Language.
b. All necessary components and consumables required to complete the installation as per the instructions, i.e. accessory components, cleaning kit and earthing kit as well as connectors.
c. It shall not be left to the jointer to decide the quantity to use in each application.

d. A bill of materials referenced according to the component part numbers.
e. Packing shall be such as to permit easy identification of the components without their removal from the packaging.

11.5.3. Management of Material with Limited Shell Life

The supplier shall indicate measures taken to ensure prudent management of material with limited shell life. These measures may include staggered delivery of such material.

11.5.4. Detailed Safe Procedure for Decommissioning

The manufacturer shall provide a detailed safe procedure for decommissioning and disposal of the termination and jointing kits. This may include retrieval of decommissioned kits by the manufacturer from the Employer for safe disposal.

Note: The characters used in marking shall be at least 3mm high.

11.6. Documentation

11.6.1. Bid Documentation to be Submitted

The bidder shall submit its bid complete with technical documents required by Annex A2-9 (Guaranteed Technical Particulars) for bid evaluation.

11.6.2. Successful Bidder (Supplier) Shall Submit the Following Documents/Details

The successful bidder (supplier) shall submit the following documents/details to The Employer for approval before manufacture:

a. Guaranteed Technical Particulars.
b. Design manufacturer's drawings showing outline of joints, terminations and accessories together with all pertinent dimensions. Any variation in these dimensions due to manufacturing tolerances shall be indicated.
c. Catalogue for all the components used. Catalogue numbers for the offered items shall be high-lighted.
d. Construction and method of assembly of joints and terminations shall be clearly set out in illustrated installation instructions supplied at the time of biding and included in every product kit during delivery. All documentation shall be in English Language.
e. Duly completed attached technical data schedule for each offered item.
f. Complete list of items contained in each joint and termination kit along with the price for each item of kit contents.
g. Quality Assurance Plan (QAP) that will be used to ensure that the joints and terminations design, material, workmanship, tests, service capability, maintenance and documentation will fulfil the requirements stated in the contract documents, standards, specifications and regulations.
h. Test Program to be used after manufacture.
i. Marking details and method to be used in marking of the joints and terminations,
j. Supplier’s undertaking to ensure adequacy of the design, good workmanship, good engineering practice and adherence to applicable standards in the manufacture of the joints and terminations for THE EMPLOYER.
k. Packaging details (including packaging materials, total number of joints/terminations per packaging).

11.6.3. Recommendations for Use, Care, Storage and Routine Inspection/Testing Procedures

The supplier shall submit recommendations for use, care, storage and routine inspection/testing procedures, all in the English Language, during delivery of the joints/terminations to THE EMPLOYER stores

11.7. Technical data for 11 kV XLPE cable accessories

The 11 kV XLPE cable accessories to be supplied shall comply with guaranteed technical particulars as indicated in Annex A2-9 (Outdoor and Indoor Cable terminations).

12. Fiber Optical underground cable

This section describes the functional requirements, technical parameters, type testing, packaging, transportation and installation requirements for underground fibre optic cables, to be installed in HDPE pipes.

12.1. Regulations and Standards

The latest revision/amendments of the following codes and standards shall be applicable for the equipment/material covered in this Specification. In case of any conflict, the vendor/manufacturer may propose equipment/material conforming to one group of industry codes and standards quoted hereunder without jeopardizing the requirements of this standard specification.

IEC 60793-1-1	Optical fibers – Part 1-1: Measurement methods and test procedures general and guidance
IEC 60794-1	Optical fiber cables: Generic specifications
IEC 60304	International standard color for insulation for low-frequency cables
TIA-598-D	Standard for optical fiber color coding
EIA 440A	Fiber optic terminology
EIA/TIA 455	Standard test procedure for fiber optic cables, transducers, sensors, connecting & terminating devices, and other fiber optic components
EIA 472	Sectional specification for fiber optic communication cables for underground and buried use
IEEE 1222	All-dielectric self-supporting fiber optic cable
IEEE 1428	Guide for installation methods for fiber optic cables in electric power generation stations and in industrial facilities
IEEE 1594	Helically applied fiber optic cable systems (wrap cable) for use on overhead utility lines
ITU-TG.652	Characteristics of single-mode fiber optic cables
ITU-TG.657	Characteristics of Bend insensitive Single-Mode Optical Fiber
ISO 175	Test Methods for Optical Fibres
ASTM D-566, ASTM D-790, ASTM D-1248, ASTM D-4565	Test Methods
IEC61300	Fibre Optic Interconnected Devices and Passive Components – Performance Standard

12.2. Service conditions

General Operating Conditions

The conditions under which the cables will be required to operate are:

- Installed in a separate single way duct comprised of HDPE conduit in concrete encasement
- at a nominal depth of around 1,500mm
- Cable ends rising up concrete, timber, or metal poles and exposed to direct sunlight;
- Ambient air temperature not exceeding 40°C summer day time and 15°C winter night time as determined by a shaded thermometer;
- Ambient soil temperature not exceeding 35°C;
- An altitude not exceeding 1,500m above sea level;
- A high humidity (90%) combined with a high temperature (40°C); followed by a sudden drop in temperature of up to 10°C;

- Soil thermal resistivity 1,5 K m/W
- An area in which the cables may be installed is home to subterranean termite, Mastotermes Darwiniesis and the coastal brown ant, Pheidole Megacephala.
- High Seismicity conditions

Operating Conditions – Exposed Cable
Exposed sections of cable will be subject to the following additional service conditions:

- Solar radiation intensity of 1,100W/m²;
- Tropical summer storms with high winds upto 288km/h and an annual rainfall in excess of 1,500mm;
- Areas of coastal salt spray and/or industrial pollution with equivalent salt deposits densities in the range of 2.0 - 3.0g/m².
- Maximum wind pressure 700 N/m2
- Level of pollution, very high

12.3. Design & construction requirement

The underground fiber optic cable shall be Non-Metallic/Unarmoured and shall be suitable for underground installation in duct pipes both for conventional and blow type installation.

The cable should be of low weight, small volume and high flexibility. The mechanical design and construction of each unit shall be inherently robust and rigid under all condition of operation, adjustment, replacement, storage and transport.

The (NFOC) Non-Metallic Fiber Optic Cable Duct type shall meet or exceed the requirements of this specification in all respect.

Manufacturer's drawings are required to show the outline of fiber optic cable, together with all pertinent dimensions. Tolerance of any variations in dimensions shall be according to relevant standards.

The fiber optic cable shall be strengthened, reinforced and sheathed to offer protection, rendering it suitable for installation in different environments.

The fiber used shall be in full compliance with ITU-T G.652D or ITU-T G.657 Recommendations. Main fiber requirements are summarized in the following table:

Parameter	**Requirement**
Material	Germanium doped silica glass or pure silica glass
Mode Field Diameter	8.6 to 9.5 µm (+ 10% of the nominal value)
Cladding Outside Diameter	125 µm ± 2.0 µm
Mode field eccentricity	≤ 1 µm at 1310 nm
Cladding Non-circularity	≤2%
Nominal coating diameter	In the range of 250 µm for pulling type & to 200 µm for blown type
Maximum continuous operating temperature without optical degradation	+ 70°C
Maximum optical loss variation in temperature range of -10°C to +70°C	±0.05db/km

There shall be no joints or splices in any optical fiber in any reel length of the complete optical cable. Optical fibers shall be free of material and manufacturing defects, which would prevent them from meeting the requirements of this specification.

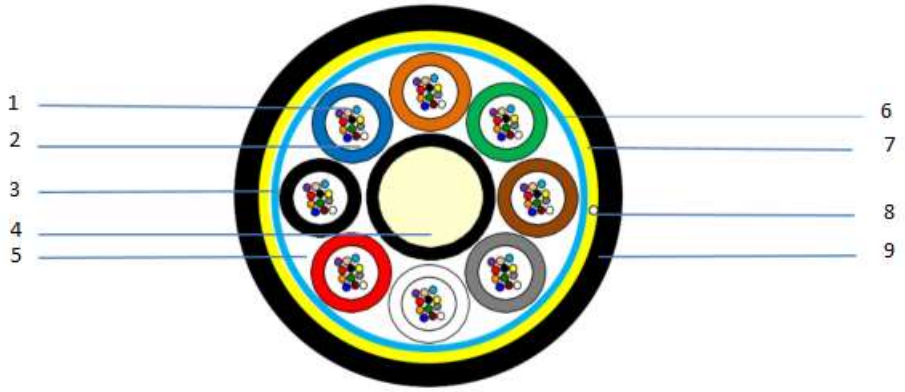
Each group of fiber may be enclosed in a loose buffer tube or may be taped in a helical fashion to provide protection against mechanical stresses and environmental effects.
The buffer shall be easily removable. Buffer shall not need a shrink back tubing once installed in a closure box if special tools are recommended by the manufacture; these shall be provided.

The optical cable shall consist of a central fibre optic unit protected by one or more layers of helically wound anti-hygroscopic tape or yarn. The central fiber optic unit shall be designed to house and protect the fibres from damage due to forces such as crushing, bending, twisting, tensile stress and moisture, wide temperature variations, hydrogen evolution etc. The fiber shall be of loose tube construction. The inner polyethylene jacket and outer sheath jackets shall be free from pinholes, joints, splits or any other defects.

All fibre optic cable shall have a minimum service life span of 25 years

The cable shall consist of Single Mode fibers conforming to ITU-T G.652D or to G.657 and the Technical parameters stipulated in this document. Documentary evidence in support of guaranteed life span of cable & fiber shall be submitted by manufacturer for approval

Manufacturer shall submit a detailed cable design & diagram. The detailed cable design & diagram shall contain the coding information used to identify the individual cable elements.



1: 250 Micron Colored fiber
2: Water Blocking Jell filling
3: Loose tube jelly filled
4: Central Strength Member
5: Water swellable yarn
6: binder
7: Peripheral Strength Member
8: Ripcord
9: Outer Jacket HDPE

Figure 10: Typical cross section for FO cable

Colour Coding & Fiber Identification

The colour coding system shall be discernible throughout the design life of the cable. Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogenous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing. Each

cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre.

Loose tubes shall be individually coloured for ease of identification. Individual fibers shall also be colour coded. The method used for colouring and tubing fibers shall be fully described. The tube colouring shall follow the same colour code.

Fillers shall be of natural colour to fill up the cable core. Individual optical fibers within a fiber unit, and fiber units shall be identifiable in accordance with international standard for fiber optic colour coding scheme TIA598-D and international standard color for insulation for low-frequency cables IEC 60304/IEC 304 or RAL 9023.

If more than the specified number of fibers are included in any cable, the spare fibers shall be tested by the cable manufacturer and any defective fiber shall be suitably bundled, tagged, and identified at the factory.

The colouring scheme shall be submitted along with the cable detailed design & drawing by manufacturer for approval.

Strength Members

The duct placement cables shall have a non-metallic central strength member covered by a suitable coating.

The cable shall be designed with sufficient strength members to meet installation and service conditions so that the fibers are not subject to excessive strain.

The central fiber optic unit should include a central strength member of Fiber Reinforced Plastic (FRP). FRP is good corrosion material, having good corrosion resistance to the atmosphere, water, and general concentration of acid, alkali, salt, and a variety of oils and solvents. Peripheral strength members and aramid yarns are also acceptable. The central FRP strength member may be of slotted type with SZ lay (reverse oscillation lay) of fibre units or it may be cylindrical type with helical lay of fiber units.

Filling compound

The interstices of the central fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any longitudinal water migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC607941-2-F5.

The filling compound used shall be a non-toxic Homogenous waterproofing compound that is free of dirt and foreign matter, anti-hygroscopic, electrically nonconductive and non-nutritive to fungus.

The compound shall also be fully compatible with all cable Components it may come in contact with and shall inhibit the generation of hydrogen within the cable.

The filling compound shall remain Stable for ambient temperature up to +70°C and shall not drip, flow or Leak with age or at change of temperature.

Reference method to measure drip point shall be as per IEC 60811-5-1 and drip point shall not be less than 70°C.

The Sheath / Inner jacket

The sheath shall be black, smooth, concentric, and shall be free from holes, splits, blisters and other surface flaws.

The sheath shall be extruded directly over the central fiber optic unit and shall also be non-hygroscopic.

The cable sheath design shall permit easy removal without damage to the optical fibers or fiber units.

The sheath shall be made from good quality of weather resistant polyethylene compound (Black High Density Polyethylene- HDPE) and thickness shall be > 1.8mm.

The cable core shall be covered with a seamless black sheath mask of U.V. stabilised weather resistant polyethylene incorporating a moisture barrier (swellable components).

The outer sheath excluding moisture barrier shall have a minimum thickness of 0.5 mm

The Outer Jacket/ Termite protection

A circular jacket of not less than 0.65mm Polymide-12 (Orange Nylone-12) material should be applied over the sheath as an outer jacket. The outer jacket shall have smooth finish and shall be termite resistant.

Rip cord

Suitable rip cord(s) shall be provided to open the outer sheath of the cable.
The rip cord(s) shall be properly waxed to prevent wicking action and shall not work as a water carrier.

Loose tube protection

The cables shall be of the loose tube type construction. The material used (e.g. PBT) and the tubing process shall be fully described.
Loose tube duct type cables shall have 12 or 8 fibers per tube for 48F.
The interstices of the cable core shall be filled with a water swellable compound and the core covered with a plastic wrap.
The loose tubes shall be filled with a thixotropic jelly in pulling type FOC.
Any material coating on the fibers which required to be removed for splicing purposes shall be readily removable without hazard to either the fiber or personnel

Secondary protection

The cables shall be of the tight or semi-tight construction.
The method of removal of the secondary protection shall be clearly described by manufacturer including the specific tools, if required.

12.4. Testing

The general conditions for Type, Factory Acceptance Testing & Site Acceptance Testing shall be in accordance with standards, and the complete type test report shall be submitted for review & approval. Employer shall witness the type tests as required.
All type tests shall be conducted on approved Labs

<u>Type Tests</u>

The manufacturer shall submit along with their detailed Design & Drawing Specification with the earlier carried out type test reports and/or Third Party Independent Testing laboratory certificates for the offered fiber optic cable meeting the specified technical requirement.
The manufacturer shall submit the previously carried out type test report for the same design of cable for the tests listed below. The fiber should have been type tested as per relevant International standards for the tests listed below.
All type tests prescribed in the relevant EIA/TIA or equivalent IEC standard shall be performed on the representative unit or on the first unit of every new design or rating to be supplied for approval.
In lieu of the actual type tests, certified test reports of type tests performed on an identical unit may be submitted for review and approval during the prequalification stage.
The type tests are as mentioned below:

- Cable cut-off wavelength tests:
  a) The cut-off wavelength of the cabled fiber shall be less than or equal to 1250nm and 1450nm for dispersion un-shifted single-mode fiber and non-zero dispersion-shifted single-mode fiber respectively.

b) Measurement shall be as specified in the relevant standard or in accordance with EIA/TIA-455-170.

- Fluid penetration test:
  a) Water ingress tests for cables designed for water blocking shall be performed for one meter cable sample for one hour in accordance with the requirements of EIA-455-82B or IEC 60794-1-FSB.
  b) No water shall leak through the open end of 1 m sample. If the first sample fails, one additional 1m sample, taken from a section of cable adjacent to the first sample may be tested for acceptance. Water leakage from second sample shall constitute failure.
- Compound flow (drip) test:
  a) A 0.3 m sample of NFOC shall be tested in accordance with EIA/TIA-455-81b.
  b) The sample shall be prepared per method A of EIA/TIA-455-81b. The filling and flooding compound shall not flow (drip or leak) at 65°C.
- Vibration test:
  a) Vibration test shall be carried out in accordance with EIA-455-11D.
  b) Any significant damage to any component of the composite NFOC, permanent or temporary increase in optical attenuation greater than 1.0dB/km at 1310 nm or 1550 nm for single –mode fibers shall constitute failure.
- Crush test and impact test:
  a) A crush and an impact tests shall be performed in accordance with EIA-45525C and EIA-455-41A or IEC 60794-1-E3 and IEC60794-1-E4.
  b) A permanent or temporary increase in optical attenuation value greater than 0.1dB change in sample at 1310 nm or 1550 nm for single mode fibers shall constitute failure.
- Rated strength test on completed NFOC:
  a) The breaking strength of the completed NFOC shall not be less than the specified rated breaking strength of the NFOC unless the failure occurs in the gripping device.
  b) If the failure occurs in the grip, the test value must not be less than 95% of the specified rated breaking strength.
- Tensile loading and bending test:
  a) Tensile loading and bending tests shall be performed on cable sample in accordance with ITU-T G62D, EIA/TIA-455-33B or IEC 60794-1-E1 and IEC 60794-1-E6.
  b) Any visual damage to the conductor strands or permanent or temporary increase in optical attenuation greater than 0.2 dB/km at 1310 nm or 1550nm for single mode fibers shall constitute failure.
- Micro-bending:
  Micro bending measurement shall be made in accordance with EIA/TIA-455 or equivalent IEC standards.

Cable Routine Tests

All routine tests prescribed in the relevant EIA/TIA or equivalent IEC standards shall be performed on all units prior to delivery for approval.
Tests for mechanical and physical properties of messenger support or strength member shall be made before assembly.
The routine tests consists of the optical acceptance test:

a) Attenuation test shall be performed on each fiber of each individual reel in accordance with EIA/TIA 455-61A or IEC 60793-I-CIC.
b) Measurement shall be made from both directions if accessible and the results shall be averaged. Attenuation loss values exceeding those specified shall constitute failure.

Fiber type tests

All type tests prescribed in the relevant EIA/TIA or equivalent ICE standards shall be performed on the representative unit or on the first unit of every new design or rating to be supplied for approval.
In lieu of the actual type tests, certified test reports of type tests performed on an identical unit shall be submitted.

All the required test reports shall be submitted for review and approval during the bidding stage.
The Type tests are as follows:

- Attenuation variation with wavelength:
  a) The measurement shall be made in accordance with EIA/TIA 455-78B or IEC 60793-1-CIA.
  b) The spectral width of the source shall be less than 10 nm.
  c) The attenuation coefficient of un-shifted single mode fibers for wavelength between 1285 nm and 1310nm shall not exceed the attenuation coefficient at 1330 by more than 0.1dB/km.
- Attenuation with bending:
  a) Attenuation with bending measurements shall be made in accordance with EIA/TIA 455-62A or IEC 60793-1-c11.
  b) The two attenuation with bending requirements are measured by winding 100 turns of fiber on a collapsible reel or removable mandrel of 75mm ± 2 mm diameter and by wrapping a single turn of fiber around a 32 ± 0.5 mm diameter mandrel.
  c) Attenuation shall not exceed 0.35 dB at 1310 nm.
  d) Attenuation shall not exceed 0.5 dB at 1550 nm
- Temperature cycling test:
  a) Temperature cycling measurement shall be made in accordance with EIA/TIA 455-3B or IEC 60793-1-D1, using test condition A, -10°C to + 70 °C, 2 cycles.
  b) The change in attenuation between extreme operational temperatures for single mode fibers shall not be greater than 0.05dB/km at 1310nm and 1550nm.
- Attenuation at the water peak:
  a) For un-shifted single mode fiber, the attenuation coefficient at the water peak found within 1383 nm shall not exceed 3 dB/km.
  b) The attenuation coefficient of un-shifted single mode fibers for wavelength between 1285 nm and 1310nm shall not exceed the attenuation coefficient at 1330 by more than 0.1dB/km.
- Mode field diameter:
  a) Mode field diameter shall be measured in accordance with EIA-455-174.
  b) The measurement wavelength as a minimum shall be 1310 + 20 nm for dispersion un-shifted single mode fibers.
  c) The nominal mode field diameter (MFD) for dispersion-un shifted single-mode fibers shall be 9-10µm ± 5% at 1300-1323nm.
- Concentricity error:
  a) Core-to-Clad concentricity error measurements shall be mad in accordance with EIA/TIA 455 or ICE 60793-1-A2.
  b) Concentricity error- the offset between the center of the core and the center of the cladding shall be < 1.0 micron.
- Cladding diameter:
  a) Cladding Diameter and non-circularity error measurements shall be in accordance with EIA/TIA 455 or IEC 60793-1-A2.
  b) Cladding diameter - the cladding outside diameter shall be 125.0 microns ± 2.0% microns. Cladding non circularity – the cladding non circularity shall be <2%.
- Fiber tensile proof test:
  a) Individual fibers shall be proof tested in accordance with EIA/TIA 455-31C, or
  IEC 60793-1-B1.
  b) All fibers shall be subjected to a minimum proof stress of 0.35 GN/m2 for one second equivalent by the fiber manufacturer (100% testing).
- Chromatic dispersion:
  a) Dispersion measurements shall be made in accordance with EIA/TIA 455168B or IEC 60793-1-C5C.
- Coating diameter:
  a) Coating diameter measurements shall be made in accordance with EIA/TIA455-55c, or IEC60793-1-A3 as a sample test for each contract.
  b) Coating diameter - the nominal coating diameter for loose buffer shall be 250 microns

Fiber routine tests

All routine (productions) tests prescribed in the relevant EIA/TIA or equivalent IEC standards shall be performed on all units prior to delivery.
The routine tests are as follows:

- Attenuation coefficient:
  a) Single mode fiber attenuation measurements shall be made in accordance with EIA/TIA 455-78B.
  b) Spectral attenuation shall be modelled according to ITU-T-G.652 if OTDRs are used, measurements shall be made from both directions and the results shall be averaged if accessible.
  c) The attenuation coefficient shall be 0.45 dB/km or less at 1300 nm and 0.25dB/km or less at 1550 nm wavelength.
  d) All the traces (hard copies) shall provide at least the following information other than the standard data provided by the OTDR.
    i. For the graphical representation of the trace, sufficient acquisition time shall be set OTDR for the straight line of the graph. Hazy lines due to insufficient acquisition time shall constitute failure.
    ii. All traces shall clearly identify fiber number, binder colour (group identifier) and fiber colour.
    iii. All traces shall be furnished with the fiber-ID and the drum/reel number and physical length of the cable ordered for cross reference.
- Fiber point defects:
  a) Attenuation uniformity shall be measured in accordance with EIA/TIA 455-59 or IEC 60793-1-C1C. Measurement shall be made bi-directionally, if accessible and there results shall be averaged.
  b) The attenuation of the fiber shall be distributed uniformly throughout its length such that there are no discontinuities in excess of 0.1 dB for single mode fiber.

Field acceptance testing

Upon receipt of the NFOC from the manufacturer, the purchaser shall at his option, perform acceptance tests in order to verify that the optical characteristics of the fiber meet the order requirements and to determine if optical fibers have been damaged during shipment.
The results of these tests and the manufacture's certified quality control information, which is attached to each reel, shall be compared to the fiber requirements specified in the purchase order.
The tests shall be performed and documented by the use of optical time domain reflectometer (OTDR). The end of the cable shall be sealed after completion of these tests in order to prevent entry of moisture into the optical fiber. Tests shall be performed from both ends and results shall be averaged.
The following tests shall be performed in accordance with EIA/TIA-455 or equivalent IEC standards:

- Fiber continuity: Continuity checks of each fiber may be made to determine if any fiber is broken or any attenuation irregularities exist.
- Attenuation: Total attenuation for the entire reel length and attenuation per kilometre should be measured on each fiber. Attenuation uniformity shall meet the requirements of section 5.6.4.4.
- Fiber length: The fiber length may be measured using the OTDR. The index factor to be used in this measurement should be furnished by the fiber manufacturer. A check should be made to verify received reel numbers and lengths correspond to ordered quantities.

12.5. Cable drum, Marking, Packing and Transport

All optical fibre cable shall be supplied on strong standard sized non-returnable wood provided with lagging with adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation.
The cable drum shall be suitable to carry underground fibre optic cable of length up to 2km ±10%. The Contractor may offer higher cable drum length in straight routes subject to transportation, handling and installation limitations. However, the exact lengths for drums to be supplied for each link shall be determined by the Contractor during detailed engineering/survey. Drum schedule shall be approved by the Employer before manufacturing the FO cable.

Both cable ends in the drum shall be sealed and shall be readily accessible. The drum shall be marked with arrows to indicate the direction of rotation. Both the ends of the cable shall be provided with pulling eye. The pulling eye and its coupling system should withstand the same tensile load as applicable to the cable. The following marking shall be done on each side of the cable drums:
i) Drum number
ii) Consignee's name and address
iii) Contractor's name and address
iv) Type of cable
v) Number of fibres
vi) Type of fibres
vii) Year of manufacturing, month & batch no
viii) Name of manufacturer
ix) Total cable length
x) Inner end marking and Outer end marking
xi) Gross weight
xii) Direction of rolling of reel

Packing list supplied with each drum shall have all the information provided on marking on the respective cable drum and following additional information: OTDR length measurement of each fibre and Ratio of fibre and cable length.
All markings shall appear on both sides of the reel. Reel marking locations shall be shown in Specified Figure. FO reel identification shall include any additional information & labelling as necessary.

Optical fibre cable marking
A suitable marking shall be applied in order to identify this cable from other cables. Marking on the cable shall be indelible, of durable quality, shall last long and shall be applied at regular interval of one-meter length. Marking shall be imprinted and must clearly contrast with the surface and colors used must withstand the environmental influences experienced in the field.
The accuracy of the sequential marking must be within + 0.5% of the actual measured length.

The sequential length marking must not rub off during normal installation. In case laser printing is used the marking shall not exceed 0.15 mm depth. The optical fibre cable shall have the following markings in every meter.

i) Type of Cable
ii) Running meter length
iii) Number of fibres
iv) Type of fibre
v) Laser symbol & caution notice
vi) Year of manufacture and batch no.
vii) Manufacturer's name
viii) Owner's Name " "

Operating Instructions
Complete technical literature in English with detailed cable construction diagram of various subcomponent with dimensions and test data of the cable shall be provided.
All aspects of installation shall also be covered in the handbook.

12.6. FO cable accessories

Splice Box for (OPGW/underground FO cable) and (underground FO cable/underground FO cable)

The fibre optic cable (OPGW) shall be joined with the underground FO cable coming from substations in splice boxes located on the pole body at the locations where the OPGW is dead ended. The fibre optic leads shall be brought down and up the poles on the inside of the tower legs supporting the splice box.

The splice box shall be of the corrosion resistant metallic material and watertight. The box shall be able to contain trays for the required number of fibres specified in the Technical Schedules. The splice box shall be equipped with locker and shall be designed for direct mounting to the pole suing non rotating slack bracket as shown in the figure below.

The splice box shall include the mounting hardware, optical fibre splice kits, OPGW and underground FO cable entries seals and all accessories for a permanent optical joint.

Splicing boxes for the terminal towers/poles of the substation shall be designed for connection of one OPGW and one optical fibre underground cable.

The OPGW and underground FO cable leads shall be attached to the tower/pole at 1.0 m interval by double groove aluminium alloy clamps specifically designed to accommodate the diameter of the composite fibre optical ground wire and underground FO cable.

The splice box shall be installed on the poles at a height of approximately 5 meters (min.) from the ground. The OPGW and underground FO cable leads shall be laid in a loop at the tower/pole side. The length of the OPGW and underground FO cable leads shall be such that the splicing can be made on the ground 10 meters from the tower/pole.

The splicing shall be made by fusion welding. The attenuation in any single splice shall be less than 0.20 dB at 1550 nm with an average value of maximum 0.15 dB and at 1310 nm less than 0.25 dB and 0.20 dB, respectively.

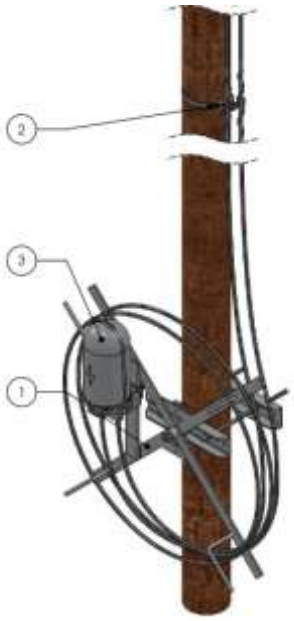


Figure 11: Non rotating Slack bracket for FO Splice box mounted on pole

The same consideration must be taken for FO Splice boxes used to connect two underground FO cable inside a L3T type manhole dedicated for FO joint.

The Contractor shall submit with the bid complete information regarding the splice boxes and the method and equipment to be used for mounting, splicing and testing.

12.7. Technical data for Underground FO cable and accessories

The underground FO cable and its relative accessories to be supplied shall comply with guaranteed technical particulars as indicated in Annex A2-11 (underground FO cable) and Annex A2-12 (Splice box for OPGW and underground FO cable).

13. Additional Equipment, Spare Parts and Tools

The quantities of the spare parts and tools shall be considered for the whole lot.

Supplier has to provide for the Employer the necessary tools to carry out repair and maintenance work at the equipment/devices supplied. The list of the tools has to be mutually agreed between the Contractor and the Employer. Beside the sets of cable accessories, it is necessary to also provide special tools for the equipment/devices supplied.

Further the following sets of equipment of the following two list shall be supplied the quantity is the total quantity for this Lot.

SPARE-PARTS FOR UGC 69kV

Item	Description	Quantity
1	69kV single core aluminium cable 240mm²	600 meters
2	69kV cable Joint kit (for single phase)	6
3	Outdoor composite cable termination with integrated surge arresters	3
4	Plug-In SF6 gas cable termination	1
5	Cross-bonding box with SVL	1
6	Earthing box	1

SPARE-PARTS FOR UGC 33kV

Item	Description	Quantity
1	33kV three core copper cable 240mm²	1200 meters
2	33kV cable Joint kit (for three phases)	4
3	Outdoor cold-shrinkable cable termination kit (for three phases) with integrated/or separate surge arresters	3
4	Indoor cold-shrinkable cable termination kit (for three phases)	3
5	Cross-bonding box with SVL	1
6	Earthing box	1

SPARE-PARTS FOR UGC 11kV

Item	Description	Quantity
1	11kV three core aluminium cable 185mm²	200 meters
2	Indoor cold-shrinkable cable termination kit (for three phases)	1

3	Outdoor cold-shrinkable cable termination kit (for three phases)	1

SPARE-PARTS FOR FO cable

Item	Description	Quantity
1	FO underground cable	2000 meters
2	Splice box (OPGW/Underground FO cable) mounted on pole	1
3	Splice box (Underground FO cable /Underground FO cable) mounted in underground manhole	1

14. Detailed Requirements for Civil Works

14.1. Introduction:

Following the devastation by Hurricane Maria, Dominica is resolved to not only re-build, but to become the first climate-resilient island nation.

In the Power Sector, government has developed a vision to make its electrical grid more resilient while reducing its own contribution to global emissions.

Key elements of that plan include undergrounding of main transmission lines throughout the country and distribution lines in urban centers, increasing the penetration of renewable energy with both centralized and distributed systems, and establishing mini grids for isolated communities capable of serving customers independently from the grid.

Given that the geothermal and the hydro plants will provide the bulk of the generation capacity (to Roseau at least), it will be crucial to have an interconnection that is resilient to weather and any other disruptive event.

The most resilient transmission lines routes have been identified as the ones avoiding as much as possible all the areas exposed to high level of wind, landslides and flood hazards.

It is noted that undergrounding is recommended for some parts of the distribution system of Roseau. For the rest of the transmission system, only overhead transmission lines are recommended.

Regarding the 2020 transmission system configuration, it has been calculated that the transmission system capacity will be exceeded (in contingency case) with the injection of the additional 7 MW (8,75 MVA) from the new geothermal power plant coming year.

Therefore, it is recommended to upgrade the transmission system straightforward to 33 kV and avoid its operation on 11 kV since it may rise safety and reliability issues.

14.2. General Technical specifications of Materials

Concrete:

a) Concrete Characteristics:

The Contractor must choose the concrete composition for which he is responsible.

The Contractor should submit the concrete formulation and the results of his studies to the Project Owner for approval.

It is not authorized to pour concrete before the complete validation of the concrete composition studies and the test results.

The concrete formulation must present the best workability according to the climatic conditions and the structure type to be carried out.

Three types of concrete can be distinguished:

- **Lean concrete** that will not be subjected to resistance testing.
- **Concrete for all underground structures** like foundations, blocks, footings, slabs, gutters, manholes, etc.
- **Concrete for upper-ground structures.**

The concrete resistance will be at least **C25 Mpa**.

The Contractor is responsible for choosing the relative exposure class, and he must take into account the results of his geotechnical studies, in particular the aggressiveness of the soil, the possible presence of corrosive agents, and the presence of water table.

b) Concrete Component:

i) Aggregate:

a. Characteristics:

The contractor must choose the relative granulometric classes, in order to obtain a concrete granulometry that respect perfectly the art rules.
The used of river sand is authorized if it respects the chloride classes and required resistance, otherwise, the contractor should use crushed sand.
The sand equivalent test will be at least equal to 80% for the reinforced concrete structures, and 65% for the foundations.
The different categories of aggregates, mainly sands, will be stored separately protected from atmospheric precipitation and infiltration.
In addition, the water content should be controlled permanently.
Provisions must be made so that during concreting operations, which can last 24 hours, the water content in the sands, must not vary by more than 0.5%, with respect to the sand's weight.
The stocked quantities must be sufficient for at least 10 days of concreting production.
The sands must be stored in an area protected by a roof, on a concrete slab sufficiently inclined to facilitate the drainage.

b. Protection against alkali reaction:

Preferably, the used aggregates must be classified as non-reactive.
If it was necessary, aggregates classified as potentially alkaline reactive could be used.
In this case, the Contractor must provide the alkaline percentages in each component of the concrete to the Project Owner.
All measurements of the alkaline content for these various components should be carried out by a specialized laboratory and must take into account the variability of these percentages.

ii) Cement:

The contractor shall submit for the Project Owner's approval, the proposed hydraulic binder datasheets.

The contractor should provide the Project Owner with the results of the tests carried out by the cement manufacturer.

The Customer has the right to carry out other tests in an independent laboratory.

If these tests' results were in accordance with the specifications, they will be the responsibility of the project owner, and if not, they will be the responsibility of the Contractor.

The contractor should provide samples and laboratory tests to the project owner.

The contractor must carry out a statistical control of the weight of the cement bags, at the request of the Client.

iii) Water:

The Project owner reserves the right to periodically check the quality of the used water.

The water must be clean and free of all substances that can affect the concrete quality.

iv) Additives:

The concrete of the superstructures as well as the concrete of the foundations allows the use of an additive (plasticizer), which will be added to the concrete mix to make high-concrete strength.

The Contractor must include the cost of using these admixtures in the concrete prices.

If any used additive was not included in the concrete formulation studies, it will be a subject of a written request from the Contractor and authorization from the project owner.

The use of chlorides, particularly as accelerators, is prohibited.

c) Concrete batching tolerance

The concrete compositional weight tolerances are defined as follow:

- +/- 5% for each category of aggregates,
- +/- 1% for water
- +/- 1% for cement

N.B.: Random samples may be taken at the request of the Client.

d) Concrete's Controls:

If a ready-mixed concrete plant is used, the Contractor shall make available to the Client all the relative concrete delivery notes.

For the foundations and superstructure's concrete, the required tests per batch are as follows:

- Consistency test
- Compressive strength: (3 samples for the 7-day tests, 3 samples for compression tests at 28 days)
- A test to determine the density,

The considered resistance will be the arithmetic mean of the obtained results.

The contractor takes per casting day:

- 3 samples for the 7-day tests and 3 samples for the 28-day tests for any poured volume less than 50m3
- 3 specimens for the 7-day tests and 3 specimens for the 28-day tests for each additional 50m3 poured on the same day

Steel Reinforcement:

e) General requirement:

The Contractor should submit for project owner approval the dimensional, mechanical, and compositional characteristics of the proposed steel reinforcements.

Used reinforcements must systematically have a provenance sheet and a relative certification.

The reinforcements shaping is authorized only in the Contractor's workrooms located in his site installation.

Rebar welding is prohibited.

f) Delivery and storage conditions:

The bars must not show any deformation, staining, or other defects.

Accidentally deformed bars will be treated.

The contractor stores the reinforcements as follows:

- In the site installation area
- With a systematic cleaning of storage areas
- The reinforcements should not be in contact with the ground and moisture

If the steels are delivered assembled in cages, these must be transported with care to the places of use so that no element undergoes permanent deformation.

Formwork and scaffolding:

The Contractor shall submit for Project Owner approval:

- Formwork wood,
- Scaffolding
- accessories

As shown in the figure below, for a passage by a simple cable trench, an ordinary formwork can be used.

It is a kind of formwork made up of beams and raw wooden planks, held together by a bolting system.

Figure 12: Ordinary system formwork (Type 1)

The shoring of the concrete structure must be carried out with rigid elements in order to eliminate all kinds of deformation risks during concrete pouring operations.

The use of a fixation system with twisted or parallel wires passing through the concrete is prohibited.

Pipes:

g) HDPE PIPES:

i) Characteristics

The contractor shall submit the proposed HDPE pipes to the Project Owner for approval.

The contractor is responsible for selecting the conduits that fit the most with the various civil works of our project.

The pipes shall be designed, constructed and installed in accordance with the instruction of the manufacturer.

ii) Connection between pipes:

Three major Welding methods can be adopted to link the pipe's segment, estimated by 6 m of length.

These methods can be summarized by the following:

- Electrofusion fittings
- Play and Plug fittings
- Welding by special machines

The connections between HDPE pipes coming from two different reels will be made in such a way as to avoid any sharp internal edges presenting risks of damage to the outer surface of the cable either during pulling or during the structure shelf life.

In addition, a perfect seal should be used between pipes to ensure a good connection that prevents the penetration of all kinds of fluid.

In addition, it is recommended to clean these pipes, especially after welding operations.

N.B.: If the contractor will use another type of pipe, it would be subject to the approval of the Project owner.

Templates/Spacers:

They make it possible to ensure the precis pipes positioning and the respect for the center distances between them.

They must maintain the assembly during concreting.

They can also be referred to as “templates”, or “spacers”.

They can be made of stiffened polystyrene, PVC, concrete, or any other material making it possible to satisfy the above conditions.

Stiffened polystyrene or PVC spacers, like those shown below or equivalent, are more recommended than concrete ones.

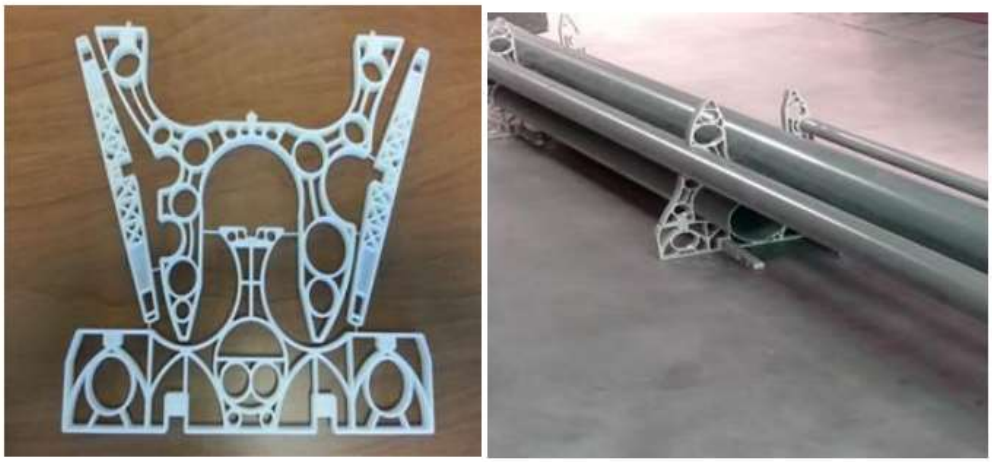


Figure 13: templates or pipes spacers

Warning grid:

The warning grids used in the context of the project must respect the values indicated in the approved technical datasheet.

The warning grids are placed 0.20m above the concrete block of the structure.

The following colors will be used depending on the type of work: Red (Electricity) and Green (Telecommunication Video).

Backfilling:

The Contractor is required to prove in an approved laboratory that the backfill materials comply with the requirements set out in this chapter.

The contractor must be responsible for all the carried-out tests.

The Backfill should not contain any sources of invasive alien plant species.

If a non-compliance take place, the Project Owner have the right to require any other additional tests, at the Contractor's expense that he deems necessary.

The bottom of all excavated areas shall be trimmed, levelled and well rammed to achieve at least 98%

Compaction.

The bottom level of excavations shall be inspected and approved by the Engineer before the commencement of pouring operations.

h) Special case of the roads base backfilling layers:

The road base must not be the same of another trench backfill.

Its implementation requires special quality material, and it must meet the road managers requirements.

i) Backfill Characteristics:

The used materials must:

- Enable effective compaction, The required compaction is (98% OPM)
- Be free of elements likely to damage structures and cables.
- Ensure the structure functionality
- Ensure the required bearing capacity for the various relative layers.

j) Backfill quality:

Backfill materials can be extracted from excavations.

Materials that do not satisfy the previous clauses cannot under any circumstances be reused as backfill.

k) Imported Backfill

The maximum value D must meet the following conditions:

- Dmax < 1/10 of the trench width,
- Dmax < 1/5 of the compacted layer thickness

14.3. General Technical specifications of Civil structures

Junction boxes:

Junction boxes are reinforced concrete structures, cast in situ or prefabricated, allowing the installation of power junctions between two sections of a link.

Their location results from the design studies.

The contractor is responsible to specify the dimensions of this box relative to his made studies. It is of **9m*2.5 m** minimum.

The design of the junction chambers must guarantee the capacity of supporting any electrical fault that may occur on the cables inside.

The junction boxes must be buried at **1.5 m minimum of depth**.

Immediately near the junction box, the following may be installed:

- visitable cross bonding pit
- Visitable earth pit
- Telecommunication junction box

Junction box dimensions:

The foundation, the walls, and the cover slab of the junction box will be made of reinforced concrete (double layer of reinforcement minimum T12, with a maximum spacing of 15 cm between rebars).

The reinforced concrete slab will be inclined with a slope between 0.5 and 1%

The cover slab must be sized for supporting any probable electrical fault from inside.

Telecommunication boxes:

The telecommunication junction boxes are located close to the power junction box to allow the connection of the telecommunication cable sections between them.

The number of telecommunication junction boxes is not necessarily equal to the number of power junction boxes: the lengths of the telecommunication cables can be two to three times greater than those of the power cables.

They must have a secure closing system that cannot be modified or degraded by the public.

The minimum excavation bottom depth depends on the type of box and is not imposed.

Earth pit:

a) ***Functionality***

The earth pits boxes are located close to the power junction boxes.

They constitute boxes in which the intermediate earthing equipment is installed.

The earth pits must have a secure closure system that cannot be modified or degraded by the public.

The Contractor must provide the tests carried out on the boxes for approval to the client.

b) ***Components****:*

Earth pits consist of a reinforced concrete structure, which can be either prefabricated or cast on site.

The pits must have:

- Closing with a horizontal locking device.
- A security plate and a terminal nameplate will be placed on the cover of the earthing box.

Cross bonding pit:

The cross-bonding pits are deployed close to the power junction boxes.

They constitute rooms in which are installed the necessary equipment for the screen's permutation.

The Contractor must provide the tests carried out on the boxes for approval to the client.

The pits must have a secure closure system that cannot be modified or degraded by the public.

A safety and a terminal identification plate are to be provided in the cross-bonding pit.

The pits will have minimum internal dimensions of 1x1.80 meters.

14.4. General Technical specifications of Civil work

General:

The underground cables design and construction conditions must guarantee:

- The Personnel safety during the execution phase,
- The required power transit so that the structure satisfies the need for which it was built,
- The environment respect,
- The security of third parties encountered networks

Project studies:

The project study begins with a preliminary study file that will be given by the Project Owner.

The contractor carries out the detailed design studies for which he is responsible.

The detailed studies allow in particular:

- To specify the installation methods and the resulting encountered constraints on the construction site
- To identify all the "singular points" of the relative construction work

N.B.: During all the project phases, the safety, environmental and social aspects, will be well taken into account.

Site preparation:

The site preparation requires:

- To establish the provisional planning and to organization the site with respect to the quality assurance, safety, and environmental requirements.
- The implementation of procedures that take into account environmental, technical, and safety constraints,
- To carry out administrative procedures with the various concessionaires and services, in order to guarantee the safety of third parties and personnel involved in the working process.

Georeferencing process:

After the topographical surveys that will be carried out by the contractor, all the plans will be georeferenced.

The requested Projected Coordinate System for this project is: **Universal Transverse Mercator Grid system (UTM Zone 20)**

Soil Investigations

The Contractor carries out the necessary studies for the dimensioning of all the civil engineering works for which he is responsible.

The Project Owner provides the results of the pre-soil studies in the appendix of this document. These studies are given for information only.

It is the responsibility of the Contractor to carry out the soil studies necessary for the dimensioning of the structures he designs:

- Surveys, samples, on-site and laboratory tests
- Mechanical characteristics and composition of soils, …
- Soil temperatures
- Thermal resistivity of soils
- Detailed report

For the Topographical study, the Project Owner provides the layouts of the planned works approved by the local authorities and taken from topographical surveys (given in the appendix of this document for information only).

It is the responsibility of the Contractor to carry out the topographical studies necessary for the dimensioning of the structures he designs and installs.

Topographic studies include:

- The research of the various network concessionaires and the requests for information and representation of their works,
- Field surveys, obstacles, networks, of any kind, encountered on the routes,
- Surveys and detection of buried networks by appropriate means (Georadar, (Lidar Technology is preferred)),
- The production of engineering and execution plans (plan views, longitudinal profiles, assembly plans, sections, etc.)

The coordinates (X, Y, Z) of the various elements recorded are given in **Universal Transverse Mercator Grid system (UTM Zone 20)**

In addition to the geotechnical studies that define the encountered soil all along the route, the Contractor will perform electrical and thermal resistivity measurements as well as soil temperature measurements.

In addition, he is responsible to make a hydrological study (runoff, drainage, stormwater treatment, outlets), and hydrogeological study (impacts related to aquifers, infiltration of discharges, etc.), for each site.

Removal / Demolition of top surfaces:

The demolition of road surfaces and the stripping of topsoil constitute the first earthworks operations.

The choice of materials and methods must guarantee the non-deterioration of the parts located outside the trench limit.

Working near roads infrastructures:

The longitudinal trench must not be located at the immediate limit of constructions (including curbs and gutters), so as not to destabilize them.

A minimum distance of 2.5 m must be respected between the axis of the trench and these constructions.

Working near Plantations:

The minimum distance between power cables and trees is equal to 2.00 m from the axis of the trunk for installation without special protection.

When the distance of 2.00 m cannot be respected, the cables can be installed at a minimum distance of 1.50 m from the trees by taking special measures to avoid the deterioration of the networks by the roots of the tree.

It is forbidden to cut roots with a diameter greater than 0.05 m. However, in case accidental cutting has taken place, the owner of the tree must be notified.

Prior to the work, each trunk should be protected over its entire height by the installation of joint boards separated from the trunk and not attached to it.

All the necessary measures must be implemented so that no machine or material damages the branches of the tree.

Buried network detection work

The Contractor proceeds, at his own expense, to the detection of all buried networks along the planned route, before the start of any excavation or earthwork.

In parallel with the buried network detection, the contractor carries out to collects all the existing documentation relating to these networks (maps, plans, surveys, GIS files, etc.).

The Contractor must, at his own expense, locate the surface of the various surveyed or mapped buried networks.

Working near existing networks

The Contractor must comply with the construction code of the project zone and inform the various concessionaires and third-party network managers of the start of its work.

The Contractor complies with the recommendations that the concessionaires may give him in terms of safety.

The Contractor will be responsible for any accrued damage during the performance of his work, except in the case of a non-detectable network, or if this network was not identified before by the contractor.

In the event of accidental damage or if the opening of an excavation reveals gas fumes or leaks on the water pipes, the Contractor shall immediately notify the concessionaire in charge of operating the damaged structures.

It is strictly prohibited that the contractor intervenes alone on an existing network without the agreement of the relative concessionaire.

The neighborhood and crossing conditions of the underground designed connections with the existing networks must comply with the following requirements:

- Minimum distance for crossing **water or gas pipe: 0.5 m minimum**
- Minimum distance for crossing **electrical or Telecom lines: 0.20 m minimum**

Earthworks and Excavation process:

General:

The work includes any surface cleaning, stripping, excavation, reinforcement, evacuation of invasive exotic plants source, transportation of excavated soil, regardless of the depth or encountered material quality, cleaning and drying of excavations for later concreting or backfilling operations.

Before any earthworks, a soil analysis, at well-defined depths will be carried out in order to know whether it is respectively contaminated, potentially contaminated, or even uncontaminated soil.

These test results contribute to the marking of the various areas to be excavated.

The Contractor is responsible for carrying out the excavation work by crossing the various layers encountered, whatever was the type of materials, (rock, concrete, or others), with the appropriate equipment and machinery.

During the excavation, the Contractor must continuously visually inspect the excavated or displaced soil.

If visual or olfactory signs of impact or significant PID measurements (>20 ppm) are identified and confirmed, the impacted soils must be considered as being contaminated and must be managed in the same way as the known contaminated soils, until their characterization is carried out to verify their real quality.

If materials likely to contain asbestos have been identified, the site must be stopped and secured, and the Project Owner or his representative must be notified without delay.

In such a case, the Contractor will work with the project owner to prepare a specific action plan.

The contractor will be responsible for all the produced disturbances that concern the water flows.

He will also ensure, under his responsibility, the evacuation of water from all sources from the sites to the existing outlets, after verifying that they can be received in a safe way.

In addition, the contractor will be responsible for the maintenance of pumping equipment (including spare equipment), and the supply of energy and fuel.

During the working process, secure access will be provided for cars, pedestrians, and site workers.

Access to neighboring properties must be always maintained.

The circulation zones must be clearly marked and identified

At the end of the work, the excavated volume will be characterized (photographs and drawing with measurements), and samples will be taken along the surfaces (edge and bottom of the excavation). These samples will be analysed with rapid diagnostic tests, at the rate of a minimum sample for an area of approximately 100 m2.

The Contractor is responsible for providing all the necessary resources for the realization of excavations and earthworks.

As part of its Quality Assurance Plan, these resources to be used must be subjected to the approval of the Project Owner.

Execution phases of the earthworks:

c) Recognition phase of the work area:

A preparatory phase must be carried out at least 24 hours before any start of work, and it includes respectively:

- Training of the team.
- Obtaining the work permit issued by the Engineer for all excavation work
- Installation of the water pumping system, (main and stand by)
- Checking the tools to be used
- Marking and limiting the work area

d) Depths and width of the trenches

The laying depth and width of the trenches should satisfy the project owner's needs to ensure the durability of the underground line.

The theoretical profiles of the corresponding excavations to be carried out will be defined by the execution plans that the Contractor must produce under his responsibility.

Any executed excavation by the Contractor without order or authorization will not be taken into account for payment.

At least a surface of 0.40 m should be provided along the excavation to ensure the safe circulation of personnel and to prevent the falling of materials into the trench.

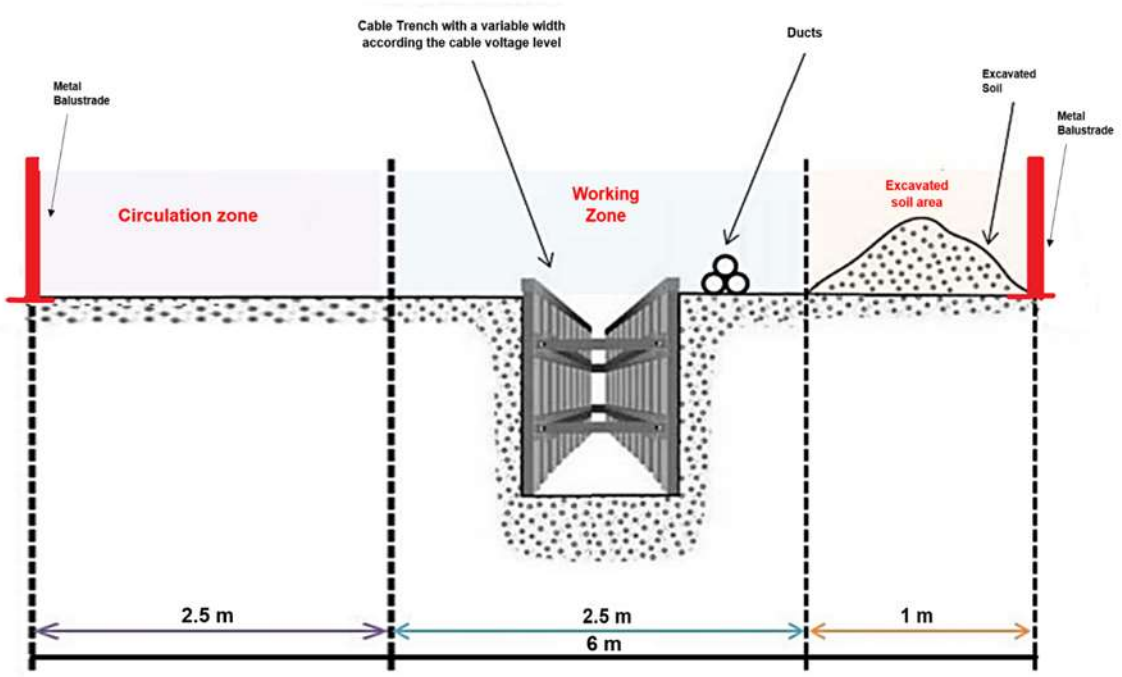


Figure 14: Basic layout diagram – Trenches

e) Vegetation removal:

The contractor must uproot the existing plants in the working zone, and carry out the clearing and deforestation operations.

The plant uprooting will take place after obtaining a Service Order from the Project owner.

f) Land stripping:

Topsoil will be stripped all over the working zone, which will be subjected to the approval of the Project Owner.

Stripping will be carried out over **0.30 m on average**.

It will be temporarily stored for later use if it shows no signs of contamination, and the rest will be evacuated from the site according to regulations.

The Contractor will set up the storage areas in such a way that they do not interfere with the progress of the site.

The work will be carried out in such a way that the machine follows the thickness of the topsoil in place and does not mix it with the underlying soil.

Plant debris will be placed in temporary storage as the work progress, then evacuated to another approved area.

In addition, rubble, large stones, and rubbish encountered during these operations will be evacuated.

The Contractor shall take all necessary precautions not to alter the qualities of the topsoil, it should not be stored for more than three meters of thickness.

g) Protection of Excavation:

The Contractor is responsible for all damages and degradations, caused by the settling of the ground, at the level of neighboring buildings, on the roads, or on the ground, during or after the work process.

The protections of excavations should be adapted to the behaviour of the soil under the climate action, the water table level, the applied soil, etc.

Excavations carried out near other structures must be shielded.

When a trench with vertical walls is deeper than 1.30 m and its width is equal to or less than 2/3 of its depth, it must be shielded regardless of the nature of the ground.

The dimensioning and the choice of the shielding material are defined by taking into account: the nature of the ground (cohesion, angle of friction, sensitivity to water); the presence of a water table; overloads likely to exist at the trenches' edge (circulations, material storage areas, existing constructions); etc.

During the works, if it appears that the stability of the neighboring structures, the shielding and/or shoring system, or even excavation edges, is not ensured, the contractor must submit a detailed report of the necessary measures to the prior agreement of the project owner.

h) Provisions relating to third-party structures/networks:

The existing structures/networks encountered during excavations should be left in their original state and no modification to be made without a written agreement of the owner, or the specified concessionaires.

i) Road's interventions:

The top surface must be removed, according the defined trench width on the execution plans.

The Contractor makes a clean cut by sawing or slicing.

These operations must be limited only to the trench's width, and no accepted deterioration at the outside of this zone.

The use of jackhammers is prohibited.

Paving stones, bricks, tiles, and separate elements, must be carefully removed and cleaned, before being reused when resurfacing.

j) Lowering the water level (if it exists):

If a dewatering process looks necessary, the resulting cost must be included in the price schedule.

The Contractor should ensure that the excavations are kept always dry by pumping.

He should keep a stand-by pump on-site for emergency case.

The Contractor is responsible for the pumps' maintenance on his site.

k) Storage of excavated soil:

The excavated soil will be placed on the trenches' edge without blocking either the circulation or the personnel access.

They will be placed in carefully arranged heaps, without impeding either the traffic or the water flow.

The contractor should always maintain secure access to the neighboring properties.

l) Backfilling:

i) General:

The Contractor shall backfill the excavations as soon as possible.

The Contractor should provide a maximum total duration of 1 week per section.

For each interconnection, the Contractor shall submit for approval a detailed schedule, by section of 1 week, as indicated above.

m) Reuse of extracted materials:

The Contractor determines the extracted materials likely to be reused for backfilling and submits his proposal to the Project Owner for approval.

If it was possible, and with respect to the roads and/or landowner's requirements, it will be a good idea to recycle the extracted materials with a view to their reuse.

Unsuitable materials must be evacuated directly from the site.

n) Surface Repairs:

After the work completion, the affected road surfaces and/or sidewalks, with the relative road signs, must be repaired by the contractor.

Directional drilling passage:

Horizontal directional drilling commonly referred to as HDD is typically used to install pipelines in areas not amenable for open-cut construction including major water bodies, wide or busy highways, railroads, environmentally sensitive areas, and urban environments.

During construction, no disruption will occur to any feature being crossed by the HDD installation.

A limited workplace should be established on both sides of the crossing to house the necessary drilling equipment and to facilitate product pipe string fabrication.

Some Execution requirements:

The directional bore shall not begin until the Engineer or his authorized representative is present on site and agrees that proper preparations and precautions for the operation have been made.

The Engineer’s approval for beginning the installation shall in no way relieve the Contractor of the ultimate responsibility for the satisfactory completion to the work as authorized under the Contract.

Prior to any alterations to the work-site, the Contractor shall photograph or video record the entire work area, including entry and exit points.

Drilling fluid (mud) system:

Drilling fluid will be composed of bentonite clay, potable water and appropriate additives.

Water shall be from a clean source with a pH as per mixing requirements of the manufacturer.

No hazardous additives may be used.

Drilling fluid shall be maintained at a sufficient viscosity to maintain the integrity of the bore wall.

This grout must make it possible to guarantee a thermal resistivity of 1 K.m / W.

At the end this fluid can be recycled and reused.

HDPE ducts bundle composition:

The preparation of the joined HDPE ducts bundle is carried out under guaranteed conditions:

- The non-deterioration of the ducts,
- The internal cleanliness of the ducts,
- Maintaining the respective position of the ducts.
- The head-up trefoil position must be ensured by a suitable device.

It is recommended to strap the HDPE ducts every two meters.

The internal diameter of the power cable ducts should be greater than 1.5 times the external diameter of the cable.

The Contractor must determine the minimum distance guaranteeing compliance with the minimum requested power transit (Amps).

Site restoration:

Following drilling operations and pipeline installation, the Contractor must de-mobilize equipment and restore the worksite to its original condition.

Cable trenches passage:

Under roadways:

At first, the traffic should be stopped, and appropriate signs will be used, one lane at least will always remain functional.

In addition, appropriate road signs should be used when the narrowing of the roadway seems necessary, and a detailed circulation plan must be provided by the contractor before any commencement of work.

The excavated soil will be immediately transported from the site to another approved area, with the exception of recovered pavement materials (stones, cobblestones, curbs).

The final repair of the road must be totally conformed to the relative initial state.

Under sidewalks, natural ground, etc.

The cable trenches under the sidewalk will be backfilled in accordance with the below specifications

First, the top surface will be demolished with special care and clean edge trimming.

Excess or poor-quality excavated soil will be removed from the site by the Contractor to another approved area dedicated to receiving such waste.

The placement of the excavated soil should never block the personnel's access to the excavations.

If a top surface of paving takes place, the Contractor is required to dismantle these materials for reuse. He should clean these materials before putting them back in place.

The installation of these materials will be carried out the same as the initial layout, regardless of the complexity.

If the excavation cannot be backfilled before the night, the Contractor should plan to secure the work area with appropriate barriers, fence and nocturnal signalling (reflective panels, traffic lights).

Concreting works:

The concrete encased underground ducts will be laid either directly at the bottom of the excavation, or on a lean concrete surface when the ground conditions require it.

The concrete should be:

- Installed in successive layers with a maximum thickness of 0.40 m, and a maximum permissible drop height of 1.20 m,
- Protected from dirt on the ground or backfill,
- Carefully vibrated to obtain compact concrete without segregation
- Poured without interruption, avoiding the creation of air pockets that affect thermal conductivity.

After a long stoppage of pouring operations, the surface of the concrete must be clean, before the resumption of concreting, in order to ensure it bonds properly.

During underwater concreting, the concrete composition must guarantee the required mechanical characteristics. The use of suitable devices or operating methods must avoid washout and segregation of the concrete.

The use of dry-mixed concrete is prohibited.

Site Installation:

The Site Installation Plan of underground passages designates the location of the various necessary equipment and elements to install on-site during the execution phase.

It determines respectively the location of the following:

- Construction machinerie (cranes, nacelles, bulldozers, etc.)
- storage areas for materials;
- offices,
- dressing room,
- dining room
- Rest areas for the workers.
- Toilets
- etc.

Hence this document aims to globally define the minimum requirements relating to these areas on the various links sites, which can be defined as follow:

a) Staff accommodation

The characteristics of the Site installation depend on the following criteria:

- If the site personnel will be housed on-site or in the immediate vicinity of the project.
- The sizing of accommodation and dormitories, by taking into account the comfort of the contractor's employees or subcontractors.
- The size of the site installation depending on the staff number expected on site.
- If necessary, the number of staff per accommodation will be proposed by the contractor taking into account the following factors:
  - ✓ Social, environmental, and gender aspects. (In addition to the overall number of people, the number of male and female staff should be taken into account)
  - ✓ Limit the number of staff sharing accommodations, in compliance with health rules (in particular COVID-19) and gender
  - ✓ Provide an adequate air conditioning system

b) Kitchens:

The contractor must install, at each Site Installation:

- A refectory with an area of 1.3m² minimum
- A cafeteria with a rest area

c) Sanitary facilities

The contractor provides the following for the installation of sanitary facilities:

- Sinks:
  - ✓ 1 sink for 10 workers
  - ✓ With adjustable temperature
  - ✓ Appropriate ways of drying or wiping, etc. (maintained whenever necessary)
- Showers:

- ✓ Mandatory
- ✓ The showers (at least one for eight people)

- Separate facilities if mixed staff

d) Dressing rooms:

The Contractor shall install equipped dressing Rooms in accordance with the following requirements:

- dressing rooms with sinks installed near the passage of workers
- Mandatory lighting
- Mandatory air conditioning
- Floor and walls (easily cleanable)
- Sufficient ventilation
- Maintains a constant state of cleanliness
- Separate facilities if mixed staff
- If dressing rooms and washbasins were in separate rooms, a communication passage between them will take place without going outside or through storage areas
- The surface of the dressing rooms will be at least 1m²
- A sufficient number of seats must be considered on site
- Individual cupboard

e) Lavatory, urinals

The contractor provides the following for the installation of sanitary facilities:

- 1 cabinet and 1 urinal for 20 men
- 2 cabinets for 20 women
- Lavatories for female staff
- General provisions;
- toilet Flush
- Lighting
- Waterproof and easily cleanable floors and walls
- Solid doors
- Evacuation of effluents in accordance with health regulations
- Toilet paper
- Separate facilities in case of mixed staff

The Holder is responsible to provide all these facilities and the toilets and urinals must be cleaned and disinfected at least once a day.

f) Care infirmary

The contractor must provide on each site a specific security plan that includes the following elements:

- Rescue and evacuation arrangements that include:
  - ✓ First aid instructions for accident victims and the sick;
  - ✓ The number of site workers trained to provide first aid in an emergency;
  - ✓ Existing medical equipment on site;
  - ✓ Quick steps to take, to a hospital any accident victim who appears to have serious injuries.
- Measures ensuring the hygiene of the working conditions and that of the premises intended for the workers.

i) First aid kit

Provide a first aid kit in case of an accident at each site.

g) Guard room:

A Guard room must be provided at the level of the main entrance with dimensions of 1.50 x 1.50 m²

h) Water supply

The contractor will install at his own expense a municipal water meter to ensure the water supply to the site installation.

i) Assembly point:

It is essential to provide a secure waiting area, known as the "assembly area" so that personnel can gather safely in the event of an emergency.

It is also necessary to indicate the assembly point with indicative signs specifying its position.

All personnel must be made aware by the site QHSE manager of the existence of these assembly points.

j) Emergency alarm:

The Contractor must equip the various site installations with a visual and audible alarm system in case of an emergency.

k) Project identification backboard:

The contractor must install Site Signage backboards at each entrance to the Site installation.

These backboards must include information relating to the project, the project stakeholders, and the nature of the works under construction.

l) Circulation plan:

The contractor must submit for approval a circulation plan inside the site installation:

- The direction of the traffic of the trucks

- Places of loading and unloading

- The areas where any maneuvers are authorized

The authorized circulation of personnel must be well defined in the circulation plan.

m) Parking zone:

The contractor provides safe and secure parking for cars.

n) Safety equipment on site

The contractor must ensure the presence of the following equipment on site:

- Adapted fire extinguishers to the type of fires that may break out
- fire detection systems on all premises

o) Trashes storage area:

An area must be reserved for the storage of trash generated throughout the execution phase.

Dangerous trashes must be stored in a well-protected metal cage with a lock.

This area must be as far as possible from the guard room.

p) Storage area, and warehouse:

The contractor provides an area suitable for storing his equipment (Ducts, formwork, cables, reels, prefabricated junction boxes, warning grids, etc.)

In addition, the contractor provides containers for the storage of small equipment and tools to be protected from external aggressions (tools, compactors, small engines, etc.)

In addition, the contractor provides on-site dedicated spaces for work such as welding, cutting of certain materials, etc.

q) Drilling Mud Treatment Area

A drilling mud treatment area must be provided by the contractor in his site installation or on a nearby area where he has obtained authorization.

The details of this area can be as follow:

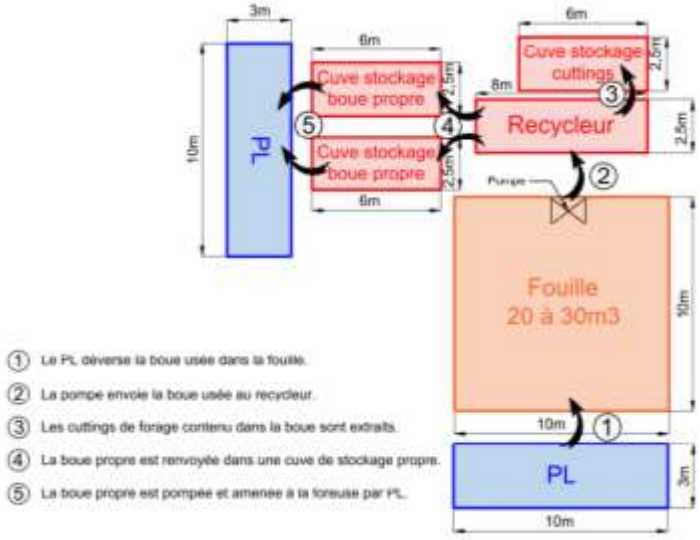


Figure 15: Details of the drilling mud treatment area

r) Power Supply and Lighting

For the entire duration of the works, the Contractor will pay for the electricity and lighting supply of its site facilities.

If generators were used on site, they must comply with the maximum tolerated noise level of 65 dB (A).

The contractor provides a 50kVA electrical cabinet to supply the storage area, premises, offices, etc.

s) Communication:

The Contractor will provide an effective communication network between the different working zones during the construction period.

The contractor will provide mobile phones to its personnel.

For the entire duration of the work, the Contractor will provide an internet communications infrastructure in the offices and in the meeting room.

t) Offices and meeting room:

The Contractor must make available to the Project Owner and its representatives all the necessary offices and premises for meetings. They will be supplied with electricity, water supply, air conditioning, and provided with Internet access, adequate furniture (chairs, desks, cupboards, etc.), adequate lighting, and sanitary facilities.

The Contractor must ensure the security of the offices 24 hours a day throughout the duration of the project.

Each site office will be equipped for 2 people.

They will include:

- Two desks and a meeting table equipped with four office chairs
- office storage cabinet
- One printer per office

They will be equipped with a power supply, fire detection, and extinguishing system, air conditioners, and a fast internet connection via wifi.

Provide the following common facilities per site:

- 1 sink
- 1 refrigerator
- 1 WC
- drinking water
- 1 coffee machine

The Contractor must also provide a meeting room for 15 people intended for the use of the contracting authority and located directly next to its main offices.

The meeting room will be air-conditioned and will be equipped as follows:

- 1 writing board with erasable markers,
- 1 connected screen for projections (Bluetooth option),
- 1 digital projector
- 1 meeting table and its 15 chairs equipped with electricity
- 1 Internet access (Wi-Fi)

u) Lifting and transporting equipment around the Site

The contractor will provide all the needed lifting, handling, and transport equipment on Site.

Lifting equipment must all have up-to-date certificates of conformity and periodic regulatory inspections.

v) Sanitary system

The contractor will design, build, operate and maintain during the Construction Period a sanitary system including the collection, treatment, and disposal of wastewater.

Any septic tank installed by the contractor will be drainable.

Temporary or mobile sanitary facilities will also be provided on construction sites, for a minimum of 30 workers.

w) Transportation of the Contractor's personnel and materials on site

The Contractor must provide, at his own expense, all the necessary transportation vehicles for his personnel and the supplied materials on site.

x) Machines' reparation

The repair of the various Machines must be carried out outside the site, except in the event that they cannot move the machine before repair, they then proceed to repair it on-site according to a procedure that takes into account the various requirements of Safety

15. Annexes of UNDERGROUND CABLES (UGC)

Annex A2: Guaranteed Technical Data

Annex A2-1: 69kV XLPE Cable Guaranteed Technical Data

Annex A2-2: 69kV single core plug-In SF6 gas cable terminations for GIS switchgear Guaranteed Technical Data

Annex A2-3: 69kV single core Outdoor composite cable terminations with integrated surge arresters Guaranteed Technical Data

Annex A2-4: 69kV single core Joints Guaranteed Technical Data

Annex A2-5: 33kV XLPE Cable Guaranteed Technical Data

Annex A2-6: 33kV three cores Outdoor and Indoor cable terminations Guaranteed Technical Data

Annex A2-7: 33kV three core Joints Guaranteed Technical Data

Annex A2-8: 11kV XLPE Cable Guaranteed Technical Data

Annex A2-9: 11kV three cores Outdoor and Indoor cable terminations Guaranteed Technical Data

Annex A2-10: Cross-bonding with SVL Guaranteed Technical Data

Annex A2-11: Fiber Optical Cable Guaranteed Technical Data

Annex A2-12: Splice Box for Fiber Optical Cable Guaranteed Technical Data

Annex A2-13: HDPE ducts for UGC Guaranteed Technical Data

Annex A2-14: HDPE ducts for FO Guaranteed Technical Data

Annex A2-15: FO junction box Guaranteed Technical Data

Annex A2-16: Straps and accessories Guaranteed Technical Data

Annex A2-17: Warning Grid Guaranteed Technical Data

Annex A2-18: Joint Hydrogonflant Guaranteed Technical Data

Annex A3: Drawings

Annex A3-1: Typical section - cable trench - 69 kV

Annex A3-2: Typical section - cable trench - 11 kV

Annex A3-3: Typical section - cable trench - 33 kV

Annex A3-4: Typical section – junction box - 69 kV

Annex A3-5: Typical section – junction box - 33 kV

Annex A3-6-1: Indicative line route for GLI LINK - 11 kV

Annex A3-6-2: Indicative line route for GFI LINK - 33 kV

Annex A3-6-3: Indicative line route for GFI LINK - 69 kV

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Annex A2: Guaranteed Technical Data

Annex A2-1 69kV XLPE Cable Guaranteed Technical Data

(To be filled and signed by the supplier and submitted together with copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records and copies of test certificates for bid evaluation)

	Description	**Unit**	**Minimum Required Data**	**Data Offered By The Bidder**
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC 60840 – IEC502	
5	**Type**		XLPE, Single core	
6	**Highest System Voltage (Um)**	kV	72.5	
7	**Rated Voltage (Ur)**	kV	69	
8	**System earthing**		Solidly grounded	
9	**Rated frequency**	Hz	50	
10	**Conductor material**	-	Stranded compacted aluminium class2	
11	**Cross section of wires**	mm^2	To be confirmed by design: 15MVA → $240mm^2$	
12	**Rated short circuit current (1 s.)**			
12-1	Conductor	kA	22.56	
12-2	Screen	kA	10	
13	**Design continuous operation at rated full load current, the max. temp. of conductor shall not exceed**	°C	90	
14	**The conductor temperature after a short circuit for 1.0 sec. shall not exceed (°C)**	°C	250	
15	**Basic insulation level**			
15-1	(1.2 / 50 Micro second wave)	kVp	350	

15-2	1-min. power frequency withstand voltage	kV	140	
16	**Conductor shield**			
16-1	Material		SEMICON	
16-2	Minimum thickness	mm	1.5	
17	**Insulation**			
17-1	Material		Super clean XLPE	
17-2	Minimum thickness	mm	9	
18	**Insulation shield**			
18-1	Material		SEMICON	
18-2	Minimum thickness	mm	1.5	
19	**Watertight layer**		water-swellable semi-conductive tape	
20	**Metallic shield**			
	Material		Corrugated Aluminium	
21	**Jacket**			
21-1	Material		LMDPE or MDPE	
21-2	Minimum thickness	mm	3	
22	**Continuous current @90°C**			
22-1	in ground	A		
22-2	in single duct bank (as described in annexe)	A		
	Electrical parameters			
1	**Electrical Stress**			
1-1	Conductor Shield	kV/mm	To provide	
1-2	Insulation Shield	kV/mm	To provide	
2	**Conductor Resistance**			
2-2	DC @ 20°C	Ω/km		
2-3	AC @ 90°C	Ω/km		
3	**Capacitance**	Pf/km		
4	**Charging current**	A/km		
	Dimensional			
1	**Bending radius (single core cables)**	mm	approx.15 x d	
2	**Maximum Pulling Tension**	kg	1360	
3	**Conductor Diameter**	mm		
4	**Diameter over Insulation**	mm		

5	**Diameter over Sheath**	mm		
6	**Overall Jacket Diameter**	mm		
7	**Net weight of the cable**	Kg		
	Quality Management system			
1	Quality Assurance Plan		To provide	
2	Copy of ISO 9001:2008 Certificate		To provide	
3	Manufacturer's experience, Manufacturing Capacity (units per months), List of previous customers, Customer reference letters		To provide	
	Test and Inspection			
1	Test standards and responsibility of carrying out tests		To specify	
2	Copies of Type Test Reports submitted with bid		To provide	
3	Acceptance tests to be witnessed by the Employer at the factory before shipment		To specify	
4	Test reports to be submitted by supplier to Employer for approval before shipment		To provide	
5	Replacement of rejected termination and jointing kits		To specify	
	Marking, Labeling and Packaging			
1	Marking		To specify	
2	Packing		To specify	
3	Storage		To specify	
4	Procedures for decommissioning and disposal		To provide	
	Documentation			
1	Documents submitted with bid		To provide	
2	Documents to be submitted by supplier to Employer for approval before manufacture		To provide	
3	Statement of compliance to specification		To provide	

Annex A2-2 69kV single core plug-In SF6 gas cable terminations for GIS switchgear Guaranteed Technical Data

	Description	Unit	Minimum Required Data	Data Offered By The Bidder
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC 60840, IEEE 48, IEC 62271-209	
5	**Cable Type**		XLPE, Single aluminium core with corrugated aluminium metallic sheath	
6	**Highest System Voltage (Um)**	kV	72.5	
7	**Rated Voltage (Ur)**	kV	69	
8	**System earthing**		Solidly grounded	
9	**Rated frequency**	Hz	50	
10	**Type Termination**		Dry plug-in GIS switchgear	
11	**Rated lightning impulse withstand voltage BIL**	kV	325	
12	**Conductor cross section**	mm^2	To be confirmed by design: 15MVA → 240mm^2	
13	**Diameter over cable insulation - prepared**	mm		
14	**Max. diameter over outer cable sheath**	mm		
15	**Minimal creepage distance**	mm/kV	31.5	
16	**Dimensions comply with IEC 62271-209**		yes	
17	**Pressure-tight resin housing**		yes	
18	**Operates in SF6**		yes	
19	**Pre-fabricated and factory-tested silicone-rubber stress cone**		yes	
20	**No special tools required to install the termination**		yes	
21	**Insulated cable gland for sectionalization**		yes	

22	**Type tested according to IEC 60840,** **IEC 62067 and IEC 62271-209 standards**		yes	
23	**All materials be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 second duration)**		yes	
24	**Silicone rubber with an excellent adhesive property**		yes	
25	**Contents of the kit and Material used**		To specify	

Annex A2-3 69kV single core Outdoor composite cable terminations with integrated surge arresters Guaranteed Technical Data

	Description	Unit	Minimum Required Data	Data Offered By The Bidder
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC 60840, IEEE 48, IEC 60815	
5	**Cable Type**		XLPE, Single aluminium core with corrugated aluminium metallic sheath	
6	**Highest System Voltage (Um)**	kV	72.5	
7	**Rated Voltage (Ur)**	kV	69	
8	**System earthing**		Solidly grounded	
9	**Rated frequency**	Hz	50	
10	**Type Termination**		outdoor composite	
11	**Rated lightning impulse withstand voltage BIL**	kV	325	
12	**Conductor cross section**	mm²	To be confirmed by design: 15MVA → 240mm²	
13	**Diameter over cable insulation - prepared**	mm		
14	**Minimum creepage distance**	mm/kV	31.5	
15	**Min. arcing distance**	mm		
16	**Applied standard for the integrated surge arrester**		IEC 60099	
17	**Rated voltage Ur of the integrated surge arrester**	kV		
18	**Nominal discharge current of the integrated surge arrester**	KA	10	
19	**Line discharge class of the integrated surge arrester**		4	
20	**Max. rated short circuit current of the**	kA	63	

	integrated surge arrester			
21	**Outdoor cable terminations characteristics**		To specify	
22	**Specialized tools for termination process**		To specify	
23	**Installation procedures and instructions**		To provide	
24	**All materials be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 second duration)**		yes	
25	**Silicone rubber with an excellent adhesive property**		yes	
26	**Contents of the kit and Material used**		To Specify	

Annex A2-4 69kV single core Joints Guaranteed Technical Data

	Description	Unit	Minimum Required Data	Data Offered By The Bidder
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC 60840 and IEEE 48	
5	**Cable Type**		XLPE, Single aluminium core with corrugated aluminium metallic sheath	
6	**Highest System Voltage (Um)**	kV	72.5	
7	**Rated Voltage (Ur)**	kV	69	
8	**System earthing**		Solidly grounded	
9	**Rated frequency**	Hz	50	
10	**Rated lightning impulse withstand voltage BIL**	kV	325	
11	**Power frequency voltage withstand test**		170kV/30 sec. No breakdown no flashover	
12	**Room temperature partial discharge test**		Test voltage 72kV, Partial discharge < 5pC	
13	**Thermal cycle test**		Heating: 100°C for 4 hours Cooling: -25°C for 4 hours Holding: 20°C for 1 hour	
14	**High temperature partial discharge test**		Test Voltage 72kV Test temperature 95-100°C, Partial discharge < 5pC	
15	**Lightning impulse voltage test**		450 kV positive and negative polarities each 10 times, No breakdown, No flashover.	

16	**After the impulse voltage withstand voltage test**		140 kV/15min. No breakdown. No flashover	
17	**Outdoor joint / termination short-term power frequency voltage test**		Wet, at 150kV, for 15 min. No flashover, No breakdown.	
18	**Short circuit current for conductor (1 sec)**		42kA	
19	**Short circuit current for sheath (1 sec)**		42kA	
20	**Outdoor joint / termination radio interference test**		5 microvolts at 10 kHz 50 microvolts at 100 kHz 500 microvolts at 1 MHz	
21	**Pressure leak test**		No gas shall escape at 0.2 MPa for 1 hour	
22	**Partial Discharge**		< 5pc	
23	**Voltage withstand across screen break (kVp)**		35	
24	**Short Circuit current withstand on links**		25kA rms for 1s	
25	**Conductor cross section**	mm^2	To be confirmed by design: 15MVA → 240mm^2	
26	**Impact Resistance (Wedge dropped 2m)**		No damage	
27	**Maximum working stress level (kV/mm)**			
28	**Cold Applied Insulating components**	(yes/no)		
29	**Fully Metallic Screened**	(yes/no)		
30	**Joint sleeve material**		Aluminium	
31	**Covering over joint sleeve**		Resin Filled Outer Box	
32	**Re-enterable**	(yes/no)		
33	**Overall Length/Required Pit Length**	**mm**		
34	**Detailed Instructions to suit cable type and voltage included in kits**	(yes/no)		
35	**Pack Weight**	Kg		
36	**Shelf Life**	Years		

37	**Contents of the kit and Material used**		To Specify	
38	**Suitability for the use in the service condition**		To Specify	
39	**Finish**		To Specify	
40	**High moisture sealing capacity, resistance to fungal and insect attack characteristic**		To Specify	
41	**Silicone rubber with an excellent adhesive property**		yes	
42	**All materials be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 second duration)**		yes	

Annex A2-5 33kV XLPE Cable Guaranteed Technical Data

	Description	Unit	Minimum Required Data	Data Offered By The Bidder
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC60502, IEC 60228, IEC811, IEC61442, IEC60229	
5	**Type**		XLPE, three core	
6	**Highest System Voltage (Um)**	kV	36	
7	**Rated Voltage (Ur)**	kV	33	
8	**System earthing**		Solidly grounded	
9	**Rated frequency**	Hz	50	
10	**Conductor material**	-	Classs2 Stranded compacted Cooper	
11	**Cross section of wires**	mm²	To be confirmed by design: 22MVA → 240mm²	
12	**Rated short circuit current (1 s.)**			
12-1	Conductor	kA	25	
12-2	Screen	kA	To provide	
13	**Design continuous operation at rated full load current, the max. temp. of conductor shall not exceed**	°C	90	
14	**The conductor temperature after a short circuit for 1.0 sec. shall not exceed (°C)**	°C	250	
15	**Basic insulation level**			
15-1	(1.2 / 50 Micro second wave)	kVp	170	
15-2	1-min. power frequency withstand voltage	kV	70	
16	**Conductor shield**			
16-1	Material		SEMICON	
16-2	Minimum thickness	mm	0.8	

17	**Insulation**			
17-1	Material		Super clean XLPE	
17-2	Minimum thickness	mm	8	
18	**Insulation shield**			
18-1	Material		SEMICON	
18-2	Minimum thickness	mm	0.5	
19	**Metallic screen**			
	Material		copper	
	Minimum thickness	mm²	equivalent total cross sectional 35mm²	
20	**Filler / Separation seath**			
	Material		EPR or PP	
	Minimum thickness	mm	2	
21	**Inner sheath / Bedding**		PVC	
22	**Watertight layer**		water-swellable semi-conductive tape	
23	**Armour**			
	Material		Galvanized steel double layers	
	Minimum thickness	mm	0,5	
24	**Jacket (Outer sheath)**			
24-1	Material		PVC-ST2	
24-2	Minimum thickness	mm	3	
25	**Continuous current @90°C**			
25-1	in ground	A		
25-2	in single duct bank (as described in annexe)	A		
	Electrical parameters			
1	**Electrical Stress**			
1-1	Conductor Shield	kV/mm		
1-2	Insulation Shield	kV/mm		
2	**Conductor Resistance**			
2-2	DC @ 20°C	Ω/km	0.075	
2-3	AC @ 90°C	Ω/km	0.1	
3	**Capacitance**	Pf/km	227	

4	**Charging current**	A/km	1.353	
	Dimensional			
1	**Bending radius (single core cables)**	mm	approx.15 x d	
2	**Maximum Pulling Tension**	kg	50.4kN/5135kg	
3	**Conductor Diameter**	mm		
4	**Diameter over Insulation**	mm		
5	**Diameter over Sheath**	mm		
6	**Overall Jacket Diameter**	mm		
7	**Net weight of the cable**	kg		
	Fire retardant		yes (Level ZB)	
	Moisture resistant		yes	
	Water proof armour		AWA	
	Quality Management system			
1	Quality Assurance Plan		To provide	
2	Copy of ISO 9001:2008 Certificate		To provide	
3	Manufacturer's experience, Manufacturing Capacity (units per months), List of previous customers, Customer reference letters		To provide	
	Test and Inspection			
1	Test standards and responsibility of carrying out tests		To specify	
2	Copies of Type Test Reports submitted with bid		To provide	
3	Acceptance tests to be witnessed by the Employer at the factory before shipment		To specify	
4	Test reports to be submitted by supplier to Employer for approval before shipment		To provide	
5	Replacement of rejected termination and jointing kits		To specify	
	Marking, Labeling and Packaging			
1	Marking		To specify	
2	Packing		To specify	
3	Storage		To specify	
4	Procedures for decommissioning and disposal		To provide	
	Documentation			
1	Documents submitted with bid		To provide	

2	Documents to be submitted by supplier to Employer for approval before manufacture		To provide	
3	Statement of compliance to specification		To provide	

Annex A2-6 33kV three cores Outdoor and Indoor cable terminations Guaranteed Technical Data

	Description	Unit	Minimum Required Data	Data Offered By The Bidder
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC60502, IEC61442, IEEE48	
5	**Cable Type**		XLPE, three core copper with galvanized steel armour	
6	**Highest System Voltage (Um)**	kV	36	
7	**Rated Voltage (Ur)**	kV	33	
8	**System earthing**		Solidly grounded	
9	**Rated frequency**	Hz	50	
10	**Type Termination**		outdoor and indoor cold-shrinkable	
11	**Power frequency voltage withstand test**		70kV/1 min. No breakdown no flashover	
12	**Room temperature partial discharge test**		Test voltage 36kV, Partial discharge < 5pC	
13	**Thermal cycle test**		Heating: 100°C for 4 hours Cooling: -25°C for 4 hours Holding: 20°C for 1 hour	
14	**High temperature partial discharge test**		Test Voltage 36kV Test temperature 95-100°C, Partial discharge < 5pC	
15	**Lightning impulse voltage test**		170 kV positive and negative polarities each 10 times, No breakdown, No	

			flashover.	
16	**Outdoor joint / termination short-term power frequency voltage test**		Wet, at 95kV, for 15 min. No flashover, No breakdown.	
17	**Short circuit current for conductor (1 second)**		34.3kA	
18	**Short circuit current for sheath (1 second)**		10.1kA	
19	**Outdoor joint / termination radio interference test**		5 microvolts at 10 kHz 50 microvolts at 100 kHz 250 microvolts at 1MHz	
20	**Pressure leak test**		No gas shall escape at 0.2 MPa for 1 hour	
21	**Conductor cross section**	mm^2	To be confirmed by design: 22MVA → 240mm^2	
22	**Diameter over cable insulation - prepared**	mm		
23	**Minimum creepage distance**	mm/kV	31.5	
24	**Min. arcing distance**	mm		
25	**Applied standard for the surge arrester**		IEC 60099	
26	**Rated voltage Ur of the integrated surge arrester**	kV		
27	**Nominal discharge current of the integrated surge arrester**	KA	10	
28	**Line discharge class of the integrated surge arrester**		4	
29	**Max. rated short circuit current of the integrated surge arrester**	kA		
30	**Outdoor cable terminations characteristics**		To specify	
31	**Specialized tools for termination process**		To specify	
32	**Installation procedures and instructions**		To provide	
33	**All materials be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 second duration)**		yes	
34	**Silicone rubber with an excellent adhesive property**		yes	
35	**Contents of the kit and Material used**		To Specify	

Annex A2-7 33kV three core Joints Guaranteed Technical Data

	Description	Unit	Minimum Required Data	Data Offered By The Bidder
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC60502, IEC61442, IEEE48	
5	**Cable Type**		XLPE, three core copper with galvanized steel armour aluminium metallic sheath	
6	**Highest System Voltage (Um)**	kV	36	
7	**Rated Voltage (Ur)**	kV	33	
8	**System earthing**		Solidly grounded	
9	**Rated frequency**	Hz	50	
10	**Power frequency voltage withstand test**		70kV/1 min. No breakdown no flashover	
11	**Room temperature partial discharge test**		Test voltage 36kV, Partial discharge < 5pC	
12	**Thermal cycle test**		Heating: 100°C for 4 hours Cooling: -25°C for 4 hours Holding: 20°C for 1 hour	
13	**High temperature partial discharge test**		Test Voltage 36kV Test temperature 95-100°C, Partial discharge < 5pC	
14	**Lightning impulse voltage test**		170 kV positive and negative polarities each 10 times, No breakdown, No flashover.	
15	**Outdoor joint / termination short-term**		Wet, at 95kV, for 15	

	power frequency voltage test		min. No flashover, No breakdown.	
16	**Short circuit current for conductor (1 second)**		34.3kA	
17	**Short circuit current for sheath (1 second)**		10.1kA	
18	**Outdoor joint / termination radio interference test**		5 microvolts at 10 kHz 50 microvolts at 100 kHz 250 microvolts at 1 MHz	
19	**Pressure leak test**		No gas shall escape at 0.2 MPa for 1 hour	
20	**Conductor cross section**	mm^2	To be confirmed by design: 22MVA → 240mm^2	
21	**Short Circuit current withstand on links**		25kA rms for 1s	
22	**Impact Resistance (Wedge dropped 2m)**		No damage	
23	**Maximum working stress level**	kV/mm		
24	**Cold Applied Insulating components**	(yes/no)		
25	**Fully Metallic Screened**	(yes/no)		
26	**Joint sleeve material**		Tinned Copper	
27	**Covering over joint sleeve**		Resin Filled Outer Box	
28	**Re-enterable**	(yes/no)		
29	**Overall Length/Required Pit Length**	**mm**		
30	**Detailed Instructions to suit cable type and voltage included in kits**	(yes/no)		
31	**Pack Weight**	Kg		
32	**Shelf Life**	Years		
33	**Contents of the kit and Material used**		To specify	
34	**Suitability for the use in the service condition**		To specify	
35	**Finish**		To specify	
36	**High moisture sealing capacity, resistance to fungal and insect attack characteristic**		To specify	
37	**Silicone rubber with an excellent adhesive**		yes	

	property			
38	**All materials be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 second duration)**		yes	

Annex A2-8 11kV XLPE Cable Guaranteed Technical Data

	Description	Unit	Minimum Required Data	Data Offered By The Bidder
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC60502, IEC 60228, IEC811, IEC61442, IEC60229	
5	**Type**		XLPE, three core	
6	**Highest System Voltage (Um)**	kV	12	
7	**Rated Voltage (Ur)**	kV	11	
8	**System earthing**		Grounded through earthing transformer	
9	**Rated frequency**	Hz	50	
10	**Conductor material**	-	Stranded compacted Aluminium Class2	
11	**Cross section of wires**	mm²	To be confirmed by design: 5MVA → 185 mm²	
12	**Rated short circuit current (1 s.)**			
12-1	Conductor	kA	17.39	
12-2	Screen	kA	10	
13	**Design continuous operation at rated full load current, the max. temp. of conductor shall not exceed**	°C	90	
14	**The conductor temperature after a short circuit for 1.0 sec. shall not exceed (°C)**	°C	250	
15	**Basic insulation level**			
15-1	(1.2 / 50 Micro second wave)	kVp	75	
15-2	1-min. power frequency withstand voltage	kV	28	
16	**Conductor shield**			
16-1	Material		SEMICON	

16-2	Minimum thickness	mm	0.3	
17	**Insulation**			
17-1	Material		Super clean XLPE	
17-2	Minimum thickness	mm	3.4	
18	**Insulation shield**			
18-1	Material		SEMICON	
18-2	Minimum thickness	mm	0.3	
19	**Metallic screen**			
	Material		copper	
	Minimum thickness	mm	0.05	
20	**Filler / Separation seath**			
	Material		EPR or PP	
	Minimum thickness	mm	1	
21	**Inner sheath / Bedding**		PVC	
22	**Watertight layer**		water-swellable semi-conductive tape	
23	**Armour**			
	Material		Galvanized steel double layers	
	Minimum thickness	mm	0,5	
24	**Jacket (Outer sheath)**			
24-1	Material		PVC-ST2	
24-2	Minimum thickness	mm	3	
25	**Continuous current @90°C**			
25-1	in ground	A		
25-2	in single duct bank (as described in annexe)	A		
	Electrical parameters			
1	**Electrical Stress**			
1-1	Conductor Shield	kV/mm		
1-2	Insulation Shield	kV/mm		
2	**Conductor Resistance**			
2-2	DC @ 20°C	Ω/km	0.164	
2-3	AC @ 90°C	Ω/km	0.211	

3	**Capacitance**	Pf/km	410	
4	**Charging current**	A/km	1.353	
	Dimensional			
1	**Bending radius (single core cables)**	mm	approx.15 x d	
2	**Maximum Pulling Tension**	kg	27.8kN/2829kg	
3	**Conductor Diameter**	mm		
4	**Diameter over Insulation**	mm		
5	**Diameter over Sheath**	mm		
6	**Overall Jacket Diameter**	mm		
7	**Net weight of the cable**	kg		
	Fire retardant		yes (Level ZB)	
	Moisture resistant		yes	
	Water proof armour		AWA	
	Quality Management system			
1	Quality Assurance Plan		To provide	
2	Copy of ISO 9001:2008 Certificate		To provide	
3	Manufacturer's experience, Manufacturing Capacity (units per months), List of previous customers, Customer reference letters		To provide	
	Test and Inspection			
1	Test standards and responsibility of carrying out tests		To specify	
2	Copies of Type Test Reports submitted with bid		To provide	
3	Acceptance tests to be witnessed by the Employer at the factory before shipment		To specify	
4	Test reports to be submitted by supplier to Employer for approval before shipment		To provide	
5	Replacement of rejected termination and jointing kits		To specify	
	Marking, Labeling and Packaging			
1	Marking		To specify	
2	Packing		To specify	
3	Storage		To specify	
4	Procedures for decommissioning and disposal		To provide	
	Documentation			

1	Documents submitted with bid		To provide	
2	Documents to be submitted by supplier to Employer for approval before manufacture		To provide	
3	Statement of compliance to specification		To provide	

Annex A2-9 11kV three cores Outdoor and Indoor cable terminations Guaranteed Technical Data

	Description	Unit	Minimum Required Data	Data Offered By The Bidder
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC60502, IEC61442, IEEE48	
5	**Cable Type**		XLPE, three core aluminium with galvanized steel armour	
6	**Highest System Voltage (Um)**	kV	12	
7	**Rated Voltage (Ur)**	kV	11	
8	**System earthing**		Grounded through earthing transformer	
9	**Rated frequency**	Hz	50	
10	**Type Termination**		outdoor and indoor cold-shrinkable	
11	**Power frequency voltage withstand test**		24kV/1 min. No breakdown, No flashover.	
12	**Room temperature partial discharge test**		Test voltage 12kV. Partial discharge <10pC	
13	**Thermal cycle test**		Heating: 100°C for 4 hours Cooling: -25°C for 4 hours Holding: 20°C for 1 hour	
14	**High temperature partial discharge test**		Test Voltage 12kV Test temperature 95-100 °C, Partial discharge < 10pC.	
15	**Lightning impulse voltage test**		95 kV positive and negative polarities each 10 times, No breakdown, No	

			flashover.	
16	**Outdoor joint / termination short-term power frequency voltage test**		Wet, at 42kV, for 15 min. No flashover, No breakdown.	
17	**Short circuit current for conductor (1 second)**		17.5	
18	**Short circuit current for sheath (1 second)**		10.1	
19	**Outdoor joint / termination radio interference test**		5 microvolts at 10 kHz 50 microvolts at 100 kHz 500 microvolts at 1 MHz	
20	**Pressure leak test**		No gas shall escape at 0.2 MPa for 1 hour	
21	**Conductor cross section**	mm^2	To be confirmed by design: 5MVA → 185mm^2	
22	**Diameter over cable insulation - prepared**	mm		
23	**Minimum creepage distance**	mm/kV	31.5	
24	**Min. arcing distance**	mm		
25	**Outdoor cable terminations characteristics**		To specify	
26	**Specialized tools for termination process**		To specify	
27	**Installation procedures and instructions**		To provide	
28	**All materials be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 second duration)**		yes	
29	**Silicone rubber with an excellent adhesive property**		yes	
30	**Contents of the kit and Material used**		To Specify	

Annex A2-10 Cross-bonding with SVL Guaranteed Technical Data

	Description	Unit	Minimum Required Data	Data Offered By The Bidder
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		-------	
5	**Type**			
6	**Highest System Voltage (Um)**	kV kV	72.5 36	
7	**Rated Voltage (Ur)**	kV kV	69 33	
8	**System earthing**		Solidly grounded	
9	**Rated frequency**	Hz	50	
10	**Conductor material**	-	Single core, Stranded compacted Aluminium for 69kV Three core, Stranded compacted Copper for 33kV	
11	**Cross section of wires**	mm²	240 mm² AL for 69kV 240 mm² Copper for 33kV	
12	**Rated short circuit current (1 s.)**			
12-1	Conductor	kA	25	
12-2	Screen	kA	10	
13	**Design**			
	Material		Stainless steel	
	Enclosure Rating		IP68	
	Application		Cross-bonding	
	Impulse Level		75 kVp Ph-Ph 40 kV Ph-E	
	Bonding Cable		Single Core for 69kV Three core for 33kV	

	Short circuit current (1sec)	kA	40	
	Internal power Arc (0,12s)	kA	20	
	Mounting		Pit	
	DC withstand (5minutes)	kV	25	
	Pressure withstand	KPa	250	
	With insulation between phases		yes	
	Cable Sheath Protection using metal oxide sheath voltage surge limiters (SVLs).		yes	
	weight	Kg		
14	**Sheath voltage surge limiters (SVLs).**			
	Rated voltage	kV	6	
	Maximum Continuous Operating Voltage	kV	5.1	
	Rated 8/20µs current	kA	20	
15	**Specialized tools for termination process**		To specify	
16	**Installation procedures and instructions**		To provide	
17	**Contents of the kit and Material used**		To specify	
18	**Marking, Labeling and Packaging**			
	Marking		To specify	
	Packing		To specify	
	Storage		To specify	
	Procedures for decommissioning and disposal		To provide	
19	**Documentation**			
	Documents submitted with bid		To provide	
	Documents to be submitted by supplier to Employer for approval before manufacture		To provide	
	Statement of compliance to specification		To provide	

Annex A2-11 Fiber Optical Cable Guaranteed Technical Data

	Description	**Unit**	**Minimum Required Data**	**Data Offered By The Bidder**
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC 60794-1, IEC 60304, IEEE 1428, ITU-TG.652	
5	**Type**		Multi loose, Single mode optical Fiber	
6	**Mechanical characteristics:**			
	Temperature Range (IEC 60794-1-2-F1)			
	Laying and Installation			
	Operation			
	Transport and Storage			
	Cable Bending Radius (IEC 60794-1-2-E11A)			
	During Installation (Full Load)			
	Installed (No Load)			
	Repeated Bending (IEC 60794-1-2-E6)			
	Tensile Force (IEC 60794-1-2-E1)			
	Torsion Resistance (IEC 60794-1-2-E7)			
	Crush Resistance (IEC 60794-1-2-E3)			
	Impact Resistance (IEC 60794-1-2-E4)			
	Kink Resistance (IEC 60794-1-2-E10)			
	Water Penetration (IEC 60794-1-2-F5B)			
7	**Optical characteristics:**			
	Fiber used in the cable manufacturing fully comply to ITU-T-Rec G 652 D			
	at 1310 nm			
	at 1550 nm			
	Mode Field Diameter		8.6 to 9.5 µm (± 10% of the nominal value)	
	Cladding Diameter		125.0 µm ± 2µm	

	Mode field Concentricity Error		≤1.0µm at 1310 nm	
	Core-Clad concentricity error		≤1.0µm	
	Cladding non-circularity		≤2%	
	Cable Cut off Wavelength		≤1260 nm	
	1550 loss performance		As per G.652	
	Proof Test Level		≥ 0.35 Gpa (50.76 Kpsi)	
	Attenuation coefficient		@1310nm ≤ 0.35 dB/km @1550nm ≤ 0.23 dB/km	
	Attenuation at water peak (1383nm)		≤2.1 dB/km	
	Attenuation variation with wavelength **1285 nm - 1330 nm** **1525 nm – 1575 nm**		Attenuation coefficient @1310 ± 0.05 dB Attenuation coefficient @1550 ± 0.05 dB	
	Point discontinuities		≤ 0.1 dB	
	Chromatic Dispersion; Maximum **Zero Dispersion Wavelength** **Zero Dispersion Slope**		20 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) @ 1288-1339nm 5.3 ps/(nm x km) @ 1271-1360nm 1300 to 1324nm -0.093 ps/(nm² x km) maximum	
	Polarization mode dispersion coefficient		≤ 0.5 ps/km^1/2	
	Temperature Dependence		Induced attenuation = 0.05 dB (-60°C - +85°C)	
	Bend performance		@1310nm (75±2 mm dia Mandrel), 100 turns; Attenuation rise ≤ 0.05 dB @1550nm (75±2 mm dia Mandrel), 100 turns; Attenuation rise ≤0.10 dB @1550nm (32±0.5 mm dia Mandrel), 1 turn; Attenuation rise ≤ 0.50 dB	
8	**Color coding (for 48F)**			
	Colour of Fibers in a Loose Tube			
	Colour of Loose Tubes (48F)			
9	**Cable construction details**			
	Primary Coated Fiber			

	Tube Filling Compound			
	Loose Tube(s) (D= 2.4mm, Nom)			
	Central Strength Member (D= 2.5mm, Nom)			
	Cable Filling Compound			
	Core Wrapping			
	Perephral Strength Member			
	Rip Cords			
	Outer Sheath (T = 1.6 mm Nom)			
10	**Delivery information**			
	Nominal Cable Weight (kg/km)			
	Nominal Cable Diameter (mm)			
	Standard Length per Drum (Mtr)			
11	**Cable sheath marking**			
	Sheath marking as per specification details			
12	**Cable drum packing**			
	Length delivered as per specification details			
	Arrow with direction for rolling the drum			

Annex A2-12 Splice Box for Fiber Optical Cable Guaranteed Technical Data

	Description	Unit	Minimum Required Data	Data Offered By The Bidder
1	**Manufacturer**			
2	**Country of Origin**			
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC 61300	
5	**Type**		**Metal Junction Box For Tower/pole**	
6	**Material**		Aluminium Alloy	
7	**Suitable Range**		Two ports, 48 Fibers	
8	**Entry ports number:**		1 oval port, 5 round ports	
9	**Tray number**		8 trays	
10	**Tray capacity**		Min 48F	
11	**Raw material**		Tray: ABS Metal parts：Stainless steel	
12	**Base sealing method**			
13	**Applications**		Aerial, Pole mounting, directly buried, Wall mounting	
14	**IP**		68	

Annex 3: Drawings