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#### **4.1.6. TELECOMMUNICATIONS**

##### **4.1.6.1. General requirements**

In order to achieve the desired telecommunication links OPGW shall be installed as part of all the new 66kV lines. The fibre link shall be based on 48 core fibre and shall include necessary ODF at Terminal stations and approach cable from OPGW to substation control building. Terminal equipment is not in scope of supply.

These specifications describe the basic requirements for the various systems.

Tenderers are requested to submit with their offers the detailed catalogues, brochures and technical drawings with the specific items on offer clearly marked for the products they intend to supply.

Tenderers must indicate on the specifications sheets whether the equipment offered comply with each specified requirement.

The tender documents shall be accompanied by Type test and Routine test certificates, certified by the National Testing or the National standards Institute of the country of origin.

At her discretion, all equipment shall be subjected to inspection by the client's Engineers or her representative at the place of manufacture, where all routine tests on randomly picked sample(s) shall be carried out in their presence. Test reports shall be completed for each equipment and made available to KPLC after the tests have been carried out.

All the dimensions and capacities of the equipment to be supplied shall not be less than those required in these specifications. Deviations from the basic requirements, if any, shall be explained in detail in writing with the offer, with supporting data such as calculation sheets, etc. The Procuring entity reserves the right to reject the products, if such deviations shall be found critical to the use and operation of the products.

The Tenderers are requested to indicate the shortest possible delivery period of each product.

##### **4.1.6.2. SCOPE OF WORK**

The scope includes detailed system design, manufacture, supply, installation, testing, commissioning, remedying of defects, maintaining the works during the defects liability period and any incidental work necessary for the proper completion of the work in accordance with this project. Contractors shall be required to submit for approval detailed design of fibre before manufacture.

### 4.1.6.3. OPGW

#### Technical Description

The transmission line earth wire integrating optical fibres shall be of design and construction to ensure long service with high economy and low maintenance costs. It shall be suitable in every respect for continuous operation at nominal parameters as well as in transient operating conditions under the climatic conditions peculiar to the site.

- The OPGW shall incorporate at least 48 optical fibres. The OPGW constitution shall be of stranded aluminum-clad steel (ACS) wires or Galvanized steel wires (GS). Other OPGW types are acceptable if the required performance characteristics are met.
- All materials used shall be of the best quality and workmanship, and shall be of the highest class throughout with the designs and dimensions of all parts such that the stresses to which the OPGW are subjected to shall not render them liable to distortion or damage under the most severe conditions encountered during installation as well as in service.
- Special attention shall be paid to the OPGW stranding process to ensure the necessary tightness between different layers in order to avoid slippage or relative movement of strands or cage formation during stringing.
- Stranding tolerances as well as inspection and testing shall be as per IEC 61089 as far as applicable, and to the respective manufacturing standards.
- The OPGW manufacturer shall have ISO 9000 quality assurance system certified and shall prove a minimum experience in successful supply of similar OPGW in the last 5 years.
- The OPGW installation shall include all cable fittings (tension and suspension spirals, vibration dampers, earth connection etc.), joint boxes, termination boxes, fibre connectors and other accessories required for a complete working fibre link.

The cable shall have the following characteristics

<b>MECHANICAL PERFORMANCE</b>	
	Specification
1 Cable diameter	< 10.5 mm
2 Cable weight	< 360 Kg/m
3 Rated Tens strength RTS	≥ 60KN
4 Max working tensile (40% RTS of item 3)	≥ 24KN
5 Every day working tension	20% RTS
6 Elasticity coefficient	15900 Kg/mm <sup>2</sup>
7 Thermal expansion Coefficient	0.000014 1/K
<b>ELECTRICAL PERFORMANCE</b>	

1 DC resistance	$\leq 1.0$ ohms/km
2 Short circuit current capacity	$\geq 4.8$ kA
OTHER CONDITIONS	
1 Initial temperature value of short circuit	40°C
2 Failure time value	1 s
3 Matching conductor wire type	Aluminum clad steel
5 Conductor cross section	$\geq 55$ mm <sup>2</sup> (metallic cross section)
Weather and circumstance	
1 Average Wind Speed(m/s)	15m/s
2 Max wind speed (m/s)	35m/s
3 Min temperature	-10°C
4 Max temperature	50°C

- The OPGW, access cables and underground cables shall have at least 48 (forty-eight) single mode optical fibres with following characteristics:
- Transmission wavelength: 1310 nm and 1550 nm
- Mode field diameter: 9.0 to 11.5 micrometers ( $\mu\text{m}$ ), including tolerances
- Optical cladding diameter:  $125 \mu\text{m} \pm 2.4\%$
- Cable Attenuation: not greater than 0.38 dB/km for every fibre in every drum at optical wavelength of 1310 nm; and not greater than 0.22 dB/km for every fibre in every drum at optical wavelength of 1550 nm
- Joint attenuation: not greater than 0.1 dB at optical wavelength of 1310 nm and not greater than 0.2 dB at 1550 nm for every fibre, measured on the fully installed joint
- Total dispersion: not greater than 3.5 ps/km.nm at optical wavelength of 1310 nm and not greater than 19.0 ps/km.nm at optical wavelength of 1550 nm
- Core numerical aperture: less than 0.23
- Life span: greater than 30 years
- The Contractor is required to supply a graph of attenuation versus wavelength over the range of 1200 nm to 1600 nm
- No joints shall be allowed in any fibre in any drum length.
- Discontinuities will be acceptable if:
  - Less than 0.10 dB in magnitude measured at 1310 nm, and
  - OTDR traces from both ends of the cable at 1310 and 1550 nm wavelength show a difference of less than 0.05 dB/km for every fibre in every drum.
- Power Meter & Light source. The test shall be used to verify that the measured loss is in average equal or less than the calculated link budget.
- The Contractor shall state the refractive index of the optical fibres at 1310 nm and 1550 nm. The overhead earth wire shall be Fibre Optic Ground Wire (OPGW) with a minimum of 48 strands.
- The fibre optic earth wire supplied shall be suitable for installation on transmission line and shall be supplied complete with all necessary fittings and optical joint boxes. The earthwire fittings and optical joint boxes shall be type approved.

- The fibre optic earth wire shall comprise an optical sub-unit containing optical fibres over which shall be laid aluminium, aluminium alloy or aluminium coated steel strands. The clad steel wire incorporated in fibre optic earthwire shall comply with the requirements of IEC 61232. Shaped aluminium or aluminium alloy wire sections shall conform to the requirements of the appropriate IEC standard.
- The optical sub-unit shall withstand the temperature rise associated with the specified lightning fault current flowing in the earthwire without damage. The fibre optic earthwire (OPGW) shall be manufactured in continuous lengths of not less than 2,000 m.
- The overall system design of the fibre optic system shall meet the following minimum requirements:
  - Single failure or degradation in any optical fibre not more than one year averaged over five years;
  - Failures or degradations affecting more than one optical fibre, not more than one in ten years;
  - Increase in optical system transmission attenuation due to accumulated ageing and other effects at the end of five years and not more than 0.05 dB/km.

### **OPTICAL FIBRES**

Optical fibres shall be single mode fibre and shall conform to IEC 793-2-BI.

The fibre coating material shall be mechanically strippable. The optical fibres shall be capable of being jointed by fusion technique.

There shall be no measurable long term or short-term optical attenuation change due to the temperature rise associated with a fault current flowing in an earth wire, or a lightning strike on the earth wire.

### **OPGW FITTINGS**

The fibre optic earth wire shall be with approved conductor fittings. The application of these fittings shall not damage the earth wire or fibres, either mechanically or optically.

At each support, a bypass device shall be provided to guide the cable around the earth wire fittings associated with the support.

### **OPTICAL JOINT BOXES**

Optical joint boxes shall be provided to protect the splice joint of optical fibres, either when individual lengths of the fibre optic OPGW, are jointed or between the fibre optic earth wire and the underground fibre optic cable.

The joint boxes shall consist of external steel or die cast aluminium housing providing protection to IEC 529 IP 44 and an internal die cast aluminium or high impact plastic ABS box to IEC 529 IP54

The external housing shall be designed so that the rainwater is directed away from the door and there shall be no water ingress when the door is opened.

The joint boxes shall be supplied complete with all fittings to secure and seal the cable in the gland plates or blank the unused spigots. The cable cleats to secure the fibre optic OPGW or underground cable shall be fitted inside the box. The cleats shall not have a detrimental effect on the performance of the optical fibres when tightened to the recommended torque.

The top and bottom of the joint box shall be vented and the vents provided with the vermin shields.

The box shall be supplied complete with internal splice cassettes to accommodate the required number of splices. The glands shall be fitted to accommodate either the fibre optic OPGW or underground fibre optic cable.

### **FIXING CLAMPS**

A bolted clamping system shall be used to attach the OPGW to the inside of the support, without drilling or modifications to the support steel work.

The attachment clamps shall be capable of being attached and detached from the support, without affecting the OPGW.

### **NON – METALLIC UNDERGROUND FIBRE OPTIC CABLE**

The fibre optic cable shall be circular in cross section and shall be designed so that any cable strain is not directly on the optical fibres. The cable shall not include any metallic components to prevent high-induced voltages when used in switching or substation compounds. The cable shall be suitable for laying in cable ducts and in the ground in switching stations. The cable shall have the pre-requisite Mechanical Protection to prevent damage during installation and due to other Human activities such as excavation. It shall be suitable for laying in areas next to roads with heavy traffic, resistant to aggressive chemical substances, corrosion and moisture. The cable shall offer good protection against rodents and shall be suitable to withstand harsh environmental conditions.

### **PROTECTIVE TREATMENT**

### **Fibre optic earth wire**

Where two layers of wire strands are provided over the optical sub-unit, the external surface of the optical sub-unit and the inner strand layer shall be greased, using approved conductor grease.

### **Ingress of Moisture**

The cable shall be capped before shipment to prevent the ingress of water.

## **INSTALLATION**

### **General**

The supplier of the OPGW shall be responsible for the supervision of installation by the Contractor; to ensure that system reliability requirements are met.

### **Workmanship**

The Contractor shall ensure that the fibre optic cable are not strained or damaged either mechanically or optically during stringing and/ or jointing.

### **Fibre optic joints**

Optical fibre joints in the OPGW, or between the OPGW and the non-metallic underground fibre optic cable, shall be housed in optical joint boxes. The joint boxes shall be located immediately above the anti-climbing device for convenient access by technical personnel. All joint boxes shall be earthed to the support steel work using approved multi-wire / multi-strand flexible aluminium earth bond.

#### **4.1.6.4. Optical Distribution Frames (ODF)**

The optic distribution frame shall be equipped with low loss optical connectors (< 0.3 dB including the loss in the bulk head, loss in the connector splice & the loss in the pig tail) of the screw-on type. Auxiliary connectors shall be provided to facilitate testing and maintenance of the fibres/equipment. All spare fibres shall be properly terminated and spliced on connectors of the same type within the frame

#### **4.1.6.5. SPARE PARTS**

The Contractor shall furnish supply 10 km of spare cable with all necessary fittings, including connectors, splice boxes etc.

#### **4.1.6.6. TOOLS AND TEST EQUIPMENT**

The bidder shall include special tools and test equipment needed to maintain the fibre (including OTDR –MTS8000 or its equivalent; and splicing Kit. Bidder shall provide relevant technical data/pamphlets for all the items. The test kit shall include necessary laptop(s) and all equipment applications and their licences. The licenses shall include 5 AutoCAD licenses for use for review of design drawings.

The test equipment and other special tools proposed shall be of the same type as used by the contractor for erection and commissioning. The test equipment shall not however be available to the contractor during erection and commissioning.

**4.1.6.7. DOCUMENTATION:**

The Contractor shall provide all necessary drawings, design specifications, design details, operation and maintenance manuals. All manuals and As-Built-Drawings documents shall be supplied in three hard copies and a softcopy in PDF and AutoCAD.

**4.1.6.8. TESTING**

Factory Acceptance Tests (FAT).Fibre and OLTE shall pass these tests before they may be shipped to site. The employer shall witness FATs unless he waives this in writing. FAT shall be carried out for fibreand OLTE.

**4.1.6.9. SYSTEM ACCEPTANCE**

- The fibre shall be accepted by KPLC if both:
- The fibre and all items of equipment have successfully completed all the specified tests
- All failures, problems and reservations noted during the tests have been corrected to the satisfaction of KPLC.
- If either of these conditions has not been complied with, then the necessary corrective action shall be agreed between the Contractor and KPLC.