4.1.6. Telecommunications

4.1.6.1. General requirements

The objective of the telecommunications system is to transmit and receive data, voice and Teleprotection signals. Telecommunication links based primarily on Fibre (OPGW and ADSS) multiplexers and on some cases Radio and PLC shall be established linking various equipment in substations to Regional Control Centres (RCCs).
Necessary engineering required, both on existing KPLC infrastructure and new equipment, for transmitting data and speech signals to the Regional and National Control Centre(s) shall be included. The links shall consist of STM-1/4 SDH Terminal equipment(s), and shall primarily be point to point and be connected to existing KPLC network backbone at nearest access point, most likely at the end of the point to point link. KPLC has a SDH network with the backbone mainly consisting of STM-1/4 network.
The telecommunication system to be provided shall be designed to transmit and receive data, voice, and Tele-protection signals where necessary.
Where the station is for Voltages above 66 kV the SAS/RTU and Telecommunications links shall be configured to have connection to both Regional and National Control Centres. These links shall include Tele-protection facilities with four commands per line.
For 33kV substations with a transformation capacity of **less than** 23 MVA, the links shall be designed for connection to respective RCCs. .

The solution offered
These specifications describe the basic requirements for the Telecommunications 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 clients Engineers or 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.

TECHNICAL SPECIFICATIONS

4.1.6.2. ADSS Cable

i. **Design Principles**:

The proposed Fibre cable shall be single mode, 48 core all-dielectric self-supporting cable (ADSS).

The cable shall be designed and manufactured in accordance with the following standards:

- Cable IEEE 1222
- Fiber IEC 60793, ITU-T G.65X series
- Color code ANSI/EIA 359-A, IEC 60304

ii. **Route Survey**:

Prior to design and installation, the contractor shall visit the route accompanied by KPLC staff to ascertain for themselves the requirements for the link. During this survey a pole count and a sketch for the cable installation shall be carried out. This sketch shall indicate the locations of splice boxes and the approximate distances between them. The poles shall also be assessed for their ability to support the ADSS cable. Any need for modification shall be determined at this stage.

Suitable drum lengths shall also be determined at this stage to reduce the number of joints preferably at section poles. KPLC shall assess the contractor's report and carry out modifications where it is felt necessary.

iii. **Installation:**

The cable installation shall be aerial on existing power lines. Majority of these lines are on wooden structures and the ADSS cable shall be installed below the power line. The installation shall be done under live line conditions except in some instances where safe working clearance cannot be maintained.

It is not the intention of the employer to recommend any specific installation method but whichever method applied should be in accordance with the international standards, manufacturer's recommendation and within KPLC safety regulations.

iv. **Installation Materials & Fittings:**

All bolts, nuts and clamps used during the construction shall confirm to IEEE standards that apply to testing and performance of Hardware for All-Dielectric Self Supporting cable (ADSS)

All fitting materials shall conform to the approve standards by IEEE1222. The bidder shall attach type test certificates from the certifying bodies

v. **Splicing & Testing:**

All joints shall be fusion spliced. The splice loss shall be equal to or less than **0.1db**.After all the terminations are done the cable shall be tested from ODF to ODF using the OTDR as well as power meter and the results tabulated.

vi. **Fittings & Spare Capacity:**

Unless otherwise specified in this specification, all requirements for individual components and completed cable shall be mainly in accordance with the following standard specifications.

1EEstd 1222, IEC 60794-4, IEC 60793-1, IEC 60793-2, IEC 60794-1, ITU-T G.650, ITU-T G..652, ITU-T G..655, EIA 492A, EIA 472A, EIA 598 or ANSI/EIA 359-A-1985, ISO 9001 and ISO 14001.

The Contractor shall include **10%** spare cable capacity for future maintenance work on the link at agreed intervals.

4.1.6.3. Fibre Optic Ground Wire (OPGW)

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 earth wire fittings and optical joint boxes shall be type approved.
The manufacturer of the OPGW shall be responsible for the supervision of installation by the Contractor; to ensure that system reliability requirements are met.

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 earth wire 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 earth wire without damage. The fibre optic earth wire (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.
The Contractor shall ensure that the fibre optic cable are not strained or damaged either mechanically or optically during stringing and/ or jointing.
The cable shall be capped before shipment to prevent the ingress of water.

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. Fixing clamps shall be made from a suitable grade of aluminium alloy complying with the requirements of BS 1490 and / or BS EN 1676. Bolts shall be made from mild steel grade S275JR to BS EN 10 025. Bolts and nuts shall be ISO Metric Black Hexagon to BS 4190 and shall unless otherwise specified be threaded ISO Metric Coarse Pitch to BS 3643: Part 2, Tolerance Class 7h/8g.

4.1.6.4. Non – Metallic Underground Fibre Optic Cable

Where required, The fibre optic cable shall be circular in cross section and shall be designed so that any cable strain is so directly imported on the optical fibres. The cable shall not include any metallic components to prevent high-induced voltages when used in switching or substation compounds.

4.1.6.5. Approach Fiber Optic Cable:

The ADSS/OPGW cable shall terminate at first structure after the bus bar at the substations. An underground fibre optic cable shall be run from this structure to the building. This approach cable shall be 48 core SM, armoured, loose tube cable, with a dielectric central member. The cable shall be Kevlar yarn reinforced, steel tape armour and a UV resistant HDPE outer layer. It is for outdoor applications, in ducts, for direct burial or latched installations

4.1.6.6. Optical Distribution Frames (ODF)

The optical fiber distribution frame (OFD) is installed for terminating optical fiber cables and patch cord. The distribution frame should include the metallic casing, adapter plate, splice tray, and other necessary materials for the termination of optical fiber cable. Therefore it should be designed properly for the fiber splicing and distribution. Separate storage shelf and distribution shelf can be offered if required. The OFD shall be of corrosion resistance and robust construction; and shall allow both top or bottom entry for access to the splice trays. Specific selection of the entry points shall be made at the time of installation. The OFD shall be installed on the international standard (ETSI 19”) equipment rack or cabinet rack. The optical fiber distribution frames shall include all necessary parts to complete the joint. This

will comprise all components to protect and store the spliced fiber; and provide sheath continuity. The distribution frame shall be designed with enough spare capacity for fiber splices. The distribution frame shall be made from fabricated mild steel not less than 1.2mm thick or equivalent and painted in good condition. The design of the fiber distribution frame shall allow minor deviations from the escribed installation procedures without any harm to the fibers and the long-term performance of the installation. The shelf and the connection between shelves shall be designed to maintain minimum bending radius of 30mm. the connectors to be used shall be subject to approval by the Project Manager.
Assignment between station fibre cable and OLTE's shall be made by using patch cords between the termination box and the optic distribution frame. Capacity of the optic distribution frame shall allow free assignment between each individual fibre of the station fibre optic cables and the relevant optical I/O ports of the OLTE's.

The optic distribution frame shall be equipped with low loss optical connectors (< 0.25 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

4.1.6.7. Fibre Terminal Equipment

The terminal equipment shall be the type SDH STM-1/4 optical terminal equipment and shall be supplied from 48 VDC source.

SDH (STM-1) multiplexer shall be installed in racks that are EMC compatible and suitable to work in HV system environments.

The multiplexer shall be based on the SDH technology, working on the basic transmission Bit Rate of 155.520 Mbit/s (STM-1). It shall be in accordance with the latest ITU-T SDH recommendations such as: G.703, G.704, G774, G.783, G.784, G.785, G.811, G.812, G.813, G.823, G.825, G.826 and M.3010.

The equipment shall be able to perform both, multiplexing and line terminating functions. The SDH Equipment (Terminal Equipment, Add/Drop Multiplex, Synchronous Digital Cross-Connect) to be offered shall meet the following requirements:

- It shall have at least all the functions outlined in ITU-T G.783.
- The PDH electrical tributary interfaces to the SDH equipment shall conform to ITU-T G.703.
- The SDH electrical and optical interfaces shall conform to ITU-T G.703 and G.957.
- The cross-connect offered shall be capable of providing non-blocking connection between virtual containers.

- The Optical Power to be offered shall be such that under normal operating condition, the BER of the system at the receiver is better than $1x10^{-10}$. Error performance versus the receive signal shall be verified during the factory acceptance tests.

The multiplex structure shall conform to ITU-T G.707. Details of the Multiplex structure for the offered equipment including the usage of the overhead bits shall be detailed with the offer. The synchronous optical interface protection shall be achieved by having 1+1 protection. The laser shall automatically cut-off when the link is disturbed. Redundant cross connect, where failure on either one shall not cause link outage, and path protection on the traffic interface and the 2 Mbit/s levels shall also be provided.

Timing and synchronization shall conform to ITU-T G. 783, G.811, G.812 and G.813. Timing references, number of timing references available, switching time to a different timing reference, type and level of clocks shall be stated in the offer.

The equipment shall automatically switch to another clock if the reference timing is lost and automatically revert back upon restoration. The accuracy of the internal clock as well as the details of the clock signal distribution shall also be stated in the offer.

The equipment shall be capable of diverting timing references between the STM-1, 2 Mbit/s and a G.703 tributary interfaces.

The SDH equipment shall be wired for the full STM-1 capacity, however equipped under the scope of this specification to receive at least four (4) PCM tributaries as specified below. However, if higher PDH signals other than the 2 Mbit/s are required to be routed through, the same shall be possible just by adding the respective interface cards and no extra wiring needed. It shall have 2 Mbit/s outputs where it can directly be connected to digital telephone exchanges or teleprotection equipment.

The jitter and wander tolerance for PDH and SDH interfaces shall conform to ITU-T G.823 and G.825. Jitter and wander characteristics of SDH multiplex and line equipment shall conform to ITU-T G.783.

The Contractor shall submit the details of the power budget calculations stating the following (based on 0.25 dB/km optical fibre attenuation at 1550 nm):

- Transmitter Power
- Minimum receive Signal @ BER $1x10^{-10}$
- Connector Loss
- Repair Splice Loss
- Power Penalty (Chromatic dispersion and LD reflection Loss)
- Maintenance Margin (> 2dB)
- Other Loss
- System Margin
- The SDH equipment to be offered shall provide the followings:

- Remote access to the equipment for monitoring and configuration via Telnet sessions or other SNMP driven process
- A Craft interface in accordance with ITU-T G.773 to allow a local terminal to access the network element.
- Performance monitoring in accordance with ITU-T G.784 and G.826.
- Optical safety as per ITU-T G.783.
- The alarm functions shall include but not limited to:
- Alarms classified as critical, major, minor, and information.
- Indications of loss of incoming signal.
- Visual and audible indication of alarms.
- Test function of alarm indicators to ensure workability of alarm indicators.
- Alarm functions shall be detailed by the Contractor, e.g. if implemented in Telecommunication Network Management System.
- The offered equipment shall have sufficient capacity for speech, Ethernet data, SCADA data etc and capable of extension to higher capacity by adding relevant modules.

4.1.6.8. Specifications For VHF 2-Way Base Radio

NO.	DESCRIPTION	part/model NUMBER	Comments
1	MOTOROLA BASE STATION APX 2500 DIGITAL VHF RADIO Freq;138-150MHZ: *Flashport code:* Complete with:13.5VDC PWR cable, desk microphone, desk Tray		
2.	Fiberglass: COLLINEAR base station omni-directional 3db antenna 138-150MHZ range		
3.	30 METERS RG 213 COAXIAL CABLE		
4.	Mini-UHF Crimp type connector to N-MALE RG213, 2Mtr RG58 N-Male/Mini-UHF pigtail Jumper		
5.	ASTRON POWER SUPPLY UNIT/BATTERY CHARGER	RS 20A-220-BB	
6.	RS-232 Motorola CPS Programming cable	HKN6183	
7.	Motorola CPS Programming software NB; VERSION 19		
8.	75 or 70 AH 12V DC Free maintenance battery		

9.	6 Meter 1-1/2 Galvanized pipe complete with support arms brackets for mounting	HARDWARE STORES	

4.1.6.9. Spare Parts, Tools and Test Equipment

Spares for Telecommunications shall be one module for each type of the modules supplied. Specialised tests tools and equipment for testing, configuration and maintenance of equipment, shall be supplied. This shall include data tester and optical test tools.
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 be new and shall not however be available to the contractor during erection and commissioning. All licences required for commissioning of equipment shall be included.

An OTDR (MTS 8000) or its Equivalent and an Optical Power meter test and source kit to be supplied and The Contractor shall furnish a list of recommended spare parts for the OLTEs.

4.1.6.10. Documentation:

i. 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.
ii. Functional Design Specification (FDS)
iii. Test Specification for Factory Acceptance Test (FAT)
iv. Operator's Manual
v. Product Manuals

4.1.6.11. Training:

The Contractor shall provide 1 week training for four KPLC staff at the supplier's manufacturing premises on each Telecommunication type of equipment supplied and on site during installation works. All training costs shall be borne by Contractor excerpt travel to manufacturers place and accommodation which shall be borne by KPLC. The scope of each service shall be given. The training content shall be subject to approval of the project Manager.

4.1.6.12. Testing

The formal stages of testing to be performed fall into the following three categories:

- Type Tests Equipment shall pass these tests in order to be accepted for use under this Contract

- Factory Acceptance Tests (FAT) Systems shall pass these tests before they may be shipped to site. The employer shall witness FATs unless he waives this in writing. FAT preparation costs shall be borne by contractor except transport and accommodation. FAT shall be carried by two KPLC staff for 5 days..
- Site Acceptance Tests (SAT) Systems shall pass these tests before they may be put into operation and before they are Taken Over

4.1.6.13. System Acceptance

The System will be accepted by KPLC if both:

- The System 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**.**