## 4.1.6. TELECOMMUNICATIONS

### 4.1.6.1. General requirements

In order to achieve the desired SCADA functionality telecommunication links based on either Fibre, Power Line Carrier or Radio shall be established linking the SAS in new substations to respective control centres. Necessary engineering required for transmitting data and speech signals to the Regional and National Control Centre(s) shall be established. The various links shall be based on: Fibre links,48 fibre OPGW or 24 fibre ADSS (figure 8), Digital PLC links while Radios shall be UHF point-to- point or Point-to-Multipoint links.

Where fibre or PLC links are to be installed, teleprotection modules with at least four (4) commands shall be installed.

These specifications describe the basic requirements for the various systems.

Bidders 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.

Bidders 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.

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

**FIBRE CABLE**

## 4.1.6.2. ADSS – FIGURE 8

### Introduction

The proposed ADSS cable shall be figure 8, single mode, 24 core all-dielectric self-supporting cable (ADSS). This is a fibre cable that has a high strength steel cable (messenger) attached to it. The messenger provides the support to the fibre component. This type of cable is preferred where in some distribution substations
The cable shall be designed and manufactured in accordance with the following standards:

| | |
|---|---|
| **(a) Cable** | **IEEE 1222** |
| **(b) Fiber** | **IEC 60793, ITU-T G.65X series** |
| **(c) Color code** | **ANSI/EIA 359-A, IEC 60304** |

### INSTALLATION OF AERIAL FIBRE CABLE

The cable installation shall be aerial on existing or new power lines. Some of these lines are on wooden structures and the figure- 8 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.
Contractors shall demonstrate capacityto carry out the works.

### Grounding Requirements

Like with any cable containing conductive elements, Figure-8 cable must be electrically grounded. Grounding dissipates and limits voltage accumulation by the cable, thus reducing the danger of electrical shock and outside plant damage. Grounding interval requirements will vary and the contractor shall show how this shall be done in his design.

### Messenger Component

Electrical continuity of the strand must be established bybonding messenger spans together at dead-end poles. This may be done in two ways:
Leave sufficient strand past the dead-end fitting so that the two strands can be placed in a bonding clamp.
Jumper between the two strands.
Electrical continuity between parallel strands should also be established at each dead-end pole.
Actual grounding of the messenger shall be done at dead-end poles by jumpering between the stripped messenger strands.

### Approach fibre optic cables

The ADSS aerial cable shall terminate at first structure after the bus bar and at the last pole towards the office building. This is normally a distance from the building. An underground fibre optic cable shall be run from this structure to the building. This approach cable shall be 24 cores SM, armoured, loose tube cable, with a dielectric central member. The cable is glass yarn armoured, steel tape armour and a UV resistant HDPE outer layer. It is for outdoor

applications, in ducts, for direct burial or latched installations. Below is an illustration of an approach cable.

**INSTALLATION MATERIALS**
All bolts, nuts and clamps used during the construction shall confirm to IEEE standard that applies to testing and performance of Hardware for All-Dielectric Self Supporting cable (ADSS). The bidder shall quote the standard used and test certificates for the material shall be provided together with the bid.

**SPLICING AND TESTING**
During the survey, locations for joints in every link shall be determined. These joints shall be preferably at the tension poles. These lengths shall determine the various drum lengths for every link. The design per section shall ensure that minimum numbers of joints are used. 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 and the results tabulated.

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

**Standards**
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.

### 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.

- Optical fibre parameter and performance

- 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 (μm), including tolerances
- Optical cladding diameter: 125 μm ± 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.

**Underground Fibre Optic Cable**

Underground fibre optic cables shall be provided and installed between the splice boxes at the substation gantries to the optical fibre distribution frame installed inside the telecommunication room at the substation control buildings and shall be suitable for laying indoors, outdoors (direct or indirect sunlight), in ducts, on trays, under ground and in water. The cable-sheaths shall be resistant to solar radiation, the effect of oil, bacterial action, insects and rodents. Cable entries shall be protected against insects and rodents. Tenderers shall indicate the type and construction of the underground cables included in their offer

**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 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. It 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)

Each Optical Line Terminal Equipment (OLTE) or SDH multiplexer shall include an optical distribution frame, installed in a own wall mounted fixed cubicle .

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 (< 0.3 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. FIBRE TERMINAL EQUIPMENT

**Specifications**

The terminal equipment shall be the type SDH STM-1 optical terminal equipment

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:
- A data communication channel to the Telecommunication Management Network, in accordance with ITU-T G.773 for the purpose of integration of the new equipment into the Telecommunication Network Management System.
- A Craft interface in accordance with ITU-T G.773 to allow a local terminal to access the network element.
- An engineer order–wire which shall have conference and selective calling features.
- 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.

### 4.1.6.6. POWER LINE CARRIER

State-of-the-art single side band multipurpose DPLC terminals shall be installed in the network. The modulation shall be single step without use of intermediate frequencies. It shall be possible to operate transmitter and receiver in adjacent frequency bands or in non-adjacent bands

The equipment shall be operated with a channel bandwidth of 8 kHz in each direction in a carrier frequency range of 40 kHz to 500 kHz. The Bidder shall state the range of channel bandwidths > 8 kHz that are available for increasing the data rate. The methods of transmission shall be clearly stated with the offer.

Any limitations in paralleling their own or other manufacturer's equipment shall be stated with details of necessary frequency spacing. The equipment shall be compatible on the line side with any existing equipment, both analogue and digital, i.e. coexistence shall be possible.

The design of the DPLC terminal equipment shall be modular, based on dedicated processors and interfaces for the different services as necessary (data, speech and teleprotection) and shall employ self-monitoring functions.

All DPLC terminals shall be equipped with data transmission interfaces for connection to the RTUs and with telephone interfaces (2/4 wire) for connection to the PAX/PABXs and/or to the remote subscriber telephone sets.

The installation of different interface cards in any combination, according to the needs of the different links in the network shall be possible. The Bidder shall describe any restriction regarding combination of interfaces. Where the offered equipment has interoperability restrictions to existing links, bidders shall in scope of supply deliver complete links to respective regional control centres.

The equipment shall be furnished with local failure indication by LEDs and potential free contacts for external alarm annunciation (for higher level supervision and monitoring in a future SCADA system).

Besides a general alarm/warning, single alarms shall at least be generated for:

Transmitter failure,
Receiver failure,
Signal-to-noise ratio too small
DC supply failure.

The terminals shall be equipped with a telephone handset to be used for maintenance purposes or in emergency situations and with a test tone generator.

Provision shall be made for terminating the HF output with an appropriate dummy load for test purposes.

The bidder shall perform calculations in accordance with IEC 60663 detailing coupling equipment, line attenuation and any other losses in order to show that the proposed PLC system will attain a signal-to-noise ratio of not less than 30 dB for full digital operation under fair weather conditions.

**Digital Transmission Multiplexing System**

The unit shall be a universal service multiplexer, which for a given bandwidth transfers speech and data channels in a multitude compared to traditional technologies. It shall use latest Digital Signal Processor (DSP) technology, permitting the implementation of a transmission system, which is robust, and economical with bandwidth. If the bidder proposes an external MUX, the advantages of the solution shall be explained.

The system shall use Multi Carrier Modulation for converting the digital data to a suitable line signal. Important channel parameters shall be continuously monitored in order to detect and

compensate changes in line characteristics resulting in optimal transmission quality at all times.

The systems data rate shall be programmable over the range of 1200 bit/s to 64 kbit/s. The Bidder shall state the range of available system data rates and DPLC transmission bandwidths. An adjustment facility shall permit optimal capacity utilization of the presently available bandwidth.

In case of channel noise ratio changes, the data rate shall be automatically adjusted to new conditions. In case of worse signal-to-noise ratio, the data rate shall be reduced until an adequately low bit error rate in reinstated. When the conditions improve, the transfer rate shall automatically raise accordingly. The step width for this rate adjustment shall be programmable.
The equipment shall be capable of boosting protection-signaling inputs along with suppression of voice/tele-control during transmission of protection trip-signals.

In substations with low traffic volume, a PABX switching system may not be economically viable. In such cases a local subscriber shall access the remote PAX on two-wire basis via a connection to the multiplexing system. The standard performance features shall be available at the subscriber station.

**Data Channels**
The DPLC equipment shall be capable for data transmission. It is foreseen to operate the data channels for the SCADA data transfer at a rate between 2400 to 9600 bit/s. It shall be possible to utilize the capacity of speech channels, which are not in use for improving of data transmission capacity. The Tenderer shall state with his offer the data rates possible.

**Service and Test Functions**
It shall be possible to connect a PC with the appropriate software based on an MS-Windows-XP-Professional (latest build) to the DPLC terminal and perform any service and test functions. The change of transmission frequency, change of bandwidth and sideband, the configuration of speech, data and teleprotection channels and the execution of test procedures shall be programmable as a minimum. The PC shall also be used for monitoring of the DPLC equipment.

**Power supply**
Each DPLC terminal equipment shall be connected individually to one feeder of the DC supply distribution panels. No inter-equipment looping of supply circuits is allowed.

**RADIO SYSTEM**

## 4.1.6.7. UHF POINT TO POINT RADIO

**Description**
A solution is sought to connect a remote station to a master station for data and voice communication.
The radio, the data communication Equipment (DCE) is to connect data terminal equipment (DTE) via a standard RS232 serial interface at a data rate of 9600bps.
Standard connectors must be used: DB25 or DB9
The DCE is to be fully transparent to data from DTE at both ends.
For voice communication, One analogue, 2- wire telephone is to be extended to the remote station, hence, an FXO is to be provided at the master station and an FXS (with a ringer) at the remote end.
A **VHF 2-way Base Radio** shall also be provided for each remote site.
The **radio** shall be supplied with a **wall mounted, lockable, 12-U cabinet**, with the interfaces (Data, voice and antennae) extended to a more accessible place.
The vendor shall carry out **site surveys**, to determine **the line of site** and perform RF **path calculations** for optimal performance of the Radio link.
The vendor shall also supply **antennas, feeder cables** and other accessories necessary for installation of the remote Radio, and shall also install and test the **Radio link**.
The minimum performance parameters of the radio link shall be:

- **Fade margin: >30dbm**
- **SNR: >30dB**

The installation shall be **professional** with **standard grounding** of the **feeder cables** and the **equipment,**
The vendor is to decide on how to integrate the solution on condition that, any additional equipment like a multiplexer must meet the network management specifications of the radio.
Specifications for the UHF radio equipment and **VHF 2-way Base Radio** are given below.

**UHF POINT TO POINT RADIO SPECIFICATIONS**

**General**

- Standard: ETSI
- Transmission: Subrate,
- Frequency Band: 300-512 MHz
- Channel size: >25,
- Data rates: 64 kbps with overhead
- Modulation: Digital,

**Transmitter**

- Output control range: minimum 10 steps of upto 10dB.
- Freq. Stability: < 1.5 ppm.
- Output power: 30dBm
- Residual BER: $<1x10^{-6}$

**Interfaces:**

- Data: EIA 530 D25 DCE / G.703
- Oderwire: DTMF capable

- Ethernet NMS: 10 Base-T
- Configuration Port: RS-232, 300 bps – 115.2 Kbps
- Alarms: At least 2 programmable outputs, 2 programmable inputs
- Antenna: 50 Ohms impedance

**Network Management**

- Local LED Indicators: LED status indicate-Power, general alarm, TX alarm, Rx alarm, I/O alarm
- Element Management: Full management via command line interface, Full IP based management through SNMP and HTML Web Server.
- Remote element management: Able to manage remote radio over the air.

**Environment**

- Temp:-10 to +60C
- Humidity: <95% non condensing

**Electrical**

- Power consumption: <80W
- Voltage range: ±48 Vdc

**Mechanical**

- Rack mounted standard cabinet – 1 U

- Weight: Max 10kgs

**Agency Approvals**

- Transmission: FCC Part 90, 74, 22, IC RSS-119
- EMC: ETS 300 385, FCC Part 15

**System Performance**

- Receiver Sensitivity at (10-6 BER) : <-90dbm

- System Gain at (10-6 BER) : >120db

### 4.1.6.8. POINT TO MULTIPOINT RADIOS

**Description**

A solution is sought to provide **Remote radios** to operate in an existing point to multipoint radio communication system based on the UHF licensed frequency band, to be used for **data acquisition**.

The system consists of a **Master station**, with a **master Radio**, and **remote stations** with **remote radios.**
The **radio system** provides a **transparent data channel**, where communication is managed by the **central data acquisition system**.
The remote radios must operate with an existing master radio of type MDS 4790 whose specifications are outlined.
The remote radio shall be supplied with a **wall mounted, lockable, 12-U cabinet**, with the interfaces (Data and antennae) extended to a more accessible place.
The vendor shall carry out **site surveys**, to determine **the line of site** and perform RF **path calculations** for optimal performance of the Radio link.
The vendor shall also supply **antennas, feeder cables** and other accessories necessary for installation of the remote Radio, and shall also install and test the **Radio link**.
The minimum performance parameters of the radio link shall be:

- **Fade margin: >30dbm**
- **SNR: >30dB**

The installation shall be **professional** with **standard grounding** of the **feeder cables** and the **equipment,** with **lightning protection**.
Voice communication at the remote stations to be realized through one **VHF, Two-way base radio** for each station, compatible with an existing, **APCO, Project 25(P25)** based **VHF digital trunking Radio system**.
The specifications for the VHF base radio shall be outlined.

**MASTER RADIO SPECIFICATIONS**

**General**

- Make: MDS 4790
- Actual operating frequency: TX 360MHZ, RX 370MHZ
- Data Rate (Data): 110 bps - 38.4 Kbps
- Frequency programmability: 6.25 kHz increments to any MAS channel pair
- Operational modes: asynchronous - half-duplex, full-duplex, protected.
- Modulation: digital
- Latency (Rx-Tx-Rx): <10 ms including RTS/ CTS delay
- CTS Delay: 0-255 msec programmable in 1 msec increments
- Range: Up to 50 miles
- RF Data Rate: upto 19,200 bps
- Frequency Bands: 330 - 512 MHz
- Network wide diagnostics: Management software managing the master and remote radios. The software used is Insite 6.

**REMOTE RADIO SPECIFICATIONS**

**General**

- Data Rate (Data): 110 bps – 19.2 Kbps
- Modulation: digital
- Range: Up to 50 miles
- RF Data Rate: 19200 @ 25 kHz

- Frequency Bands: 330 - 512 MHz

**Transmitter**

- Frequency Stability: +/- 1.5 ppm
- Carrier power: 0.1 to 5 Watts Programmable
- Carrier power Accuracy: Normal +/- 1.5 dB
- Duty Cycle: Continuous
- Output Impedance: 50 Ohms

**Receiver**

- Type: Double Conversion Super heterodyne
- Selectivity: >70dB
- Bit Error rate: <1x10-6 @ -110 dBm typical

**Interfaces**

- Data interface: EIA/RS-232, DB25 Female
- Data Rates: 1200–19200 bps, asynchronous
- Diagnostic: RS232, DCE, 300 bps – 115.2 Kbps

**Management**

- Local: Via -Diagnostic port
  -Front panel display: DCD, RX activity LED, TX activity LED.
- Network wide management

**Environmental**

- Temperature: -30°C to +60°C
- Humidity: Min 95% at 40C (104°F) non condensing

**Mechanical**

- Rack mounted standard cabinet – Max 1 U
- Weight: Max 5kgs

**Electrical**

- Primary power ±48 Vdc
- Power required < 30 Watts nominal

**Agency Approvals**

- Transmission: FCC Part 90, 74, 22, IC RSS-119
- EMC: ETS 300 113, EN 300, 279

## 4.1.6.9. SPECIFICATIONS FOR VHF 2-WAY BASE RADIO

**General**

- APCO. PROJECT 25 compatible for trunking system
- Frequency range: 136-174 MHz
- Modulation: C4FM of QPSK-C family
- Protocol: Project 25-CAI (4.4 kbps IMBE, 2.8 kbs Error Correction Coding, 2.4 kbps Embedded Signaling)

**Channel Bandwidth**

- **Analogue**: 12.5/25/30 kHz (136-174 MHz)

- **Digital:** 12.5 kHz

**Voice coder**

- Voice Coding Method IMBE (CAI): Improved Multi Band Excitation (IMBE)
- Frame Re-sync Interval: 180 mSec (Clear Digital Mode)
- Forward Error Correction: Golay code

**Signaling**

- Signaling Rate:9.6kbps
- Error Correction Techniques: Golay, BCH, Reed-Solomon codes

**Transmitter**

- RF Power:10-50W
- Max Freq Separation: Full Bandsplit
- Freq Stability Operating Freq Accuracy<2ppm

**Electrical**

- Power Supply: 13.8V DC ±20% Negative ground
- Standby at 13.8V DC ±20%: 0.85A
- Transmit current at rated power 13.8V DC ±20%:13A (50W)
- Receive at 13.8V DC ±20%: 3.2A

**Environmental**

- Operating Temperature: –30ºC / +60ºC
- Ingress Protection: IP54 certified

### 4.1.6.10. SPARE PARTS

The bidder shall include any special tools and test
The Contractor shall furnish a list of recommended spare parts and test equipment for the fibre and OLTEs. The spare parts list shall be subdivided into:

- short-term spare parts that are necessary for two (2) years of operation. These spare parts shall be included in the contract and shall comprise at least one spare module for supplied equipment and basic tools for system maintenance.
- long-term spare parts that are necessary for ten (10) years of operation.

### 4.1.6.11. TOOLS AND TEST EQUIPMENT

The bidder shall include special tools and test equipment needed to maintain the fibre (including OTDR and splicing Kit), PLC, Radios and OLTEs over their expected lifetime. Bidder shall provide relevant technical data/pamphlets for all the items. The test kit shall include necessary laptops and all equipment applications and their licences.

- 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.

### 4.1.6.12. DOCUMENTATION:

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

b. The following documentation should be provided for the system in the course of the project. It shall be consistent, CAD supported and of similar look/feel:

c. Control Room Layout
d. Single-Line Diagram
e. Block Diagram
f. Circuit Diagram
g. List of Apparatus/ Equipment
h. List of Labels
i. Functional Design Specification (FDS)
j. Test Specification for Factory Acceptance Test (FAT)
k. Logic Diagram
l. List of Signals
m. Operator's Manual
n. Product Manuals
o. Calculation for uninterrupted power supply (UPS) dimensioning
p. Concept and contract for maintenance
q. It is necessary to present the technical description and the technical data for the whole system and for any equipment and function
r. Time plan for the project realization.

### 4.1.6.13. TRAINING:

- The Contractor shall provide 1 week training for four KPLC staff at the supplier's manufacturing premises oneach Telecommunication type of equipment supplied and on site during installation works. The scope of each service shall be given.

### 4.1.6.14. TESTING

The formal stages of testing to be performed fall intothe 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 shall be carried out for fibre, SCSMS and OLTE
- Site Acceptance Tests (SAT) Systems shall pass these tests before they may be put into operation and before they are Taken Over

### 4.1.6.15. SYSTEM ACCEPTANCE

- The System will be accepted by KPLC if both:
- The System and all items of equipment have successfully completed all the specifiedtests
- 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**.**