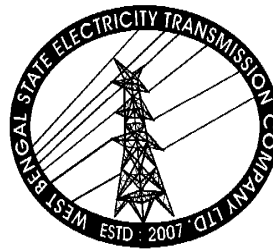


OPTICAL EQUIPMENT



September 2017

Engineering Department

WEST BENGAL STATE ELECTRICITY TRANSMISSION COMPANY LIMITED

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Technical Specification of Optical Equipment

1.0 Description

This is a technical specification for survey, planning, co-ordination with other suppliers' equipment, design, Engineering of multi input and multi output fibre optic equipment complete for speech communication in dialing mode and or through express telephone, data communication, fibre optic based power system protection, suitable for multi point to multi point fibre optic network for Sub-Stations.

The fiber optic link shall be based on minimum STM-4 bit rate. The Bidder, however can propose a system based on higher bit rate systems meeting the fibre optic link budget requirements. One complete equipment meeting the specifications requirement in lieu of separate Fibre Optic Terminal Equipment and Multiplexer may also be referred to. Mandatory spares for the offered equipment should be available to the manufacturers for another 15 years or more.

The security related requirements of the equipment shall be as per DOT (Department of Telecommunication) guidelines and all similar security requirements as amended by DOT on time to time basis shall be followed/complied by the vendor at no additional cost to Employer till the implementation of the project.

The manufacturer shall allow the Employer and/or its designated agencies to inspect the hardware, software, design, development, manufacturing facility and supply chain and subject all software to a security /threat check any time during the supplies of equipment

The contractor shall ensure that the supplied equipment have been got tested as per relevant contemporary Indian or International Security Standards e.g. IT and IT related elements against ISO/IEC 15408 standards, for Information Security Management System against ISO 27000 series Standards, Telecom and Telecom related elements against 3GPP security standards, 3GPP2 security standards etc. from any lab in India.

The Contractor shall also ensure that the equipment supplied has all the contemporary security related features and features related to communication security as prescribed under relevant security standards. A list of features, equipments, software etc. supplied and implemented in the project shall be given for use by the Employer.

In case of any deliberate attempt for a security breach at the time of procurement or at a later stage after deployment/installation of the equipment or during maintenance, liability and criminal proceedings can be initiated against the Contractor as per guidelines of DOT and any other Government department.

2.0 Scope of Work

Survey, planning, design, engineering, supply, transportation, installation, termination, testing, commissioning and documentation of:

- (i) Fibre Optic Transmission System (FOTS) suitable for multi-point to multi point fibre optic network which can be designed for linear type/mesh type/ring type as required including optical & electrical interfaces, DDF, racks, synchronization, Network Management System (NMS) etc.
- (ii) Multiplexer including Voice, data & protection cards to achieve simultaneous transmission/reception of voice & data from/to one station to/from another two three or more stations.
- (iii) All required cabling, wiring and interconnections to the supplied equipment at the defined interfaces. All the subscriber channels shall be terminated on Main Distribution Frame(MDF).
- (iv) Interconnection of equipment with PABX, Telephone sets, Fibre Optic Distribution Panel (FODP), existing PLCC system directly or through EPAXes, new PLCC system directly or through EPAX etc.
- (v) Integration with existing PLCC equipment /system and new PLCC equipment /system directly and through EPAX for data,carrier aided protection and voice communication.
- (vi) Integration with existing Fiber Optic equipment/system and new Fiber Optic equipment/system directly and through EPAXes for data, carrier aided protection and voice communication.
- (vii) Integration with existing EPAX.
- (viii) Integration of fibre optic system with power system for power system protection. Power system signal may be either electrical that shall meet CCITT Recommendation G.703-1 & G.703-6 or optical.
- (ix) Installation of power supply system (48 Volt DC with positive ground) wherever required.

3.0 DRAWINGS AND TECHNICAL LITERATURE:

For the purpose of submission of Tender, the following Drawings and Technical Literature in Triplicate shall be submitted by the bidder along with the Tender:

- a) Detailed Drawing of each equipment showing Block Diagram, Plan, Elevation and Side view with all dimensions and weight.
- b) Schematic drawing of complete installation of equipment at each substation.
- c) Technical Literature covering details of erection, operation, maintenance and technical particulars of each equipment.
- d) Technical Literature furnishing principle of operation and detailed Circuit Diagrams of Equipment wherever applicable.
- e) All software details.

The Contractor shall ensure that all the documents, including software details are supplied to the Employer in English language. A record of all the software updation and changes shall be given to the Employer and any major updation and changes shall be done with the prior approval of the Employer.

4.0 Functional Requirement

4.1 Description

The proposed fibre optic communication network shall support the voice & data communication requirements of RTUs, SCADA/EMS system Power system protection and other operational requirements. The communication system shall provide data & voice connectivity across the various locations or connectivity of RTUs with Control Centres (SLDC and Back Up SLDC). . The RTUs located at various locations will report to Control Center using IEC 60870-5-101 or IEC 60870-5-104 Protocol. The proposed communication system shall provide connectivity of some RTUs over TCP/IP protocol using Ethernet interface and other RTUs over serial interface. The offered communication System shall support the communication requirements of RTUs and the SCADA/DMS system described in point to multi point and/or multipoint to multipoint configurations using Ethernet over SDH.

The fibre optic network shall be based on the Synchronous Digital Hierarchy (SDH) having bit rate of STM-4. The network shall consist of overhead fibre optic links with a minimum bit rate of Synchronous Transport Module-4 (STM-4) for nodes falling in ring and linear network. The Contractor can propose a system based on higher bit rate systems, if required, so as to meet the link budget requirements or any other specification requirement.

- 4.2** The primary function of the communication network is to provide a highly reliable voice & data communication system in support of the SCADA/EMS and tele-protection system for power system protection. The communications support requirement for SCADA/EMS system is for low & high speed data, express voice circuits and administrative voice circuits.

The communications channel requirement system shall be as follows:

- (a) High speed E1 channel support
- (b) 64kbps & nx64kbps data channel support
- (c) Low speed (300 -1200 bps) data channel support
- (d) Voice (2 wires, 4 wires) channel support.
- (e) Network Management channels either through (Data Communication Channel (DCC) or through data channel as may be suitable as per site requirement.
- (f) The connectivity envisaged between RTUs and Control Centre is Wide Area Network (WAN) on TCP-IP using IEC 60870-5-104 protocol and IEC 60870-5-101 protocol.
- (g) Teleprotection interface (min. four commands) for simultaneous transmission and reception of trip (teleprotection) signal from/to one station to/from another two three or more stations.

Teleprotection interface should be equipped with 64Kbps E1 interface to communicate with remote end teleprotections through fiber optic equipment. Teleprotections should be capable to communicate with remote end teleprotections directly or through fiber with 64Kbps E1 as back up path through fiber optic equipment.

4.3 System Synchronization

The Contractor shall synchronize the existing equipment and all the new equipment under the contract using existing Master clock. The Contractor shall provide the additional clocks as required. In addition to GPS input reference, the synchronization clock must have provision to take INPUT reference coming from other clock. The contractor shall submit the

synchronization plan as per standard ITU-T G.811. All sync equipment proposed under this contract should meet ITU-T G.811 criterion. The holdover quality of slave clock, if any, shall meet ITU-T G.812 standard requirements.

The Contractor shall provide system wide synchronization fully distributed throughout the telecom network and connected to all equipment new & existing. The Contractor shall submit the synchronization plan for the entire network meeting the requirement of ITU-T G.803. The synchronization plan shall clearly indicate the requirement of additional clocks with full justification.

The system equipment requiring "clock" shall be connected to the master clock using external clocking. For this purpose, appropriate interfaces(s) in the transmission & termination equipment being supplied and all other associated hardware shall be provided by the Contractor.

5.0 Equipment Availability

The availability of fibre optic link (E2 to E2) shall be at least 99.999%. The average per link subscriber to subscriber availability shall be at least 99.97%. The per link subscriber to subscriber availability is defined as the availability between any two data or voice subscribers between RTU to reporting Control Centre and between control centers.

The calculated availability is defined as the theoretical availability determined by a statistical calculation based on the mean-time-between-failure (MTBF) and the mean-time-to-repair (MTTR) of the components and subsystems comprising the FOTS. The down time of available standard fibre optic cable shall also be considered in the aforesaid availability calculations although the supply and installation of the same is not part of this specification.

In order to ensure that the equipment & configuration proposed by the Bidders shall be capable of demonstrating of the specified availability figures it is required that the Bidder shall include in their proposal a calculated availability analysis for the proposed equipment/sub system. The calculated failure rates of the units and the calculated availabilities of the equipment being offered shall be provided in the proposal. The analysis shall be based on an availability block diagram and shall include the mean-time-between-failure (MTBF) and the mean-time-to-repair (MTTR) of all of the components on the link. The Bidder shall indicate in the analysis the MTBF and MTTR and the resulting availability of each point-to-point link. For this analysis, an MTTR of at least 4 hours shall be assumed.

6.0 Survey requirements

The Bidder shall carry out the survey at respective Sub-Stations and other linking Sub-Stations to assess the requirements. The required wiring and cabling for the integration with new & existing PLCC system, new & existing Fiber Optic system, new & existing EPAXs, space requirements, power supply requirement. Patching of proposed FOTS equipment with FODP shall also be assessed by the Bidder during the Site survey.

7.0 General Equipment Characteristics

All Bidder's supplied equipment shall be new and of the finest production quality. The Owner will not accept modules or printed-circuit boards that are modified by appending wires or components. Wired strapping options shall be incorporated in the board design to meet the above requirement.

Bidder shall furnish with their bids, detailed functional description, Guaranteed Technical particulars etc. of the equipment such as OLTE including MUX, FOTS, EPAX, Battery charger, Battery etc. The information should meet the specification requirements and should include information of manufacturers and type of equipment.

7.1 Redundancy Requirements and Protection Schemes

Equipment redundancy and Automatic Protection Schedule (APS) are specified in the Table 1.

Table 1
Equipment Redundancy Requirements Summary

Fibre Optic transmission Equipment :	
Fibre Optic Terminal equipment	
Power Supply & Converters	1:1 APS or distributed power supply
Common Control* Cards	1:1 APS
DACS (Cross Connect)	1:1 redundant
Power Supply & converters	1:1 APS or distributed power supply
Common control* cards	1:1 APS
Multiplexer Power Supply	1:1 APS or distributed power supply
*= Common control cards which are essentially required for operation of the equipment.	

The offered equipment shall support automatic switchover function between the redundant modules and all required modules and hardware to support the automatic switch over shall be provided by the Bidder.

7.2 Lost Signal Recovery

At any digital signal level, reapplication of a lost signal shall result in automatic resynchronization and full restoration to normal operation without manual intervention. All alarms incident to the signal failure, shall be automatically cleared at the equipment, rack and monitoring levels and normal operation indications restored and reported if applicable.

7.3 Software Upgrades

The Contractor shall provide antivirus software along with all the computer hardware/software. Further, to meet all the specifications requirements during implementation, if upgrade in the hardware/software of supplied item is required, the same shall be done by the contractor without any additional cost to the Employer.

7.4 General Site Considerations and Fibre Optic Link Lengths

All fiber optic links up to 250 kms transmission line length shall be implemented by the Contractor without repeaters. In order to meet the link budget requirement, the Contractor shall provide all the necessary equipments only in the end stations. The contractor may provide the optical amplifier, wave length translator, optical cards or high capacity SDH equipment with suitable rack/subrack to meet the maximum distance limit. All the provided equipments shall be monitored by centralized NMS.

Optical Ground Wire (OPGW) with G.652D fibres shall be installed and terminated on FODP.

7.5 Fibre Optic Transmission System

The Fibre Optic Transmission System (FOTS) is defined herein to include ETSI digital optical line termination equipment. The FOTS shall be based on SDH technology. Minimum aggregate bit rate shall be STM-4 and equipped with 2 nos. of minimum 16 port E1 interface(G.703) card, one no. of minimum 4 port Ethernet interface (IEEE 802.3/IEEE 802.3u) card supporting layer 2 switching as tributaries. The Ethernet interfaces shall support VLAN (IEEE 802.1P/Q), spanning tree (IEEE 802.1D) quality of service. Protection scheme for Ethernet traffic should be ERPS based (Ethernet ring protection scheme) as per ITU-T G.8032.

The Contractor shall provide (supply and install) connectorised jumpers (patch cords) for FODP-to-equipment and equipment-to-equipment connection. Two number spare jumpers shall be provided for each equipment connection. Fiber jumpers shall be of sufficient lengths as to provide at least 0.5m of service loop when connected for their intended purpose.

7.6 SDH Equipment

7.6.1 Functional Requirement

The SDH Equipment is considered to be divided in three parts i.e. Optical interface/SFP, Tributary Cards (Electrical tributaries such as E1 & Ethernet 10/100 Mbps) and Base Equipment (Consisting of Common Cards, Control Cards, Optical base card, Power supply cards, sub-rack, cabinet, other hardware and accessories required for installation of equipment i.e. everything besides optical interface/SFP and tributary cards). If bidder is offering equipment with multifunction cards such as cross-connect or control card with optical interface/SFP or tributary interface, such type of multifunction card shall be considered as Common control card and shall be the part of base equipment. In case optical interface/SFP is embedded with control card, the adequate number of optical interface/SFPs shall be offered to meet the redundancy requirements of the specifications. Further, control card shall not be equipped with more than one optical interface/SFP and optical base card shall not be equipped with more than two optical interface/SFPs.

The equipment shall be configurable either as Terminal Multiplexer (TM) as well as ADM with software settings only.

7.6.2 STM-4 (MADM) with 3 MSP protected direction.

The aggregate interfaces shall be (at least) STM-4 towards at least three/four protected directions (Protected as specified in this specifications). At present the equipment shall be equipped with a 2 nos., min.16 E-1 port electrical tributary cards & one no., min.4 port Ethernet interface card as tributaries. The equipment shall provide non-blocking cross connect capability of 64 STM-1 (bi-directional) at high order VC-4 level and as well as at low order VC-12 level.

7.6.3 Redundancy and Protection

Two fibre rings shall be implemented wherever the network permits. On linear sections of the network, protected links using 4 fibres shall be implemented.

7.6.4 Service Channel

Service channels shall be provided as a function of the SDH equipment and shall be equipped with Service Channel Modems that shall provide at a minimum: One voice channel (order wire) with analog interface (0.3 to 3.4 kHz) and one data channel. Both omnibus and selective calling facilities shall be provided. There shall be a facility to extend the line system order-wire to any other system or exchange lines on 2W/4W basis.

7.6.5 Supervision and Alarms

ISM (In Service Monitoring) circuitry shall be provided as a function of the SDH equipment. Local visual alarm indicators shall be provided on the equipment, as a rack summary alarm panel. Alarms shall be as per ITU-T Standards G.774, G.783 and G.784. Additionally, F2/Q2 interfaces for a local craftsperson terminal interface and remote equipment monitoring is required.

The Equipment shall support collection of at least four (4) external alarms for monitoring and control of station associated devices by the TMN.

7.6.6 Synchronization

The equipment shall provide synchronization as per Table-2. One 2MHz synchronization output from each equipment shall be provided.

7.6.7 Electrical and Optical I/O Characteristics and General Parameters

Table 2 provides the electrical and optical characteristics as well as other general parameters for SDH equipment.

Table 2

Electrical and Optical I/O Characteristics and General Parameters	
Optical Wavelength - NOTE (1)	1310/1550nm
Optical Source - NOTE (2)	Laser
Optical Source Lifespan	Better than 5 X10 ⁵ hours
Optical Fibre Type	G.652 D
Optical Connectors	Type FC-PC
Transmission Quality	Per ITU-T G.821, G.823, G.826
Source Primary Power	-48 Vdc
Equipment Specifications	Per ITU-T G.783
Tributary, Electrical Interface	Per ITU-T G.703, 75 Ω
Ethernet Interface	10/100 Mbps
SDH Bit Rates	Per ITU-T G.703
Optical Interfaces	Per ITU-T G.957, G.958
Frame and Multiplexing Structure for SDH	Per ITU-T G.707
Synchronization	Per ITU-T G.813
Management Functions	Per ITU-T G.774, G.784
Protection Architectures	Per ITU-T G.841
Built In Testing and Alarms	Per ITU-T G.774, G.783, G.784

NOTE (1) Optical wavelength shall be selected considering the characteristics of the optical fibre and the link budget.

NOTE (2) **Eye Safety for Laser Equipment:** To avoid eye damage, when a receiver detects a line interruption, it is required that the optical power of the laser shall be reduced to safe limits on the transmitter in the opposite direction as per ITU-T G.958.

NOTE (3) In case other than FC-PC connector is provided in the equipment, suitable patch cord with matching connector are to be provided to connect with FODP.

7.6.8 Optical Link Performance Requirements

The optical fibre link performance requirements are specified as follows:

7.6.9 Link Budget Calculations

The fibre optic link budget calculations shall be calculated based upon the following criteria:

(1) Fibre attenuation: The fibre attenuation shall be taken to be the guaranteed maximum fibre attenuation i.e. 0.21 dB/Km @1550nm and 0.35 dB/km @1310nm.

- (2) Splice loss: Minimum 0.05 dB per splice. One splice shall be considered for every 2kms.
- (3) Connector losses: Losses due to connectors shall be considered to be minimum 1.0 dBper link.
- (4) Equipment Parameters: The equipment parameters to be considered for link budget calculations shall be the guaranteed "End of Life (EOL)" parameters. In case, the End of Life parameters are not specified for the SDH equipment, an End of Life Margin of at least 2 dB shall be considered and a similar margin shall be considered for optical amplifiers.
- (5) Optical path Penalty: An optical path penalty of at least 1 dB shall be considered to account for total degradations due to reflections, inter symbol interference, mode partition noise and laser chirp.
- (6) Maintenance Margin: A maintenance margin of at least 2.5 dB/100Km shall be kept towards cabling, repair splicing, cable ageing and temperature variations etc.
- (7) Other losses: Other losses, if any required specifically for system to be supplied shall also be suitably considered.
- (8) Dispersion: The fibre dispersion shall be taken to be the guaranteed maximum dispersion i.e. 18 ps/nm.Km@1550 nm & 3.5 ps/nm.km @ 1310 nm for DWDM fibres.
- (9) Bit Error Rate: The link budget calculations shall be done for a BER of 10^{-10} .

The bidders shall determine the total link loss based on the above parameters and shall submit the system design (including link budget calculations) for each category of fibre optic link during detailed engineering.

For finalising the FOTS system design & BOQ, above methodology shall be adopted taking into account fibre attenuation, dispersion and splice loss determined during the detailed engineering. Accordingly, additions and deletions from the contract shall be carried out based on unit rates indicated in the contract.

7.6.10 Link Performance

The Link performance for ES, SES and BER for the fibre optic links shall correspond to National Network as defined in ITU-T G.826.

7.6.11 Built-in Testing

OLTE equipment shall be provided with in-built testing capabilities as follows :

- (i) Loopback: Each OLTE transceiver pair shall be able to provide local (manual) and remote on demand loopbacks of the composite baseband and each E-1 port
- (ii) Alarms and Indicators : Alarms and indicators shall be provided on the equipment

7.7 FODP to OLTE (SDH) Connectivity

The Bidder shall be responsible for connectivity between the FODP (to be provided under separate contract) and the Fibre Optic equipment. The Bidder shall provide suitable patch-cords of suitable length as per requirement. However, min. length shall be 10 m.

The patch-cord return loss shall be equal to or better than 50 dB and insertion loss equal to or better than 0.5 dB. The patch-cord length between the FODP and equipment rack shall be suitably protected from abrasion, crush or mechanical damage otherwise by flexible conduits or equivalent. Owner approved techniques.

7.8 Termination Equipment Subsystem

The Termination Equipment Subsystem is defined to include the equipment that interfaces (adapts) the subscriber (user) to the Fibre Optic Transmission System (FOTS). A Functional description of these equipment are as follows:

7.8.1 Functional Description

The transmission network node provides subscriber interface to the transmission network and/or switching/routing. For clarity, the basic functions accomplished at the network nodal points, are described briefly as follows:

Primary Multiplexer shall be used to accomplish subscriber connectivity to the Digital Communication Network. Subscriber Line Units shall provide analog to digital and direct digital conversion to 64 Kbps digital channel. In the CEPT standard hierarchy, thirty (30) such 64 Kbps digital channels shall be Time Division Multiplexed (TDM) resulting in a single 2.048 Mbps (E-1) digital bit stream.

Digital Drop-Insert and Branching Equipment shall be used to digitally interface a small number of channels at spur locations without requiring successive D/A and A/D conversions of the throughput channels.

Digital Cross connect Equipment (DACS) shall be used to provide software controlled dynamic routing/rerouting of the primary (E-1) bit stream as well as the 30 channels of the E1 bit stream.

The equipment shall also have an interface for external 2048 kHz synchronization signal according to ITU-T Recommendation G.703.

MUX should have redundant power supply cards, controller cards etc.

7.8.2 First Order (Primary) Multiplexing

Primary Multiplexer shall be of multi input-multi output used to accomplish various interfaces for voice, data & protection signal connectivity and to provide optical interface modules for communication with various stations in the network depending on channel design in order to achieve simultaneous transmission/reception of voice, data&protection signals from/to one station to/from another two, three or more stations. The Contractor shall be required to provide E-1 Drop & Insert Multiplexer and E-1Channel Bank primary multiplexing in compliance with the electrical input-output characteristics provided in Table 3.

7.8.3 Drop & Insert Primary Multiplexing

Drop & Insert primary multiplexing in conformance with CEPT E-1 characteristics shall be required at locations where the subscriber requirement is minimal. The drop and insertion of up to thirty 64 Kbps channels supporting subscriber line units (SLU) shall be required at intermediate locations. The Drop& Insert Muxes supplied shall be performance and card compatible with the Channel Bank Equipment provided so that all Subscriber Line Interface cards are interchangeable.

Table 3
CEPT E-1 Standard First Order Multiplexing

Electrical Input/output Characteristics

Applicable Standards:	CEPT per CCITT Recommendation G.702, G.703-1, G.703-6, G.711 and G.712
Number of Tributaries:	30 X 64 Kbps
Alternative Sub-rate Tributaries:	n x 64 Kbps V.36, V.35, X.21, X.24, V.24, V.28, 64 Kb/s V.11/V.36
Output Aggregate Rate: Interface Code: Impedance: Peak Level @ 120 ohm: Peak Level @ 75 ohm: Maximum Insertion Loss:	2.048 Mb/s ± 50 ppm HDB3 75 ohm unbalanced 3.0 volts ± 10% 2.37 volts ± 10% 6 dB
Signal Waveform: Frame Structure: Jitter Performance:	Per CCITT G.703 Per CCITT G.742 Per CCITT G.823
Power Supply Voltage:	-48 Vdc

7.8.3.1 Channel Banks (Mux, Drop/Insert)

User voice and data equipment interfacing requirements are defined at the subscriber line level. Primary multiplexing in conformance with CEPT E-1 characteristics shall be used to provide first order multiplexing of up to thirty 64 Kbps channels supporting Subscriber Line Units (SLUs).

7.8.3.2 Subscriber Line Units\Subscriber Line Interface Cards

The terms Subscriber Line Interface Cards and Subscriber Line Units have been used interchangeably throughout the specification. Multiple configurations of SLUs shall be required to provide subscriber to primary multiplexer Bank interfacing for a variety of voice and data communications.

The SLU interface requirements are discussed in the following subparagraphs:

(A) Voice Channels

The voice channel requirement is for (i) 4-Wire E&M trunking in support of PABX trunks & PLC VF Fibre Optic VF etc. and (ii) 2-Wire telephonic interfaces. 2 wire SLUs shall be DTME/TP optioned for 2-wire loop start or 2-wire GND start. The voice cards shall utilize ITU.T A – law companded PCM G.711,64kbits/s encoding.

(B) Nx64 kbps Synchronous Data

There is also a requirement for N x 64 kbpsco-directional, V. 35 X.21, RS485 (4 wire), V.24/V.28, X.24/V.11, X.21 all options for interfaces. Data signal may be a low speed data acquired from PLCC system as well as high speed data (each64kb/sec.)

8 MDF and Cabling

The Bidder shall provide MDF for patching facilities. MDF shall be sized to terminate all the subscribers and shall have Krone type or equivalent connectors.

It shall be the Bidder's responsibility to provide cables required for full supplied equipment interconnection in accordance with communications industry standard practices and the specification requirements. Only screened armoured type copper cable should be offered. The connections between Multiplexer and subscriber shall always be routed through MDF to provide maintenance access.

For all telemetering purpose including data communication screened armoured type copper cable of suitable dimension and specification as per relevant IS/IEC shall have to be used.

9. Telephone Characteristics

Telephone instruments shall be standard Dual Tone Multi-Frequency (DTMF) or Tone Pulse switchable with a 2-wire 600Ω balanced interface. Telephone should be as per DOT norms and should match with the EPAX and OLTE. Direct telephone cross connects to the SLU i.e. not established through a PABX, shall be accomplished through MDF cross connects to the SLU channel.

10. Primary -48V DC Power

Power supplies/converters for communications equipment provided under this specification, shall use -48V DC primary source power. The power supply may vary normally within the voltage range -42 to -58 V DC and the supplied equipment shall operate satisfactorily within this range.

11. Enclosure Requirements

Equipment racks, enclosures and installation hardware shall at a minimum comply with the following requirements:

a. Equipment Cabinets (Enclosures) Construction

All equipment provided under this specification shall be physically mounted in cabinets. Selection of equipment cabinets shall meet the following requirements.

- (1) Equipment cabinets shall be steel/steel & Aluminum extrusion fabricated and finished on all surfaces. All surfaces shall be treated for rust and primed to form a bond between metal and the finish coats of paint.
- (2) Equipment cabinets shall be designed free-standing but shall be mounted to the floor.(EPAX should be fixed on a still structure mounted on the floor. Structure height should be such that a normal person can work freely by standing in front of the EPAX). All Cabinets shall have secured fitting, lockable, full-length front doors for access to hardware and wiring.
- (3) All doors and removable panels shall be fitted with long life rubber beading.
- (4) Equipment cabinets shall be dust and moisture-proof as per IP41 specification or better.

b. Station Safety Earthing and Signal Grounding

For each facility, the Bidder is responsible for meeting the following station and equipment earthing requirements:

- (1) All safety earthing and signal grounding shall be in full compliance with EMI/EMC requirements as per relevant international standards
- (2) Each cabinet shall include suitable signal ground and safety earth networks. The signal ground network shall terminate at a separate signal ground stud connection isolated from safety earth.
- (3) Each earth/ground network shall utilize copper bus bars, copper brands and/or 16 sq. mm. or bigger earth cable. All equipment earth/ground connections shall be made directly to the equipment chassis utilizing grounding lugs and secured metal-to-metal with star washers. Use of the enclosure frame, skin or chassis mounting hardware as part of the earthing/grounding networks is not acceptable.
- (4) The safety earth network shall be connected to "earth ground" at the safety earth stud. The earth stud connection shall be sized for an external earthing cable equipped with a 2/0 solid copper lug secured metal-to-metal with star washers. Primary AC feeds and distribution within enclosures, requires earthing wire connection to the safety earth stud.
- (5) The safety earth and signal ground networks shall be inter-connected only at the safety earth stud and signal ground stud.

At each location, the Bidder shall execute separate equipments earthing for extending earthing connection with FO equipment and other communication equipment.