BIDDING DOCUMENT

FOR

COMPETITIVE BIDDING DOCUMENT
FOR
Implementation of Fibre Optic Terminal Equipment for Connectivity of LKHEP Generating Station with the Existing Fiber Optic Network of AEGCL from 132KV Shankardevnagar GSS AEGCL

*(Design, Engineering, Manufacture, Assembly, Inspection, Testing at Manufacturer's Works before Dispatch, Packing, Supply, Delivery at Site, Including Insurance During Transit, Subsequent Storage, Erection and Commissioning of FOTE in 220KV APGCL Switchyard Control Room , 110MW (55MW*2) APGCL Main Power House Control Room and (2.5MW*2, 5MW*1) APGCL Auxilliary Power House Control Room at Umrangshu Assam and 220KV AEGCL substation and 132KV AEGCL substation at Shankardevnagar Assam along with interfacing requirement with existing network at 220KV Samaguri GSS)*

SINGLE STAGE TWO ENVELOPE
(e-Tender)
Under
Deposit Scheme of APGCL

VOLUME II

O/o CGM T&C and Communication
ASSAM ELECTRICITY GRID CORPORATION LIMITED
The State Transmission Utility of Assam
Regd. Office, Bijulee Bhawan
Paltanbazar, Guwahati - 781001

TENDER IDENTIFICATION NO.: AEGCL/MD/CGM(T&CC)/APGCL Comm/2025/05

Section1

Introduction & General Information

This Part of technical specifications for Communication Equipment Package describe functional and performance requirements of Fibre Optic Terminal Equipment, Multiplexer Equipments, Network Management System, etc.

This Part of Technical Specification describes Network Configuration requirement of Communication equipment, EMI/EMC requirement and testing requirement of Communication equipments.

Besides these, a detailed BoQ is described in price schedules of Vol. I.

Section2

Technical Specifications

2.1 Introduction

This section describes the Fiber Optic Communication network configuration and the equipment characteristics for communication system to be installed under the project. The sub-systems addressed within this section are:

(1) FiberOpticTransmissionSystem(FOTS)
(2) TerminationEquipmentSubsystems
(3) MDF,DDFandCabling

The requirements described herein are applicable to and in support of network configurations depicted in Appendix and Network Management System (NMS) for monitoring and control of this communication network. TMN and NMS have been interchangeably used in this specification.

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 and CEA/CERC/NCIIP 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 anytime 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, Telecomand Telecom related elements against 3GPP security standards,3GPP2 securitystandardsetc. From any international agency/labs of the standardse.g.CommonCriteria Labs in case of ISO/IEC 15408 standards until 31st March 2019. From 1st April, 2019, the certification shall be done from authorized and certified agency/lab in India from CERT-IN. (Few different certified quality vendors be proposed & the final one among these would be approved by the employer tocarry out the job.It is important to have different vendors carrying out the job to have varied security suggestions & solution implementation. Further, implementation of the suggested measures shall be addressed within stipulated timeperiod.)

While designing and implementing operational networks it will be necessary to comprehensively address cyber security issues. A “defense in depth” (security measures deployed at various physical and conceptual layers of a deployment) approach should be adopted throughout the

deployment. Security capabilities must therefore be layered such that defense mechanisms have multiple points to detect and mitigate breaches for all service types that an EPUwishes to deploy. These capabilities should be integral to all segments of the grid infrastructure and address the full set of logical functional requirements, including:

-Physical security
-Identity and access control policies
-Hardened network devices and systems
-Threat defense
-Data protection for transmission,distribution and storage
-Real-time monitoring,management,and correlation

Secureness of a technology: All technologies outlined within this document possess specific attributes which at a basic level reduce or introduce additional risks to cybersecurity, information separation, data privacy and data authenticity. All technologies should be assessed based upon these criterion to evaluate suitability and to highlight any additional activities required to ensure a secure introduction of the technology.
Cyber Security encompasses the overall security landscape from a physical level to a user and electrical/electronic level.
Information separation is the ability for a technology to transport a specific data stream in a fashion which can be deemed isolated from dependencies of other data streams.

Other security considerations:.
Access Control: Authentication and authorization of all personnel management toolsand physical devices
Authentication,Authorization and Accounting for data and devices
Data Confidentiality and Privacy
Securely scalable
Tools:Zones, Segmentation, Logging
Tools:Tamper-resistant design, authenticity and integrity of hardware and software
Integrity of Platforms and Devices: Secure devices over the entire life-cycle

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, equipment, software etc. supplied and implemented in the project shall be given for use by the Employer.

The contractor shall get the Employer’s network audited from security point of view from a network audit & certification agency as empanelled byCERT-IN/DoT.The audit of the network shall be carried twice in a financial year till the maintenance service contract.Network forensics, Network hardening, Network penetration test, Risk assessment, Actions to fix problems and to prevent such problems from reoccurring etc.shall be covered under network audit.

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.

During maintenance period the Contractor shall keep a record of all operation and maintenance procedure in the form of manual and shall also maintain a record of all command logs (actual command given, who gave the command, time & date and from where) for a period of 12 months.For next 24months the same information shall be stored/retained in an on-online mode. A list of all User ID linked with name and other details of the user duly certified by the Employer shall also be maintained.

A record of all supply chains of the products(hardware/software)shall be given to 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.

2.2 General Network Characteristics

2.2.1 Description

The proposed fibre optic communication network shall support the voice&data communication requirements of RTUs, SCADA/EMS system and other Powersystem operational requirements. The communication system shall provide data&voice connectivity across the various locations or connectivity of RTUs with ControlCentres.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 RTUs over TCP/IPprotocol using Ethernet interface and few other RTUs over serial interface. The offered communication System shall support the communication requirements of RTUs and the SCADA/EMS 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-16.The network shall consist of over head fibre optic links with a minimum bitrate of Synchronous Transport Module-16. 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. The detailed BoQ is described in Price Schedules.The proposed communication system shall be implemented on VLAN configuration along with existing network. The details of make/model of existing communication equipment are mentioned in this technical specification.

The offered equipment shall also be used for VoIP based voice connectivity and connectivity to various sitesatE1/Ethernetlevel.VoIP along with interface cards as per BOQ shall be provided VoIP gateways for minimum4/8 subscribers shall be provided at other location. VoIP gateways to be provided at other locations shall be directly connected through telephones.

The contractor shall develop numbering plan for the proposed voice communication system in sync with the existing numbering plan.

2.2.2 **Functional Requirement**

The primary function of the communication network is to provide a highly reliable voice and data communication system in support of the SCADA/EMS. The communications support requirement for SCADA/EMS system is for low & high-speed data, express voice circuits and administrative voice circuits as defined in appendices. A brief summary of the communication system requirements is as follows:

(a) High speed E1channel support

(b) 64kbps & nx64kbps data channel support

(c) Low speed(600-1200bps)data channel support for IEC60870-5-101protocol.

(d) Voice(2wires,4wires) channel support and integration with Employer's EPABX System(s).The details of EPABX System shall be provided during detailed engineering.

(e) Data transport supporting Network Management channels

(f) The connectivity envisaged between RTUs and Control Centre is Wide Area Network (WAN) on TCP-IP using IEC 60870-5-104 protocol.

(g) Data transport using the EoSDH.

(h) Data transport Ethernet channel for PMU/SPS/VMS/metering etc.

Further, the network should seamlessly support following services:

- Teleprotection
- Outage Management Systems

- Network and Access management
- SCADA services
- Energy Management Systems
- Energy metering
- Event recorders
- Switchover of services between controlcenters
- Disturbance recorders
- Real-time PMU
- Polling telemetry operationalcommunications and BlackStart telephony
- Operational VoiceServices
- Maintenance & Support
- Private Mobile Radio
- General site alarms,supervision and surveillance
- Video services
- Physical site security using access control mechanisms.
- Smart Metering communications.
- IEC61850 based communications.
- Dynamic Line Rating
- Weather Monitoring&Lightening Detection

Corporate services may be as follow:

- Corporate IP network.
- Corporate fixed telephony
- Corporate mobile telephony
- Corporate voicemail
- Corporate VideoConferencing

2.2.3 General Systems Requirements

Required characteristics are defined and specified here in at the system level, subsystem level, and equipment level.

2.2.3.1 System Synchronization

The Contractor shall synchronize the existing equipment and all the new equipment under the contract using Masterclock.TheContractor shall provide the additional clocks as required under the set of clock indicated in BOQ.In addition to GPS input reference,the synchronization clock must have provision to take INPUT reference coming from other clock. All sync equipment proposed under this contract should meet ITU-TG.811criterion.The hold over quality of slave

clock, ifany,shallmeetITU-TG.812standardrequirements and MTCTE compliant.

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

Further, the successful bidder has to ensure that the old equipments are seamlessly integrated with new equipment and the complete backbone network.Further the network design should be done by the successful bidder in such a way that network management is smooth and end to end data/voice communication at STM4/STM16 level is achievable. SFPs for interpatching to be provided by successful bidder and employer to extend all reasonable support in such inter patching.

2.2.3.2 System Maintainability

To facilitate performance trending, efficient diagnosis and corrective resolution,the system shall permit in-service diagnostic testing to be executed both locally and from remote locations, manually and/or initiated under TMN control. Such testing shall not affect the functional operation of the system.

Preventive and problem oriented maintenance of the communications system shall be performed using diagnostics tools such as TMN and test equipment. They shall support complete maintenance of all system elements and shall permit the diagnosis of any fault without requiring additional test equipment. The Contractor shall provide specialized training required to operate above mentioned diagnostic tools. For all redundant systems, disconnection and repair of any failed device shall not interrupt the operation of the system.

2.2.3.3 System Upgradeability and Expandability

Equipment supplied shall be sized (though not necessarily equipped) to support system / subsystem expansion to full capacity as provided by specified aggregate transmission rates. Equipment units provisioned for equipped subunits shall be terminated at appropriate patching facilities or termination blocks.Power supplies and TMN shall be sized for maximum equipped system capacity.

2.2.3.4 Equipment Availability

The Contractor shall ensure the availability for subscriber to subscriber where they are providing the new equipment (MUX/Drop-Insert)under this contract.The availability requirements are as follows, which shall be demonstrated at site for the equipment being provided under this contract:

(1) The availability of each fibre opticlink(E1toE1)shall be at least 99.999%.
(2) The availability of network end to end(E1toE1)shall be atleast 99.998%.
(3) 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 centres.
(4) The network-wide subscriber to subscriber availability shall be at least 99.8%. The network-wide subscriber to subscriber availability is defined as the availability between any two data or voice subscribers on the wideband network.

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 the fibre optic cable shall not be considered in the aforesaid availability calculations.

In order to ensure that the equipment & configuration proposed by the bidders shall be capableof demonstrating the specified availability figures it is required that the Bidders 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 mean-time-to-repair (MTTR) of all of the components on the link. The Contractor shall indicate in the analysis the MTBF and MTTR and there resulting availability of each point-to-point link.For this analysis,an MTTR of at least 4 hours shall be assumed.

2.2.4 General Equipment Characteristics

All Contractor supplied equipment shall be new and of the finest production quality. The Employer will not accept modules or printed-circuit boards that are modified by appendingwires or components. Wired strapping options shall be incorporated in the board design to meet the above requirement.
All applicable requirements stated in this section shall equally apply to the TMN equipment as specified in this Section.

2.2.4.1 Revision Levels and Modifications

All hardware, firmware and software delivered as part of the communications network shall be field proven and at the most of current revision level.All modifications and changes necessary to meet this requirement shall be completed prior to the start of the factory tests or under special circumstances, on written approval by Employer, prior to the completion of SAT.

All field modifications of the hardware, firmware and software that is required to meet installation and / or performance specifications, shall be fully documented as part of the deliverables, both as a separate field modifications record and as corrected equipment / configuration documentation.

2.2.4.2 Equipment Capacities

Equipment supplied shall be sized and equipped with sufficient capacity to support BoQ and configuration requirements as identified in the appendices. Each subsystem supplied shall be sized (to be equipped as specified) to support full subsystem expansion.

Data communications channelization required to support the TMN subsystems specified in Technical Specifications (TS) are not identified in the appendices. Therefore, the Contractor is required to size and equip the system to include all channelization and channel cards required to support the TMN function.

2.2.4.3 Redundancy Requirements and ProtectionSchemes

Equipment redundancy and Automatic Protection Schemes(APS)are specified in theTable2-1. The failure of one element shall not prevent the use of any other that has not failed.

Table2-1 EquipmentRedundancyRequirementsSummary	
FiberOptictransmissionEquipment:	
SDHEquipment	
PowerSupply&Converters----------	1:1 APS or distributed power supply
CommonControl*Cards----------	1:1 Redundancy
DACS(CrossConnect)	

Table2-1 EquipmentRedundancyRequirementsSummary	
PowerSupply----------	1:1 APS or distributed powersupply
Commoncontrol*cards----------	1:1APS
Drop/InsertMultiplexer	
PowerSupply----------	1:1 APS or distributed powersupply
Commoncontrol*cards----------	1:1APS
***=Common control cards which are essentially Required for operation of the equipment.**	

The offered equipment shall support at least SNCP **as per standard ITU-T G.841**. In case the equipment offered by the Bidder does not support the above mentioned minimum protection methods, the bidder shall have to provide all additional equipment needed to provide same level of flexibility, redundancy and functionality at no additional cost to Employer. The bidders shall provide details of protection schemes supported in the Bid document.

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 Contractor.

2.2.4.4 Lost Signal Recovery

At any digital signal level, re application of a lost signal shall result in automatic re-synchronization 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.

2.2.4.5 Hardware/Software Upgrades

The Contractor shall provide antivirus software along with all the computer hardware /software which shall be upgraded periodically till the maintenance services contract in the bid.Further,to meet all the specifications requirements during implementation and maintenance, 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. All software and hardware shall support MPLS-TP functionality at packet cross connect level &such functionality would be exhibited/tested

during the Equipment FAT.

2.2.4.6 General Site Considerations

All fiber optic links upto 225 kms transmission line length for STM-16 and upto 250 kms transmission line length for STM-4 shall be implemented by the Contractor with out 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 equipment shall be monitored by centralized NMS.

2.2.4.7 Proposed Optical Fiber Characteristics

DWSM (G.652D) fibers shall be installed on the new fiber optic links. However, the existing fibers already installed under G-20(01) & TL projects comprise of DWSM (G.652) and DSSM (G.653) fibers. The details/characteristics of DWSM (G.652) and DSSM (G.653) fibers are as follows:

Fiber attenuation: For DWSM (G.652), the maximum fiber attenuation to be considered as 0.23 dB/Km @1550nm and 0.35 dB/km @1310nm. For DSSM (G.653), the maximum fiber attenuation to be considered as 0.35 dB/Km @1550nm.

Dispersion: For DWSM(G.652),the maximum fiber dispersion to be considered as 18ps/nm.Km @1550nm&3.5ps/nm.km@1310nm.For DSSM fibers, the fiber dispersion to be considered as per ITU-T G.653 standard.

2.2.5 Fiber Optic Link Lengths

The fiber optic route lengths areas specified in appendices. The lengths specified in appendices are the transmission line route lengths; however the actual fiber cable length shall exceed the route lengths on account of extra cable requirement due to sag, jointing & splicing, approach cabling etc.For bidding purposes the Contractor may assume an additional cable length of 5%of given route length +1Km towards approach cable for calculating the link length.The exact cable lengths shall be determined by the Contractor during the survey. The same shall be used by the Contractor for final link design during the detailed engineering of the project. In case of change in the specified BOQ, the contract price shall be adjusted accordingly.

2.3 Fiber 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-16 equipped with E1 interface cards with minimum 16 interfaces (G.703) per card and Fast Ethernet interface card with minimum 8 interface per card (IEEE 802.3/IEEE 802.3u) supporting layer 2 switching as tributaries. In addition, Gigabit Ethernet interface shall also be required as specified in the BPS. Ethernet shall support LCAS feature. It shall support full throughput upto 1000Mbps on Ethernet port by virtual concatenation of requisite no.ofVC-12. There shall be the provision of "Auto Negotiation" and "Flow control" Enabling/disabling through NMS of the system. Also there shall be provision of configuring the equipment for unrestricted nxVC12 bandwidth(upto1000Mbps).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-TG.8032.

All software and hardware shall support IPv4 and IPv6 simultaneously (dual stack).

The Contractor shall provide (supply and install)connectorised jumpers(patchcords) for FODP-to-equipment and equipment-to-equipment connection.

2.3.1 SDH Equipment

2.3.1.1 Functional Requirement

There is a requirement for different types of equipment under this project which are described in this section. The BOQ is provided in the Price Schedules. For the purpose of BOQ, the SDH Equipment is considered to be divided in three parts i.e. Optical interface/SFP, Tributary interfaces (Electrical tributaries such as E1,Fast Ethernet 10/100 Mbps, Gigabit Ethernet interface & Optical tributaries such as Gigabit Ethernet etc.)and Base Equipment(Consistingof 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, main and protection channel shall be terminated on separate cards and there should be no single point of failure.

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

(i) STM-16(MADM) with 5MSP protected direction.

The aggregate interfaces shall be (at least) STM-16 towards at least five protected directions (Protected as specified in this specifications). At present the equipment shall be equipped with one(1)nos.E1interfacecardwithminimum16interfacespercard&two(2)nos.FastEthernet interface card with minimum 8 interfaces per card, as tributaries. Gigabit Ethernet (optical/electrical) interface shall also be provided if specified in BPS. The equipment shall provide non blocking cross connect capabilityof 256 STM-1 (bidirectional) at high order VC-4 level and 128 STM-1 (bi-directional) at low order VC-12 level. .

(ii) Optical Interface/SFP to be implemented in the existing SDH equipment

The bidder shall be required to provide only Optical Interface/SFP to be installed in the existing/third party SDH equipment at few locations. The bidder has to ensure compatibility of the supplied Optical Interface/SFP for the same.

2.3.1.2 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.

2.3.1.3 Service Channel

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

2.3.1.4 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 crafts person 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.

2.3.1.5 Synchronization

The equipment shall provide synchronization as perTable2-2. One 2MHz synchronization output from each equipment shall be provided.

2.3.1.6 Electrical and Optical I/O Characteristics and General Parameters

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

Table2-2
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 $5X10^5$ hours
Optical Fiber Type	G.652D
Optical Connectors	TypeFC-PC
Transmission Quality	PerITU-TG.821,G.823,G.826
Source Primary Power	-48Vdc
Equipment Specifications	PerITU-TG.783
Tributary, Electrical Interface	PerITU-TG.703,75Ω
Ethernet Interface	10/100Mbps
SDH Bit Rates	PerITU-TG.703
Optical Interfaces	PerITU-TG.957,G.958
Frame and Multiplexing Structure for SDH	PerITU-TG.707
Synchronization	PerITU-TG.811,G.812,G.813, G.803
Management Functions	PerITU-TG.774,G.784
Protection Architectures	PerITU-TG.841
Built InTesting and Alarms	PerITU-TG.774,G.783,G.784

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

NOTE(2)<u>**Eye Safety for Laser Equipment:**</u>To avoid any damage,when a receiver detects a line interruption,it is required that the optical power of the laser shall be reduced to safelimits 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.

2.3.2 Optical Link Performance Requirements

The optical fiberlink performance requirements are specified as follows:

2.3.2.1 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 0.05dB per splice.One splice shall be considered for every 3kms.

(3) Connector losses: Losses due to connectors shall be considered to be minimum 1.0 dB per 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 atleast 2dBshall 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,intersymbol interference.

(6) MaintenanceMargin:A maintenance margin of atleast 2.5dB/100Km shall be kept towards cabling, repair splicing, cable ageing and temperature variations etc.

(7) Otherlosses:Otherlosses,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 dispersioni.e. 18ps/nm.Km@1550nm&3.5ps/nm.km@1310nm for DWSM fibres.

(9) BitErrorRate:The link budget calculations shall be done for a BERof10-10.

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 finalizing the FOTS system design &BOQ, above methodology shall be adopted taking into account fibre attenuation,dispersion and spliceloss determined during the detailedengineering. Accordingly, additions and deletions from the contract shall be carried out based on unit rates indicated in the contract.

2.3.2.2 Link Performance

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

2.3.2.3 FODP to SDH Equipment

The Contractor shall be responsible for connectivity between theFODP and the SDHequipment. The Contractor shall provide FC PC or as required as per site coupled patch cords. The location of FODP shall be finalized during detailed engineering.

The patch-cord length between the FODP & equipment rack shall be suitably protected from rodents, abrasion, crush or mechanical damage.

2.4 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).The interfacesfor Termination Equipment Subsystem maybe supplied either in the same equipment asSDHor as independentPDHequipment.Functional descriptions of these equipment are as follows:

2.4.1 Functional Description

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

Multiplexer shall be used to accomplish subscriber connectivity to the Digital Communication Network.Subscriber LineUnits shall provide analog to digital and direct digital conversionto64 Kbps digitalchannel. 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 smallnumber 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)bitstream as well as the 30channels of the E1 bitstream.

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

2.4.2 First Order Multiplexing

The Contractor shall be required to provide E-1 Drop & Insert Multiplexer and E-1 Channel Bank primary multiplexing in compliance with the electrical input-output characteristics provided in Table 2-3.

2.4.2.1 Drop & Insert Multiplexing

Drop & Insert multiplexing in conformance with CEPT E-1 characteristics shall be required at locationswherethesubscriberrequirementisminimal.Thedropandinsertionofuptothirty64 Kbpschannelssupportingsubscriberlineunits(SLU)shallberequiredatintermediatelocations. The Drop & Insert Muxes supplied shall be performance and card compatible with the Channel BankEquipmentprovidedsothatallSubscriberLineInterfacecardsareinterchangeable.

Table2-3 **CEPT E-1 Standard First Order Multiplexing** **Electrical Input / Output Characteristics**	
Applicable Standards:	CEPT per CCITT RecommendationG.702,G.703,G.711 and G.712
Number of Tributaries:	30X64Kbps
Alternative Sub-rate Tributaries:	n X 64 KbpsV.36 64Kb/sV.11/V.36
Output Aggregate Rate:	2.048Mb/s±50ppm

Table2-3 CEPT E-1 Standard First Order Multiplexing Electrical Input / Output Characteristics	
InterfaceCode:	HDB3
Impedance:	75ohmunbalanced/120ohmbalanced
PeakLevel@120ohm:	3.0volts±10%
Peak Level @75 ohm:	2.37volts±10%
Maximum Insertion Loss:	6dB
Signal Waveform:	Per CCITT G.703
Frame Structure:	Per CCITT G.742
Jitter Performance:	PerCCITTG.823
PowerSupplyVoltage:	-48Vdc

2.4.2.2 Channel Banks(Mux,Drop/Insert)

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

2.4.2.3 Subscriber LineUnits\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 .In case there are changes in number or type of cards because of changes in channel requirements, the contract price shall be adjusted accordingly.

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 and (II) 2-Wire telephonic interfaces. 2 wire SLUs shall be DTMF/TP optioned for 2-wireloopstartor2-wireGNDstart.ThevoicecardsshallutilizeITU.TA-lawcompandedPCM G.711, 64 kbits/sencoding. The voice card requirements are indicated in the BoQ.

(B) Sub-Channel Data Multiplexing

For this Project,the RTUdata interface to the wideband telecommunications network nodes hall be defined at the DTE level at low-speed rates of 300, 600 and 1200 baud. The port shall be compatible with RS232C interface. The Contractor shall be required to furnish 64 Kbps SLU asynchronous dataplexing for at least 4 selectable low speed DTE interfaces whenever multiple asynchronous data circuits are required.

(C) Nx64kbps SynchronousData

There is also arequirement forNx64kbps.The tentative quantities have been identified in the appendices.

2.4.3 Digital Access Crossconnect System

The Contractor shall be required to provide Digital Access Cross connect Systems (DACS) capable of switching 16 or more E-1 lines in compliance with the electrical input-output characteristics provided in Table 2-4.DACS shall be fully compatible with CEPT E-1tributary standards.

DACSs shall be provided at locations specified in the appendices and shall be used to establish and reconfigure cross-connections at the tributary level of up to 480 x 64Kb/s channels. DACS E-1 line interface shall be fullycapable of accessing each E-1 line.

Within the context of this specification,sizing of DACS system is defined as 4xn wheren is the maximum size of the port switching matrix.Thus a DACS sized as 8x16means that 8E1ports are interfaced over a 16 port (E1) matrix.

A DACS system shall consist of the switch matrix, all routing logic and timing circuitry for internally sourced,line derived or externally supplied network timing and full software support.

TheDACSs to be provided under this contract shall consist of at least a16port switching matrix, with16ports equipped,i.e.16X16size.TheDACS shall also be able to switch the signaling of the voice channels along with the voicechannels.The DACS shall not use,decrease or block the specified capacity of the switching matrix while switching the signalling. The DACS shall support the Channel Associated Signalling(CAS)and CommonChannelSignalling(CCS)both as per ITU-T G. 704.

The DACS shall provide user friendly control and management software.The user shall be able to operate the DACS locally through craft terminal, via an RS-232 interface or remotely under TMN supervisory control.

Table2-4
CEPT E-1 Digital Access Cross Connect System Required Operating Characteristics

E-1TrunkCapacity:	Minimum 16-Port Switch Matrix Minimum 4-Port I/O per card
TributaryCapacity:	30X64Kbps
Compatibility:	CEPTE-1,CEPTE-1tributarychannel
FrameDelay:	Minimum < 1 frame Maximum < 2 frames
E-1 Port Interface: **Interface Code:** **Impedance:** **PeakLevel@75ohm:** **MaximumInsertionLoss:**	2.048 Mb/s ± 50 ppm HDB3 75ohmunbalanced/120ohmbalanced 2.37volts±10% 6dB
SignalWaveform: **Frame Structure:** **Jitter Performance:**	PerCCITTG.703 Per CCITT G.742 PerCCITTG.823
Synchronisation:	Internal, external source and synchronized on incoming E-1
Routing: **RoutingTableCapacity:**	Fully non-blocking tributary to/from E-1 channel Minimum of 9 routing tables for reconfiguration
Supervisory Ports: **Supervisory Port Interface:** **Interface:**	Serial Com Ports RS-232 StandardASCIIANSIcompatibleterminal
SupervisoryChannel:	Asyncdatarates,softwareselectable: speed of 110-9600 bps, odd or even parity 7 or 8 bits.
PowerSupplyVoltage:	-48VDC

2.5 MDF, DDF and Cabling

For the purposes of the specification,the contractor shall provide cabling,wiring,DDFpatching facilities and MDFs interfacing to the wideband telecommunications system. Equipment and material componentsforMDF,DDF and cabling are also part of this procurement.It shall be the Contractor's responsibility to provide all cable support required for full supplied equipment interconnectionwiththeMDFandshallbeinaccordancewithcommunicationsindustrystandard practices and the requirements mentioned in the technical specifications.

2.5.1 MDF and DDF Patching Facilities

The Contractor shall supply and install all cabling, wiring, connectors, cross connects, Digital Distribution Frames (DDF) and Main Distribution Frames (MDF) associated with the installation and interconnection of equipments procured under this package as follows:

(i) DDF for termination of new SDH equipment E-1ports.

(ii) Cabling (including connectors) for E1 level connections from DDF to existing SDH equipments, DDF to Existing & new PDH equipments. To the extent possible, existing cable at site shall be used.

(iii) All Ethernet ports shall be terminatedwithRJ-45connector.Provisionfor100%expansion with connector for terminating additional Ethernet ports shall be provided.

(iv) MDF for termination of all the subscriber channels at new PDH node

(v) Cabling and connectors required to enable subscriber-to-subscriber circuits over the telecom network. The Line side of the MDF shall be cabled to the Primary Multiplex and the equipment side shall be cabled to the MDF of the assigned subscriber (PLCC,PABX, Telephone at wideband locations etc).

(vi) Any other cables, connections etc required for a fully functional, integrated telecom system.

The connections amongst various equipments such as FOTS, termination equipment and subscriber MDFs etc shall always be routed through DDF and MDF to provide maintenance access.

2.5.2 Digital Distribution Frame Functional Requirements

The Contractor shall provide DDF for Digital Signal Cross connect (DSX) Broadband-quality (better than 20 MHz) patching facilities configured "normally-thru" with Equipment, Line and Monitor Patch Jacks. DDFs shall provide the following basic functions:

(i) "Normally thru"circuit routing

(ii) Circuit rerouting via patch cord assemblies

(iii) Circuit disconnect and termination

All DDFs shall be sized and equipped to support the offered configuration of the provided equipment. Independent Transmit and Receive patch jack assemblies (lineandequipment)shall provide for separate transmit and receive single-plug patching. Transmit and receive patch jack assemblies shall be located side-by-side such that dual-plug patch cord assemblies maybe used to route both transmit and receive for the same circuit.

2.5.3 Main Distribution Frames

The Contractor shall make provision for cross connection of subscriber services to the subscribers utilizing Krone type or equivalent and shall provide full connectivity upto and

Terminated on the equipment side of the appropriate DDFs and line side of MDFs.The Contractor shall terminate on the equipment side of patching facilities provided by other contracts and shall provide DSX type patching facilities supporting aggregate bit streams (i.e. dataplexers and E-1 ChannelBanks).Separate Patch panels or MDFs shall be provided for Data and Voice.Allcross connects shall be accomplished utilizing one, two or three pair patch cords. Patch plugs are permissible for direct one-to-one circuit "cut-thru".

2.6 Patch Cords

The Contractor has to supply FC PC coupled Patch cords as described in BOQ. The Patch cord return loss shall be equal to or better than 40 dB and insertion loss equal to or less than 0.5 dB. Fiber jumpers shall be of sufficient lengths as to provide at least 0.5m of service loop when connected for their intended purpose.

2.7 Telecommunication Management Network / Network Management System

The Contractor shall provide a Telecommunications Management Network System (TMN) for operational support to the FOTS and associated Termination equipment subsystems. This TMN shall provide the capability to monitor, reconfigure, and control elements of the telecommunications network from a centralized location and at each node of the network where equipment is located. This TMN system shall assist Employer/Owner in the operations and maintenance of the wideband communication resources of the including detection of degraded circuits,system performance, the diagnosis of problems,the implementation of remedial actions and the allocation or reallocation of telecommunications resources and addition/deletion of network elements.

The contractor shall supply preferably a single TMN for all the NEs(Network Elements) such as SDH equipment,Mux, Drop-Insert,DACS etc. In case a single TMN cannot be provided for all the NEs, the contractor may supply separate TMNs. Each of the offered TMN shall meet the requirements indicated in this section.The bidder shall provide details of the offered TMN in the bid.TMN and NMS (Network Management System) have been interchangeably used in this specification.

2.7.1 Applicable Standards

The TMN design concept, functional and informational architecture and physical architecture, shall be in compliance with ITU-T Recommendation M.3010.

2.7.2 TMN Architecture

The TMN shall provide

(a) Collection of Management data from all Network Elements (NEs) supplied under this package. The minimum monitoring and control requirements for the communication equipment shall be as defined in this section.

(b) Processing of above management data by using processor(s) located at Control Centre and additional intermediate station processor(s), wherever required.

(c) Monitoring and control of the NEs as defined below:

i) The Control Centre for all the network elements being procured under this package (including local operator console) shall support management of all equipments supplied under this package. At minimum functions of Network management layer (NML) and Element management layer (EML) as defined in CCITTM3010.The detailed functions are listed in TS.

ii) Monitoring and control of NEs using Craft Terminals as defined in this Section.

(d) Supervisory monitoring and control of the following station associated devices:

I) Intrusion Detection Alarms
II) Power Failure
III) Fire and Smoke Detection
IV) Environmental Control (Temperature, Humidity etc.)

(e) Communication channel support for TMN System as specified in Technical Specifications (TS).

The supplied TMN system shall be capable of handling all management functions for at least 150% of the final network elements.The NMS location indicated here are tentative and the same shall be finalized during detailed engineering. TMN system should not be dependent on each other for their working.

The TMN system hardware shall be so designed that failure of single processor/component (router,switch,converteretc.)shall not inhibit any of the functionality of the TMN system.The Contractor shall submit for Employer's approval the TMN architecture describing in detail the following subsystems/features:

(a) Database used in TMN
(b) Master Processor,server/workstation,LAN,Peripherals and hardware
(c) Software and operating system
(d) Local Consoles/remote consoles
(e) Craft Terminals
(f) Data communication between NEs,Remote/LocalConsoles and TMN Processor(s)
(g) Routers/Bridges
(h) Expansion Capabilities

f) The offered TMN system shall be capable of integration to other supplier's Network Management System (NMS) upwardly through SNMP/CORBA - TMF418 complaint North bound interface. The interface shall accommodate all required functionalities to implement OSS but not limited to the following:

i) Realtime forwarding and synchronization
ii) Provisioning ofcircuits
iii) Upload of network topology
iv) Monitoring of events for topology and circuit changes
v) Alarm handling

The details shall be finalized and discussed during detailed engineering and the Contractor shall be obliged to provide/share all necessary information and co-ordinate with the implementation vendor of OSS.

2.7.3 Management Functions

The TMN shall support following Management functions:

2.7.3.1 Configuration Management

Configuration management is concerned with management, display, and control of the network configuration.Minimumspecificrequirementsthatshallbesatisfiedincludethefollowing:

a. Provide tools to establish and maintain the backbone topology and configuration information and provide graphical maps depicting the configurations.
b. Gather descriptive information about the current configuration of the equipment, provide operator displays, and prepare reports.
c. Provide tools for planning, establishing, and changing the static equipment configuration. Provide for changes to the equipment configuration in response to equipment failures, planned upgrades, and operator requests to take equipment offline for testing.
d. Provide verification testing to support new equipment installation.

2.7.3.2 Fault Management

Fault management is concerned with detecting, diagnosing, bypassing, directing service restoration, and reporting on all the backbone network equipment,systems ,and links.Minimum specific requirements that shall be satisfied include the following:

a. Display equipment status in a consistent fashion regardless of the source of the data on a graphical topological, map-type display. Status shall be displayed through the use of colors on links and nodes as well as through text.

b. Obtain status and detect faults through periodic polling, processing of unsolicited alarms and error events, and periodic testing for connectivity.

c. Maintain an alarm summary of unacknowledged alarm events on the management station display and maintain a logo fall received alarms.The operator shall be able to acknowledge and clear alarms individually and as a group. The use of alarm correlation techniques is encouraged to minimize the proliferation of alarms caused by a single, common event. All alarms shall be configurable as critical alarms, major alarms and minor alarms with different colours.

d. Provide the capability to diagnose and isolate failures through analysis of error and event reports and through the use of both on-line and off-line diagnostic tests and display of monitored data.

e. The criteria for fail over shall be configurable as automatic fail over to redundant equipment wherever possible and through operator-initiated actions where automatic fail over is not possible.The status of fail over shall be reported to the NMS.

f. Track network equipment failure history.

2.7.3.3 Performance Management

Performance management is concerned with evaluation of the use of network equipments and their capability to meet performance objectives.Minimum specific requirements that shall be satisfied include the following:

a. Provide support for an operator to initiate, collect, and terminate performance metrics under both normal and degraded conditions. For example, BER of each link,together with other data measured at each node, shall be available on operator request (atleast for SDH).

b. Monitor point to point & end to end signal quality and history. Provide operator controls to monitor performance of specified events,measures, and resources(atleast for SDH). Specifically provide displays to permit the operator to:

1. Select/deselect network equipments, events ,and threshold parameterstomonitor
2. Set monitoring start time and duration or endtime
3. Set monitoring sampling frequency
4. Set/change threshold values on selected performance parameters
5. Generate alarm events when thresholds are exceeded.
6. Set multiple thresholds on certain performance parameters. Alarm categories include as a minimum a warning and a failure.
7. Calculates elected statistical data to measure performance on selected equipment based on both current and historical performance data maintained in performance logs. Performance data provided is limited to what is available from the equipment Contractors.
8. Provide graphical displays of point to point and end to end current performance parameter values. Provide tabular displays of current, peak, and average values for performance parameters.
9. Generate reports on a daily, weekly, monthly,and yearly basis containing system statistics

2.7.3.4 Security Management

The TMN shall be provided with security features to limit access to monitoring and control capabilities to only authorized personnel. One access level of System Administrator and at least two levels of operator access shall be provided - read (view) only, and write (configure). The system administrator shall be able to create, define and modify operators with different access levels, network domains and perform all kind of maintenance and up gradation of the TMN system.With"readonly"accesslevel,network parameters should only be viewed. Access to

Data base maintenance,command control and test functions shall be available with "write"access level. Means shall be provided to ensure only one authorized user has write capability for a selected domain of the network.It shall be possible to define multiple domains for purposes of monitoring and control.

Human error and conflict detection are also required. Such errors and access violations shall be reported to the offending user as error messages and warnings.

2.8 Communication Channel Requirement and Integration

Communication requirements for TMN system have not been considered in Appendice and the Contractor shall provide the seas apart of TMN system.TheContractor shall provide all required interface cards / devices, LAN, routers/bridges, channel routing, cabling, wiring etc. and interfacing required for full TMN data transport.

The TMN data transport shall utilize the wideband communications transmission system service channel in the overhead whenever possible.This will provide inherent critical path protection

Should the configuration requirements dictate multiple TMN station processors,the TMN Master Station shall require bidirectional data transport with its station processor(s). This communications interfacing shall be via critically protected data channels.It shall be the Contractor's responsibility to provide for and equip all necessary critically protected TMN data channel support.

In case supervisory channels are not available,the Contractor shall provide suitable interfaces in their supplied equipment for transport of TMN data.The Contractor

Shall also be responsible for providing suitable channels with appropriate interfaces to transport the TMN data.

The NMS information of new PDH & SDH system shall be transported through the existing communication network, wherever required, up to the NMS location. The NMS information of the new SDH&PDH system being procured under the package shall be transported throughthe existing communication network using 64 kbps/2Mpbs (G.703) interfaces. Any hardware required for above interfacing shall be provided by the Contractor.

The bidders shall describe in the proposal the TMN data transport proposed to be used by the bidder in detail including capacity requirements and various components/equipment proposed to be used.

2.9 Craft Terminal

Each equipment (SDH equipment,Mux,Drop/Insert and DACS etc.)on the fibreoptic communication network shall include provision for connecting a portable personal computer (PC) to be known as craft terminal to support local commissioning and maintenance activities. Through the use of this PC and local displays/controls,the operator shall be able to:

a. Change the configuration of the station & the connected NEs.
b. Perform tests
c. Get detailed fault information

The craft terminal shall be connected to the interface available in the communication equipment. Portable (laptop) computers (Craft terminals), each complete with necessary system and application software to support the functions listed above, shall be supplied to the employer as per BOQ given in the Price Schedules.

2.10 Hardware Requirements

2.10.1 Master Processor, Server/Workstation and Craft Terminal

The server/workstation and craft terminal shall have suitable processor(s) which shall be sufficient to meet all the functional requirement and expansion capabilities stipulated in this specification. Only reputed make like Dell, IBM, HP, Compaq make shall be supplied.

The server shall have minimum configuration of 2.4 GHz Quad-Core processor, 8 GB RAM, DVD-RW drive, redundant 320 GB internal Hard Disk Drive, 101-Enhanced style keyboards, mouse, serial, USB (3.0) ports and hot swap redundant power supply. VDUs shall be 19" TFT active matrix color LCD with a minimum resolution of 1024 X 768. Appropriate network drive card shall also be provided wherever required. However, the internal hard disk drive for the server shall be redundant and all the data shall be mirrored. Further, the TMN software shall support data mirroring on redundant disk drives.

The workstation shall have minimum configuration of 3 GHz Core 2 Duo, 16 GB RAM, DVDRW drive, 1 TB Hard Disk Drive, 101-Enhanced style keyboards, mouse, serial and USB (3.0)ports.VDUsshallbe19"TFTactivematrixcolorLCDwithaminimumresolutionof1024 X 768. Appropriate network drive card shallalso beprovided wherever required.

CPU enclosures shall be desktop type and shall include available expansion slots except for the CraftTerminal whichshallbealaptop.Thecraftterminalshallhaveminimumconfigurationof 2.4 GHz, 16 GB RAM, 1 GB Video Graphics Memory, 1 TB Hard Disk Drive, keyboard, mouse/trackball etc., serial/USB (3.0) ports to accommodate printers, and Internal/external Data/Fax modem and a battery back-up of at least 3hours.VDUs shall be14"TFT active matrix color LCD with a minimum resolution of 1024 X 768.The craft terminals should be supplied with the latest Wndows 11 Software

The configurations mentioned for server, workstation & craft terminal are minimum and the same shall be finalizedduringdetailedengineeringasperlatestindustrialstandards.

2.10.2 Peripherals and hardware

TMN system shall be provided with laser printer. The laser printer shall have a minimum print speed of 17 pages per minute and a minimum resolution of 1200 x 1200 dpi. The laser printer shall have LAN ports for connecting to TMN system.

Thelaserprinterunderthisspecificationshallbe colourandincludeprintenhancedbufferingto prevent loss of print data in the event of a print failure.

2.10.3 Local/RemoteOperatorConsoles

The Contractor shall provide operator consoles sized and equipped to support the subsystem(s) furnished and in compliance with the specification. The console shall provide alongwith the TMN Server interfacing for the TMN users to the software operating support systems. At a minimum, a console shall include the hardware similar to a workstation. The Local Operator Console & Server Hardware & Software is part of the set for Network Manager & Element Manager System as specified in BoQ in Price Schedules.

2.10.4 Power Supplies

The TMN system shall use 220 volts 50 Hz A.C or -48 volt D.C as available at site for its operation as available at site.

2.11 General Software/Firmware Requirements

Due to various alternative design approaches, it is neither intended nor possible to specify all software and firmware characteristics. It is the intent herein to provide design boundaries and guidelines that help to ensure a demonstrated, integrated program package that is maintainable andmeetsbothhardwaresystemsrequirementsandthecustomer'soperationalrequirements.

2.11.1 Operating System Software

Operating system software shall be provided to control the execution of system programs, application programs, management devices, to allocate system resources, and manage communications among the system processors.The contractor shall make no modifications to the OEM's operating system, except as provided as USER installation parameters.

2.11.2 Applications Software

All applications software shall be written in a high-level programming language unless developedusingindustryprovenapplicationprogramsanddevelopmenttoolsprovidedwiththe system. The contractor shall make no modifications to the applications program except as provided as USER development tools.

2.11.3 Software Utilities

A utility shall be provided to convert all reports into standard PC application formats such as excel.

2.11.4 Revisions,Upgrades,Maintainability

All firmware and software delivered under this specification shall be the latest field proven version available at the time of contract approval.Installed demonstration for acceptance shall be required.All firmware provided shall support its fully equipped intended functionalrequirements without additional rewrite or programming.

All software shall be easilyuser expandable to accommodate the anticipated system growth, as defined in this specification. Reassembly recompilation or revision upgrades of the software or components of the software,shall not be necessary to accommodate full system expansion.

Software provided shall be compliant with national and international industry standards.

2.11.5 Database(s)

The contractor shall develop all the databases for final wideband network following the global acronyms for all stations. Database(s) to be provided shall contain all structure definitions and data for the integrated functional requirements of TMN system.

TMN operator Groups shall share the same virtual database.This means that they shall share the same database and database manager, whether or not physically separate databases are maintained.

2.11.6 Help

All applications shall be supported by USER accessible HELP commands that shall assist the user in the performance of it stasks. HELP commands for an application shall be available to the

User from within the active application and shall not interfere with the activities of the application.

Section-3

Environment, EMI, PowerSupply, Cabling and Earthing

The purpose of this section is to describe the minimum general equipment characteristics and specifications for environmental conditions, source power conditioning and backup, equipment construction, and installation. The section also highlights the stringent Electro Magnetic Compatibility (EMC) guidelines for equipment that will be operated under the severest Electro MagneticInterference(EMI)andElectroStaticDischarge(ESD)conditionsexpectedinanExtra High Voltage (EHV) power system environment.

3.1 Environmental Requirements

Equipment and their components provided under this specification shall operate reliably under the following environmental conditions. The Equipment shall be able to work under Non Air-Conditioning, as most of the 132 kV & above Substations of HVPNL do not have air conditioning.

3.1.1 Temperature and Humidity

Most of the equipment will not be installed in environmentally controlled shelters. Therefore, equipment shall operate inaccordance with the limits shown in Table 3-1.

Table3-1
Environmental Operating Limits

Temperature Range:	(Un Controlled Environment)
Specification	0 to 45°C
Operation without damage	-10to55°C
Shipping/storage	-40to60°C
Relative Humidity,non-condensing	Upto90%
Elevation:	
Operating	to3,000m
Non-operating	to10,000m

For each location, the Contractor is required to assess the environmental conditions for the equipmenttobeinstalledunderthisspecification.TheContractorisresponsibleforallnecessary enclosure,rack or equipment upgrades to ensure the proper operation of the installed equipment.

3.1.2 EMI and Electrostatic Interference

At each location, the Contractor shall assess the need for shielding against radiated emissions and shall provide recommended solutions for any EMI problem found at each location. Specifications provides the type of immunity tests for which the equipment shall be required to pass without failure. For the individual tests to be carried out at the different interfaces, references are made to the relevant IEC and ITU-T recommendations.

3.1.3 Vibration and Shock Resistance

As per testing requirements indicated in this specification.

3.1.4 Tropicalization

Communications equipment will often be stored and operated in uncontrolled environment areas and will be subject to mould, growth of fungus, corrosion and oxidation. The equipment and components shall be suitably tropicalized during manufacture through commissioning, as necessary.

3.1.5 Contaminants

Communications equipment may be located in areas of poor air quality with the main contaminantbeingdust.Cabinetsshallbetightfittingutilizingfilteredventilationopeningsonly.

3.2 Primary Source AC/DC Power Requirements

Facilities will be required to support both AC and DC power load requirements of telecommunications equipment as specified below:

3.2.1 Primary Source AC Power

It will be the Employer's responsibility to provide required Primary AC source Power for communications equipment installed under this specification. The Primary AC Power supplied will be 240 VAC ± 10%, 50Hz with a frequency variance between 46 and 55 Hz. Harmonic distortion will not exceed five (5) percent.

All equipment and components provided under this specification requiring Primary AC Power, shallbedesignedfornormaloperationundertheabovestatedtolerancesfor240VACsupply.

The Contractor shall provide in their Bid as well as in the survey report to the Employer the projected 240 VAC Primary Power load requirement per equipment and totals, by location, for equipment provided under this specification. The Contractor shall provide suitable UPS for communicationequipment/module etc. requiringAC power supplyat locations otherthancontrol centre.

3.2.2 -48V DC Power

Power supplies/converters for communications equipment (except computer system supplied as part of NMS which shall use 240 VAC) provided under this specification, shall use -48Vdc uninterrupted primary source power. The power supply may vary normally within the voltage range-42to-58Vdc and the supplied equipment shall operate satisfactorily within this range.

3.2.3 Power Distribution and Protection

The Employer will furnish only one source primary240VACand/or-48VDCpower.It shall be the Contractor's responsibility for the connection and distribution of all Primary AC and -48Vdc source power,in full compliance with all local and national electrical codes.

The Employer shall indicate during the survey by Contractor, on the primary source, the feeders/points that can be used by the Contractor.The Contractor shall supply &install Primary AC and -48Vdc feeder cables to Contractor-furnished distribution panels.

The Contractor shall provide required distribution panels,circuit breakers and appropriate Panel Disconnects. Distribution Panel feeders, Panel Disconnects, distribution panels and circuit breakers shall be sized and equipped to support atleast 100% expanded load requirements.

The Contractor shall provide and install all required primary power distribution sourced from the distribution panels.The Contractor shall also be responsible for Load Balancing.

The Contractor is responsible for all inter-rack (enclosure) and intra-rack (enclosure) power distribution required to support equipment supplied under this specification.TheContractor shall provide all cabling,fusing,switching and circuitbreaker and surge protection required.

Partially equipped subsystems shall be installed with provision for expansion.Equipment power supplies provided under this specification, shall be sized to support fully equipped subsystems. Primary power distribution protection shall be sized to support and protect maximum operating load potential whether or not the actual projected load shall meet that maximum load potential.

The Contractor shall provide equipment and rack safety earthing in compliance with this specification.

3.3 Equipment Construction, Assembly and Installation

All equipment supplied under this specification shall be constructed, assembled and installed in accordance with the following requirements:

3.3.1 Identification

All cabling,racks/enclosures,equipment,modules and materials shall be uniquely identifiable as per the following:

3.3.1.1 Equipment

Each equipment component to the level of printed circuit card, shall be clearly marked with the manufacturer's part number, serial number, month/year of manufacture and revision level. Changes to components shall be identified by an unambiguous change to the marked revision level. The Contractor shall be responsible for maintaining the master revision level list until the Contractor has complied with all requirements of this specification.

Where custom components and parts are provided, each component/part shall be marked to specifically identify that component/part.Printed circuit card cages are defined as an equipment component and as such, shall be clearly identified as stated within this specification.

Equipment chassis and printed circuit card cages having wired backplanes, shall be clearly markedwiththemanufacturer'spartnumber,serialnumber,month/yearofmanufacture,revision level and an additional identifier corresponding directly to the applicable backplane wiring diagram/list.

3.3.1.2 Power Distribution

Power distribution panels shall be clearly marked with their unique identifier, source feed information, and remote source feed emergency disconnect location and identity.

Power distribution panel"Main Disconnect" and circuit breakers shall be clearly marked with a unique identifier. Circuit breaker feed lists shall be clear, accurate and the feed list information shall be posted inside each distribution panel door.

Inter-rack and intra-rack (enclosure) power distribution shall be clearly identified with source feed, voltage and power rating information. All power feed cabling shall be clearly identified near the point of termination.

All power distribution identification shall utilize heat-resistant permanent marking techniques such as stamped non-metallic tags, embossed labels,etc.Marking techniques are subject to

approval by the Employer. Power distribution identifiers and information shall agree with the Contractor's power cable plant drawings.

3.3.1.3 Signal Cabling

Connectorised signal cabling/wiring requires marking with a unique identifier at each connectorised end. The signal cable/wire identifier shall include a cable identifier and the location of both terminations.

Signal cable/wiring installed on terminal blocks requires marking with the cable identifier and distantendlocation.Thecabletagshall be clearlyvisible at the cable fanout point.

All signal cable, wiring and terminations shall be clearly labelled / tagged with identifiers consistent with Contractor supplied cable plant records. Marking techniques are subject to approval by the Employer.

3.3.1.4 Equipment Racks and Enclosures

All equipment racks, enclosures and equipment, including distribution frames, shall be clearly labelled with unique identifiers consistent with Contractor supplied floor plans and rack elevations.

3.3.2 Installation Hardware

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

3.3.2.1 Equipment Sub-Racks and Cabinets (Enclosures)

All equipment provided under this specification, shall be physically mounted in sub-racks and cabinets(enclosures).The Contractor shall determine and propose for the Employer approval,the type, size, weight and manner of installation for each location.

Selection of equipment sub-racks and cabinets (enclosures) shall meet the following requirements:

(A) Equipment Sub-Rack Construction

Equipment Sub Racks provided for installation in environmentally controlled facilities, shall meet the following minimum requirements:

(1) Equipment Sub Racks shall be steel / aluminium fabricated and finished on all surfaces.All metal and welds shall be thoroughly cleaned and sanded to obtain a smooth finish. All surfaces shall be treated for rust and primed to form a bond between metal and the finish coats of paint.

(2) Equipment covers shall be provided for exposed components mounted in equipment sub Racks.

(3) Dust and moisture protection shall meet or exceed IP20 standards.

(B) EquipmentCabinet(Enclosure)Construction

(1) Equipment cabinets (enclosures) shall be steel / steel & Aluminium extrusion fabricated and finished on all surfaces. All metal and welds shall be thoroughly cleanedandsandedtoobtainasmoothfinish.Allsurfacesshallbetreatedforrust and primedto form a bond between metal and the finish coats ofpaint.

(2) Equipment cabinets (enclosures) shall be designed free-standing but shall be mounted to the floor. Cabinets (enclosures) shall have secure fitting, lockable, full-length front doors for access to hardware and wiring. Equipment covers for exposed components mounted inside cabinets are not required unless specifically recommended.

(3) All doors and removable panels shall befitted with long life rubber beading. All panels shall be fabricated from minimum2.0mmthickness steel sheet. However, for racks with load bearing Aluminium extrusion frame, door panels and side panels may be fabricated from minimum1.6mm thickness steel sheet and the top &bottom panels shall be fabricated from minimum2.0mm thickness steelsheet.

(4) Equipment cabinets (enclosures) shall be dust and moisture-proof as per IP41 specification, or better (supporting test certificates/documents for meeting IP41 protection class of offered cabinets shall be submitted during detailed engineering).

3.3.2.2 Cable Raceways

The Contractor is required to provide and install all additional necessary indoor and outdoor cable raceways.The cable raceways shall be in conformance with the following:

(1) Signal cabling and power cabling shall require separate cable raceways. Signal

And power cabling shall not share the same raceways and shall be installed as far apart as is practical. Adequate shielding shall be provided as required.

(2) All cable raceways shall be sized to support full loading requirements plus atleast a 200% safety loading factor.

(3) Outdoor cable raceways shall be of corrugated construction and shall be fitted with solid covers overlapping all sides of the cable raceways.

(4) Outdoor cable raceways shall be fabricated from construction grade aluminum, galvanized iron or anodized sheet metal or any other suitable material approved bytheEmployer.Suitableanti-corrosionmeasuresshallbetaken.Steelfabricated raceways shall be finished inside and out, treated to resist rust and to form a metal-to-paint bond.

(5) Indoor cable raceways fabricated of aluminum or galvanized iron, shall not normally need special finishing or painting, unless otherwise stipulated by the Employer. Steel fabricated raceways shall require a red oxide primer coat at a minimum.

3.3.3 Signalling Distribution

The Contractor shall be responsible for all signal wiring associated with furnished equipment in accordance with the following:

(1) All signal wiring connections to the communications equipment shall be via Krone type or equivalent terminal blocks.

(2) The Contractor shall provide subscriber level wiring and patching wherever required.

3.3.4 Lightning and Transient Voltage Protection

The Contractor shall be required to provide protection from lightning and transient voltages for all wideband communications equipment,in accordance with the following:

(1) At the outside cable plant point-of-entry of all cabling penetrations for all cabling installed by the Contractor, the Contractor shall provide lightning and transient voltage isolation for the inside plants cabling, wiring, and all terminations and equipment.

(2) All equipment installed under this specification that requires 240VAC primary power, shall be surge protected.

3.3.5 Station Safety Earthing and Signal Grounding

For each facility, the Contractor 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 (enclosure) or cabinet (enclosure) group 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 braids and/or 16 sqmm or bigger earth cable. All equipment earth/ground connections shall be made directlytotheequipmentchassisutilizinggroundinglugsandsecuredmetal-to-metal with star washers. Use of the enclosure frame,skinor chassis mounting hardware as part of the earthing/grounding networks, is not acceptable.

(4) The safety earth network shall be connected to“earthground”at the safety earthstud. 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.

The Contractor shall extend the existing station earth to the equipment room using suitable G.I. earthing strip (50 x 6 mm), wherever required. .

The Contractor is responsible for providing all required earthing / grounding cable and installation. Cabinet (Enclosure) and equipment safety earthing and signal grounding shall be subject to the Employer’s approval.

The Contractor shall be responsible for determining the suitability of existing station earth for the equipment to be supplied under this contract. In case existing earthing arrangement at the site is not adequate, the Contractor shall either make improvement in the existing earthing arrangement or make new earthing as per requirement.

3.3.6 Interconnections

All power and signal cabling between component units of the communications systems shall be supplied and installed by the Contractor and shall be shown on contractor-supplied as-built drawings.

The Contractor shall supply and install all primary power cords, powerstrips, receptacles, circuit breakers, fuse panels, switches, earth fault detectors, surge protectors, distribution cabling, and power connectors required to support all equipment enclosures and system components furnished and installed under this specification, except as specifically excluded.

Plug-type power connectors with captive fastening (such as “Twist-Lock”) shall be used for interconnection of source power to the equipment enclosures or racks.

Plug-type connectors with captive fasteners (ie.DB-25,etc)shall be used for the interconnection of all inter and intra-enclosure signaling cable.

3.3.7 Finish Colors

Unless otherwise specified, finish colors for enclosures shall beg loss white enamel on the inside, and semi-gloss medium grey enamel on the outside. Only brushed aluminum trim shall be used. Employer reserves the right to approve the proposed color scheme.

3.4 Location of Equipment,Cable Routes and Associated Civil Works

During the Site Surveys, the Contractor shall determine and propose locations for all equipment to be supplied under this contract. Further, the Contractor shall locate and identify proposed routing for all cabling between all equipment locations including existing and planned equipment not provided under this contract, but required to be connected under the scope of this contract. This subsection defines the requirements and clarifies the responsibilities of the Employer and the Contractor regarding equipment siting,intra and interfacility interconnectivity and necessary associated civil works.

3.4.1 Locations for Supplied Equipment

All transmission equipment, the NMS and associated DDFs and MDFs, shall generally be co-locatedinthesamecommunicationsroomlocatedintheControlBuildingwheneverpossible.

3.4.2 Associated Civil Works

The Contractor shall provide all required minium or civilworks necessaryfor full connectivity as Required in the Contractor’s scope of work as follows:

(1) All wall and floor penetrations necessary for the installation of all cabling to be performed in accordance with the requirements of this specification.

(2) Installation of racks, cabinets,cableraceways,and cabling supplied as part of this contract.

3.4.3 Cable Trenches

A network of cable trenches and/or ducts may exist at some sites but shall require expansion and/or new construction at some stations. It shall be a responsibility of the contractor to cooperatefullywiththeEmployerandallotheron-goingprojectcontractorsintheplanningand efficient use of existing and new cable trenches. The existing cable trenches/ cable raceways proposed to be used shall be identified in the survey report. The contractor shall make its best effort to route the cable through the existing available cable trenches. Where suitable existing cable trenches are not available, suitable alternatives shall be proposed for Employer approval. The Employer shall provide any additional cable trenches required for such approved alternatives.

It maybe noted that in order to utilise the existing trenches, the Contractor supplied cables may be required to be co-located with LV cables. Accordingly, the contractor shall ensure that selectionandinstallationofcablesissuitableforthepurpose.Thecontractorshallberesponsible for new building penetrations required for supplied cabling. Caution shall be taken to ensure existing equipment and site personnel are protected from dust and debris incident to the cable penetration work. Penetration shall be neatly formed and sealed for protection from moisture, dust wind and vermin intrusion.

All required fitting, supports, accessories, ducts, inner ducts, conduits, riser and any item not specially mentioned but required for lay and installation of cables in trenches shall be supplied and installed by the Contractor.

Section–04

Inspection, Test and Availability

All materials furnished and all work performed under this Contract shall be inspected and tested**.** Deliverables shall not be shipped until all required inspections and tests have been completed, and all deficiencies have been corrected to comply with this Specification and approved for shipment by the Employer.

Except where otherwise specified, the Contractor shall provide all manpower and materials for tests, including testing facilities, logistics, power and instrumentation, and replacement of damagedparts.The costs shall be borne by the Contractor and shall be deemed to be included in the contract price.

The entire cost of testing for factory & site acceptance, routine tests, production tests and other test during manufacture & site activities specified herein shall be treated as included in the quoted unit price of materials, except for the expenses of Inspector/Employer's representative.

Acceptance or waiver of tests shall not relieve the Contractor from the responsibility to furnish material in accordance with the specifications.

All tests shall be witnessed by the Employer and/or its authorized representative (hereinafter referred to astheEmployer) unless theEmployer authorizes testingto proceed without witness. The Employer representative shall sign the test form indicating approval of successful tests.

Should any inspections or tests indicate that specific item does not meet Specification requirements, the appropriate items shall be replaced, upgraded, or added by the Contractor as necessary to correct the noted deficiencies at no cost to the Employer. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The Employer reserves the right to require the Contractor to perform,at the Employer's expense, any other reasonable test(s) at the Contractor's premises, onsite, or elsewhere in addition tothe specified Type, Acceptance, Routine, or Manufacturing tests to assure the Employer of specification compliance.

All security related features shall be demonstrated during FAT/SAT as required by the Employer.

4.1 Inspection

Access to the Contractor's facilities during system manufacturing and testing and to any facility where systems/ equipment are being produced/ tested/ integrated for the fibre optic communication network,shall be available to the Employer. At all times the Employer shall have full facilities for unrestricted inspection of such materials or equipment. To facilitate this, the Contractor shall submit for the Employer approval, a comprehensive Quality Assurance Plan using ISO 9000 as a general guideline. In addition, the Quality Assurance Plan shall satisfy the following:

(a) Sufficient office facilities, equipment, and documentation necessary to complete all inspections and to verify that the equipment is being fabricated and maintained in accordance with the Specification shall be provided by the Contractor to the Employer.

(b) Inspections to be performed by the Employer will include visual examination of hardware, cable dressings and labeling. Contractor's documentation will also be examined to verify that it adequately identifies and describes all offered items and spare parts.

(c) Access to inspect the Contractor's standards, procedures, and records that are applicable to the supplied equipment shall be provided to the Employer. Documents will be inspected to verify that the Contractor has performed the required quality assurance activities.

(d) The inspection rights described above shall also apply to sub Contractors who are responsible for supplying major components described in this Specification. These items shall be inspected and tested at the sub Contractor's factory by the Employer's representativespriortoshippingthisequipmenttotheContractor'sfacilityordirectly to the Employer.

(e) The above inspection rights shall also apply to sub Contractors supplying assemblies, sub assemblies and components. However, such items will normally be inspected and tested by the Employer's representatives at the Contractor's site before acceptance.

4.2 Test Plans and Procedures

Test plans and test procedures for both factory and site acceptance tests shall be provided by the Contractor. Test plans and test procedures shall ensure that each factory and site test is comprehensive and verify all the features of the equipment to be tested. Test plans and test procedures shall be modular to allow individual test segments to be repeated upon request.

The Contractor shall submit a Test Schedule for the Employer's approval within one (1) week after the award of contract for TypeTests and three(3)months after the award of contract for all other tests. The test schedule shall list the tests to be carried out, and the approximate test duration. The test periods shall also be indicated in the PERT chart or equivalent for the work.

The Contractor shall give the Employer twenty one (21)days written notice of any material being ready for testing. Fifteen days prior to the scheduled testing, the Employer shall provide written notice to the Contractor of any drawings, equipment, material, or workmanship which, in the Employer's opinion, are not compliant to the specification. The Contractor shall give due consideration to such objections, if valid ,effecting the corrections as necessary or shall prove,in writing, that said modifications are unnecessary for contract compliance.

4.2.1 Factory and Site Test Plans

A test plan for factory and site acceptance tests shall be Submitted for approval, at least four(4) weeks before the start of testing. The test plan shall be a single overview document that defines the overall schedule and individual responsibilities associated with conducting the tests, documenting the test results, and successfully completing the test criteria. Test Plans shall include, at a minimum, the information contained in Table 4-1.

Table4-1

Factory & field Test Plan Requirements

Item:	Description:
1.	Test schedule
2.	Record-keeping assignments, procedures and forms
3.	Procedures for monitoring, correcting and retesting variances
4.	Procedures for controlling and documenting all changes made to the communications equipment after the start of testing

4.2.2 Test Procedures

Test procedures for factory and site testing shall be submitted for the Employer approval at least four (4) weeks before each individual test. Fully approved test procedures shall be submitted to the Employer at least four weeks prior to the commencement of testing. Testing shall not commence without approved test procedures. At a minimum, test procedures shall include the items listed in Table 4-2.

All test equipment and/or instruments shall bear calibration stickers indicating valid calibration on and beyond the testing date. The time lapsed since last calibration shall not exceed the test equipment manufacturer recommended calibration interval or the interval recommended in the test lab's internal quality procedures.

TheContractorshallensurethatalltestingwillbeperformedbyqualifiedtestingpersonnelwell experienced in performing such tests.

Table4-2

Test Procedure Requirements

Item:	Description:
1.	Test Title and Revision Level,if applicable
2.	List of Standard(s)complied with
3.	Function(s)/parameter(s) to be tested
4.	Purpose of each test segment
5.	List of required test equipment
6.	Description of any special test conditions or special actions required.This includes complete descriptions, listings and user interface procedures for all special hardware and software tools and/or display formats to be used during the test.
7.	Test setup including test configuration block diagrams and/or illustrations.
8.	Test procedures to be followed.

Table4-2

Test Procedure Requirements

Item:	Description:
9.	Required inputs and expected outputs for each test segment
10.	Acceptance criteria for each test segment.
11.	List of test data to be supplied by the Contractor(s) and copies of any certified data to be used
12.	Format of test reports.

4.2.3 Test Records

Complete and indexed records of all factory and site acceptance tests results shall be maintained and provided to the Employer by the Contractor in hardcopy. The records shall be keyed to the steps enumerated in the test procedures. The minimal items required in test records are described in Table 4-3.

Table4-3

Test Record Requirements

Item:	Description:
1.	Test Title and Revision Level, if applicable ;contract references
2.	Date and time for test start and test completed
3.	Test title and reference to the appropriate section of the test procedures
4.	Description of any special test conditions or special actions taken(Includestest-case data).
5.	Test results for each test segment including an indication of Passed, Conditional Pass, Incomplete or Failed.
6.	Test procedure modifications made during testing.
7.	Variance Report(s) tracking information and copies (if variance(s) was detected).

Table4-3

TestRecordRequirements

Item:	Description:
8.	Contractor's test engineer(s)identification, signature and remarks
9.	Employer's test witness identification, signature and remarks
10.	List of all attachments
11.	Attachments (including systemlogs, printouts, variances,hardcopies of visual test result displays, etc.)

All principle test records, test certificates and performance curves shall be supplied for all tests carried out as proof of compliance with the specifications and/or each and every specified test. These test certificates, records and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Employer within the specified duration after the completion of test. Information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificates refer, and shall also bear the Contractor's reference and heading.

4.2.4 Rejection of Elements

Any item or component which fails to comply with the requirements of this Specification in any respect, at any stage of manufacture ,test ,erection or on completion at site may be rejected by the Employer either in whole or part as considered necessary.

Material or components with defects of such a nature that do not meet the requirements of the Specification by adjustment or modification shall be replaced by the Contractor at his own expense. After adjustment or modification, the Contractor shall submit the items to the Employer for further inspection and/or tests.

4.2.5 Test Periods Defined

The terminology used in Volume I, Conditions of Contract and their correlation with the tests requirements described within this section is as follows:

Pre-Commissioning & Commissioning Period-TheSite Acceptance Test(SAT) Operational Acceptance / Taking Over - Successful completion of SAT

4.3 Type Testing

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. Type Testing shall comply with the following:

(a) All equipment being supplied shall conform to type tests as per technical specification.

(b) The test reports submitted shall be of the tests conducted within last five (5) years prior to the date of bid opening. In case the test reports are older than five years(5) ago on the date of bid opening, the Contractor shall repeat the tests at no extra cost to the purchaser.

(c) The Contractor shall submit, within 30 days of Contract Award, copies of test reports for all of the Type Tests that are specified in the specifications and that have previously(before Contract award)been performed. These reports may be accepted by the Employer only if they apply to materials and equipment that are essentially identical to those due to be delivered under the Contract and only if test procedures and parameter values are identical to those specified in this specifications carried out at accredited labs and witnessed by third party/ customer's representatives.

In the event of any discrepancy in the test reports or any type tests not carried out, sameshallbecarriedoutbyContractorwithoutanyadditionalcostimplicationtothe Employer.

d) Type Tests shall be certified or performed by reputed laboratories using material and equipment datasheets and test procedures that have been approved by the Employer. The test procedures shall be formatted as defined in the technical specifications and shall include a complete list of the applicable reference standards and submitted for Employer approval at least four (4) weeks before commencement of test(s). The Contractor shall provide the Employer at least 30 days written notice of the planned commencement of each type test.

e) The Contractor shall provide a detailed schedule for performing all specified type tests. These tests shall be performed in the presence of a representative of the Employer.

(f) The Contractor shall ensure that all type tests can be completed within the time schedule offered in his Technical Proposal.

(h) In case of failure during any typetest, the Supplier is either required to manufacture

A fresh sample lot and repeat all type tests successfully or repeat that particulartype test(s) at least three times successfully on the samples selected from the already manufactured lot at his ownexpenses.In case afresh lot is manufactured for testing then the lot already manufactured shall be rejected.

4.3.1 Type Test Samples

The Contractor shall supply equipment / material for sample selection only after the Quality Assurance Plan has been approved by the Employer.The sample material shall be manufactured strictly in accordance with the approved Quality AssurancePlan.The Contractor shall submit for Employer approval, the type test sample selection procedure. The selection process for conducting the type tests shall ensure that samples are selected at random.Atleast three samples of each of the proposed equipment shall be offered for selection, out of which one sample for each equipment shall be selected.

4.3.2 List of TypeTests

The type testing shall be conducted on the following equipment

(a) SDH Equipment with all types of cards(optical card,Tributary card or any other equipment/ devices as part of repeater less links for the maximum fibre lengths)
(b) Drop & Insert Multiplexer with subscriber interface card
(c) DACS

4.3.2.1 List of type test to be conducted on Telecomequipment

The type tests for SDH Equipment with all types of cards, Drop & Insert Multiplexer with subscriber interface card and DACS are described below:

4.3.2.1.1 Temperature and Humidity Tests

The tests listed below are defined in IEC Publication 60068

(a) Low Temperature Test: Operation to Specifications

Low temperature tests shall be conducted as defined in IEC Publication 60068-2-1, test method Ad, with the following specifications

(1) Test Duration:The equipment is started up as soon as thermal equilibrium has been reached and operated for sixteen (16) hours. Its performance is checked during the test.

(2) Degree of Severity:Test shall be done at 0℃.

(3) Acceptance Criteria: No degradation of performance during and after the test.

(b) Low Temperature Test: Operation without Damage

Low temperature tests shall be conducted as defined in IEC Publication 60068-2-1, test method Ad, with the following specifications:

(1) Test Duration:The equipment is started up as soon as thermal equilibrium has been reached and operated for 72 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (Post-test).

(2) Degree of Severity:Test shall be done at-10℃.

(3) Acceptance Criteria:Degradation of performance is allowable during the test, however there shall be no degradation of performance in the post-test..

(c) DryHeatTest:Operation to Specifications

Dry heat test shall be done as defined in IEC Publication 60068-2-2, test method Bd, with the following specifications:

(1) Test Duration:The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test.

(2) Degree of Severity:Aspertable 5-1: operation to specification range.

(3) Acceptance Criteria:No degradation of performance during and after the test.

(d) DryHeatTest: Operation without Damage

Dry heat tests shall be done as defined in IEC Publication 60068-2-2,test methodBd,with the

Following specifications:

(1) Test Duration:The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test andafter the test as soon as the thermal equilibrium is reached at the room temperature (Post-test).

(2) Degree of Severity:Test shall be done at 55ºC.

(3) Acceptance Criteria:Degradation of performance is allowable during the test, however there shall be no degradation of performance in the post test.

(e) Damp Heat Test

Damp heat testing reveals aging with respect to the humidity level and applies basically to electronic equipment. This test shall be done as defined in IEC Publication 60068-2-3 with the following specifications:

(1) Test Duration:The equipment is started up as soon as thermal equilibrium has been reached and operated for 10 days.Its performance is checked during the test.

(2) Degree of Severity:Test shall be done at (40±2)ºC &(93±3)% RH

(3) Acceptance Criteria:The equipment shall meet the specified requirement and there shall not be any degradation in BER.

(f) Temperature Variation Test

Temperature variation testing shall be as per IEC Publication 60068-2-14 (Gradual Variations, Method Nb). The equipment shall be powered on and various parameters shall be monitored continuously during the test period.

(1) Number of cycles required is five(5)
(2) The degree of severity: temperature TL:0°C, TH: As per table 5-1 (Operation to specification range)
(3) Cycle duration for each temperature is three(3)hours.
(4) Ramp:1°C/minute.
(5) Acceptance Criteria:The equipment shall meet the specified requirement and

There shall not be any degradation in BER.

4.3.2.1.2 Power Supply and EMI/EMC tests

The test procedure and acceptance criteria shall be as defined in IEC60870-2-1.

(a) Immunity Tests

The list of Immunity tests are specified below in Table4-4:

Table4-4: Recommended Immunity Tests

S. No.	ImmunityTest	AC Power Supply	DC Power Supply	Control &Signal	Telecom Line	Para-metres
1	Voltage Fluctuations	Yes	Yes	N/A	N/A	Table 11 of IEC 60870-2-1:1995 -Level:1
2	Voltage dips and Interruptions	Yes	Yes	N/A	N/A	Table 11 of IEC 60870-2-1:1995 -Level:1
3	1.2/50 - 8/20 µs surges	Yes	Yes	Yes	N/A	Table 12 of IEC 60870-2-1:1995 -Level:4
4	Fast transient bursts	Yes	Yes	Yes	Yes	
5	Dampedoscillatory waves	Yes	Yes	Yes	Yes	
6	10/700µssurges	N/A	N/A	N/A	Yes	
7	Electrostatic discharge	Yes				Table 13 of IEC 60870-2-1:1995 -Level:4
8	Power frequency magnetic field	Yes				Table 14 of IEC 60870-2-1:1995 -Level:4

Table4-4:Recommended Immunity Tests

S. No.	ImmunityTest	AC Power Supply	DC Power Supply	Control &Signal	Telecom Line	Para-metres
9	Dampedoscillatory magnetic field	Yes				
10	Radiated electromagnetic field	Yes				Table 15 of IEC 60870-2-1:1995 -Level:4
11	Power Frequency voltage on control and signal lines	N/A	N/A	Yes	Yes	IEC61000-4-16 : 2002-07 -Level:4
12	DC voltage on control and signal lines	N/A	N/A	Yes	N/A	IEC61000-4-16 : 2002-07 -Level:4
-EndofTable-						

(b) EmissionTests

The list of Emission tests are specified below in Table4-5

Table4-5:
RecommendedEmissionTests

S.NO.	Emissiontest	AC Power Supply	DC Power Supply	Control & Signal	Telecom Line	Para-metres

Table4-5:
Recommended Emission Tests

S.NO.	Emissiontest	AC Power Supply	DC Power Supply	Control & Signal	Telecom Line	Para-metres
1	LF disturbance voltages CCITT recommendation P.53	N/A	Yes	N/A	N/A	Table 17 of IEC 60870-2-1: 1995 - Class:B
2	RF disturbance voltages CISPR22	Yes	Yes	N/A	N/A	Table 17 of IEC 60870-2-1: 1995 - Class:B
3	RF disturbance currents CISPR22	N/A	N/A	N/A	Yes	
4	RFradiatedfields CISPR 22	Yes				
-EndofTable-						

(c) InsulationWithstandVoltages

As per section6 of IEC870-2-1.Recommended class:VW1ofTable18.

4.3.2.1.3 Mechanical Tests

(a) Mechanical Vibration Test

The procedure for this test is described in IEC Publication60068-2-6.The testing procedure shall be carried out in the sequence 8.1 + 8.2.1 + 8.1 as described in document 60068-2-6.

For the vibration response investigation (clause 8.1 of 60068-2-6), the test shall be carried out over as weep cycle under the same conditions as for the endurance test(described later),but the vibration amplitude and the sweep rate may be decreased below these conditions so that the determination of the response characteristics can be obtained.

The endurance test conditions are selected according to the vibration withstand requirements.

Transportation tests shall be performed with the equipment packed according to the Contractor's specifications.

(b) Shock Test

The procedure of this test is defined in IEC Publication 60068-2-27 (each test) with a semi-sinusoidal shape (clause 3.1.1.2).

The recommended severity shall be A = 294 m/s2, D = 18 ms. Three shocks per axis per direction shall be applied to the equipment packed according to the Contractor's specifications.

Or Free Fall Test

This test could be performed as an alternative to the shock or Bump test. The procedure is defined in IEC publication 60068-2-32. The equipment shall be packed according to the Contractor's specifications. The drop height shall be defined in accordance with IEC 68-2-32. The surface of the packing case which comes into contact with the ground is the surface on which the packing case normally rests; if the packing does not have any features (inscription, special shape, etc.) identifying this surface, the test is carried out successively on all the surfaces of the packing.

Or Bump Test

This test could be performed as an alternative to Shock test or Free Fall test. The procedure is defined in IEC 60068-2-29.

4.4 Factory Acceptance “Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out on SDH Equipments, associated line & tributary cards, Termination Equipments (Primary Mux, Drop/Insert DACS,

Associated Subscriber Line Interface Cards etc),NetworkManagement System etc.and all other items for which price has been identified separately in the Bid Price Schedules.

Equipment shall not be shipped to the Employer until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Employer, and the Employer has issued Material Inspection & Clearance Certificate (MICC). Successful completion of the factory tests and the Employer approval to ship, shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the employer's authorized representatives unless waiver for witnessing by Employer's representatives is intimated to the contractor.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation by the Employer.

The factory acceptance test shall demonstrate the technical characteristics of the equipment in relation to this specifications and approved drawings and documents. List of factory acceptance tests for Fibre Optic Transmission system,Termination EquipmentSub-system,NMSaregiven in specified Tables in this section. This list of factory acceptance tests shall be supplemented by the Contractor's standard FAT testing program. The factory acceptance tests for the other items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's / supplier's) standard FAT testing program. In general the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces, alarms and diagnostics etc.

For Test equipment & clock, FAT shall include supply of proper calibration certificates, demonstration of satisfactory performance, evidence of correct equipment configuration and manufacturer's final inspection certificate/ report.

4.4.1 Sampling for FAT

From each batch of equipment presented by the Contractor for Factory acceptance testing, the Employer shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples. The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum1)for all items. The physical verification shall be carried out on100% of the offered quantities as per the approved FAT procedure.In case any of the selected samples fail; the failed sample is rejected and additional 20% samples shall be selected randomly and tested.In case any sample from the additional 20% also fails the entire batch maybe rejected. In case a number of equipments are required for demonstration of the performance of any equipment during FAT,the sample size shall be taken as that number of equipment which are necessary to demonstrate the performance, irrespective of the percentage.

Since FAT testing provides measure of assurance that the Quality Control objectives arebeing met during all phases of production, the Employer reserves the right to require the Contractor to investigate and report on the cause of FAT failures and to suspend further testing/approvals until such a report is made and remedial actions taken, as applicable.

4.4.2 Production Testing

Production testing shall mean those tests which are to be carried out during the process of production by the Contractor to ensure the desired quality of end product to be supplied by him. The production tests to be carried out at each stage of production shall be based on the Contractor's standard quality assurance procedures. The production tests to be carried out shall be listed in the Manufacturing Quality Plan (MQP), along with information such as sampling frequency, applicable standards, acceptance criteria etc.

Table4-8:

Factory Acceptance Testing for Fibre Optic Transmission System

Item:	Description:
1.	Physical inspection for conformance to DRS,BOQ,drawings and appearance of equipment
2.	Optical output power
3.	Transmitter light wave spectral analysis
4.	Low receive level threshold
5.	Generation of bit error rate curve
6.	Measurement of analog and digital service channel parameters as well as service channel functionality
7.	Performance of supervision, alarm, Craftsperson interface, diagnostics, loop backs etc.

Table4-8:

Factory Acceptance Testing for Fibre Optic Transmission System

8.	Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for multiplexers
9.	At a minimum tests on Ethernet interface shall include demonstration of ping test, throughput test, Latency test, Packet Loss test as per RFC 2544
11.	Simulation of failure conditions and failover of each redundant unit.
12.	VLAN(Layer-2switching)feature testing with atleast three equipment configuration
13.	Protection scheme for EthernetTraffic(ERPS)
14.	Test of spare cards lots
15.	Checks of power supply/converter voltage margins
16.	Random inspections to verify the accuracy of documentation
17.	Test of spare parts/modules/cards as per applicable tests
18.	Test to exhibit the MPLSTP functionality of the Equipment.

Table4-9

Factory Acceptance Testing Requirements for Termination Equipment (MUX &DACS)

Item	**Description:**
1.	PhysicalInspectionforconformancetoDRS,BOQ,drawingsandappearanceof

Table4-9

Factory Acceptance Testing Requirements for Termination Equipment (MUX &DACS)

Item	Description:
	Equipment
2.	Performance of supervision,alarm,control and switchingsystems,diagnostics, loopbacks, Craftsperson interface etc.
3.	Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for the channel banks/low-level multiplexers
4.	Framing,signaling,and operational and maintenance tests consistent with applicable ITU-T requirements
5.	Simulation of failure conditions and failover of each redundant unit
6.	Test of sparecards lots and test of spareparts/modules/cards as per applicable tests
7.	Checks of power supply/converter voltage margins and short circuit and overvoltage protection
8.	Random inspections to verify the accuracy of documentation

Table4-10 **FATonNMS**	
1	Physical inspection of NMS hardware for conformance to approved BoQ, DRS &drawing
2	Test to demonstrate the expansion capability of the NMS system
3	Test to demonstrate the functionality of Northbound interface
4	Testing of NMS to demonstrate proper operation of allfunctions:Configuration Management, Performance Management, Fault Management and Security Management.All standard features and required customization of the NMS shallbe

	Demonstrated for proper functioning.

4.5 Site Acceptance Tests

The Contractor shall be responsible for the submission of all equipment & test equipment supplied in this contract for site tests and inspections required by the Employer.Allequipment shall be tested on site under the conditions in which it will normally operate.

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. At a minimum Site AcceptanceTesting requirement for Telecom equipment, NMS etc. is outlined in following section. This testing shall be supplemented by the Contractor's standard installation testing program, which shall be in accordance with his quality plan(s) for Telecom equipment installation.

During the course of installation, the Employer shall have full access for inspection and verification of the progress of the work and for checking workmanship and accuracy, as maybe required.On completion of the work prior to commissioning; all equipment shall be tested to the satisfaction of the Employer to demonstrate that it is entirely suitable for commercial operation.

4.5.1 Phases for Site AcceptanceTesting

The SAT shall be completed in following phases:

4.5.1.1 Installation Testing

The field installation test shall be performed for all equipment at each location.If any equipment has been damaged or for any reason does not comply with this Specification,the Contractor shall provide and install replacement parts at its own cost and expense.

In the installation test report, the Contractor shall include a list of all hardware or components replacedorchangedbetweenthecompletionoffactorytestsandthestartoffield tests and show that documentation and spare parts have been updated**.**

The minimal installation testing requirements for fiber optic transmission subsystem, Termination equipment sub-system and NMS are provided in respectiveTables in this section.

4.5.1.2 LinkCommissioningTests

The commissioning tests shall verifythat communication can be performed over the fiber optic link under test. Delay measurement, Bit Error measurements & service channel performance monitoring shall be made on the fibre optic links to verify compliance with designed link performance.

For Ethernet interface: At a minimum the following test requirements shall be demonstrated as per RFC 2544:

a) Ping test
b) Throughput test
c) Latency test
d) Packet Loss

VLAN(Layer-2switching)featuretestingwithequipmentsaspernetworkconfigurationshallbe demonstrated.

10% of the total communication links(Chosen by the Employer,generally to cover links from all configurations used) shall be tested for a duration of 12 Hours.

Rest of the links shall be tested for 1 Hour. In case a link does not meet the performance requirements during 1hour,then the duration of the test shall be increased to12hours.

In case any link does not meet the performance requirements during 12 hour, then the cause of failure shall be investigated and the test shall be repeated after rectifying the defects.

This phase of testing shall be conducted by the Contractor and witnessed by the Employer.Field adjustments shall be made to meet established standard, however if the field adjustments fail to correct the defects the equipments may be returned to the Contractor for replacement at his own expense. In case any adjustments are required to be made during the interval of the test then the test shall be repeated.

4.5.1.3 Integrated Testing

Prior to commencement of integrated testing the overall system shall be configured as required to provide all the data and voice channel required to interconnect the various control centres and RTU. The integrated testing for a batch shall include end-to-end testing of back-bone network included in that batch.Integrated testing for last batch shall include testing of the entire back-

bone.The intent of integrated testing is to demonstrate that the equipment is operational end to end under actual conditions,that all variances identified during factory and field installation and communications testing have been corrected, and that the communication equipment is compatible with other equipment at all locations. The Integrated System Test shall include all fibre optic transmission equipment, termination equipment,the network management subsystem and other components.

At a minimum the following tests shall be included in the integrated testing:

(1) Installation testing for NMS as per tables below

(2) Equipment configuration shall be checked to establish that it supports the channel routing.

(3) End to end testing of all individual voice circuits originating from PLCC, PABX or PhonesandtoestablishproperinterfacingwithPLCC\PABX\Phonesandtodemonstrate proper operation of channels over wideband systems.Operation shall be checked in terms of quality of voice, call initiation and call termination processes. The requirements for integrated testing for PABX system is described separately below.

(4) End-to-end testing of all individual Data Circuits originating from PLCC, RTU and SCADA Front Ends and to establish proper interfacing with PLCC\RTU\Front End and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of monitoring of BER/packet loss.

(5) Testing of NMS to demonstrate proper operation of all functions: Configuration Management,Performance Management,Fault,Management and Security management. All the standard features of the NMS shall be demonstrated for proper functioning.

(6) Demonstration of Protection switching and synchronization of equipment as per synchronization plan.

Table4-12

Fibre Optic Transmission system Installation Testing

Item:	**Description:**
1.	Physical Inspection for conformance to drawings,rack elevations and appearanceof equipment and cabling
2.	Station power supply input and equipment powersupply(DC-DCconverter) output voltage measurements

3.	Terminaltransceiverperformancetesting(Txpower,Txspectrum,receivesignal strength,connectorlossesetc.)
4.	Service channel performance
5.	Crafts person interface,alarm andcontrolfunctionalperformance
6.	Rack and localalarms:No alarms shall be present and all alarms shall be demonstrated to be functional
7.	Network management interface and supervision performance
8.	Correct configuration,levelsetting&adjustmentsandterminationofInput/output interfaces
9.	Proper establishment of Safety and signaling earthing system and resistanceto ground to be checked.
10.	Simulation of failure conditions and fail over of protected components.

Table4-13

Termination Equipment Sub-system InstallationTesting

Item:	**Description:**
1.	Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling
2.	Power supply/converter voltage measurements
3.	Modem performance testing
4.	Crafts person interface,alarmand control functional performance
5.	Rack and Local alarms
6.	Network management interface and supervision performance

7.	Channel performance
8.	Safety and signaling earthing system
9.	Simulation of failure conditions and failover of protected components.

----------EndofthisSection----------

Section-5
Training and Support Services

This section describes the requirements for Contractor-supplied training, support services, and maintenance of the FOTS, Terminations equipments sub-systems, Network Management System, etc.The intent of the training and support program is to ensure a smooth transfer of systems and technologies from the Contractor to the Employer, and to ensure that Employer staff is fully trainedtooperate,maintain and expand the integrated telecommunication network.

5.1 Training

The Contractor shall provide a comprehensive training program that prepares the Employer's personnel for on-site installation support, operation, and maintenance of the telecommunication network.

Training may be conducted by the Contractor, the Contractor's subcontractors, and/or original equipment manufacturers (OEMs).The training requirements of this Specification shall apply to all such courses.

Training courses shall be conducted by personnel who speak understandable English and who are experienced in instruction. All necessary training material shall be provided by the Contractor. The training charges quoted by the Contractor shall include training materials and all associated expenses. However, for all training courses in India or abroad, the travel (e.g., airfare) and per diem expenses of the participants will be borne by the Employer. For courses conducted abroad, however, the Contractor shall extend all necessary assistance for making appropriate lodging arrangement.

Hands-on training shall be provided with equipment identical to that being supplied to the Employer.

The schedule,location and detailed training contents shall be submitted by the Contractor to the Employer for approval.

5.1.1 System Design & Overview Training

This training shall provide a functional description of the telecommunication subsystems for both fibre optic transmission system and Termination equipment system and a discussion of the fail over and alternate routing schemes inherent in the configuration.The training shall include an overview of the network configuration and indicate the functional responsibilities of all major subsystems including the network monitoring system hardware and software. The training shall

highlight all significant methodologies or concepts utilized by the hardware and software to perform the required functions. High-level hardware configuration block diagrams and network/sub-network block/flow diagrams shall be included to enhance the understanding of the overall capability incorporated into all network and sub-network equipment.

The training shall be oriented to a user's point of view. The Employer/Owner users will include managers, design & planning personnel, communication support staff and maintenance person-nel.As part of the proposal, the Contractor shall identify the number of days deemedappropriate for this training.

The overview training shall be customized for the specific functions, features, and equipment purchased by the Employer; it shall not be a general presentation of the Contractor' standard equipment repertoire. Personnel assigned by the Contractor to implement the Employer's system shall conduct this overview training. The Employer shall review and approve the contents of the overview training at least four (4) weeks prior to the course.

5.1.2 Installation & Maintenance Training

There shall be separate modules of the installation & maintenance training for the following systems:

(1) FO Transmission SystemTraining
(2) Termination Equipment SystemTraining

The installation & maintenance trainings shall enable the Employer to be self-sufficient in preventive&restorativemaintenanceoftherespectivecommunicationssubsystemspurchasedby the Employer. The training courses shall cover equipment installation, testing & commissioning, operation,interfaces and cabling between equipment, preventive maintenance,diagnostic tools and trouble shooting procedures,corrective maintenance, and expansion procedures for all equipment. The courses shall provide theoretical background and extensive hands on experience.

Courses shall include equipment adjustments, board-level troubleshooting and repair and, where appropriate, component-level troubleshooting and repair. Course participants shall operate actual equipment and diagnose and repair simulated failures.

5.1.3 Network Management Training

The Network Management training shall familiarize the Employer’s telecommunication personnel with the concepts and techniques for configuring, programming, maintaining, and troubleshooting the Contractor supplied NMS and its associated database. The training course shall provide a thorough understanding of the general design concepts,features,and user interface requirements for local and remote monitoring of the equipment,as well as procedures for restoring service after

Equipment and power failures.

The Network Management training course shall provide the course participants with hands-on experience using the actual system being supplied. Table 5-1 summarizes the minimal Network Management training requirements.

Training aids for each course shall include the Operator's User Manual for each type of equipment. Operator training that is a standard part of the maintenance training will be applicable.

5.1.4 Training Course Requirements

This section describes general requirements that apply to all training courses.

5.1.4.1 Class Size

The Employer plans to send a number of participants to the training courses for a specified duration as described in Appendices**.**

5.1.4.2 TrainingSchedule

The Contractor shall provide training in a timely manner that is appropriate to the overall project schedule.All training courses shall be available to the Employer for a minimum of five years After final acceptance of the communication system.

The training courses shall be offered in one cycle,such that none of the courses within the cycle overlap.

The Contractor shall take the above requirements into account in developing the preliminary training schedule. Contractor shall develop a final training schedule in consultation with the Employer after contract award.

5.1.4.3 Manuals and Equipment

The Contractor, subcontractor, or OEM shall prepare training manuals and submit them to the Employer for review at least one month prior to the start of classroom instruction. The training manuals shall be prepared specifically for use as training aids; reference manuals, maintenance manuals, and user's manuals may be used as supplementary training material. Principal documents used for training shall be tailored to reflect all the Employer requirements specified.

Each course participant shall receive individual copies of training manuals and other pertinent material at least two weeks prior to the start of each course.The Employer shall retain the master and two additional copies of all training manuals and materials as reference documentation. A complete set of instructor's manuals and training aids shall also be provided.

Upon completion of each course, instructor's manuals, training manuals, and training aids shall become the property of the Employer. As part of the delivered system documentation and the final documentation, the Contractor shall supply the Employer with all changes and revisions to the training manuals and other training documentation.The Employer reserves the right to copy all training manuals and aids for use in the Employer-conducted training courses.

The Contractor shall furnish for use during training courses all special tools,equipment,training aids, and any other materials required to train course participants.

5.2 Support Services

Throughout design, implementation, factory testing, and field installation and testing, the Contractor shall supply consulting assistance, as required by the Employer for site preparation, field installation, and other areas where technical support maybe required.

The Contractor shall be responsible for minor facility renovation, and maintenance of the supplied system upto and including successful completion of the SiteAcceptanceTest.

After final acceptance of the communications equipment, the Contractor shall offer continuing

technical support and spare parts for the designed life of the equipment or 7 years after the declaration of withdrawal of equipment from production whichever is earlier. However the termination of production shall not occur prior to Operational Acceptance / Taking Over of the system by the Employer.Some locations have existing SDH&MUX equipment. The traffic may be switched over to new fibre optic communication equipment in phase manner.The Contractor shall review the Employer existing equipment make, integration & switch over recommendation and prepare a detailed field implementation plan.

5.2.1 Technical Support

Consultation with Contractor's technical support personnel and trained field service personnel shall be readily available on a short-term/long-term basis to assist the Employer personnel in maintaining, expanding, and enhancing the telecommunication network upon expiration of the warrantyperiod.The Contractor shall include in their offer(s),a proposal for ensuring continued technical support as stated above.

5.2.2 Contractor's Future Hardware/SoftwareChanges

The Employer shall be informed of all alterations or improvements to the hardware supplied under this Specification.The Employer shall be placed on the Contractor's mailing list to receive announcements of the discovery,documentation ,and solution of hardware/software problems as well as other improvements that could be made to supply equipment. The service shall begin at the time of contract award, and shall continue for 10 years. The Contractor shall also include a subscription to the hardware subcontractors' change notification service from the time of contract award through the warranty period,with a Employer renewable option forex tended periods.

5.3 Spare Parts and TestEquipment

The spare parts and test equipment shall be provided for each subsystem as described below.

5.3.1 Mandatory Spare Parts

Appendices provides the Mandatory Spare Parts Requirements described in subsystem sets.The mandatory spare parts table represents the minimum spares the Contractor shall be required to supply. The subsystem set of spare parts is defined to include all equipment modules, subunits and parts required to effect replacement, repair and restoration to full operational status of a defined unit of a subsystem (i.e.SDH equipment, PrimaryMux, Drop/InsertDACS etc.)

5.3.2 Recommended Spare Parts List

In addition to the MandatorySpares the bidder shall provide a list of“ Recommended Spare

Parts",which may be required over and above the spares listed in Mandatory Spare parts list(Vol II, appendices), to support system availabilities specified in specificationsduring a one year period. This list of spares shall be called the "Recommended Spare Parts List". The Recommended spare parts list shall not be considered for evaluation and may be included in the final scope of supply. The Bid shall include the following minimum information for the recommended spare parts:

a. Original manufacturer and part number
b. Name and Description
c. Either theoretical or empirical MTBFof the unit
d. Number of units in each set
e. Total number of sets to be provided

The unit as well as set prices shall be provided for each subsystem set item of the spare parts list in the appropriate Bid Price Schedule.

5.3.3 Test Equipment

TECHNICAL SPECIFICATION OF OPTICAL TIME DOMAIN REFLECTOMETER (OTDR)	
To install & maintain optical fiber system and for auto fiber analysis the Optical Time Domain Reflectometer (OTDR) is required. The OTDR offered should be rugged and easy to use with intelli-trace facility. It should be designed to stand the rigors of field work, while providing precise measurements on single mode optical fiber systems.	
Make: EXPO /Yokogawa/Anritsu/Fuzikura/Agilent are preferred.	
TECHNICAL CHARACTERISTICS:	
Optical characteristics	OTDR Calibrated to dual wavelength with 1310/1550nm ±20nm
Dynamic range (dB)	
1310 nm	42 dB
1550 nm	40 dB
Readout Resolution	0.04cm
Distance measurements (in)	Kilometres, Feet, Miles, Meters
Attenuation measurement:	
i) Vertical	0.001dB
ii) Readout resolution (display)	0.001dB
iii) Accuracy	0.001dB
OTDR Distance Range setting	0.1 to 400 km

System measurement accuracy	± 0.5dB
Distance measurement accuracy (m)	± (0.5m + sampling resolution + 0.001% × distance)
Reflectance measurement accuracy (m)	± 2dB
Measurement time (sec)	Live or Predefined values
Event Dead zone (m)	< 1mtrs
Attenuation dead zone (m)	<3mtrs
Data sampling point	up to 256000
Sampling resolution	4cm
Laser safety class (21CFR)	Class 1.
Refractive index Range	130000 to 170000 in 0.00001
Linearity	± 0.03dB
Selectable pulse width	3ns to 20000ns
Memory capacity	20000 Traces Internal Memory or more
One-touch multiple acquisitions, with clear go/no-go results presented in a straight forward visual format	Simplify OTDR tests while optimizing characterization accuracy for all network topologies. powered by intelligent algorithms that can adapt to the context. Still unmatched in the industry, dynamically locates and identifies all network components and faults with maximal resolution— all at the push of one button.
Fiber Inspection Probe	Should be provided with OTDR with FC/PC Type ionterface for Tips & Bulkhead. Also Power Meter & VFL Should be available in same platform
Display	8 inch or more TFT Colour touch screen with high resolution
Interfaces	RJ45 LAN 10/100/1000 M bits Two USB 2.0 ports
Optical Interfaces (Connection)	FC-PC
Power supply	AC/DC Adapter, input 100-250V AC 50-60Hz, 2.5A max, output 12V DC, 25W.
Battery	Rechargeable Lithium Polymer battery up to 12hrs of operation
Operating/Storage temperature	0 C to 50 C (operating) and -20 C to +60 C(storage)
Humidity	0% to 95% non condensing.

TECHNICAL SPECIFICATION OF OPTICAL POWER METER

The Optical Power Meter offered should be operable in windows used in Telecommunication system and shall be suitable for measuring the power of Optical signal sources and the attenuation of optical cables. The equipment shall be suitable for installation and maintenance of optical links and for component characterization.	
Make: EXPO /Yokogawa/Anritsu/Fuzikura/Agilent are preferred.	
Technical Specification:	
Wavelength range	800 to 1650 nm
Accuracy	± 5% ± 1 nW
Measurement Range	-50 to +25 dBm
Operating Temperature	- 10 to + 50 C
Storage Temperature	- 20 to + 70 C
Optical Connector Type	FC
Operating time with battery	At least 10 hours
Optical Power Meter should be operated on DC voltage. Suitable AC/DC Adapter and battery shall be provided.	
Display	Color display with capacitive touchscreen Display
Memory	Storage capacity 1000 test results for local reading
Built In Option	VFL should be available
Accessories along with power meter	
1. FC/PC Type connector	
2. Battery pack	
3. Carrying Bag	
4. AC/DC adapter.	
5. User Guide	

	TECHNICAL SPECIFICATION OF OPTICAL POWER SOURCE

	Make: EXPO /Yokogawa/Anritsu/Fuzikura/Agilent are preferred.	
	Technical Specification:	
S.NO.	**PARAMETERS**	
1	Nominal Wavelength	1310 and 1550nm
2	Spectral Width(RMS)	5 nm
3	Number of Ports	Single Port
4	Fiber Type	9/125 um
5	Output Power Range	-3dBM
6	Resolution of Power Setting	Fixed
7	Signal Stability	Short term:±0.03 dB, within 15 min, long Term: ±0.1 dB, Within 8 hours
8	Auto Power Off	Shall be provided
9	cabinet	Shock Proof with bumpers
10	Optical Connector	Shut down
11	Ambient Temperature:: Usages(operating temperature) Storage	-10 °C to 50 °C '-40 °C to 70 °C
12	Power Supply	
13	Operating time for battery	>50h
14	Environmental Condition	-10 °C to 50 °C
		-40 °C to +70 °C
		Shock Proof Design, vibration, dust proof
15	Connectors type	FC/PC
16	Relative humidity	0% to 95% non-conductivity
	Optical Power Source should be operated on DC voltage and suitable AC/DC Adapter and battery shall be provided.	

TECHNICAL SPECIFICATION OF MULTI SERVICES TESTER
MULTISERVICES TESTER WHICH CAPABLE TO TEST ETHERNET & SDH LINK
Make: EXPO /Yokogawa/Anritsu/Fuzikura/Agilent are preferred.
TECHNICAL CHARACTERISTICS:
1.0 Ethernet/IP testing:
1.1 Date Rates: 10/100/1000, 1Gbps,10Gbps
1.2 Number of Ethernet ports:
Two ports working simultaneously, each port capable of 10M/100M/1G electrical, 1G optical & 10G optical with SFP+ modules
1.3 Optical Interface modules: SFP+ multi-rate modules to support 10km range,1310nm band for STM1, STM4, STM16, OTU1, 1GE, 10GE, STM64, OTU2: Quantity =2 numbers
1.4 Industry Standard RFC 2544 Tests. Including traffic generation and Analysis.
1.5 ITU-T Y.1564 Ethernet service activation Testing
1.6 Multi streams generation, analysis of statistics capability at layer 2 and layer 3 for QOS measurement.
1.7 Provision for VLAN /Q in Q
1.8 Layer2/Layer3 frame/packet header fields pre-setting & measurements.
1.9 Provision for MPLS tags
1.10 BER Testing at layer 2 and layer 3 with selectable PRBS patterns.
1.11 Provision for End to End bi-directional testing of network performance (RFC2544) by using two ports of the instrument simultaneously.
1.12 Support both IPv4 and IPv6 protocols
1.13 Packet capture feature on both the ports, storing and viewing of captured packets
1.14 Mode of operation: Terminate and loop back mode
2.0 PDH, SDH and OTN testing
2.1 Data rates: E1, E3, E4, STM1, STM4, STM16, STM64, OTU1, OTU2
2.2 Number of ports:
PDH with E1 balanced, E1 unbalanced, E3, E4 electrical interface & STM1, STM4, STM16, STM64, OTU1, OTU2 with SFP+ optical interface modules.
2.3 Optical Interface modules: As given in 1.3
2.4 BER testing & error performance analysis as per ITU-T standards.
2.5 OTN overhead testing: OTU/ODU/OPU overheads pre-setting & measurements.
2.6 SDH overhead testing: SOH and POH overheads pre-setting & measurements.
2.7 OTN Error, Alarm addition & Measurement
2.8 SDH Error, Alarm addition & Measurement

2.9 PDH Error, Alarm addition & Measurement
2.10 Traffic mappings:
2.10.1 OTU1/OTU2 with Bulk
2.10.2 STM1/4/16/64 with Bulk
2.10.3 PDH framed & unframed mode
2.11 Receiver optical signal power level measurement
2.12 Model of operation: terminate & through modes.
2.13 Round trip delay measurement
2.14 Transmitter clock frequency offset range setting: +/-50 ppm minimum
2.15 Transmitter clock source selection: Internal, recovered from receiver, external input.
2.16 Transmitter and Receiver clock frequency reporting
2.17 MPLS - Generates and analyzes streams with up to two layers of labels
2.18 Carrier Ethernet OAM - Fault-management and performance-monitoring Ethernet and MPLS-TP OAM protocols, including Y.1731, 802.1ag, MEF, Link OAM (802.3ah) and G.8113.1 OAMs
230V AC, 50Hz Indian power cord with DC adapter.
In built battery to operate the BER tester for at least 2 hours in the absence of AC power.
(i) In built display with keyboard (or) touch screen (ii) Remote control/operation using LAN management port
Test Report & Results generation in tabular and graphical depiction.
Storage facility to save the setting for particular configurations of interface and to store the results for further reference for documentation purpose. These Data should be saved directly or by connecting a pen drive or to be transferable to PC through LAN interface.
All interfaces (Ethernet, PDH, SDH and OTN) should be supported in a single instrument/tester fitted permanently with required modules. Only SFP+ optical modules are pluggable as required.
Calibration report and the guidelines to calibrate the equipment to be provided.
(i) 2 numbers of SFP+ Modules (ii) Optical patch cables (4 Nos. of LC to LC single mode each of about 3 meters‟ length. (iii) 2 numbers of BNC cables for E1, E3 Tests.
Portable module (less than 3Kg) with Carry case/bag

5.4 SystemMaintenance

As per DoT guidelines, operation and maintenance of the network shall be entirely by Indian engineers and dependence on foreign engineers shall be minimal within a period of two years from the date of LoA. The contractor shall be responsible to maintain the confidentiality of the Employer's System Information that Employer shares with the contractor for maintenance

period.

5.4.1 WarrantyPeriod

The one year period commencing immediately after the operational acceptance / taking over is called the Warranty Period/Defect liability Period.In addition to the responsibilities covered under Vol-I Condition of Contracts during Defect Liability Period, the Contractor shall also be responsible for maintenance of the Fibre Optic Transmission System, Termination Equipment, NMSetc.suppliedunderthisPackage.Thespecificationforthemaintenanceofthesystemafter Operational Acceptance / Taking Over is enclosed at Annexure-I.

5.4.2 Contractor'sMaintenanceResponsibility

The Contractor shall be responsible for carrying out "Comprehensive Maintenance" of the CommunicationSystemforaperiodofsixyearsafterwarrantyperiodforensuringthesuccessful operationofthesystem.TheContractorshallberesponsibleforachievingthesystemavailability and the response time mentioned in technical specifications. The bidder shall quote the Annual Maintenance Charges for six years after Warranty Period which shall be considered in the bid evaluation. Bidder shall submit the detailed procedure for achieving above in the bid. The specificationforthemaintenanceofthesystemisenclosedatAnnexure-I.Uponexpiryofthesix years AMC period Employer may, at its discretion, extend this Maintenance for additional two year at the same price & terms and conditions.

5.4.3 Additional Procurement of Spares

A provision of add-on buying of spares during maintenance period or at the completion of maintenance period or at the time of product termination notification is envisaged. The procurement quantity of such spares shall be limited to 5% of the Main equipments BoQ. The procurementofthesesparesitemsshallbeatthesamerate,terms&conditionsasenvisagedfor the spare items under the present scope of contract.

5.5 Miscellaneous Supplies

TheContractorshallprovideallrequiredconsumableandnon-consumablesuppliesnecessaryto support all installation and test activities through final operational acceptance / Taking over. However, if there are any problems in the SAT and additional consumables are required, the same shall also be supplied bythe Contractor at no additional cost.

5.6 Materials Handling and Storage

This section describes material handling and storage requirements.

(a) All the equipment furnished under the contract and arriving at site shall be promptly received, unloaded and transported and stored by the Contractor.

(b) The Contractor shall be responsible for examining all the shipment and notify the Employer immediatelyof anydamage, shortage, discrepancy, etc., for the purpose ofEmployer information only. The Contractor shall submit to the engineer every week a report detailing all the receipts during the week. However, the Contractor shall be solely responsible for any shortagesordamagesintransit,handlingand/orinstorageanderectionoftheequipmentatsite. Anydemurrage,wharfageandothersuchchargesframedbythetransporter,railways,etc.,shall be to the account of the Contractor.

(c) The Contractor shall maintain an accurate and exhaustive record detailing out the list of all equipment received by him for the purpose of erection and keep such record open for the inspection of Employer.

(d) All equipment shall be handled very carefully to prevent any damage or loss. The equipment stored shall be properly protected to prevent damage. The equipment from the store shall be moved to the actual location at the appropriate time so as to avoid damage of such equipment at site.

(e) All the materials stored in the open or dusty location must be covered with suitably weatherproof and flameproof covering material wherever applicable.

(f) The Contractor shall be responsible for making suitable indoor storage facilities to restore all equipment which require indoor storage.

Contractor shall inspect pertinent locations,door openings,and other passages at the installation locations to avoid building any components of the system too large for such passages. Further, any components of the supplied equipment too large or too heavy for existing facilities at the

installation locations shall be hoisted or otherwise handled with apparatus as required at Contractor'sexpense.AllspecialhandlingchargesshallbeprovidedbytheContractorandshall be included in the Contract.

The Contractor shall be solelyresponsible and liable for anydamage to existing facilities at the installation locations caused by the Contractor, any of the Contractor's employees, or any subcontractor of the Contractor. Employer mayarrange for the repair of such damage, should it occur,at the Contractor's expense.The Contractor shall take reasonable precautions to protect the installation locations from damage. The Contractor shall not cut, drill into orotherwise alter the installation locations without first obtaining permission from Employer.

Throughout the installation of the equipment, the Contractor shall keep the installation locations free from debris and remove from the installation locations all refuse resulting from any work being done by the Contractor. At the completion of the installation the Contractor shall leave all installation locations in a clean and finished condition.

Annexure-I

Technical Specifications for Maintenance after operational acceptance / taking over during maintenance period (i.e. Warranty/defect liability period & AMC Period if applicable in BoQ)

A-1.0 GENERAL

The Contractor shall be responsible for comprehensive maintenance of all the communication equipment (i.e.SDH,PDH,VOIP Equipment,etc.)including NMS&DCPS system supplied& installed under this Contract.The maintenance contract shall commence after completion of the project i.e. after Operational Acceptance / taking over. BOQ is given in Price schedules. There may be some variation during detailed engineering. Contractor shall meet system availability of 99.9%for all the communication equipment.Contractor will have to make their own assessment of the network and deploy manpower accordingly. However, it is to be ensured that specified manpower of requisite qualification are deployed.

Contractor's maintenance engineer/service engineer should preferably an employee from OEM who have been also involved during the commissioning of ibid project. The site engineer shall have minimum qualification of graduate in Computer or IT or Electronics&Telecommunication with minimum one year experience or Diploma with three years maintenance/testing & commissioning experience on the equipment proposed to be supplied & installed. The Degree/Diploma must be recognized Indian professional qualification. This staff shall be supported by head office technical staff for restorative problem or other assistance as may be required. Maintenance engineer shall have technical background and trained in first & second levelmaintenanceonthesuppliedcommunicationsystem,DCPS&BatteryandNMSsystemof their own without technical assistance from Head Office.

Contractor will arrange for adequate transportation for their staff as per the work demand. Contractor's staff should be equipped with necessary toolkits,mobilephones,vehicle etc.

The contractor shall carry out the Bi-Annual Cyber Security Audit from CERT-In Certified auditorsforthecompletesystemsunderthisprojectandimplementtherecommendationgivenby auditor in consultation with the owner at no additional cost to the owner.

The Maintenance of the system supplied & installed by the Contractor shall be comprehensive and all the spares required during maintenance period shall be provided bythe Contractor at no additional cost to the Employer.

Note : The maintenance support is the sole responsibility of the contractor. However, the Contractor should provide an undertaking from OEM to the employer for ensuring it's unconditional support services during the warranty/AMC period as provisioned in the contract and BoQ.

A1.4HARDWARE SERVICES

In case any failure or malfunction is discovered,the maintenance team shall identify the problem, organise to promptly attend the fault, replace the faulty equipment/card/module or any other hardware component with as par unit and ship the faulty unit to specified location.Eachfaulty unit shall be accompanied with correctly filled-out Event Report.Contractor shall ensure maximum utilisation of the channel capacity, hence healthy channel/s will be put in use and hardwiredtorespective DDF/MDF point,in coordination with Employer,without disturbing end user (VOIP Equipment, RTU) connection so that outright replacement of card is avoided. Card shall be replaced when all the healthy channels are faulty.Necessary modification(temporary)in drawing/s in site copy and at NMS location will have to be done without changing original document.

The Contractor shall be responsible for providing all the spares (cards/modules/accessories or any other hardware component etc.) for supplied & installed equipment . The spares shall be provided / arranged by the contractor at no extra cost to Employer. For early restoration during the emergency condition, if spares are made available by Employer, the same shall have to be replenished by the Contractor within thirty (30) days.

Contractor's hardware services shall also cover support for other equipment supplied under the package viz.NMS hardware&Software,VOIP Equipment etc.supplied to Employer as part of theContract.Contractorshallberesponsibleforprovidingsparesforthesuppli edNMSsystem, if required, during maintenance period at no additional cost to the Employer.

Efficient, reliable, responsive and effective services with minimum responsetime (RT)and Turn aroundtime(TRT)shall be the essence of the maintenance services to ensure the correct working order of the communication system.Response time when contractor's person report at site after reporting of fault in the system. TAT is Turn around time when system is brought back in service after necessary rectification/replacement works.Timezero(forRT)starts after logging the complaint with the contractor before 2 PM & after 2 PM, time zero starts at 9 AM of next day.However,the contractor shall provide support within four(4)hours of fault reporting at the Stations where contractor's engineers are deployed.

Contractor will carry out the following tasks for hardware services:

a) Making of Joint report of Faulty unit/Hardware service with the Employer
b) Replace faulty units from their own spares stock.
c) Send faulty units to Originalequipment supplier's representative for repairs/replacement with the correctly completed Failure Report with site information and symptoms of failure.

d) Test the repaired unit for their healthiness after the same is rectified by the original manufacturer.

A 5.0 CO-ORDINATION REQUIREMENTS A 5.1

MEETING PRACTICE

Regular meeting between Employer and the Contractor is vital for communication and information flow between these two organisations. The purpose of the meeting is to tackle the essential issues concerning the services and network performance. The suggested schedule for meetingis once in everymonth. Themeetingagenda shall be decided between Employer and Contractor and could for example consist of the following issues:

- Services and network performance according to the report during last month
- Review of emergency situation
- Status of spare
- Actionplan
- NextMeeting
- Alarms/events unattended till the date of meeting

The following participants should be present in this meeting:

- Co-ordinator(Contractor)
- Members of the Contractorteamasneeded
- Co-ordinatorEmployerrepresentative
- Operationandmaintenancestaffasdesignated toattend(Employer)

SECTION 6: MPLS-TP

TechnicalSpecification

1.0MPLS-TP10GOpticalLineTerminalEquipment

1.1.1 Redundancy requirement

The Core ring equipment shall be well protected by providing redundant power supply,switching card etc. The equipment shall be capable of connecting -48VDC 1 and -48V DC 2 power sources in core stations. The MPLS-TP SFPs for different directions,the Ethernet for connecting various applications shall be provided atleast in two cards. The ethernet ports shall be equally distributed among the cards. The optical fiber links connected to these stations are provided through geographically different routes. So, the overall MPLS-TP communication network shall be designed by the contractor in such a way that the equipment failure or the optical link failure will not affect the normal traffic in any manner. Tributary cards shall be as per the requirement and as per redundancy criteria elsewhere mentioned in this document.

The main and backup NMS shall be provided at geographically different locations for managing the MPLS-TP telecommunication network.

Thecommunicationsystemmustsupportsub50msfailover/recoveryintheeventof

- Fiber-Cut
- Node Failure
- Failure of RingTerminating module/port.

Equipment Redundancy Capabilities

The equipment shall provide enhanced redundancy features to ensure highest availability of the communication network. The following redundancy schemes shall be supported:

- Redundant DC power supply cards-48VDC
- Redundant packet switch fabric
- Hardware redundancy of 10G MPLS-TP aggregate interfaces
- Minimum1:1 LSP protection switching

1.1.2 Interface requirement

The minimum MPLS-TP bit rate shall be 10Gbit/s for all substation links.

1.1.2.1 MPLS-TPEquipment

MPLS-TP equipment shall support minimum ten no. of 10G MPLS-TP interfaces. MPLS-TP transport linkwith 10 portx 10G.

1. Minimum 2(two) numbers MPLS-TP transport link cards shall be available for redundancy.
2. There shall be minimum 10× 10GMPLS-TP transport link ports available in the equipment.
3. The 10GSFP+ shall be provided as per the quantity given in the BOM

For tributary connections,the equipment shall have

Minimum 02(Two) numbers Ethernet interface (IEEE 802.3/ IEEE 802.3u) cards supporting Layer-2switching.The number of ports required is 16(Sixteen).The ethernet ports shall be equally distributed among the cards.

A minimum of 08 ports out of 16 numbers in Ethernet interface cards shall be of optical type. The SFP port shall be suitable for single mode SFP and /or multimode SFP.

Preferably SFP type slots shall be provided which can accommodate electrical or optical SFP for ethernet interface.

For TDM based E1 traffic the equipment shall support 16 port CES E1 interface.

For tele-protection/line differential application, the equipment shall support 16 port IEEE C37.94 optical interface using integrated IEEE C37.94 interface cards or using IEEEC37.94 to Ethernet/ E1 converters.

The IEEE C37.94 to Ethernet/ E1 converters shall be 1U/2U size, standard 19-inch rack mountable type with all accessories like interfacing cable, time synchronization etc. The power supply of the converter shall be -48 V DC and it shall be possible to monitor and manage the converters remotely from main and back up NMS.

All cards in the MPLS-TP equipment shall be hot pluggable.

The equipment shall be supplied based on technical specifications, GTP and Schedule of requirements.

The Contractor shall provide (supply and install) connectorized jumpers (patch cords) for FODP-to-equipment connection.

1.1.2.2 Packet Switched Capacity

The central switching matrix of the MPLS-TP equipment shall have a minimum of 160 Gbit/s, full duplex non-blocking packet switching capacity and shall be future upgradable to 200 Gbit/s.

1.1.2.3 Tele-protection

The offered MPLS-TP equipment shall support standalone tele-protection coupler for distance protection using Ethernet interface.

For line differential protection, IEEE C37.94 integrated tele-protection card IEEEC37.94toEthernet/ E1 converters shall be provided.The communication system must ensure simple, reliable, and secure operation.

The E1and C37.94 interfaces shall be provided as per the quantity given in BOM.

1.1.2.4 Telephony

Digital VoIP subscriber and gateway functionality(SIP) By Connecting a VoIP Gateway shall be supported. The supply of VoIP gateway is not in the scope of the bidder.

1.1.3 Functional Requirement

The primary function of the communication network is to provide a highly reliable voice and data communication system in support of the SCADA/EMS. The communication support requirement for SCADA/EMS system is for low & high-speed data, express voice circuits and administrative voice circuits along with video and VoIP services.

The communication system shall also support tele-protection (distance and differential) services between the various voltage level substations of AEGCL.

General summary of the communication system requirements is given below, which is not comprehensive:

a) FE/GE Ethernet interfaces for the connectivity envisaged between Substations and Control Centre over TCP/IP for various data and voice services such as PMUs, RTUs, VOIP etc.

b) CES E1 interfaces

c) Support of C37.94 channel for providing differential protection

d) Support of Digital Protection Coupler(DPC) for providing distance protection

e) Data transport supporting Network Management channels

1.1.4 Equipment Availability

The Contractor shall ensure the availability for subscriber to subscriber where they will have to provide the new MPLS-TP equipment under this contract. The availability requirements are as follows, which shall be demonstrated at site for the equipment being provided under this contract:

New nodes with requirement of MPLS-TP:

1) The average per link subscriber to subscriber availability shall be at least 99.97%. The average per link subscriber to subscriber availability is defined as the availability between any two data or voice subscribers and tele-protection channel.

2) The network-wide subscriber to subscriber availability shall be at least 99.8%. The networkwide subscriber to subscriber availability is defined as the availability between any two data or voice subscribers/Tele-protection channel on the wideband network.

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 modules comprising the FOTE. The down time of the fiber optic cable shall not be considered in the aforesaid availabilitycalculations.

To ensure that the equipment & configuration proposed by the bidders shall be capable of demonstrating the specified availability figures, it is required that the Bidders shall include in their proposal a calculated availability analysis for the proposed equipment. The calculated failure rates of the units and the calculated availability 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 mean-time-to- repair (MTTR) of all 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.

The equipment offered shall have reliability equal to/better than that mentioned above in combination with a very high quality of service. This capability shall be realized by full redundancy at the link, processor, switch, and power level, together with a full, non- blocking matrix.

The equipment should support full on demand and scheduled RFC 2544 test initiation and termination capabilities. (Customer service/PW end to end).

The communication system must support In-service installation of new Customer Edge (CE) device in a live Access Ring without causing the protocol convergence inside the customer services. The communication system should support all the service redundancy features like (but not limited to) back-up LSP, back-up Pseudo wire etc.The objective is to provideacompleteserviceredundancyrightfromtheAccessnodeuptotheControlCentre.

The communication system shall also support fast detection and convergence mechanism for carrier grade network as follows:

- Static LSP/Path switch over and revert
- 1:1 LSP/PW protection
- Static PW/Serviceswitchoverandrevert

- BFD based detection and convergence with 3.3msec hello intervals Auto Fast Re-Route is preferred but not mandatory. The System shall support tunnel/path resiliency backup. In the case of primary tunnel/path failure, the traffic will be redirected to secondary tunnel/path. This capability provides end user with fully redundant tunnel/path and enable resiliency in preserving customer circuit. Tunnel/path resiliency shall be done via:
- Automatic re-directing
- Manual re-directing

Dual redundant (i.e., one to one standby) modules or subsystems that control the overall functions of the System shall be provided such that failure in those modules shall not cause the service to be totally affected.

The communication network shall support zero disruption in forwarding traffic in case of controller/management card reset/failure/removal and shall support LSP automatic bandwidth upgrade without any service disruption. There should be no impact on the existing services and services delivery architecture while augmenting additional capacities / ports.

1.1.5 MaximumOpticalFiberLink Length

To meet the link budget requirement, the Contractor shall provide all the necessary equipment only in the end stations. The contractor may provide the optical amplifier, wavelength translator, optical cards, or high capacity MPLS-TP equipment with suitable rack/sub-rack to meet the maximum distance limit. All the provided equipment shall be monitored by centralized NMS.

1.1.6 OpticalFiberCharacteristicsofavailableFibernetwork

The link budget calculations and equipment design shall be based on the specific fiber parameters. The optical cables shall have Dual Window single Mode (DWSM) fibers conforming to ITU-T Recommendations (G.652D). The exact details/characteristics of the fiber(s) shall be provided during detailed engineering. The major parameters of these optical fibers are defined in Table 2-1

Table2-1 **OpticalFiber Characteristics**	
Fiber Description:	Dual-WindowSingle-Mode
ModeField Diameter:	8.8to9.8 μm
CladdingDiameter:	125.0μm±1μm
Modefieldconcentricityerror	≤0.6μm
Claddingnon-circularity	≤1%
CableCut-offWavelengthλcc	≤1260nm
1550nmloss performance	AsperG.652D
ProofTestLevel	≥0.69Gpa
AttenuationCoefficient:	@1310nm≤ 0.35dB/km @1550nm≤ 0.21dB/km
ChromaticDispersion;Maximum: **ZeroDispersionWavelength: Zero Dispersion Slope:**	18ps/(nmxkm)@1550nm ≤3.5ps/(nmxkm)@1285–1330 nm ≤5.3ps/(nmxkm)@1270–1340 nm 1300to 1324nm 0.092ps/(nm^{2}xkm)
Polarization mode dispersion coefficient	≤0.2ps/km^½
TemperatureDependence:	Inducedattenuation≤0.05dB(-60°C-+85°C)

BendPerformance:	@1310nm(75±2mmdiaMandrel),100 turns; AttenuationRise≤0.05dB @1550nm(30±1mmradiusMandrel),100 turns; AttenuationRise≤0.05dB @1550nm(32±0.5mmdiaMandrel,1 turn; AttenuationRise≤0.50dB

1.1.7 Fiber Optic Link Lengths

For bidding purposes, the Contractor may assume an additional cable length of 5% of given route length + 1Km towards approach cable for calculating the link length. The exact cable lengths shall be determined by the Contractor during thesurvey.The same shall be used by the Contractor for final link design during the detailed engineering of the project.

1.1.8 Optical Link Performance Requirements

The optical fiber link performance requirements are specified as follows:

1.1.8.1 Link Budget Calculations

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

1. Fiberattenuation:The fiber attenuation shall be taken to be the guaranteed maximum fiber attenuation i.e. 0.21 dB/Km @1550nm and 0.35 dB/km @1310nm.
2. Spliceloss: Minimum 0.05dB persplice.One splice shall be considered for every 3kms.
3. Connectorlosses:Losses due to connectors shall be minimum1.0dB perlink.
4. EquipmentParameters: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 MPLS equipment, an End-of-Life Margin of atleast 3dB 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 fiber 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 DWSM fibers.
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 fiber optic link during detailed engineering.

For finalizing the FOTE system design & BOQ, above methodology shall be adopted considering fiber attenuation, dispersion and splice loss determined during the detailed engineering.

1.1.8.2 FODP to MPLS-TP equipment

The Contractor shall be responsible for connectivity between the FODP and MPLS-TP equipment. The location of FODPand MPLS-TP Equipments inside the communication room. The optical fiber termination in FODPis FC/PC.The patch-cord length between the FODP & equipment rack shall be suitably protected from rodents, abrasion, crush, or mechanical damage.

1.2 MDF,DDF,Ethernet patch panel and Cabling

The contractor shall provide cabling, wiring, DDF, Ethernet patching facilities and MDFs interfacing to the wideband telecommunications system. Equipment and material components for MDF, DDF, Ethernet Patch panel and cabling are also part of this procurement. It shall be the Contractor's responsibility to provide all cable support required for full supplied equipment interconnection with the MDF and shall be in accordance with communications industry standard practices and the requirements mentioned in the technical specifications.

1.2.1 MDF,DDFandEthernetPatchingFacilities

The Contractor shall supply and install all cabling, wiring, connectors, cross connects, Digital Distribution Frames (DDF) and Main Distribution Frames (MDF), Ethernet Patch panel associated with the installation and interconnection of equipment procured under this package inside the communication room.

- DDFs for termination of E1 ports are BNC.
- Ethernet Patch panels for termination of all Ethernet channels.
- The patch cord for interfacing optical Ethernet port shall be supplied by the contractor.
- Any other cables, connections etc. required for a fully functional, integrated telecom system and spares as per site requirement.

The connections amongst various equipment such as FOTE and subscriber MDFs etc. shall always be routed through DDF and Ethernet patchpanel to provide maintenance access.All such interface details are to be identified in the detailed Engineering stage.

1.2.2 Patch Cords

The Contractor shall supply FC/PC coupled Patch cords. The Patch cord return loss shall be equal to or better than 40 dB and insertion loss equal to or less than 0.5 dB.

1.3 MechanicalConstruction

The equipment shall be available as a 19”shelf to be mounted in a19”rackor19”cabinet. It shall be of robust design.All modules shall be integrated in the same shelf.All connectors shall be accessible from the front and comply with international specifications. All metal and welds shall be thoroughly cleaned and sanded to obtain a smooth finish.All surfaces shall be treated for rust and primed to form a bond between metal and the finish

Coats of paint.All equipment racks,enclosures,and equipment,includingdistribution frames, shall be clearly labelled with unique identifiers consistent with Contractor supplied floor plans and rack elevations. The equipment cabinet shall be built in such a way that it prevents the entry of all type of rodents.

At all the stations, standalone cubicle having dimension 2000mm x600 mm x 600 mm (HxWxD) with transparent front door shall be provided.
Appropriate protection using MCBs shall be provided for AC and DC power supply. An earthing bar shall be provided for terminating all ground connections. Ingress protection rating of the cabinet shall be of IP 51 standard. Equipment shall have facility for cable entry from bottom and top side of the cabinet. So necessary provisions shall be made on the gland plate.

1.4 PowerSupply

The equipment shall operate from a nominal-48VDC(-15%/+20%)battery.
The equipment shall support dual power feed (1+1 hardware protection) i.e. that two power sources can be connected directly to the equipment (two connection points) without any common circuitry which can add a point of failure. The operating voltage should be - 48V (Positive grounded).

The equipment shall supervise the power source and provide corresponding alarm in case of loss of either power source.Necessary surge protection shall be provided to filter all surges

1.5 Safety

The equipment shall be safe to use and shall comply with EN60950-1. Laser Safety according to IEC 60825-2

1.6 AmbientConditions

Storageandtransport:

.	Temperature range:	-25°C...+70°C
	Humidity:	max.95%(nocondensation)

Operation;

	Temperature range:	-5°C…+50°C
	Humidity:	max.95%(nocondensation)

1.7 Communication System Integration

The Contractor shall be responsible for integration of MPLS-TP based Fiber Optic transmission system to the Optical fiber available in the FODP installed in the Communication room. Integration shall consist of activities at

stations as listed but not limited to the following inside the communication room:

i. All necessary interconnections and interfacing including supply and installation of cables, wires, Connectors, Ethernet patch panel, MDF/DDF to MDF/DDF cross connects, additional cards/equipment required for establishing proper inter connections for data, voice, synchronization etc.

ii. Detailed channel routing at subscriber channel level, E-1 channel plan, IEEE C37.94 Channel plan etc. and equipment configuration.

iii. System wide synchronization: Contractor shall design, supply, install, test and commission necessary GPSTime synchronization system at different geographical locations as per the MPLS-TP telecommunication system requirement.

iv. Consolidated floor plans indicating the location (to be approved by the KPTCL) of supplied equipment as well as the equipment which interfaces are required/provided.

v. Necessary programming/modifications to ensure compatibility between signalingfor voice channels interfaces with other equipment such as VOIP PABX etc.

vi. The contractor shall integrate new termination equipment sub-system with the existing termination equipment if necessary.

vii. The details for the interconnection & integration shall be collected from each site during survey and shall be finalized during detailed engineering

1.8 Network Management System

- The network management system (NMS) shall have facilities to supervise, monitor, control and configure each equipment and the whole network.
- It shall have capabilities of fault detection,configuration, performance, and security management.
- It shall provide various graphical views to the network such as geographical overview, logical network structure, and hierarchical view.
- The Network Management System shall support the Fault, Configuration, Performance and Security. It shall preferably support Accounting.
- The NMS must have a rich GraphicalUserInterface(GUI).It is required that it shall be possible to perform any Network Management operation via GUI without the need for the user to perform Command Line Interface (CLI) commands.

- The network management system shall allow to define different user profiles
- A Single unified NMS shall be provided to manage the network
- This NMS shall be made of two(2)separate,independentMain and Backup Network Management Systems working in a hot/standby process
- Main and backup NMS shall be provided at geographically different locations for managing the MPLS-TP telecommunication network.
- Switching from active to the stand-by station and vice versa must be automatic or available only for the authorized operator.This action must be without any effect on the traffic.
- Thesystemmustsupportestablishingdifferentclassesofusers,distinguishedupon sets of enabled management functionalities and/or assigned management domain.
- The NMS must have a Client/Server architecture enabling a scalable expansion of the Management capacity and tasks distribution.
- The NMS of MPLS-TP system have the capability to integrate with the UNMS system which is to be implemented by PGCIL in future. It shall be possible to send Status, Alarms and events to the UNMS system from the supplied NMS using standard interfaces.

NMSshallsupportfollowingfunctions

Alarms shall be listed in

1) Yearwise, Datewise,Timewise
2) Card wise alarms
3) Category wise
4) Alarm start time&endtime
5) Export the alarm list in excel,pdf,csv format
6) Acknowledge alarm

NMS shall provide the Previous day performance and 15min performance of each tributary such as E1, Ethernet transmit, Ethernet Receive, Optical etc.

FromNMS,E1,Ethernet,Optical port can be enabled or disabled irrespective of configuration is there or not with a confirmation message.

Status of port&resources shall be visible in colours.

Inventory shall be available in the NMS including serial number. Equipment
Time can be set from NMS through back end also.

Synchronization loss shall be provided in separate indication and shall be enabled or disabled.

Any IP conflict in the nodes shall be reflected at once when it is connected Audit logs shall be

exported in xml, csv, excel, pdf formats

User activity shall be available for minimum 6 months.Invalid login and session history shall be provided and can be exported to user readable format such as excel, csv, pdf, xml.

Port loopback can be provided,and status shall be highlighted.

1.8.1 System Hardware and software requirements

All computer equipment shall be current models from reputed world-wide computer manufacturers, selected for efficient operation of a real-time system:

- System HWmust be based on an independently commercially available platform.
- Only commercial parts must be used for the hardware.
- System must be designed in a way that would ensure that no database information would be lost at shutdown procedure.
- The processors shall include facilities for orderly shutdown and resumption of processor operation upon detection of power loss and subsequent resumption of power.
- Redundancy of equipment supporting critical functions is mandatory.
- All storage devices for Servers, Workstations and PCs must be configured in RAID1 for OS and Applications and RAID 5 for Archiving.
- Archive storage devices shall be used for backup of the system data, software and archival storage for the Information Storage and Retrieval functions. The system shall also include re-writable CD, DVD or Blu-Ray RW drives which supports M-Disc, for the local backup of data from the operator's workstations. If there is any better and alternate solution, it shall be mentioned in the pre-bid stage itself.
- NMS Operating system (OS) must be based on a widespread commonly accepted OS, which is also independently commercially available. OS upgrading must not affect traffic, database, communication SW, NMS SW or other SW.

- NMS SW upgrading must be carried out without affecting traffic, NMS DB, OS, or other SW.
- SW reset (including hot reset) must not affect traffic or element configuration. Present SW configuration must be stored in each NE.
- After a power break, NE must always return to its predefined settings in designated time. That designated time must be stated.
- It must be possible to download data from NMS to all NEs such as NEconfiguration. It also must be possible to upload data from all NEs to NMSc.
- The minimum hardware configuration for NMS system

  Form factor - Blade(2U)/tower type

  Processor–8core2socketwith3GHz

  RAM - 32 GB minimum (Upgradable GHz to64GB)

  Memory–500GBinRaid1

  Networkconnection–4Ethernet

  Hardware RAID controller

  HDD/FANhotswappable

  *If the NMS system need higher configuration for the proper functioning and performance, the bidder shall provide the same without any additional cost.

1.8.2 Local Craft Terminal(LCT)Requirements

EachMPLS-TPequipmentshallincludeprovisionforconnectingaportablepersonalcomputer (PC) / Laptop to be known as Local craft terminal to support local commissioning and maintenance activities. Using this PC and local displays/controls, the operator shall beable to:

- Change the configuration of the station& the connected NEs.
- Perform tests
- Get detailed fault information

The craft terminal shall be connected to the interface available in the communication equipment.

1.8.3 UNMS

TheNMSofMPLS-TP systemshallhavethecapabilitytointegratewiththeUNMSsystem which is to be implemented by PGCIL. It shall be possible to send Status, Alarms, and events to the UNMS system from the supplied NMS using standard interface.

The Northbound interface of the NMS shall support Fault, Inventory, Configuration, and Performance functionalities using standard interface. The NMS shall support data exchange with UNMS on SNMP,CORBA,XML,HTPPS or any Industry standard protocol.

It shall be possible from the NMS to enable or disable the configuration management functionality to UNMS

*ArchitectureofUNMSmaychange.PleasereferUNMStechnicalspecificationformore details.

1.8.4 North bound interface

The NMS shall provide information for all its managed elements via a single north bound interface.

TheNMS north bound interface shall support at least one of the following:

- TM Forum's Multi Technology Network Management (MTNM) TMF-814/ Equivalent standards applicable
- SNMPV2/SNMPV3

NMSnorthboundinterfacemustsupportthefollowing functionality:

- Alarm management,
- Performancemanagement,
- PhysicalandLogicalinventory management,
- FaultManagement
- Configurationmanagement
- The NMS shall support at Northbound interfaces Upper-Level ManagementSystems (UNMS)
- It shall be possible from the NMS to enable or disable the configuration management functionality to UNMS

1.9 Spare Parts and Special Maintenance Tools

1. For MPLS-TP equipment 10% of the total BOQ of all types of cards and SFPs shall be kept by the contractor as spare and dispatched as an when required for some commercial terms which the bidder may quote during bidding.
2. These spares are not intended for use during erection, guarantee andAMC period.
3. Multi-technology handheld Tester(Ethernet/E1/ Datacom/ C37.94) battery operated shall be supplied
4. The Bidder shall submit the details of special maintenance tools and testing equipment required for commissioning and maintenance of the MPLS-TP communication system other than the testing equipment

1.10 Laptop shall be supplied with complete licensed software for the maintenance of the equipment.