



MADHYA PRADESH POWER TRANSMISSION CO. LTD.

(A wholly owned Govt. of Madhya Pradesh Undertaking)

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ADDENDUM

Date:[11.05.2018]

Loan Agreement No.:ID-P-250

IFB No. Package No.8-2

Bid Identification No : JICA/MPPTCL/TR-212

The Bid Identification no. JICA/MPPTCL/TR-212 is floated for construction of 220KV, 132KV New Substations and Extension Works in Existing Substations on Turnkey basis (PackageNo-8-2).

Some of the prospective bidders have requested to provide more elaborated details and BoQ of Fibre Optics Terminal Unit (FOTE). The description/ details, BoQ and General requirement of FOTE is attached herewith.

The Bidder is encouraged to offer standard products and designs. However, the Bidder's must conform to the requirements and provide any special equipment necessary to meet the requirements stated therein.

It should be noted that preliminary design information and bill of quantity (BoQ) specified are indicative only and are for tender purpose. The Bidder's shall verify the design data during the site surveys & detail engineering and finalize the BoQ after award of contract as required for ultimate design & system performance which covers Speech, Data and Protection and other details as specified or required.

The above amendment will form integral part of Bid identification no. JICA/MPPTCL/TR-212 (Package no 8-2). All other clauses, terms and conditions of the Bid Documents shall remain unchanged.

Suptd. Engineer (II)
O/o Chief Engineer (Procurement)

Optical Fibre Equipments

1.1 Scope

This document contains the General/ Technical specifications of communication equipments required for Fibre Optic Communication. The scope covers all required equipments and associated accessories for establishing Fibre Optic Communication as briefed hereunder.

- i. SDH and PDH equipment along with suitable optical line interfaces & tributary cards.
- ii. Craft Terminal based Network Management System (NMS).
- iii. All cabling, wiring, Digital Distribution Frame patch facilities and interconnections to the supplied equipment at the defined interfaces.
- iv. System integration of the supplied subsystems and also integration with existing communication equipment such as SDH.
- v. Integration of supplied system with the User equipments such as RTUs, SCADA system etc.

All other associated works/items described in the technical specifications for a viable and fully functional communication network.

1.2 General Requirements

The Bidder is encouraged to offer standard products and designs. However, the Bidder's must conform to the requirements and provide any special equipment necessary to meet the requirements stated herein.

It should be noted that preliminary design information and bill of quantity (BoQ) specified in this specifications are indicative only. The Bidder's shall verify the design data during the site surveys & detail engineering and finalize the BoQ as required for ultimate design & system performance which covers Speech, Data and Protection.

The Bidder's proposal shall address all functional and performance requirements within this specification and shall include sufficient information and supporting documentation in order to determine compliance with this specification without further necessity for enquiries.

An analysis of the functional and performance requirements of this specification and/or site surveys, design, and engineering may lead the Bidder's to conclude that additional items are required that are not specifically mentioned in this specification. The Bidder's shall be responsible for providing at no added cost to the Employer, all such additional items and services such that a viable and fully functional communication equipment system is implemented that meets or exceeds the capacity, and performance requirements specified. Such materials and services shall be considered to be within the scope of the contract. To the extent possible, the Bidders shall identify and include all such additional items and services in their proposal.

All equipment provided shall be designed to interface with existing equipment and shall be capable of supporting all present requirements and spare capacity requirement identified in this specification

The communication equipment shall be designed and provisioned for expansions and reconfigurations without impairing normal operation, including adding and removing circuits. The offered items shall be designed to operate in varying environments. Adequate measures shall be taken to provide protection against rodents, contaminants, pollutants, water & moisture, lightning & short circuit, vibration and electro-magnetic interference etc.

Network Configuration and Equipment Characteristics

1.3 Introduction

This section describes the Fibre 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) Fibre Optic Transmission System (FOTS)
- (2) Craft Terminal based Network Management System (NMS)
- (3) DDF and Cabling

The requirements described herein are applicable to and in support of network requirements.

The security related requirements of the equipment shall be as per DoT (Department of Telecommunication) guidelines and all similar security requirements as amended by DoT on time to time basis shall be followed/complied by the vendor.

The manufacturer shall allow the Employer and/or its designated agencies to inspect the hardware, software, design, development, manufacturing, facility and supply chain and subject all software to a security /threat check any time during the supplies of equipment. The contractor shall ensure that the supplied equipments have been got tested as per relevant contemporary Indian or International Security Standards e.g. IT and IT related elements against ISO/IEC 15408 standards, for Information Security Management System against ISO 27000 series Standards, Telecom and Telecom related elements against 3GPP security standards, 3GPP2 security standards etc. from any international agency/ labs of the standards e.g. Common Criteria Labs in case of ISO/IEC 15408 standards until 31March 2013. From 1 April, 2013, the certification shall be got done from authorized and certified agency/lab in India.

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

The contractor shall get the Employer's equipment audited from security point of view once a year from a network audit and certification agency as identified by DoT. The audit of the equipment shall be carried once in a financial year till the maintenance service contract in the bid.

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.

1.4 General Network Characteristics

1.4.1 Description

The Fibre optic network shall be based on the Synchronous Digital Hierarchy (SDH) having bit rate of STM-4/STM-16 as indentified in the BoQ. The network shall consist of overhead Fibre optic links with a minimum bit rate of Synchronous Transport Module-4/STM-16 (STM-4/16). 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 appendices.

1.4.2 Functional Requirement

The primary function of the communication network is to provide a highly reliable voice and data communication system for grid operation in support of the SCADA/EMS/RTUs/PMUs. The communications support requirement for SCADA/EMS/RTUs/PMUs system is for low & high speed data, express voice circuits and administrative voice circuits as defined in appendices.

1.4.3 General Systems Requirements

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

1.4.3.1 System Synchronization

The Contractor shall synchronize the existing equipments and all the new equipments under the contract using existing Master clock. The Contractor shall provide the additional clocks as per requirement. In addition to GPS input reference, the synchronization clock must have provision to take INPUT reference coming from other clock. The contractor shall submit the synchronization plan as per standard ITU-TG.811. All sync equipments proposed under this contract should meet ITU-TG.811 criterion. The holdover quality of slave clock, if any, shall meet ITU-TG.812 standard requirements.

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

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

1.4.3.2 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 NMS control. Such testing shall not affect the functional operation of the system.

1.4.3.3 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 NMS shall be sized for maximum equipped system capacity.

1.4.3.4 Equipment Availability

The calculated availability of each Fibre optic link (E1 to E1) shall be at least 99.999%. 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. For this analysis, an MTTR of at least 4 hours shall be assumed. The down time of the Fibre optic cable shall not be considered in the aforesaid availability calculations. The calculated failure rates of the units and the calculated availabilities of the equipment being offered shall be provided by the Contractor during detailed engineering.

1.4.3.5 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.

1.4.3.6 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 NMS 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 NMS function.

1.4.3.7 Redundancy Requirements and Protection Schemes

Equipment redundancy and Automatic Protection Schemes (APS) are specified in the Table 2-1. The failure of one element shall not prevent the use of any other that has not failed.

Table 2-1

**Equipment Redundancy Requirements
Summary**

Fibre Optic transmission Equipment :	
SDH equipment	
Power Supply & Converters	1:1 APS or distributed power supply
Common Control*Cards	1:1 APS
* = 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.

1.4.3.8 Lost Signal Recovery

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

1.4.3.9 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.

1.4.3.10 General Site Considerations

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

1.4.3.11 Proposed Optical Fibre Characteristics

The link budget calculations and equipment design shall be based on the specified Fibre parameters. The optical cables shall have Dual Window Single Mode (DWSM) Fibres conforming to ITU-T Recommendations G.652D and the major parameters of these optical Fibre(s) are defined in Table-2-2:

Table-2-2

Optical Fibre Characteristics

Fibre Description:	Dual-Window Single-Mode(DWSM)
Mode Field Diameter:	8.6 to 9.5 μm ($\pm 0.6 \mu\text{m}$)
Cladding Diameter:	125.0 μm $\pm 1\mu\text{m}$
Mode field Concentricity Error:	$\leq 0.6\mu\text{m}$
Core-Clad concentricity error:	$\leq 1.0\mu\text{m}$
Cladding non-circularity	$\leq 1\%$
Cable Cut off Wave length:	$\leq 1260 \text{ nm}$
1550 loss performance	As per G.652D
Proof Test Level	$\geq 0.69\text{Gpa}$
Attenuation coefficient	@1310nm $\leq 0.35 \text{ dB/Km}$ @1550nm $\leq 0.21 \text{ dB/Km}$
Attenuation Variation with wave length 1285 nm-1330 nm 1525 nm- 1575 nm	Attenuation coefficient @1310 $\pm 0.05 \text{ dB}$ Attenuation coefficient @1550 $\pm 0.05 \text{ dB}$
Point discontinuities	$< 0.1\text{dB}$
Chromatic Dispersion; Max.:	18.0 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) @ 1288-1339nm 5.3 ps/(nm x km) @ 1271-1360nm
Zero Dispersion Wave length:	1300 to 1324nm
Zero Dispersion Slope:	0.092 ps/(nm ² xkm) maximum
Polarization mode dispersion coefficient	$\leq 0.2\text{ps/km}^{1/2}$
Temperature Dependence:	Induced attenuation $\leq 0.05 \text{ dB}$ (-60degC- +85degC)
Bend performance:	@1310nm (75 \pm 2 mm dia Mandrel), 100turns; Attenuation rise $\leq 0.05\text{dB}$ @1550nm(30 \pm 1 mm dia Mandrel), 100turns;

1.5 Fibre Optic Link Lengths

The fibre optic route lengths are as specified in appendices. The lengths specified in appendices are the transmission line route lengths; however the actual fibre 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.

1.6 Fibre Optic Transmission System

The Fibre Optic Transmission System (FOTS) is defined herein to include ETSI digital optical line termination equipment. The FOTS shall be based on SDH technology. Minimum aggregate bit rate shall be STM-4/16 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 1000 Mbps on Ethernet port by virtual concatenation of requisite no. of VC-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 (upto 1000Mbps). The Ethernet interfaces shall support VLAN (IEEE 802.1P/Q), spanning tree (IEEE 802.1D) quality of service. Protection scheme for Ethernet traffic should be ERPS based (Ethernet ring protection scheme) as per ITU-T G.8032.

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

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

1.6.1 Fibre jumpers shall be of sufficient lengths as to provide at least 0.5m of service loop when connected for their intended purpose. SDH Equipment

1.6.1.1 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 (Consisting of Common Cards, Control Cards, Optical base card, Power supply cards, sub-rack, cabinet, other hardware and

accessories required for installation of equipment i.e. everything besides optical interface/SFP and tributary cards).

For equipment with multifunction cards such as cross-connect or control card with optical interface/SFP or tributary interface 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 either as Terminal Multiplexer (TM) as well as ADM with software settings only.

1.6.1.2 STM-4 (MADM) with 3 MSP/5 MSP protected direction.

The aggregate interfaces shall be (at least) STM-4 towards at least three/five protected directions (Protected as specified in this specifications). At present the equipment shall be equipped with two (2) nos. E1 interface card with minimum 16 interfaces per card & two (2) nos. Fast Ethernet interface card with minimum 8 interfaces per card, as tributaries. The equipment shall provide non blocking cross connect capability of 64 STM-1 (bi-directional) at high order VC-4 level and as well as at low order VC-12 level.

1.6.1.3 STM-16 (MADM) with 3 MSP/5 MSP protected direction.

The aggregate interfaces shall be (at least) STM-16 towards at least three/five protected directions (Protected as specified in this specifications). At present the equipment shall be equipped with two (2) nos. E1 interface card with minimum 16 interfaces per card & two (2) nos. Fast Ethernet 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 capability of 256 STM-1 (bi-directional) at high order VC-4 level and 128 STM-1 (bi-directional) at low order VC-12 level.

1.6.1.4 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.

1.6.1.5 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.

1.6.1.6 Service Channel

Service channels shall be provided as a function of the SDH equipment and shall be equipped with Service Channel Muldems 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.

1.6.1.7 Supervision and Alarms

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

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

1.6.1.8 Synchronisation

The equipment shall provide synchronization as per Table 3-2. One 2 MHz synchronization output from each equipment shall be provided.

1.6.1.8 Electrical and Optical I/O Characteristics and General Parameters

Table 2-3 provides the electrical and optical characteristics as well as other general parameters for SDH equipment.

Table 2-3

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 Fibre Type	G.652D
Optical Connectors	Type FC-PC
Transmission Quality	Per ITU-TG.821,G.823,G.826
Source Primary Power	-48Vdc
Equipment Specifications	Per ITU-TG.783
Tributary, Electrical Interface	Per ITU-TG.703,75Ω
Ethernet Interface	10/100Mbps
SDH Bit Rates	Per ITU-TG.703

Optical Interfaces	Per ITU-TG.957,G.958
Frame and Multiplexing Structure for SDH	Per ITU-TG.707
Synchronization	Per ITU-TG.813
Management Functions	Per ITU-TG.774,G.784
Protection Architectures	Per ITU-TG.841
Built In Testing and Alarms	Per ITU-TG.774,G.783,G.784

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

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

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

1.7 Optical Link Performance Requirements

The optical Fibre link performance requirements are specified as follows:

1.7.1 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 0.05 dB per splice. One splice shall be considered for every 3 kms.
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 at least 2 dB shall be considered and a similar margin shall be considered for optical amplifiers.
5. Optical path Penalty: An optical path penalty of at least 1 dB shall be considered to account for total degradations due to reflections, inter symbol interference, mode partition noise and laser chirp.
6. Maintenance Margin: A maintenance margin of at least 2.5 dB/100Km shall be kept towards cabling, repair splicing, cable ageing and temperature variations etc.
7. Other losses: Other losses, if any required specifically for system to be supplied shall also be suitably considered.

8. Dispersion: The Fibre dispersion shall be taken to be the guaranteed maximum dispersion i.e. 18 ps/nm.Km @1550 nm & 3.5 ps/nm.km @ 1310 nm for DWSM Fibres.
9. Bit Error Rate: The link budget calculations shall be done for a BER of 10^{-10} .

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

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

1.7.2 Link Performance

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

1.7.3 FODP to SDH Equipment

The Contractor shall be responsible for connectivity between the FODP and the SDH equipment. The Contractor shall provide FC PC coupled patch cords. The patch-cord length between the FODP & equipment rack shall be suitably protected from rodents, abrasion, crush or mechanical damage.

1.8 MDF, DDF and Cabling

For the purposes of the specification, the contractor shall provide cabling, wiring, DDF patching facilities and MDFs interfacing to the wideband telecommunications system. Equipment and material components for MDF, 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 interconnection with the MDF and shall be in accordance with communications industry standard practices and the requirements mentioned in the technical specifications.

1.8.1 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-1 ports
- (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 terminated with RJ-45 connector. Provision for 100% 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.

1.9 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 (line and equipment) 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 may be used to route both transmit and receive for the same circuit.

1.9.1 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 up to 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 Channel Banks). Separate Patch panels or MDFs shall be provided for Data and Voice. All cross connects shall be accomplished utilizing one, two or three pair patch cords. Patch plugs are permissible for direct one-to-one circuit "cut-thru".

1.10 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. Fibre jumpers shall be of sufficient lengths as to provide at least 0.5m of service loop when connected for their intended purpose.

1.11 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. The TMN shall be compatible with NMS at existing notes. The integration with existing NMS shall be in the scope of supplier.

1.11.1 Applicable Standards

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

1.11.2 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 CCITT M3010. 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, converter etc.) 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/Local Consoles 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 compliant North bound interface. The interface shall accommodate all required functionalities to implement OSS but not limited to the following:
- i) Real time forwarding and synchronization
 - ii) Provisioning of circuits
 - iii) Upload of network topology
 - iv) Monitoring of events for topology and circuit changes
 - v) Alarm handling

The details shall be finalised 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.

1.12 Management Functions

The TMN shall support following Management functions:

1.12.1 Configuration Management

Configuration management is concerned with management, display, and control of the network configuration. Minimum specific requirements that shall be satisfied include the following:

- 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.

1.12.2 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 colours 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 log of all 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.

1.12.3 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 parameters to monitor
 2. Set monitoring start time and duration or end time
 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. Calculate selected 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.

1.12.4 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 "read only" access level, network parameters should only be viewed. Access to database 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.

1.13 Communication Channel Requirement and Integration

Communication requirements for TMN system have not been considered in Appendices and the Contractor shall provide these as a part of TMN system. The Contractor 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 through the existing communication network using 64 kbps/2Mbps (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.

1.14 Craft Terminal

Each equipment (SDH equipment, Mux, Drop/Insert and DACS etc.) on the fibre optic 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.

1.15 Hardware Requirements

1.15.1 Craft Terminal

The 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 craft terminal shall have minimum configuration of core i7, 8 GB RAM, 256 MB Video Graphics Memory, DVD RW drive, 500 GB Hard Disk Drive, keyboard, mouse/trackball etc., serial/USB (2.0) ports to accommodate printers, and Internal/external Data/Fax modem and a battery back-up of at least 3 hours. VDUs shall be 15" TFT active matrix color LCD with a minimum resolution of 1024 X 768.

The configurations mentioned for craft terminal are minimum and the same shall be finalized during detailed engineering as per latest industrial standards.

1.15.2 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.

1.16 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 and meets both hardware systems requirements and the customer's operational requirements.

1.16.1 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.

1.16.2 Applications Software

All applications software shall be written in a high-level programming language unless developed using industry proven application programs and development tools provided with the system. The contractor shall make no modifications to the applications program except as provided as USER development tools.

1.16.3 Software Utilities

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

1.17 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 functional requirements without additional rewrite or programming.

All software shall be easily user 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.

1.17.1 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.

1.17.2 Help

All applications shall be supported by USER accessible HELP commands that shall assist the user in the performance of its tasks. 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 – 2

Environment, EMI, Power Supply, 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 Magnetic Interference (EMI) and Electro Static Discharge (ESD) conditions expected in an Extra High Voltage (EHV) power system environment.

2.1 Environmental Requirements

Equipment and their components provided under this specification shall operate reliably under the following environmental conditions.

2.1.1 Temperature and Humidity

Most of the equipment will not be installed in environmentally controlled shelters. Therefore, equipment shall operate in accordance with the limits shown in Table 4-1

Table 4-1 Environmental Operating Limits

Temperature Range:	(Un Controlled Environment)
Specification	
Operation without damage	0 to 45°C
Shipping/storage	-10 to 55°C
	-40 to 60°C
Relative Humidity, non-condensing	Up to 90%
Elevation: Operating Non-operating	to 3,000 m to 10,000 m

For each location, the Contractor is required to assess the environmental conditions for the equipment to be installed under this specification. The Contractor is responsible for all necessary enclosure, rack or equipment upgrades to ensure the proper operation of the installed equipment.

2.1.2 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 provide 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.

2.1.3 Vibration and Shock Resistance

As per testing requirements indicated in this specification.

2.1.4 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.

2.1.5 Contaminants

Communications equipment may be located in areas of poor air quality with the main contaminant being dust. Cabinets shall be tight fitting utilizing filtered ventilation openings only.

2.2 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:

2.2.1 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 \pm 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, shall be designed for normal operation under the above stated tolerances for 240 VAC supply.

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 communication equipment/module etc. requiring AC power supply at locations other than control centre.

2.2.2 -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 -42 to -58 Vdc and the supplied equipment shall operate satisfactorily within this range.

2.2.3 Power Distribution and Protection

The Employer will furnish only one source primary 240 VAC and/or -48 VDC power. It shall be the Contractor's responsibility for the connection and distribution of all Primary AC and -48V dc 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 at least 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. The Contractor shall provide all cabling, fusing, switching and circuit breaker 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.

2.3 Equipment Construction, Assembly and Installation

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

2.3.1 Identification

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

2.3.1.1 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 marked with the manufacturer's part number, serial number, month/year of manufacture, revision level and an additional identifier corresponding directly to the applicable backplane wiring diagram/list.

2.3.1.2 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.

2.3.1.3 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 distant end location. The cable tag shall be clearly visible at the cable fan out point.

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

2.3.1.4 Equipment Racks and Enclosures

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

2.3.2 Installation Hardware

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

32.3.2.1 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/aluminum 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) Equipment Cabinet (Enclosure) Construction

- (1) Equipment cabinets (enclosures) shall be steel/ steel & Aluminum extrusion 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 cabinets (enclosures) shall be designed free-standing but shall be mounted to the floor. Cabinets (enclosures) shall have secured 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 be fitted with long life rubber beading. All panels shall be fabricated from minimum 2.0mm thickness steel sheet. However, for racks with load bearing Aluminum extrusion frame, door panels and side panels may be fabricated from minimum 1.6mm thickness steel sheet and the top & bottom panels shall be fabricated from minimum 2.0mm thickness steel sheet.
- (4) Equipment cabinets (enclosures) shall be dust and moisture-proof as per IP41 specification, or better.

2.3.2.2 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 at least 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 by the Employer. Suitable anti-corrosion measures shall be taken. Steel fabricated 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.

2.3.3 Signaling 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.

2.3.4 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.

2.3.5 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 Sq.mm or bigger earth cable. All equipment earth/ground connections shall be made directly to the equipment chassis utilizing grounding lugs and secured metal-to-metal with star washers. Use of the enclosure frame, skin or chassis mounting hardware as part of the earthing/grounding networks, is not acceptable.
- (4) The safety earth network shall be connected to "earth ground" at the safety earth stud. The earth stud connection shall be sized for an external earthing cable equipped with a 2/0 solid copper lug secured metal-to-metal with star washers.

Primary AC feeds and distribution within enclosures requires earthing wire connection to the safety earth stud.

(5) The safety earth and signal ground networks shall be inter-connected only at the safety earth stud and signal ground stud.

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.

2.3.6 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, power strips, 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.

2.3.7 Finish Colors

Unless otherwise specified, finish colors for enclosures shall be gloss 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.

2.4 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 inter facility interconnectivity and necessary associated civil works.

2.4.1 Locations for Supplied Equipment

All transmission equipment and associated DDFs, shall generally be co-located in the same communications room located in the Control Building whenever possible.

2.4.2 Associated Civil Works

The Contractor shall provide all required minor civil works necessary for 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, cable raceways, and cabling supplied as part of this contract.

2.4.3 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 cooperate fully with the Employer and all other on-going project contractors in the planning and 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 may be noted that in order to utilize the existing trenches, the Contractor supplied cables may be required to be co-located with LV cables. Accordingly, the contractor shall ensure that selection and installation of cables is suitable for the purpose. The contractor shall be responsible 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.

BoQ & General Description

S.N.	Description	Unit	Substation		
			400KV	220KV	132KV
1.0	SDH Equipment				
A	STM- MADM				
(i)	STM-16 MADM , 5 MSP protected directions (Base Equipment (Common cards, Cross connect/control cards, Optical base card, Power supply cards, power cabling, other hardware& accessories including sub-racks, patch cords, DDF etc.)	No.	1	1	0
(ii)	STM-4 MADM , 3 MSP protected directions (Base Equipment (Common cards, Cross connect/control cards, Optical base card, Power supply cards, power cabling, other hardware& accessories including sub-racks, patch cords, DDF etc.)	No.	0	0	1
B	Optical Interface/SFP cards # for				
(i)	S4.1 (<=30KM)	No.	0	0	0
(ii)	L4.1 (<=50KM)	No.	0	2	2
(iii)	L4.2 (<=80KM)	No.	4	4	4
(iv)	L16.2 (<=80KM)	No.	4	4	0
(v)	Optical line interface card (support min 150 KMS) **	No.	4	2	0
C	Tributary Cards				
(i)	E1 interface card(Min. 16 interfaces per card)	No.	2	2	1
(ii)	Ethernet interface card with 1GbE & 8 FE port	No.	2	2	1
2.0	PDH (Termination Equipment)				
A	Drop& Insert Multiplexer				
	Base Equipment (Common cards, Power supply cards, power cabling, MDF, other hardware & accessories.)	No.	2	2	1
B	Subscriber Line Interface Cards				
(i)	2 wire(sub/sub) voice channel card	No.	2	2	1
(ii)	2 wire(sub/Exch) voice channel card	No.	2	2	1
(iii)	4 wire(E&M) voice channel cards(min. 8 channels per card)	No.	2	2	1
(iv)	Asynchronous Sub Channels data cards(V.24/V.28)(min.4 channels per card)	No.	2	2	1
(v)	Synchronous data cards(N* 64 kbps) (min. 4 channels per card)	No.	2	2	1
C	Digital Access Cross Connect Switch(DACS)				
	16 x 16 ports switching matrix, fully equipment for minimum 16 E-1 ports	No.	1	1	0
3.0	TMN				
A	Craft Terminal				
(i)	Hardware	Set	1	1	1

S.N.	Description	Unit	Substation		
			400KV	220KV	132KV
(ii)	Software	Set	1	1	1
B	Network Manager & Element manager system				
(i)	Hardware	Set*	1	0	0
(ii)	Software	Set*	1	0	0
(iii)	Printer(Laser Jet)	No.	1	0	0
4.0	Tele-protection Equipment				
	8 command channels card for transmission over fibre on E1 Interface,	No.	8	4	1
5.0	FODP				
(i)	FODP (min. 120 Fibre)	No.	1	1	1

Note:- The above requirement is subject to approval of the DRS of the Equipment.

The followings standards shall be applicable for communication system in addition to standards mentioned in respective sections:

1) General Standards for interfacing to the communication system:

Standard Interfaces:

The following general standards may be followed while interfacing the equipment with the communication system:

Interfaces	Type	Standards
Electrical Interface	Ethernet	IEEE 802.3 / IEEE 802.3u
	Ethernet VLAN	IEEE 802.1 P/Q
	Serial	RS-232 / RS 422 / RS 485 / X.21 / X.25 / G.703 / V.35 /
Optical Interface		ITU-T G.957, G.958
Tele protection / Control	Relay	IEEE C37.94 ,ITU-T G.703
Voice		2-wire FXO/2-wire FXS/ 4- wire E&M
SDH		ITU-T G.821/G.826

2) Standards applicable to wideband Communication (Fibre Optic):

The primary function of the communication network is to provide a highly reliable voice and data communication system in support of the WAM System, SCADA/EMS system, Protection System, & Market Operation Service. The communication interfaces for WAM system, SCADA/EMS system is for low & high speed data, express voice circuits and administrative voice circuits as defined as follows:

- (a) High speed bundled n x E1 support including Ethernet, GbE (Gigabit Ethernet)
- (b) High speed E1 channel support
- (c) 64kbps & n x 64 kbps data & Protection channel support
- (d) Low speed (300 -1200 bps) data channel support
- (e) Voice (2 wires, 4 wires) channel support.
- (f) Data transport supporting Network Management channels
- (g) C37.94 Interface card for tele protection of lines
- (h) Additional requirement, if any

The communication system shall finally form a wideband backbone on all India basis to support the requirement of the Power System Operation and Market operation.

3) Standards applicable to wideband Communication (Fibre Optic Cable):

Standards and Code of Practices:

The fibre cable shall be conform to standards as below:

- i) ITU-T recommended G.652D
- ii) IEEE – 1138- 1994, IEEE – 1138-2009
- iii) Electronics Industries Association (EIA)/ Telecommunications Industry Association (TIA) 455-78A, 455-3A, 455-62A, 455-164A/167A/174, 455-168A/168A/175A, 455-176, 455-59, EIA/TIA 598, EIA 455-104.
- iv) International Electro Technical Commission Standards, IEC 60304, IEC 60794-1-2, IEC60811-5-1, IEC 60794 – 4 – 10, IEC 60793 – 1 – 20, IEC 60793– 1 – 40, IEC 60793–1 – 42, IEC 60793– 1 – 45, IEC 60793 – 1– 47
- v) Bell core GR-20
- vi) Telecommunication Engineering Centre (TEC) Specification no. GR/OFC-17/01 June 2007 (including all subsequent amendments)
- vii) American Society for Testing and Materials (ASTM): AI67-92, ASTM:751-92b, ASTM: A370-82, ASTM: D2581-91, ASTM: D2287-81, ASTM: D638 for FRP, ASTM: D217, 556,93-IP-34 for Jelly, ASTM: D 570,211 for PBTP, ASTM: D1505 for poly Carbonate, ASTM: D1633, 150 for HDPE, ASTM: D1248 for Jacket density.
- viii) Applicable standards for testing the cables shall be:
 - a. Max. Tensile Strength – IEC60794 – I – E 1 (Under Ground Cable), IS 802:1995 and IS 875:1987 (OPGW), IEEE 1138-2009 clause 6.4.1.4 (OPGW)
 - b. Cable bend test – IEC 60794 – 1 – E 11
 - c. Repeated bending test – EIS – 455 – 104 IEC 60794 – 1 – E6
 - d. Crush Strength – IEC60794 – 1 – E3 (UG Cable) IEC 60794 – 1 – 2 Method E3 or EIA/TIA 455 – 41B (OPGW)
 - e. Impact Test IEC60794 - 1 – E4 (UG Cable), IEC60794 - 1 – 2 E4 or EIA/TIA 455- 25B (OPGW)
 - f. Torsion Resistance – IEC 60794 – 1 – E 7
 - g. Kink Test IEC 60794 – 1 - E 10
 - h. Drip Test IEC 60811 – 5 – 1 or IEC 60794 – 1 – E14
 - i. Water ingress test IEC60794 – 1 – 2 F 5 or EIA/TIA 455-82B
 - j. Attenuation variation with Wavelength IEC 60793 – 1 – 40 or EIA/TIA 455 – 78A
 - k. Attenuation at water Peak IEC 60793 – 1 – 40 or EIA/TIA 455 – 78A
 - l. Temperature Dependence on Attenuation IEC 60793 – 1 – 52 or EIA/TIA 455 – 3A (UG Cable) IEEE 1138-2009 clause 6.4.3.7 or IEC 60794 – 1 – 2 Method F1 (OPGW)
 - m. Bend Performance IEC 60793 – 1 – 47 or EIA/TIA 455 – 62A (UG cable), IEEE 1138-2009 clause 6.4.2.3 or IEC 60794 – 1 – 2 method E11 (for OPGW)

- n. Mode Field diameter IEC 60793 – 1 – 45 or EIA/TIA 455 – 164A/167A/174
- o. Chromatic dispersion IEC 60793 – 1 – 42 or EIA/TIA 455 – 168A/169A/175A
- p. Cladding diameter IEC 60793 – 1 – 20 or EIA/TIA 455-176
- q. Point discontinuities of attenuation IEC 60793 – 1– 40 or EIA/TIA 455 – 59
- r. Core – Clad concentricity error IEC 60793 – 1 – 20 or EIA/TIA 455 – 176
 - s. Fibre tensile Performance IEC 60793 – 1 – 31 or EIA/TIA 455 – 31B (UG cable), IEEE 1138-2009 clause 6.4.1.3 or IEC60794 – I – 2 E1 or EIA/TIA 455 – 33B (OPGW)
- t. Seepage of filling compound EIA/TIA 455 – 81B
- u. Short Circuit Test IEC 60794 – 4 – 10 or IEC 60794 – 1 – 2 (2003) Method H1 or IEEE 1138-2009 clause 6.4.3.3
- v. Aeolian Vibration Test IEC 60794 – 4 – 10 or IEC 60794 – 1 – 2 Method E19 or IEEE 1138-2009 clause 6.4.3.1
- w. Galloping IEEE 1138 – 2009
- x. Sheave Test IEC 60794 – 1 – 2 (2003) Method E18 B or IEEE 1138-2009 clause 6.4.2.1
- y. Creep Test IEEE 1138 – 2009
- z. Fibre Strain Test IEEE 1138 – 1994
 - aa. Strain Margin Test IEEE 1138 – 2009
 - bb. Stress Stain Test IEEE 1138 – 2009
 - cc. Cable cut off wavelength Test IEEE 1138 – 1994
 - dd. Fault current / Lightning Test IEC 60794 – 4 – 10 or IEC 60794 – 1-2 (2003)
 - ee. D.C. Resistance Test IEC 60228 or IEEE 1138-2009 clause 6.4.1.5
 - ff. Mechanical Strength Test for suspension Assembly IEC 61284: 1997

4) Standards applicable to wideband Communication (Wideband Network):

Standards and codes of Practices

- a) Transmission quality shall be as per ITU-T G.821, G.823, G.826
- b) Terminal equipment shall be designed as per ITU-T G.783
- c) Optical interface shall be FC-PC and shall be as per ITU-T G.957, G.958
- d) Network synchronization shall be as per ITU-T G.813
- e) Management Functions shall be as per ITU-T G.774, G.784
- f) Protection architecture shall be as per ITU-T G.841
- g) Built-in testing and Alarm shall be as per ITU-T G.774, G.783, G.784
- h) The link performance for ES, SES and BER for the fibre optic links shall correspond to National Network as defined in ITU-T G.826