

**COMMUNICATION SYSTEM**

**SECTION – 5**

**CHAPTER-01**

**TECHNICAL REQUIREMENTS OF TERMINAL EQUIPMENT & NMS**

## SECTION 5 CHAPTER-01

### TECHNICAL REQUIREMENTS OF TERMINAL EQUIPMENT & NMS

This section describes the Fiber Optic communication network configuration and the equipment characteristics for communication system to be installed in the project area under R-APDRP. The subsystems addressed within this section are:

- (1) Fibre Optic Transmission System (FOTS)
- (2) Network Management System (NMS)
- (3) DDF (Digital Distribution Frame) Patching Facilities

The requirements described herein are applicable to the communication network depicted in section 7 and the Network Management System (NMS) for monitoring and control of this communication network. NMS and TMN (Telecom Network Management System) have been interchangeably used in this specification. The technical requirements of FO cables and their installation are specified in chapter 2 & 3.

The bidders are encouraged to propose any hardware configurations better suited to the characteristics of the bidder's standard products as long as the equipment characteristic requirements of this specification are met. The SDH equipment of the proposed manufacturer must be in successful operation in the field for at least one year.

#### **1.1. Basic Communication Requirements**

The basic communication needs are as detailed below shall be provided using the proposed FO communication network:

- (i) If in a city /project area, MPLS/MLLN based on FO connectivity is available, then 2MBPs /64kbps links will be used for communication between SCADA/DMS control centre & RTUs/FRTU,
- (ii) Otherwise, utility may create FO network envisaged between SCADA/DMS control centre and RTUs on TCP-IP using IEC 610870-5-104 protocol.
- (iii) Secured VPN/SSL 64Kbps links on GPRS/CDMA on public network for communication of FRTU & FPI
- (iv) Remote VDU location will be connected using the owner provided 64 Kbps PSTN leased line MPLS/MLLN for which the modems shall be supplied by the contractor.

#### **1.2 General Network Characteristics**

##### **1.2.1 Description**

The proposed FO communication network is depicted in section 8. The communication system would support the data requirements of SCADA/DMS in point to multi point and/or multipoint to

multipoint configurations using Ethernet over SDH. The detailed BOQ is described in section 8, is based on fibre optic network considering the lowest bit rate of the Synchronous Digital Hierarchy (SDH) ie. STM-1. However, the bidder may offer higher bit rate SDH systems to meet the data requirements of the offered SCADA/DMS systems if required to meet the functional & performance requirements of the system.

### **1.2.2 General Systems Requirements**

Under this section terminal equipment refers to SDH equipment of Fibre Optic Transmission System (FOTS) and its interfaces along with other items (routers/switch, interface converters etc. if provided external to SDH equipment to meet the specification). Required characteristics of fibre optic terminal equipment, NMS system, and associated equipment of communication system are specified herein at the system level, subsystem level, and equipment level in the following sections.

#### **1.2.2.1 System Timing and Synchronization**

The Contractor shall provide system wide timing synchronization fully distributed throughout the telecom network. The system wide timing synchronization shall be slaved to a single GPS based master clock provided under SCADA.DMS system. One 2 MHz (75ohm conforming to ITU-T G.703 & G811 quality) port of the master clock shall be provided for synchronization of the communication system. The system equipment requiring “clock” shall be connected to this 2 MHz port of Master Clock using external clocking. For this purpose, appropriate interface(s) in the terminal equipment, cables and all other associated hardware shall be provided by the Contractor. The functional requirement of GPS clock has been specified in Section-02, Chapter-05

#### **1.2.2.2 System Maintainability**

Once a failure or degradation of performance is detected in the communications system, its cause shall be promptly isolated and corrected. 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.

Preventive and problem oriented maintenance of the communications system shall be performed using diagnostics tools such as NMS 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. For all redundant systems, disconnection and repair of any failed device shall not interrupt the operation of the system.

#### **1.2.2.3 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 unequipped subunit expansions, shall be terminated at appropriate patching facilities or termination blocks. Power supplies and NMS shall be sized for maximum equipped system ultimate

#### **1.2.2.4 Equipment Availability**

The calculated availability requirements are as follows:

- a. The availability of each fiber optic link shall be at least 99.99%.
- b. The availability of subscribers (on Ethernet interfaces) shall be at least 99.9%.

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 bidder shall confirm that the equipment & configuration proposed by the bidders shall be capable of demonstrating the specified availability figures. The contractor shall submit the availability analysis for the proposed equipment/ sub system. The analysis shall include the mean-time-between failure (MTBF) and mean-time-to-repair (MTTR) of all of the components on the link. For this analysis, an MTTR of at least 4 hours, shall be assumed.

#### **1.2.3 General Equipment Characteristics**

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

All applicable requirements stated in this section shall equally apply to the NMS equipment

##### **1.2.3.1 Revision Levels and Modifications**

All hardware, firmware and software delivered as part of the communications network shall be field proven and at the most 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 owner, prior to the completion of SAT.

All field modifications required to update the hardware, firmware and software to the latest revision level occurring after the above specified testing, shall be fully disclosed, documented and presented to the EMPLOYER for their consideration. Satisfaction of this disclosure requirement does not obligate the Contractor to implement the changes provided the latest revision date occurs after the above requirements are met. The intent is to provide the EMPLOYER with the documentation and opportunity to consider their implementation.

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

### 1.2.3.2 Equipment Capacities

Equipment supplied shall be sized and equipped with sufficient capacity to support the the basic communication needs specified in clause 1.1 and configuration requirements, including spare specified in clause 1.3 of this section.

### 1.2.3.3 Redundancy Requirements and Protection Schemes

The Contractor(s) shall ensure that single point of failure does not lead to communication equipment failure. The failure of one element shall not prevent the use of any other that has not failed. Equipment redundancy and Automatic Protection Schemes (APS) are specified in the Table 1-1.

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 purchaser. The bidders shall provide details of protection schemes supported in the Bid document.

**Table 1-1  
Equipment Redundancy Requirements Summary**

<b>Fiber Optic transmission System:</b>	
<b>SDH equipment (ADM and TM)</b>	
<b>Power Supply &amp; Converters -----</b>	1:1 APS or distributed power supply
<b>Common Control* Cards -----</b>	1:1 APS
<b>Tributary Cards E1(ADM and TM)-----</b>	N:1 APS
<b>* = Common control cards which are essentially required for operation of the equipment.</b>	

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.

### 1.2.3.4 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. Under NMS Control controlled sequencing of the alarm response and restoration may alter normal switch over/ switchback.

## 1.2.4 Optical Fibre Characteristics

The characteristics of optical fibre cable to be installed under this package are detailed in Chapter-02 & chapter 03 of this Section

## 1.3 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-1 and equipped with minimum 4 Ethernet interfaces (IEEE 802.3/IEEE 802.3u) supporting layer 2 switching as tributaries. The Ethernet interfaces shall support VLAN (IEEE 802.1P/Q), spanning tree (IEEE 802.1D) quality of service. The Contractor may offer external Layer-2 switch to meet the functionality if Layer -2 switching is not supported within the offered SDH equipments. The SDH equipment shall also support E1 interfaces (G.703). The requirement of tributaries & aggregates are indicated in the BOQ.

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

### 1.3.1 SDH Equipment

#### 1.3.1.1 Functional Requirement

The offered equipment shall be configurable either SDH Terminal Multiplexer (TM) or SDH Add/Drop Multiplexer (ADM) or Digital Cross Connect (DXC). The BoQ is provided in the appendices. **SDH Equipment** is considered to be divided in three parts i.e. **Optical cards** (Line), **Tributary Cards** and **Base Equipment** (Consisting of Common Cards, Power supply cards, power cabling, sub-rack, other hardware and accessories required for installation of equipment i.e. everything besides optical cards and tributary cards). The Bidder shall list out all type of cards/items being provided, in the BoQ and identify price for each separately.

The offered equipment shall support at least four optical directions with STM 1 as aggregate interfaces, 8 Ethernet Interfaces & 8 E1 interfaces as tributaries. The SDH equipment shall be equipped with required aggregate and tributary interfaces based on the network topology as indicated in the BOQ. The offered equipment shall support the following network topologies:

- a) TM (with protected/unprotected aggregates)
- b) ADM (with protected/unprotected aggregates)
- c) DXC (with protected/unprotected aggregates)

The ADM Equipment shall be capable of VC-12 level Cross Connection of up to 4 STM-1 equivalent and support mapping of each Ethernet interface over any single or multiple VC-12s.. The equipment shall support VC-12 cross connection in all the 4 directions.

In the Proposed BOQ one SDH equipment has been considered upto two protected optical directions (four unprotected directions). In case the bidder offers SDH equipment supporting more than two optical directions (protected) and/or more than four optical directions (unprotected), the bidder may propose the optimized BOQ of SDH equipment at all locations without compromising the functional requirement of specification. The bidder shall indicate & submit the justification for the proposed optimization along with the bid wherever applicable.

### **1.3.1.2 Redundancy and Protection**

Redundancy and protection requirements have been specified in clause 1.2.3.3 the network connectivity is planned in rings with SNCP protection. However, it shall be possible to protect the point to point STM1 and E1 channels across the network using the proposed scheme of protection. On linear sections of the network, protected links using 4 fibres may be implemented. The actual protection scheme shall be finalized during detailed engineering. The Contractor shall provide all required optical cards, protection cards (if any) and size the equipment accordingly.

### **1.3.1.3 Service Channel**

Service channels shall be provided as a function of the SDH equipment and shall be equipped with Service Channel Modems that shall provide at a minimum: One voice channel (order wire) with analog interface (0.3 to 3.4 kHz) and One data channel. Both omnibus and selective calling facilities shall be provided. There shall be a facility to extend the line system order-wire to any other system or exchange lines on 2W/4W basis. Also it shall be possible to extend the service telephone to another room away from the equipment; the Contractor shall be required to install the service telephone at the location indicated by the EMPLOYER during implementation.

### **1.3.1.4 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, one local craftsperson

terminal interface and Q/SNMP/Web/Telnet interfaces for a local craftsperson terminal interface and remote equipment monitoring (NMS) is required. However the type of interface shall not limit the NMS system requirement specified in the clause 1.4 of this chapter.

The Equipment shall support collection of at least four (4) external alarms for monitoring and control of station associated devices by the NMS as per section **NMS Architecture**. The Owner/Purchaser identify the alarm contact points during survey / detailed engineering and the wiring supply, installation and termination from these external points to the installed equipment shall be carried out by the Contractor.

### 1.3.1.5 Synchronisation

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

### 1.3.1.6 Electrical and Optical I/O Characteristics and General Parameters

Table 1-2 provides the electrical and optical characteristics as well as other general parameters for SDH equipment.

**Table 1-2**  
**Electrical and Optical I/O Characteristics and General Parameters**

<b>Optical Wavelength</b> <sup>NOTE (1)</sup>	1310/1550nm
<b>Optical Source</b> <sup>NOTE (2)</sup>	Laser
<b>Optical Source Lifespan</b>	Better than 5 X10 <sup>5</sup> hours
<b>Optical Fibre Type</b>	G.652
<b>Optical Connectors</b>	Type FC-PC
<b>Transmission Quality</b>	Per ITU-T G.821, G.823, G.826
<b>Source Primary Power</b>	-48 Vdc
<b>Equipment Specifications</b>	Per ITU-T G.783
<b>Tributary, Electrical Interface</b>	Per ITU-T G.703, 75 Ω/ 120 Ω
<b>Ethernet 10/100 Mbps interface</b>	Per IEEE 802.3/802.3u
<b>SDH Bit Rates</b>	Per ITU-T G.703
<b>Optical Interfaces</b>	Per ITU-T G.957, G.958
<b>Frame and Multiplexing Structure for</b>	Per ITU-T G.707

**Table 1-2**  
**Electrical and Optical I/O Characteristics and General Parameters**

<b>SDH</b>	
<b>Synchronisation</b>	Per ITU-T G.813
<b>Management Functions</b>	Per ITU-T G.774, G.784
<b>Protection Architectures</b>	Per ITU-T G.841
<b>Built In Testing and Alarms</b>	Per ITU-T G.774, G.783, G.784

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

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

**NOTE (3) Temperature Stabilisation:** Meet or exceed operational performance requirements through entire temperature range as specified

**NOTE (4)** In case other than FC-PC connector is provided in the equipment suitable patch cord with FC-PC connectors are to be provided to connect with FODP.

### 1.3.2 Optical Link Performance Requirements

The optical fibre link performance requirements are specified as follows.

#### 1.3.2.1 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. 0.23 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 2 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 per link shall be considered.

(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 0.5 dB 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 20 ps/nm.Km @ 1550 nm and 6 ps/nm Km @ 1310 for DWSM fibres.

(9) Bit Error Rate: The link budget calculations shall be done for a BER of  $10^{-10}$ .

The bidders shall confirm in their offer that the offered equipment and their interfaces shall meet the above link budget calculation criteria for the link lengths mentioned in the BOQ (which does not include sag, service loops, working lengths, wastage etc). Detailed link budget calculation shall be submitted during the detailed engineering.

### **1.3.2.2 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. Further, the Packet loss shall not be more than one percent in any of the Ethernet circuits of the offered system.

### **1.3.2.3 FODP to SDH Equipment Connectivity**

The Contractor shall provide rack mounted/wall mounted Fiber Optic Distribution Panels (FODPs) and shall terminate the fiber optic cabling on to the FODPs. The Contractor shall be responsible for connectivity between the FODP and the optical equipment and shall also supply of patch cords for the same. The patch cord shall have FC-PC type connectors at FODP end..

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.

The FODP rack shall be located preferably in the same room as of the Optical equipment rack, except where space constraint dictate otherwise. The patch-cord length between the FODP & equipment rack shall be suitably protected from abrasion, crush or mechanical damage otherwise by flexible conduits or equivalent EMPLOYER approved techniques.

## 1.4 NETWORK MANAGEMENT SYSTEM(NMS)

The Contractor shall provide a Network Management System (NMS) also referred as TMN to provide operational support for the FOTS and associated equipment. This NMS shall provide the capability to monitor, reconfigure, and control elements of the telecommunications network from a centralized location (Control Centre) and at each node of the network where equipment is located. This NMS system shall assist Purchaser in the operations and maintenance of the wideband communication resources including detection of degraded equipment, 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 and remote monitoring of alarms/indications. **The bidder shall provide details of the offered NMS in the bid supporting all the features.**

### 1.4.1 Applicable Standards

The NMS design concept, functional and informational architecture and physical architecture, shall be in compliance with ITU-T Recommendation M.3010. However, the NMS system based on TCP/IP stack shall also be acceptable provided such NMS implementation ensures security and reliability of the data transmission over the DCC, equivalent to that achieved in TMN implementation based on OSI stack (M.3010).

### 1.4.2 NMS Architecture

The NMS 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 equipments shall be as per Clause 1.3 Fibre Optic Transmission system.
- b. Processing of above management data by using processor(s) located at control Centres.
- c. Monitoring and control of the NEs as defined below:
  - D) TMN system at Control Centre (including local operator console) shall support management of all equipments supplied and monitoring of the entire network supplied under this package. At a minimum functions (viz configuration management, fault management, performance management and security management as defined in clause

1.4.3 of this section) of Network Management Layer (NML) and Element Management Layer (EML) as defined in CCIT M.3010 shall be provided.

- II) Monitoring and control of NEs using Craft Terminals as defined in clause 1.4.6
- d. Supervisory monitoring and control of the following station associated devices to the extent supported by equipment:
- e. Communication channel support as specified in section 1.4.4.

The supplied TMN system shall be capable of handling all management functions for at least 200 % of the supplied network elements. The TMN hardware shall be so designed that failure of a single processor/component shall not inhibit any of the functionality of the TMN at control centre.

The Contractor shall submit for EMPLOYER's approval the TMN architecture describing in detail the Database used in TMN, Hardware (Refer Clause 1.4.6 ), Software and operating system (Refer Clause 1.4.7 ), Craft Terminals (Refer Clause 1.4.5 ), Data communication between NEs, Local Consoles and TMN Processor(s), Routers/ Bridges, Expansion Capabilities etc. of the proposed system.

### **1.4.3 Management Functions**

The TMN shall support following Management functions:

#### **1.4.3.1 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.

### **1.4.3.2 Fault Management**

Fault management is concerned with detecting, diagnosing, bypassing, directing service restoration, and reporting on all the backbone network equipment, system 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 like red, amber/orange, blue etc. The normal condition shall be green (preferably) in colour.
- 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. Support in reducing failures through the use of automatic failover to redundant equipment where possible and through operator-initiated actions where automatic failover is not possible. The status of fail over shall be reported to TMN.
- f. Track network equipment failure history.

### **1.4.3.3 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.
- b. Monitor point to point, end to end errors/signal quality and history. Provide operator controls to monitor performance of specified events, measures, and resources. 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 as per G,826. Performance data provided is limited to what is available from the equipment Contractors.
  8. Provide graphical displays of NE current performance parameter values. Provide tabular displays of current, peak, and average values for performance parameters.
  9. Generate reports based on system statistics such as daily, weekly, monthly yearly performance reports.

#### **1.4.3.4 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 three levels of operator access shall be provided - read only, and write. 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.

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.

#### **1.4.4 Communication Channel Requirements and Integration**

The TMN data transport shall utilize the transmission system service channel in the overhead. In case overhead channels are not available, the Contractor shall provide suitable interfaces with 1+1 protection in their supplied equipment for transport of TMN data.

#### **1.4.5 Craft Terminal**

Each SDH equipment on the telecom network shall include provision for connecting a portable personal computer (PC) to be known as craft terminal to support local commissioning and maintenance activities. It shall also be possible to remote login to other NE(s) through craft terminal. 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 portable computer shall be connected to a V.24/V.28 interface available at terminal stations. Portable (laptop) computers (Craft terminals), each complete with necessary system and application software to support the functions listed above, shall be supplied to the Purchaser as per BOQ given in appendices.

#### **1.4.6 Hardware Requirements**

NMS shall include at least one server/master processor, two operator consoles (work stations), one network printer and the craft terminals as indicated in the BOQ.

##### **1.4.6.1 Master Processor, Server/Workstation and Craft Terminal**

The master processor, server/workstation and craft terminal shall have Pentium/AMD or RISC based 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 master processor, server/workstation shall have minimum configuration of 2 GHz processor (1.0 GHz in case of RISC processor), 256 MB SD RAM, 32 MB VRAM, CD-R/W drive, 72 GB Internal Disk Drive, 101-Enhanced style keyboards, mouse, USB(2.0), parallel and serial ports. VDUs for Local Operator consoles shall be 19" TFT Colour with a minimum resolution of 1024 X 768. Appropriate network drive card shall also be provided wherever required. Internal/external data/fax modem shall be provided in work stations.

However, the internal disk drive for the master processor shall be redundant and all the data shall be mirrored. Further, the TMN software shall support data mirroring on redundant disk drives.

CPU enclosures shall be desktop type and shall include available expansion slots except for the Craft Terminal which shall be a laptop. The craft terminal shall have minimum configuration of 2 GHz processor, 256 MB RAM, CD-R/W/DVD drive, 30 GB Internal Disk Drive, keyboard, mouse/trackball etc., USB(2.0), parallel and serial ports to accommodate printers, and Internal/external Data/Fax modem and a battery back-up of at least 60 minutes. VDUs shall be 15" TFT active matrix colour LCD with a minimum resolution of 1024 X 768.

#### **1.4.6.2 Peripherals and hardware**

TMN system shall be provided with one network printer. The network printer shall be connected to the LAN of the TMN system and shall be of Laser Jet type capable in printing in colours having a minimum print speed 4 pages per minute, capable to print at least A4 & A3 and a minimum resolution of 300dpi.

The printer under this specification shall include print enhanced buffering to prevent loss of print data in the event of a print failure.

#### **1.4.6.3 Power Supplies**

The TMN system shall use 230 volt 50 Hz AC from the UPS system provided under this project at Control Centre locations.

#### **1.4.7 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.

#### **1.4.7.1 Operating System Software**

Operating system software shall be provided to control the execution of system programs, application programs, and 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.

#### **1.4.7.2 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.

#### **1.4.7.3 Software Utilities**

A utility shall be provided to convert all reports into standard PC application formats i.e. dbase, dxf, excel, ASCII etc. as applicable.

#### **1.4.7.4 Revisions, Upgrades, Maintainability**

Software revisions, upgrades and maintainability is specified as follows:

##### **1.4.7.4.1 Versions**

All firmware and software delivered under this specification shall be the latest field proven version available at the time of approval. Installed demonstration for acceptance shall be required.

##### **1.4.7.4.2 Program Rewrites**

All firmware provided shall support its fully equipped intended functional requirements without additional rewrite or programming.

##### **1.4.7.4.3 Expansion**

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.

#### **1.4.7.4 Standards Compliance**

Software provided shall be compliant with national and international industry standards such as IEEE, ISO and OSF.

#### **1.4.7.5 User Maintainability**

All provided software shall be completely maintainable by the end USER utilizing the software services, tools and documentation that shall be delivered with the system.

#### **1.4.7.5 Database(s)**

The contractor shall develop all the databases for final communication 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.

#### **1.4.7.6 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

### **1.5 DDF Patching Facilities**

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

- (I) DDF shall be provided for termination of 16 E1 as minimum
- (II) Cables (including connectors) for E1 level connections between DDF and telecom Equipment.
- (III) Cables (including connectors) required for E-1 level connections of all other equipment to DDF and telecom Equipment.
- (IV) All Ethernet ports shall be terminated with RJ-45 connector. Provision for 100% expansion with connector for terminating additional Ethernet ports shall be provided.
- (V) Any other cables, connections etc required for a fully functional, integrated system.

## 1.6 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.

### 1.6.1 Environmental Requirements

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

#### 1.6.1.1 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 1-3.

**Table 1-3  
 Environmental Operating Limits**

<b>Temperature Range:</b>	(Un Controlled Environment)
<b>To Specification    Operation without damage    Shipping/storage</b>	0 to +45 °C -10 to +55 °C -40 to +60 °C
<b>Relative Humidity, non-condensing</b>	Upto 90% (non condensing)
<b>Elevation:</b> <b>Operating</b> <b>Non-operating</b>	to 3,500 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.

### **1.6.1.2 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.

This section 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.

### **1.6.1.3 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.

### **1.6.1.4 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.

## **1.6.2 Primary Source AC/DC Power Requirements**

Power requirements of telecommunications equipment is as specified below:

### **1.6.2.1 Primary Source AC Power**

It will be the Purchaser's responsibility to provide required Primary AC Power support for communications equipment installed under this specification. The Primary AC Power supplied will be 220 VAC +10%/-15%, 50Hz with a frequency variance between 46 and 55 Hz..

All equipment and components provided under this specification requiring Primary AC Power, shall be designed for normal operation under the above stated tolerances for 220 VAC supply.

The Contractor shall provide in the survey report to the EMPLOYER the projected 220 VAC Primary Power load requirement per equipment and totals, by location, for equipment provided under this specification.

Terminal which shall be powered from 230 V AC. Necessary power distribution, protection and cabling from DCPS/Inverter/UPS shall be the responsibility of the contractor.

### **1.6.3 Equipment Constructions, Assembly and Installation**

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

#### **1.6.3.1 Identification**

All cabling, racks/enclosures, equipment, modules and materials shall be uniquely identifiable. All the inter cubicle cables shall be provided with identification tags at both ends of termination for easy traceability.

#### **1.6.3.2 Equipment Sub-Racks and Cabinets (Enclosures)**

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

##### **(A) Equipment Cabinet (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 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 non load bearing panels/doors shall be fabricated from minimum 1.6 mm thickness steel sheet and all load bearing panels, frames, top & bottom panels shall be fabricated from minimum 2.0 mm thickness steel sheet
- (4) Equipment cabinets (enclosures) shall be confirm to IP41 protection class as per IEC 529 specification, or better.

- (5) The racks shall be provided with lighting system and switches for easy maintenance.
- (6) 5/15A duplex plugs shall be provided on each cabinet and electricity supply shall be extended to this plug for testing and commissioning purpose.
- (7) Racks shall be provided with key based door locking arrangement.

### **1.6.3.3 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 terminal blocks.
- (2) The Contractor shall provide subscriber level wiring and patching wherever required.

### **1.6.3.4 Lightning and Transient Voltage Protection**

The Contractor shall be required to provide protection from lightning and transient voltages to meet the requirements specified in EMI/EMC in clause 1.7.1 above and other protections deemed necessary for successful operation of the system.

### **1.6.3.5 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 provide all required earthing /grounding cable/strips to extending it to substation earthing system. The Contractor shall also be responsible for providing earthing systems including earth pits, earthing studs and earthing grid etc, as required, wherever the existing station earthing is found to be unsuitable for equipment being provided by the Contractor.

Cabinet (Enclosure) and equipment safety earthing and signal grounding shall be subject to the EMPLOYER's approval.

#### **1.6.3.6 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.

#### **1.6.3.7 Finish Colors**

Unless otherwise specified, finish colors for enclosures shall be gloss white enamel on the inside, and semi-gloss medium gray enamel on the outside. Only brushed aluminum trim shall be used. The actual colouring scheme shall be finalised during project execution

### **1.6.4 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.

### **1.6.4.1 Locations for Supplied Equipment**

All transmission equipment, the TMN and associated equipment shall generally be collocated in the same communications room located in the Control Room Building whenever possible. At all locations, the communication equipment shall be kept at the nearest available space in the RTU room/building/control room. The supply of all the interconnecting cables and interconnections is to be done by the contractor.

### **1.6.4.2 Cable Routing**

In case TMN workstations are located remotely, the Contractor shall provide all cable, wiring, long haul landline interfacing and installation to facilitate communication channel requirements for the TMN .

### **1.6.4.3 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, extension of cable trench 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.

## **1.8 Factory testing**

The factory test requirements (Type Testing and Factory Acceptance Test) are to be carried out are as follows:

### **1.8.1 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. The Contractor shall offer the type tested equipment as per relevant standards and shall submit the earlier carried out type test reports of the test requirement specified below for Employer's review and approval. In case any of the test reports are not submitted or not meeting the requirement, the same shall be carried out by the Contractor at no additional cost to the Employer.

### 1.8.1.1 List of Type Tests

The type testing requirement for communication equipment is defined in the section below:

The type testing shall be conducted on the SDH equipment with all cards.

### 1.8.1.2 Temperature and Humidity Tests

The tests listed below are defined in IEC Publication 68.

#### (a) Low Temperature Test: Operation to Specifications

Low temperature tests shall be conducted as defined in IEC Publication 68-2-1, test method and, 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 °C.
- (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 68-2-1, 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 °C.
- (3) Acceptance Criteria: Degradation of performance is allowable during the test, however there shall be no degradation of performance in the *post-test*.

#### (c) Dry Heat Test : Operation to Specifications

Dry heat test shall be done as defined in IEC Publication 68-2-2, 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: 45 °C.
- (3) Acceptance Criteria: No degradation of performance during and after the test.

**(d) Dry Heat Test : Operation without Damage**

Dry heat tests shall be done as defined in IEC Publication 68-2-2, test method , 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 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 55°C.
- (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 68-2-3 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 temperature shall be 40 deg C & RH shall be 93 (+3/-2) % non condensing as per referred standard..
- (2) 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 68-2-14 (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: as per table 2-3 (Operation to specification range i.e. 0 deg C & 45 deg C)
- (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.

1.8.1.3 Power Supply and EMI/EMC tests

The test procedure and acceptance criteria shall be as defined in IEC 870-2-1.

**(a) Immunity Tests**

The list of Immunity tests are specified below in Table 1-4:

**Table 1-4**

Test Nos.	Test Name	EUT Status	Test Level	Power Supply Points		Control lines & alarms	Telecom Lines	Passing Criteria
				CM	DM	CM	CM	
1	Surge Immunity Test	ON	Level 3	2 kV	1 kV	2 kV	---	A
2	Electrical Fast Transient Burst Test	ON	Level 3	2 KV	-	1 kV	1 kV	A
3	Damped Oscillatory Wave Test	ON	Level 3	2.5 kV	1 kV	2.5 kV	2.5 kV	A
4	Electrostatic Discharge Test	ON	Level 3	+/- 6 kV in Contact discharge mode or +/- 8 kV in Air discharge mode				A

5	Radiated Electromagnetic Field Test	ON	Level 3	10 V/m electric field strength	O
6	Conducted Radio Frequency Common mode	ON	Level 3	10 V rms DC clamp injection method as per IEC 61000-4-6 on DC & Control Signals	A
7	Damped Oscillatory Magnetic Field Test	ON	Level 3	30 A/m at 1MHz of magnetic field strength	O
8	Power frequency magnetic field	ON	Level 3	30 A/m of magnetic field strength (Continuous duration sine wave)	O
9	Power frequency voltage withstand	OFF	-	1 KVrms for 1 minute	No break down or flashover shall occur
10	Insulation Resistance Test	OFF	-	Measure Insulation resistance using 500 V DC Megger before & after Power Freq & Impulse voltage withstand tests	As per manufacturer standard

### (b) Emission Tests

The list of Emission tests are specified below :

Conducted and radiated emissions:- To comply with Class A (Class B for low capacity (below 34 Mbps data rate) of CISPR 22 (1993) “Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipments”

### 1.8.2 Factory Acceptance Tests

The factory acceptance test shall demonstrate the technical characteristics of the equipment in relation to this specifications and approved drawings and documents. The list factory acceptance tests for FOTS is provided in table 2-6 below. This list of factory acceptance tests shall be supplemented by the Contractor's standard FAT testing program. For general requirements of testing section 7 is to be referred. FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces, alarms and diagnostics etc in

addition to the standard manufacturers test program. For Test equipment, FAT shall include supply of proper calibration certificates, demonstration of satisfactory operation, evidence of correct equipment configuration and manufacturer’s final inspection certificate

**Table 1-5:  
 Fibre Optic Transmission System & NMS Factory Acceptance Testing**

<b>Item</b>	<b>Description:</b>
<b>1.</b>	Physical inspection for conformance to drawings and appearance of equipment and TMN hardware
<b>2.</b>	Optical output power
<b>3.</b>	Transmitter light wave spectral analysis
<b>4.</b>	Low receive level threshold
<b>5.</b>	Generation of bit error rate curve
<b>6.</b>	Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, and line rate tolerance
<b>7.</b>	Measurement of analog and digital service channel parameters/functionality
<b>8.</b>	Performance of supervision, alarm, diagnostics, loopbacks etc. through Craftsperson interface,
<b>9.</b>	Network Management interface performance along with NMS/TMN
<b>10.</b>	Testing of TMN to demonstrate proper operation of all functions : Configuration Management, Performance Management, Fault Management and Security management. Standard features and required customization of the TMN shall be demonstrated for proper functioning.
<b>11.</b>	Simulation of failure conditions and failover of each redundant unit.
<b>12.</b>	Test of spare card slots/parts/modules for selected tests
<b>13.</b>	Checks of power supply/converter voltage margins
<b>14.</b>	Random inspections and any other additional tests to verify the accuracy of documentation

	End of table
--	--------------

### **1.8.3 Site Acceptance Tests (SAT)**

The Contractor shall be responsible for the site tests and inspection of all equipment supplied in this contract.. All equipment shall be tested on site under the conditions in which it will normally operate in the presence of Employer’s representative.

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. A minimum Site Acceptance Testing requirement for Telecom equipment 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 may be 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.

The SAT Shall be completed in following phases:

#### **1.8.3.1 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 replaced or changed between the completion of factory tests and the start of field tests and show that documentation and spare parts have been updated.

The minimal installation testing requirements for the fiber optic transmission subsystem are provided in Table 1-6 S.no. 1, 2, 5, 6 and 9.

#### **1.8.3.2 Commissioning Tests**

The commissioning tests shall verify that communication can be performed over the fiber optic link under test. Test specified in table 1-6 S.no. 3, 4, 6, 7, 8 and 10 shall be carried out. In addition, Bit Error/Packet loss measurements shall be made on the fibre optic to verify compliance with designed link performance for a minimum duration of 48 Hours.

- (1) End to end testing
- (2) Data connectivity from SCADA/DMS/MBCCC with remote location (RTU/ billing center etc.) shall be verified.
- (2) Installation testing for TMN as per tables 1-7 (3) (4) Testing of TMN to demonstrate proper operation of all functions : Configuration Management, Performance Management, Fault Management and Security management. All the standard features and required customization of the TMN shall be demonstrated for proper functioning.
- (3) Demonstration of Protection switching and synchronisation of equipment as per synchronization plan.

**Table 1-6**  
**Fibre Optic Transmission system Installation and Commissioning Testing**

Item:	Description:
1.	Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling
2.	Station power supply input and equipment power supply (DC-DC converter) output voltage if access to o/p is available or external converters used measurements
3.	Terminal transceiver performance testing (Tx power, receive signal strength etc.)
4.	Service channel performance, EOW functionality in link test.
5.	Craftsperson interface, alarm and control functional performance
6.	Rack and local alarms: No unwanted alarms shall be present and all alarms shall be demonstrated to be functional
7.	Network management interface and supervision performance to be tested along with TMN equipment at Control Centre location.
8.	Correct configuration, level setting & adjustments and termination of Input/ output interfaces
9.	Proper establishment of Safety and signalling earthing system and resistance to ground to be checked.

**Table 1-6**

**Fibre Optic Transmission system Installation and Commissioning Testing**

<b>10.</b>	Simulation of failure conditions and failover of protected components.
------------	--

**Table 1-7**

**TMN Installation Testing**

<b>Item:</b>	<b>Description:</b>
1.	Physical inspection for conformance to drawings, rack elevations and appearance of equipment and cabling
2.	Workstation hardware inventory, configuration and characteristics
3.	Demonstration of proper operation of all hardware, including workstations peripherals

UGVCL