



Nepal Electricity Authority

(Government of Nepal Undertaking)

Project Management Directorate

Electricity Grid Modernization Project-Additional Financing

Chobhar Patan Chapagaun 132 kV Underground Transmission Line Project

Matatirtha, Kathmandu

Ref No: CPCUGTLP- 080/81 Cha No 5

Date: August 06, 2023

To,
All Prospective Bidders.

Subject: **Issuance of Clarification-I**

Ref: Design, Supply, Installation, Testing and Commissioning of New Patan 132/66/11 kV GIS Substation (Package A1.2) (PMD/EGMPAF/CPCUGTLP-079/80-01)

Dear Sirs/Madams,

In reference to the captioned Bid published on July 05, 2023, we hereby attaching the Clarification-I sought by the bidders pursuant to Clause 7.1 of the bidding documents.

It is hereby requested to acknowledge the receipt of the same.

With Regards,

(Ukesh Shrestha)
Project Manager

Chobhar Patan Chapagaun 132kV Underground Transmission Line Project
Design, Supply, Installation, Testing and Commissioning of New Patan 132/66/11kV GIS Substation (Package A1.2)
OCB No.: PMDEGMPAF/CPUC/GTL-P-079/80-01

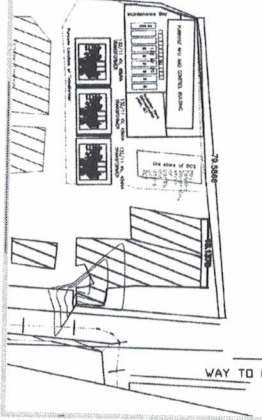
| S.N. | Volume/Section | Clause No. | Bidder's Query | NEA Reply |
|------|---|--|--|---|
| 1 | Vol I, Section 8 | Clause 26 Completion Time Guarantee: 16.2 Applicable rate for liquidated damages: 0.05 % | We understand that the applicable rate for liquidated damages: 0.05 % of Contract Price per day of delay Please confirm our understanding. | Confirmed |
| 2 | Vol I, Sections 3 & 4 | Section 3 EQC, Subclause 2.6 Subcontractor Documents submission requirement: EXP-3 Section 4 Form EXP-7: Subcontractors | We understand that the proposed manufacturers for the major items of plant and services shall submit EXP-7 not EXP-3, please confirm our understanding. | Confirmed |
| 3 | Vol II (B), Chapter 17 Substation Automation System | 1.2 Protocol converter should be used wherever required to match to existing communication system installed at MCC to be located at Baneshwor Substation. | Kindly inform the brand and type of existing communication system at MCC and at Baneshwor Substation, | Please acquaint with the site accordingly. |
| 4 | Vol III /Schedule 1 S Communication Equipment | 1.1.1 Base Equipment (Common cards, Cross Connect/control cards, optical base cards, power supply cards, power cabling, other hardware and accessories including sub racks, patch cord, DDF etc fully equipped excluding (ii) & (iii) below, integration with existing SDH equipment at Siuchatar and Baneshwor Substations and SDH equipment at Balkumari, Chobhar, Harisiddhi etc | Kindly inform the brand and type of existing SDH equipment at Siuchatar and Baneshwor Substations and SDH equipment at Balkumari, Chobhar, Harisiddhi etc as indicated in the price schedule. | Please acquaint with the site accordingly. |
| 5 | Vol II (A) Chapter 1 – Project Specific Requirement (PSR) | 4. DETAILED SCOPE OF WORK ii. Air Insulated Switchgear (AIS) and other main equipments 4. Integration/upgradation/modification of existing Sub-station automation system (SAS) with new SAS under this scope including complete hardware and software along with associated equipment for 132 kV, 66 kV & 11 kV bays as per Single line diagram (bay as defined in Technical Specification, Section - Substation Automation). | Kindly inform the brand and type of the existing SAS. | Existing SAS is installed from GE, however, Please acquaint with the site accordingly. |
| 6 | Vol II (A) CHAPTER 1- Project Specific Requirement | 1. GENERAL Nepal Electricity Authority is intending to upgrade existing New Patan Substation into 132/66/11kV Gas Insulated substation at Laganahel, Lalipur. It will be connected to Chobhar Substation (under construction) at 132 kV level. Existing New Patan Substation is connected to Baneshwor Substation and Siuchatar Substation at 66 kV level. | Whether the supply and installation of optical differential protection at Chobhar S/S is scope of work of the contractor? If not, kindly provide the brand and type of the optical differential protection at Chobhar S/S (Under construction). | Supply and installation of relay at chobhar is other contractor's scope. For, brand please acquaint with the site accordingly. However, necessary electrical/optical connections/terminations at New Patan S/S line protection relays shall be established by current bidder. |
| 7 | Vol II (B), Chapter 18 Substation Automation System | 2.3 Fibre Optic Transmission System ...The contractor shall provide Fiber Optic based Communication Equipment which has full functionality mentioned above at Sitalpati 400kV Substation as per scope of works. | Please clarify if the communication equipment supply at Sitalpati 400kV Substation is the contractor's scope of work? And if this Sitalpati 400kV Substation connected to New Patan 132/66/11kV GIS Substation? | Chapter 18-04 shall be replaced with the attached chapter 18-04 under Clarification I herewith. |
| 8 | Vol II(A) | CHAPTER 1 – PROJECT SPECIFICATION REQUIREMENT (PSR) 3. SCOPE OF WORK 132 kV line bays: 6 (Six) numbers of line bays out of which 2 numbers for 132 kV Double Circuit Chobhar Patan Underground Transmission Line and 4 (Four) numbers for future use. | We understand that the connection work with 132 kV Double Circuit Chobhar Patan Underground Transmission Line is not within the scope of this project, and we do not need to consider any cable, terminal, lightning arrester and other material equipment for this connection work. Please clarify. | Shall be as per bid document. Moreover, the GIS interfacing modules, Cable trenches suitable for connection of XLPE power cables to GIS as per SLID shall be scope of current bidder. |
| 9 | Vol II(A) | CHAPTER 1 – PROJECT SPECIFICATION REQUIREMENT (PSR) 4. DETAILED SCOPE OF WORK ii. Air Insulated Switchgear (AIS) and other main equipments 7. Connection/Upgradation/Modification of existing MV Indoor Switchgear; its price shall be included in LT transformer section. | Please clarify whether we need to replace or add more MV indoor switchgear? There is no items related to MV indoor switchgear in BOQ. | Additional switchgear is not required. |



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| 10 | Vol 2, part B Chapter 14, No.6.1 | In addition to drainage of rainwater in accordance with above clause 6.0, the contractor shall design, prepare drawings and provide rainwater harvesting system also. | According to the geological survey, the current groundwater level is 4m. If the water table is below 8m, then we need to do a rainwater collection system. But the rainwater collection system is not inside the BOQ. Whether rainwater collection system is needed? | Shall be discussed during DDE. |
| 11 | Vol 3, Schedule No. 4 (a), part C Chapter 1.2 | Dismantling and Disposing of Existing Building, deducting the salvation cost of reusable materials, and transporting all stock/store materials to place all complete as per drawings, specifications and instructions of the Engineer. | The demolished part of the built structure needs to be transported to a designated location, how far from the substation this location is not specified | As per the bid document. |
| 12 | Vol 3, Schedule No. 4 (a), part C | / | According to the geological survey report, the recommended bearing capacity of shallow foundation is only 120, and there is moderate liquefaction. Therefore, pile foundation may be required in the later stage, but there is no amount of pile foundation in BOQ, please clarify: whether pile is needed? if pile foundation is used, how to settle. | currently as per bid document and discussion during DDE. If there is amendment, it shall be published through the NEA's website and notified to bidders. |
| 13 | Vol 2, part B Chapter 14, No.7.0 | All concrete roads within substation boundary wall shall be with 3.75 m Rcc concrete pavement of suitable thickness and 1.3 m wide earthen shoulder on either side of the road. | It is stated in the contract that road shoulders are needed for the road. The project site is tight and the road shoulders cover a large area, so there may be no space. Whether shoulder is needed? | The size of shoulder shall be limited as per site condition during approval of detailed site layout plan. |
| 14 | Vol 2, part B Chapter 14, No.7.1 | 7.1 Road Outside NEA boundary (Access Road) | This project is an expansion on the basis of the old station. The old station has a road for construction, so do we still need to build a road for entering the station? | Not needed. |
| 15 | Vol 2, part B Chapter 14, No.17.0 and No.18.0 | RCC switchyard panel room with the size as mentioned in bid price schedule shall be constructed. Aesthetically pleasant RCC car parking shed as per design and drawings as developed by the contractor and suitable to park 10/5 cars as per BoQ shall be constructed at suitable location to be decided during detailed engineering stage | There is no panel room and parking shed in BOQ, but there is one in the body of the contract. Please make it clear whether it is necessary | Not needed. |
| 16 | Vol 2, part B Chapter 14, No.22.0 | (a) D-Type Quarter: One Number with size 15 mx 14 m-Single Storeyed.(b) C-Type Quarters: Four Numbers: One Block of four quarters having two quarters on ground floor and two quarters on first floor. Block will have an area of about 12 m X 25 m on each floor.(c) B-Type Quarters: Four Numbers: One Block of four quarters having two quarters on ground floor and two quarters on first floor. Block will have an area of about 10 m X 25 m on each floor. | There are technical requirements for quarter in the contract, but BOQ does not have them. May I ask whether it is necessary to build the quarter? | Not needed. |
| 17 | Vol 2, part B Chapter 14, No.23.0 | 23.0 Boundary wall, Main Gate, Security Room and septic tank and soak pit | There are technical requirements for the fence, gate and security room in the contract, but BOQ does not have them. May I ask whether they need to be done? | As per PSR and BoQ. |
| 18 | | | Please provide the original substation main transformer basic drawing, main control building structure drawing, structure support and foundation drawings. On the one hand, look at the type of foundation in the early stage, and calculate the amount of demolition works. | As per availability, it shall be provided. However, bidder shall acquaint with the site accordingly. |
| 19 | | | Please provide the wall drawing of the original substation, because the area of the site is limited, and the scope of the wall foundation will affect the layout of the foundation of the site construction structure. | Bidder shall acquaint with the site accordingly. |
| 20 | | | Is it necessary to build a new security room this time? | Not needed. |
| 21 | Volume II(C) All Drawing | | Please provide a detailed general layout, specifying the specific dimensions of the site (such as each side length) | Bidder shall acquaint with the site accordingly. |

[Handwritten Signature]



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| 22 | Volume II(C) All Drawing |  | According to the simple general layout provided in the bidding documents, the northern boundary is approximately 79.5m long, but according to satellite map measurements, this length is approximately 60m. Please clarify the specific boundary as it affects the overall layout. | Bidder shall acquaint with the site accordingly. |
| 23 | Volume II(C) All Drawing | | In addition to two single-phase transformers, which other equipment and buildings need to be dismantled, and indicate them in the diagram and provide a detailed list | As per bid document Bidder shall acquaint with the site accordingly. Dismantling cost shall be quoted accordingly. |
| 24 | Volume II(A) All Drawing | CHAPTER I Clause 4 ii Air Insulated Switchgear (AIS) and other main equ | According to the description in the bidding documents, the original LT transformer needs to be removed, but the specific quantity and location have not been specified. Please explain. | Bidder shall acquaint with the site accordingly. |
| 25 | | | According to the technical specifications of the owner, it is necessary to upgrade/renovate the existing 11kV medium voltage cabinet to adapt to the two new station transformers. However, according to on-site communication with the owner, the 11kV medium voltage cabinet needs to be increased from 23 intervals to 26 intervals. However, there is no new engineering quantity related to the 11kV medium voltage cabinet in the BOQ. Please clarify. | Supply to station transformers shall be established from existing 11 kV cabinet. |
| 26 | | | Please provide the original layout of the 11kV distribution room to understand if there is a need for additional switchgear and if the site is sufficient | Bidder shall acquaint with the site accordingly. |
| 27 | BOQ | H Digital protection coupler | Digital protection coupler devices are not listed here. We understand DPC will not be used in this project. Please confirm | Confirmed |
| 28 | BOQ | L Batteries and UPS 110VDC | Comparing to other project of NEA, the DC voltage is 220V for control. It is 110VDC for this project. Please confirm | As per bid document. If there is amendment, it shall be published through the NEA's website and notified to bidders |
| 29 | BOQ | F Relay Panels | Relay panels for remote end of the transmission line are not mentioned here. We understand that is not bidder's scope. Please confirm | Confirmed. Relays compatible with other end shall be installed by current bidder. |
| 30 | BOQ | G SUBSTATION AUTOMATION 1 Integration/upgrade/modification of existing Substation Automation System with new SAS including bus bar system and new SAS as per Technical Specification. | The best way is integrating the existing SAS into new SAS via existing gateway/RTU. Please confirmed this scheme is acceptable or not. | As per bid document. |
| 31 | 1688538857_Volume III | Schedule No.1: Plant and Equipment including Mandatory Spares to be supplied from abroad Part 1/I/6/48V DC Distribution board | Quantity is 1 set. Please confirm 1 set or 2 sets. | As per BoQ. |
| 32 | 1688538857_Volume III | Schedule No.1: Plant and Equipment including Mandatory Spares to be supplied from abroad Part 1/I/2/48V | Quantity is 1 set. Please confirm 1 set or 2 sets. | As per BoQ. |
| 33 | 1688538857_Volume III | Schedule No.1: Plant and Equipment including Mandatory Spares to be supplied from abroad Part 1/M/2/1 80A/80A | The 80A cannot meet the changing current of the battery and the operating current of the communication device. Please provide appropriate parameters. | It shall be as per design requirement. If there is amendment, it shall be notified through NEA's website. |
| 34 | 1688538857_Volume III | Schedule No.1: Plant and Equipment including Mandatory Spares to be supplied from abroad Part 1/S/1.1/1/54.1 SFP | The S4.1 optical module is not configured. Please confirm. Please provide the model of existing SDH equipment in the opposite substation. | Bidder shall acquaint with the site accordingly. |

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| 35 | 1688538857_Volume II(A) | Chapter 8 – General Technical Requirement, Fire Protection, Clause 2.01.00 Hydrant System (Not Applicable), 2.02.00, HIGH VELOCITY WATER (H.V.W) SPRAY SYSTEM (Not Applicable), 2.05.00 Water Supply System (Not Applicable) | We understand that we do not need to set up fire water supply system for the renovation station in this project. Please confirm our understanding. | Confirmed |
| 36 | Volume - 1 | Section - 3, Clause 2.4 Bidder's experience To substantiate the above qualification, the Bidder must submit certificate (notarized) from clients (end-user certificates) for all number of projects. The bidder is required to submit the notarized translation of the copy, if the document submitted is in language other than bidding language | We understand that, EPC contractor need to submit notarized copy of end user certificates as asked on clause 2.4.1 and 2.4.2 only. Please confirm if our understanding is correct. | Notarized copy of end user certificates shall be provided for clause 2.4.3 and clause 2.6 as well. |
| 37 | Volume - 1 | Section - 3, Clause 1.3.6 - Specific Additional Criteria & Section - 8, SCC - Clause 9.8 (c) Any bid not accompanied by the EHSMP may be rejected by the Employer as nonresponsive. And Within 28 days of the Commencement Date the Contractor shall submit a detailed Site Specific Environmental Management Plan (SSEMP) for the Engineer's no objection showing how he/she intends to comply with environmental laws and regulations and other specific requirements prescribed in the Contract, addressing all the monitoring and mitigation measures set forth in the Environmental Impact Assessment ("EIA") and the Environmental Management Plan ("EMP") of the project attached in Section 6- Employer's Requirements. | We understand bidder has to submit general draft version of EHSMP plan at bidding stage and site specific EMP will be submitted during execution stage, please confirm if our understanding is correct. | Confirmed. |
| 38 | Volume - 1 | Section - 3, Clause 2.6 - Power Transformer (132kV voltage class) iv) Must submit the type test reports as per IEC carried out by Reputed independent testing laboratory over last 10 years period as on the originally scheduled date of bid opening for the identical/similar rating of same voltage level except for DSC test. v) Must have successfully carried out the Dynamic Short Circuit (DSC) test as per IEC over last 10 years period as on the originally scheduled date of bid opening in Reputed independent testing laboratory on: - 132 kV voltage class, three phase 63 MVA or higher rating capacity transformer with same voltage level | We have following understanding please confirm: a. If bidder submits type test reports as per IEC by reputed testing laboratory conducted within last 10 years for 132kV voltage level and rating more than 63 MVA, then bidder need not to conduct type test on offered transformer during execution of project. | As per bid document. |



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| | | <p>Chapter - 1 - PSR, Clause 9 The Contractor shall impart the necessary training to NEA's Personnel as per following details:-</p> <p>1. Training at Manufacturer's works. The Contractor shall include in the training charges (i) Accommodation Charges (ii) payment of per Diem allowance to NEA trainees as per Financial TADA Byelaws of NEA per day per trainee for the duration of abroad towards meals and other incidental expenses and (iii) to and fro economy class air ticket from Nepal to place of training. The duration of training shall be excluding travelling period. It shall be quoted under Schedule</p> <p>4(b). Training Charges for training to be imparted abroad. The training shall be provided in the field of design, testing and maintenance at Manufacturer's works as per following:-</p> <p>(a) Control & Protection and Substation Automation System: 5 Days. (3 Nos. Trainees or as per BPS)</p> <p>(b) GIS: 5 Days. (3 Nos. Trainees or as per BPS)</p> <p>(c) Telecommunication Equipment (SDH, MUX & NMS (Craft Terminal)) and DPC: 5 Days. (3 Nos. Trainees or as per BPS)</p> <p>(d) Transformer: 5 Days. (3 Nos. Trainees or as per BPS)</p> | <p>Kindly confirm per diem allowance to NEA trainees, which is to be paid by contractor during training period.</p> | <p>Per diem allowance to NEA trainees shall be as per NEA TADA Byelaws. Please check in NEA's website www.nea.org.np</p> |
| 43 | Volume - 2 | | | |
| 44 | Volume - 2 | Price Schedule | As discussed in prebid meeting, please provide soft copy (Excel) of Price Schedule. | Shall be provided in mail of prospective bidders. |
| 45 | Volume - 2 | Drawings Plot Plan | Request you to please provide plot plan, which is available for said scope of works. | Shall be provided in mail of prospective bidders if available. However, bidder shall acquaint with the site accordingly |
| 46 | Special Conditions of Contract | 14.5.2 Unless otherwise specifically declared in the contract documents, the Contractor and its suppliers and subcontractors shall include business taxes and other taxes that may be levied in accordance with the laws and regulations in force or in effect in Nepal | We would like to know if Tax Deducted at Source (TDS) is applicable on this contract. If yes, kindly specify the % | Yes. The % depends upon prevailing rules and regulations of Nepal. Please check Inland Revenue Department, Nepal. |
| 47 | Special Conditions of Contract | 14.5.2 Duties on Equipment, Plant, Materials and Supplies | As per this section, we understand that the Customs duties and VAT are exempted for the project or shall be reimbursed to the contractor by the client. However, under the Section IV, Price schedule, Schedule No. 1, column 10 is to put Custom, VAT and Other taxes. Can we leave it blank? | Confirmed. |
| 48 | Project Specification Requirement | 4.5 and 4.6 GIB Ducts and SF6 to Air Termination | Kindly confirm if we need to consider prices for these items during our estimation | As per bid document. |
| 49 | Project Specification Requirement | Annex-I, iii. 7 Strengthening of Approach road/Repair | Kindly confirm if we need to consider the cost and under which item in the price schedule it can be included | As per bid document. Please acquaint with the sites/roads to be used accordingly. If required shall be loaded under individual items that require transportation. |
| 50 | Project Specification Requirement | 4. iv Modifications/Dismantling Works at Patan Substation | Can you kindly specify the scope in brief. | As per bid document. Please acquaint with the site. |
| 51 | Volume-2 A | Existing Drawings | Kindly share the existing 66/11kV substation layout for interconnecting with new proposed substation. | Shall be provided as per availability in mail of prospective bidders. However, please acquaint with the site. |
| 52 | Volume III | Price Schedule | Kindly share the existing 66/11kV substation layout for interconnecting with new proposed substation. Also confirm if bus extension module or Bays are available in existing 66K V Busses. | As per bid document. Please acquaint with the site. |

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| 53 | Volume III | Price Schedule | we presume that, complete Existing 66kV & 11kV bays are already integrated with existing RTU. Same shall be integrated with new SAS system. Please confirm. | As per Bid document. Please acquaint with the site. |
| 54 | Volume III | Price Schedule | For connecting 3nos of 45MVA, 132/11kV transformer 9nos of 11kV LAs required. Please confirm and revise the price schedule. | Quote under BoQ 132/11 kV transformers with Surge Protection Device that shall be mounted on LV of transformer. |
| 55 | Volume III | Price Schedule | Integration/upgradation/modification works to be done with Existing indoor 11kV VCB panels. There is no new panels to be considered. Please confirm. | confirmed |
| 56 | Volume II and III | Technical Specification and Price Schedule | In case of fire in Transformers specially bushings, pipelines when exposed to air, N2 injection will not be sufficient to prevent fire. Hence, Transformer will be out of Fire Protection. Reconfirmation required for non adoption of HHV system. | As per Bid document. Design/installation/testing/commissioning as per requirement for prevention of fire. |
| 57 | Volume II | Technical Specification and Price Schedule | May please confirm applicable Standard Code | As per Bid document. |
| 58 | Chapter -1, Project specific requirement | iii - Civil works, point no : 10 | May provide the contour details and the expected FGL for the proposed area to estimate the land development quantity.. | Please acquaint with the site. |
| 59 | Soil Investigation Report | Soil Investigation Report | Recommendations are given for Shallow type of foundation and Pile foundation. May please confirm the type of foundation to be followed.. | As per detail design engineering. |
| 60 | Volume III | Price Schedule, Part -C Civil Works | May please confirm how quantities for piles are measured and paid as per the price schedule schedule. | As per bid document. However, if there is amendment, it shall be published in NEA's website and notified to the bidders. |
| 61 | Chapter -14, General Technical Requirements, Civil Works | CI.8.0 | We propose wall type transformer foundation. May please confirm. | Shall be discussed during detail design engineering. |
| 62 | | Soil Investigation Report | According to the Soil Investigation Report attached to the Bidding Documents, pile foundation is required for the project. However, no relevant items are indicated in the Price Schedules. Please clarify whether pile foundation shall be considered in the bidding stage. If yes, please indicate the quantities of pile foundations and update the Price Schedules. | As per bid document. However, if there is amendment, it shall be published in NEA's website and notified to the bidders. |
| 63 | | | According to the Price Schedules attached to the Bidding Documents, it seems that no pile foundations shall be considered in the bidding stage. The Bidder understands that the additional cost shall be settled for pile foundations if the pile foundations are adopted during the contract performance. | As per bid document. However, if there is amendment, it shall be published in NEA's website and notified to the bidders. |
| 64 | | Price Schedules | It seems that the square meters of control room building and GIS Hall indicated in the Price Schedules are far smaller and largely insufficient to accommodate all the equipments. The Bidder understands that the quantities shall be reviewed after the detailed design is prepared by the Contractor and the Price Schedules shall be revised accordingly. The final Contract Price shall be settled based on the quoted unit prices and the quantities actually executed. Please confirm our understanding. | As per Bid document and discussion during DDE. The compact design engineering shall be established considering site constraints and cost of such design shall be loaded into individual items. |
| 65 | | | Pump house building and fire water tank are not indicated in the Price Schedule. Please clarify whether pump house building and fire water tank are required for the project. If required, please indicate the quantities and update the Price Schedule. | Not required. |

CHAPTER - 18-04**FIBRE OPTIC BASED COMMUNICATION EQUIPMENTS****1. Introduction, General Information and General Requirement**

This document describes the technical specifications for Communication Equipment which includes Fibre Optic Terminal Equipment for Establishment of Fibre Optic Communication System under the contract. This specification describes the functional and performance requirements of the system.

1.1 Scope and General Requirements

The broad scope of the procurement of this part include the survey, planning, design, engineering, supply, transportation, insurance, delivery at site, unloading, handling, storage, installation, termination, testing, training, and demonstration for acceptance, commissioning and documentation for:

- (i) Fibre Optic Communication Equipment (STM-4 MADM upto 4 MSP Protected directions as well as MPLS-TP 10G capacity upto 4 MSP protected directions) along with suitable optical line interfaces & tributary cards.
- (ii) Local Craft Terminal (Laptop) with full operational programming software and data cables.
- (iii) All cabling, wiring, Digital Distribution Frame patch facilities, equipment MDF's and interconnections to the supplied equipment at the defined interfaces.
- (iv) MDF & DDF cross connects required to route and activate circuits.
- (v) System integration of the supplied subsystems and also integration with existing communication equipment such as SDH, MPLS-TP, MUX etc.
- (vi) System integration of the supplied equipments (termination equipment system) with existing equipments for seamless transmission of communication channel
- (vii) Integration of supplied system with the User equipments such as RTU/SASs, SCADA system, etc.
- (viii) Maintenance of the supplied system

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

1.2 General Requirements

The Contractor is encouraged to offer standard products and designs. However, the Contractor 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 Contractor shall verify the

design data during the site surveys & detail engineering and finalise the BOQ as required for ultimate design & system performance.

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 inquiries.

An analysis of the functional and performance requirements of this specification and/or site surveys, design, and engineering may lead the Contractor to conclude that additional items are required that are not specifically mentioned in this specification. The Contractor 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.

The Bidders are advised to visit sites (at their own expense), prior to the submission of a proposal, and make surveys and assessments as deemed necessary for proposal submission. The successful bidder (Contractor) is required to visit all sites. The site visits after contract award shall include all necessary surveys to allow the contractor to perform the design and implementation functions. The Contractor shall inform their site survey schedule to the Employer well in advance. The site survey schedule shall be finalised in consultation with the Employer. The Employer may be associated with the Contractor during their site survey activities.

After the site survey, the Contractor shall submit to the Employer a survey report on each link and site. This report shall include at least the following items:

- (a) Proposed layout of Equipment in the existing rooms and buildings.
- (b) Proposed routing of power, earthing, signal cables and patch cords etc.
- (c) Confirmation of adequacy of Space and AC/DC Power supply

requirements

- (d) Proposals for new rooms/buildings if required
- (e) Identification of facility modifications if required
- (f) Identify all additional items required for integration for each site/location.

1.2.1 Synchronization of the Communication Network

The Contractor shall be responsible for synchronization of new communication equipment with existing network utilizing the existing clock (if available). The Contractor shall make an assessment of additional clock requirement for synchronization of the communication equipment.

1.2.2 Contractor's Responsibilities and Obligations

The Contractor shall be responsible for all cables and wiring associated with the equipment provided, both inside and outside buildings in accordance with technical specifications. The Contractor shall also be responsible for determining the adequacy of the local power source for the equipment and for wiring to it, with adequate circuit protective breakers. In addition, the Contractor shall be responsible for shielding equipment and cabling to eliminate potential interference to or from the equipment, and for earthing all cabinets and shields.

Contractor's obligations include, but are not limited to, the following:

- (1) Site visits, and surveys, necessary to identify and provide all equipment needed to implement the network.
- (2) Equipment Engineering and design specific to each location including review of, and conformance with local environmental and earthing considerations.
- (3) Overall integration of communication equipments/subsystem procured in present and existing network.
- (4) All cabling, wiring including supply, laying and termination etc of the cables, and distribution frame at wideband nodes required for full interconnectivity and proper operation of the telecommunications network including equipment supplied under this package and the connectivity and interfacing of user equipment.
- (5) Installation and integration of network management software, hardware and firmware (as applicable).
- (6) Project management, project scheduling, including periodic project reports documenting progress, review meeting during the contract period.
- (7) Engineering and technical assistance during the contract and warranty

period.

- (8) Implement all minor civil works and identify any major civil works i.e. expansion or construction of rooms, trenches necessary for installation of proposed equipment and provide the details of such work to the Employer.
- (9) Factory and site testing of all hardware, software, and firmware provided.
- (10) Provide documented evidence of satisfactory Type Test performance to the Employer and if required by The Employer, conduct type test.
- (11) Provide a Quality Assurance Plan, ensuring the Employer access to the manufacturing process.
- (12) Training of the Employer personnel.
- (13) Hardware, software, and firmware maintenance, debugging, and support of the equipment through final acceptance, and maintenance on all new equipment through out the warranty period and for a period of six (6) years after warranty period.
- (14) Availability of service, spare and expansion parts for the supplied items for the designed life of the equipment or seven (7) years after the declaration of withdrawal of equipment from production, whichever is earlier? However, the termination of production shall not occur prior to Operational Acceptance of the system by the Employer.

Detailed descriptions of the Contractor's obligations, in relation to individual items and services offered, are delineated in other sections of this specification.

1.2.3 The Employer Responsibilities and Obligations

The Employer will provide the following items and services as part of this Project:

- (1) Overall project management of the project
- (2) Review and approval of the Contractor's designs, drawings, and recommendations.
- (3) Communication network configuration data, including:
 - (a) Channel assignments for voice and data
 - (b) Interconnection drawings for existing equipment
- (4) Review and approval of test procedures.
- (5) Participation in and approval of "Type", factory and site acceptance tests where testing is required.
- (6) Review and approval of training plans.
- (7) Providing support and access to facilities at the sites.
- (8) Implement the major civil works such as expansions or construction of rooms, trenches etc. as required for the equipment to be provided by the Contractor.

- (9) Coordination of the Contractor's activities with the Employer's and constituents' concerned departments.
- (10) Provide to the extent possible drawings for existing sites and facilities for which equipment installations are planned.
- (11) Approval of the key personnel for the project

1.3 Applicable Standards

The following standards and codes shall be generally applicable to the equipment and works supplied under this Contract:

- (i) IEEE 802.3
- (ii) ITU-T/CCITT Recommendations, G.652, G.701, G.702, G.703, G.711/ 12/ 14/ 35/ 36, G.721, G.742, G.811 and G.823
- (iii) ITU-T/CCITT Recommendations, G.801, G.821, G.822, G.823, G.826.
- (iv) ITU-T/CCITT Recommendations of the V Series
- (v) ITU-T/CCITT Recommendations R35, R37, and R38A (or R38B)
- (vi) ITU-T/CCITT Recommendations M3010, G771
- (vii) Internet Activities Board, RFC-1157 (SNMP)
- (viii) International Electrotechnical Commission standards, IEC801-2/3/4/5, IEC-255-4, IEC-255-5, IEC-870-2-1, IEC-721-3-3, IEC-529.
- (ix) International Electrotechnical Commission standards, IEC 1000-4-xx series.
- (x) IEC publication 68, 68-2-2, 68-2-3, 68-2-14, 68-2-27, 68-2-32.
- (xi) ITU-T/CCITT Recommendations K.11, K.17, K.20.
- (xii) International CISPR standards
- (xiii) ITU-T/CCITT Recommendations, G.8110/Y.1370 series

Specifications and codes shall be the latest version, inclusive of revisions, which are in force at the date of the contract award. Where new specifications, codes, and revisions are issued during the period of the contract, the Contractor shall attempt to comply with such, provided that no additional expenses are charged to the Employer without Employer's written consent.

In the event the Contractor offers to supply material and/or equipment in compliance to any standard other than Standards listed herein, the Contractor shall include with their proposal, full salient characteristics of the new standard for comparison.

In case values indicated for certain parameters in the specifications are more stringent than those specified by the standards, the specification shall override the standards.

2. Network Configuration and Equipment Characteristics

2.1 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) Termination Equipment Subsystems
- (3) MDF, DDF and Cabling

The requirements described herein are applicable to and in support of network requirements. The equipment supplied shall support existing network for Power system operational requirements.

The security related requirements of the equipment shall be as per relevant agency and 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 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 31st March 2013. From 1st April, 2013, the certification shall be got done from authorized and certified agency.

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

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

2.2 General Network Characteristics

2.2.1 Description

The fibre optic network shall be based on hybrid technology with the functionality of both Synchronous Digital Hierarchy (SDH) as well as Multiprotocol Label Switching – Transport Profile (MPLS-TP) technology. The network shall consist of overhead fibre optic links with a minimum bit rate of 622 Mbps (STM-4) for SDH and 10G for MPLS-TP as identified in the Price Schedule (BOQ). The fibre optic based communication equipments shall have 4 MSP protected directions (1+1) for SDH at STM-4 level as well as 4 MSP protected directions (1+1) for MPLS-TP at 10G capacity. If the contractor proposes multiple sub-racks for fulfillment of the requirement, interconnection between such sub-racks in any capacity will not be considered as separate MSP protected directions. 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. The Contractor can propose as mentioned above Hybrid technology which can be accommodated in a single sub – rack or a multiple sub – racks but the total nos. of MSP protected direction (1+1) for SDH and MPLS – TP must be fulfilled.

2.2.2 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/RTU/SASs/PMUs. The communications support requirement for SCADA/EMS/RTU/SASs/PMUs system is for low & high speed data, express voice circuits and administrative voice circuits as defined in appendices. A brief summary of the communication system requirements is as follows:

- (a) High speed E1 channel support
- (b) Data transport supporting Network Management channels
- (c) The connectivity envisaged between RTU/SASs and Control Centre over TCP-IP using Ethernet interface.
- (d) Voice communication between different substations through IP based PABX system.

2.2.3 General Systems Requirements

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

2.2.3.1 System Synchronization

The Contractor shall synchronize the existing equipments and all the new equipments under the contract using existing Master clock, if available. The Contractor shall provide the additional clocks as required under the set of clock indicated in BOQ. In addition to GPS input reference, the synchronization clock must have provision to take INPUT reference coming

from other clock. The contractor shall submit the synchronisation plan as per standard ITU-T G.811. All sync equipments proposed under this contract should meet ITU-T G.811 criterion. The holdover quality of slave clock, if any, shall meet ITU-T G.812 standard requirements.

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

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

2.2.3.2 System Maintainability

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

2.2.3.3 System Upgradeability and Expandability

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

2.2.3.4 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.

2.2.3.5 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.

2.2.3.6 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.

2.2.3.7 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.

2.2.3.8 General Site Considerations

All fiber optic links up to 100 kms transmission line length shall be implemented by the Contractor without repeaters. In order to meet the link budget requirement, the Contractor shall provide all the necessary equipments only in the end stations. The contractor may provide the optical amplifier, wave length translator, optical cards or high capacity equipment with suitable rack/subrack to meet the maximum distance limit. All the provided equipments shall be monitored/managed by Craft Terminal.

2.2.3.9 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 below.

| 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 $\mu\text{m} \pm 1\mu\text{m}$ |
| Mode field Concentricity Error: | $\leq 0.6\mu\text{m}$ |

| Optical Fibre Characteristics | |
|---|--|
| Core-Clad concentricity error: | $\leq 1.0\mu\text{m}$ |
| Cladding non-circularity | $\leq 1\%$ |
| Cable Cut off Wavelength: | $\leq 1260\text{ nm}$ |
| 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 wavelength 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 | $\leq 0.1\text{dB}$ |
| 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 Wavelength: | 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 $\leq 0.05\text{ dB}$ (-60 deg C - +85 deg C) |
| Bend performance: | @1310nm (75 \pm 2 mm dia Mandrel), 100 turns; Attenuation rise $\leq 0.05\text{ dB}$ @1550nm (30 \pm 1 mm dia Mandrel), 100 turns; Attenuation rise $\leq 0.10\text{ dB}$ @1550nm (32 \pm 0.5 mm dia Mandrel), 1 turn; Attenuation rise $\leq 0.50\text{ dB}$ |

2.2.5 Fibre Optic Link Lengths

The fiber optic route lengths are as specified in appendices. The lengths specified in Appendices are the transmission line route lengths; however the

actual fiber cable length shall exceed the route lengths on account of extra cable requirement due to sag, jointing & splicing, approach cabling etc. For bidding purposes the Contractor may assume an additional cable length of 5% of given route length + 1Km towards approach cable for calculating the link length. The exact cable lengths shall be determined by the Contractor during the survey. The same shall be used by the Contractor for final link design during the detailed engineering of the project.

2.3 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 hybrid technology described in section 2.2.1. Minimum aggregate bit rate of SDH shall be STM-4 and MPLS-TP shall be 10G equipped with one nos. of minimum 8 port E1 interface card, 3 nos. of minimum 8 ports Ethernet interface (IEEE 802.3/IEEE 802.3u) card supporting layer 2 switching as tributaries. The Ethernet interfaces shall support VLAN (IEEE 802.1P/Q), spanning tree (IEEE 802.1D) quality of service. Protection scheme for Ethernet traffic should be ERPS based (Ethernet ring protection scheme) as per ITU-T G.8032. The VoIP telephone sets shall be supplied and shall be operated only through POE+ supported switch and no additional power supply provision for the set will be accepted.

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

The contractor shall provide Fibre Optic based Communication Equipment as per BOQ for new Patan Substation. The new Patan substation shall be connected to the existing Syuchatar substation through a 10G link. The contractor shall be fully responsible for the reconfiguration and upgradation works as well as procurement of licenses (if required), for the equipment installed at Baneshwor and Syuchatar substations, for hassle-free integration.

It is the responsibility of contractor to design, supply and install the above mentioned optical equipments in the respective places and integrate with existing communication equipments in that regions. During intergration of Patan substation, the exisiting data and voice shall be as it is as previous and it should not malfunction the existing NMS (Network Manangement system) functionality of those equipments upto LDC. The contractor is advised to study existing communication network at that region for seamless integration works.

The contractor should design the communication equipments such that it doesn't require additional fiber cores in sections leading upto LDC while integrating new substations.

2.3.1 SDH/MPLS-TP Equipment

2.3.1.1 Functional Requirement

There is a requirement for different types of equipment under this project which are described in this section. The Drawing is provided in the appendices. For the purpose of BOQ, the hybrid type communication equipment is considered to be divided in three parts i.e. Optical interface/SFP, Tributary Cards (Electrical tributaries such as E1 & Ethernet 10/100/1000 Mbps) and Base Equipment (Consisting of Common Cards, Control Cards, Optical base card, Power supply cards, sub-rack, cabinet, other hardware and accessories required for installation of equipment i.e. everything besides optical interface/SFP and tributary cards).

If bidder is offering equipment with multifunction cards such as cross-connect or control card with optical interface/SFP or tributary interface, such type of multifunction card shall be considered as Common control card and shall be the part of base equipment. In case optical interface/SFP is embedded with control card, the adequate number of optical interface/SFPs shall be offered to meet the redundancy requirements of the specifications.

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

2.3.1.2 Redundancy and Protection

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

2.3.1.3 Service Channel

Service channels shall be provided as a function of the communication equipment and shall be equipped with Service Channel Muldem's 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. VoIP based EOW shall also be accepted with speech quality as per ITU-T G.712 and voice characteristics should be in permitted limits as per ITU-T G.114.

2.3.1.4 Supervision and Alarms

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

2.3.1.5 Synchronisation

The equipment shall provide synchronisation as per Table given above. One 2MHz synchronisation output from each equipment shall be provided.

2.3.1.6 Electrical and Optical I/O Characteristics and General Parameters

Table below provides the electrical and optical characteristics as well as other general parameters for communication equipment.

| Electrical and Optical I/O Characteristics and General Parameters | |
|---|--------------------------------------|
| Optical Wavelength ^{NOTE (1)} | 1310/1550nm |
| Optical Source ^{NOTE (2)} | Laser |
| Optical Source Lifespan | Better than 5 X10 ⁵ hours |
| Optical Fibre Type | G.652 D |
| Optical Connectors | Type FC-PC, Type SC-PC |
| Transmission Quality | Per ITU-T G.821, G.823, G.826 |
| Source Primary Power | -48 Vdc |
| Equipment Specifications | Per ITU-T G.783 |
| Tributary, Electrical Interface | Per ITU-T G.703, 75 Ω/120 Ω |
| Ethernet Interface | 10/100/1000 Mbps |
| SDH Bit Rates | Per ITU-T G.703 |
| Optical Interfaces | Per ITU-T G.957, G.958 |
| | |

| | |
|---|----------------------------------|
| Frame and Multiplexing Structure for SDH | Per ITU-T G.707 |
| Synchronization | Per ITU-T G.813 |
| Management Functions | Per ITU-T G.774, G.784 |
| Protection Architectures | Per ITU-T G.841 |
| Built In Testing and Alarms | Per ITU-T G.774, G.783, G.784 |
| MPLS-TP | |
| Synchronization | Per ITU-T G.8261 |
| Management Functions | Per ITU-T G.8151, G.8152 |
| Protection Architectures | Per ITU-T G.8131, G.8132, G.8133 |
| Built In Testing and Alarms | Per ITU-T G.8110, G.8121 |

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.

2.3.2 Optical Link Performance Requirements

The optical fibre link performance requirements are specified as follows:

2.3.2.1 Link Budget Calculations

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

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

(2) Splice loss: Minimum 0.05 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 communication 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.

2.3.2.2 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.

2.3.2.3 FODP to Fibre Optic Communication Equipment

The Contractor shall be responsible for connectivity between the FODP and the Fibre Optic Communication Equipment. The Contractor shall provide patch cords as per

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

2.4 Termination Equipment Subsystem

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

2.4.1 First Order (Primary) Multiplexing

The Contractor shall provide E-1 Multiplexing and E-1 Channel Bank primary multiplexing capabilities in compliance with the electrical input-output characteristics provided in Table below.

**CEPT E-1 Standard First Order Multiplexing
Electrical Input/Output Characteristics**

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

2.5 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.

2.5.1 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.

2.5.2 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".

2.6 Patch Cords

The Contractor has to supply 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.

2.7 Telecommunication Management Network / Network Management System (As Applicable)

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/MPLS-TP equipment, Mux, Drop-Insert, DACS etc. In case a single TMN can not 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.

2.7.1 Applicable Standards

The TMN design concept, functional and informational architecture and physical architecture, shall be in compliance with ITU-T Recommendation M.3010. The offered TMN system shall be capable of integration to other supplier's Network Management System (NMS) upwardly through North bound interfaces. The north bound interface in the EMS shall be CORBA/TMF-814 compliant.

2.7.2 TMN Architecture

The TMN shall provide

- a. Collection of Management data from all Network Elements (NEs) supplied under this package. The minimum monitoring and control requirements for the communication equipment shall be as defined in this section.
- b. Processing of above management data by using processor(s) located at control Centre and additional intermediate station processor(s), wherever required.
- c. Monitoring and control of the NEs as defined below:
 - I) TMN system at LDC (including local operator console, if applicable) shall support management of all equipments supplied and monitoring of the entire regional network supplied under this package. At a 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. Further, the centralised TMN system shall also have provision for addition of at least two remote operator consoles. The TMN hardware shall be so designed that failure of a single processor/component (router, switch, converter etc.) 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 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

2.7.3 Management Functions

The TMN shall support following Management functions:

2.7.3.1 Configuration Management

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

2.7.3.2 Fault Management

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

- a. Display equipment status in a consistent fashion regardless of the source of the data on a graphical topological, map-type display. Status shall be displayed through the use of 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.

2.7.3.3 Performance Management

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

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

2.7.3.4 Security Management

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

2.8 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 existing PDH & SDH system shall be transported through the new 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.

2.9 Craft Terminal

Each equipment (SDH/MPLS-TP 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 given in the appendices.

2.10 Hardware Requirements

2.10.1 Master Processor, Server/Workstation and Craft Terminal

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

The server shall have minimum configuration of 3GHz for CISC based or 1.6GHz for RISC based processor, 8GB RAM, DVD-ROM drive, redundant 200 GB internal Hard Disk Drive, 101-Enhanced style keyboards, mouse, parallel, serial, USB(3.0) ports and hot swap redundant power supply. VDUs shall be 17" TFT active matrix color LCD with a minimum resolution of 1024 X 768. Appropriate network drive card shall also be provided wherever required. However, the internal hard disk drive for the server shall be redundant and all the data shall be mirrored. Further, the TMN software shall support data mirroring on redundant disk drives.

The workstation shall have minimum configuration of 2.4GHz for CISC or 1.4GHz for RISC based processor, 4GB RAM, DVD-RW drive, 200 GB Hard Disk Drive, 101-Enhanced style keyboards, mouse, parallel, serial and USB (3.0) ports. VDUs shall be 19" TFT active matrix color LCD with a minimum resolution of 1024 X 768. Appropriate network drive card shall also be provided wherever required.

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 2.4 GHz, 8 GB RAM, 256 MB VRAM, DVD RW drive, 500 GB Hard Disk Drive, keyboard, mouse/trackball etc., parallel, serial/USB (3.0) 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 color LCD with a minimum resolution of 1024 X 768. Operating System shall be Genuine Windows with installation DVD supplied.

2.10.4 Power Supplies

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

2.11 General Software/Firmware Requirements

Due to various alternative design approaches, it is neither intended nor possible to specify all software and firmware characteristics. It is the intent herein to provide design boundaries and guidelines that help to ensure a demonstrated, integrated program package that is maintainable and meets both hardware systems requirements and the customer's operational requirements.

2.11.1 Operating System Software

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

2.11.2 Applications Software

All applications software shall be written in a high-level programming language unless 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.

2.11.3 Software Utilities

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

2.11.4 Revisions, Upgrades, Maintainability

All firmware and software delivered under this specification shall be the latest field proven version available at the time of contract approval. Installed demonstration for acceptance shall be required. All firmware provided shall support its fully equipped intended 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.

2.11.5 Database(s)

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

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

3.1 Inspection

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

- (a) Sufficient office facilities, equipment, and documentation necessary to complete all inspections and to verify that the equipment is being fabricated and maintained in accordance with the Specification shall be provided by the Contractor to the Employer.
- (b) Inspections to be performed by the Employer will include visual examination of hardware, cable dressings and labeling. Contractor's documentation will also be examined to verify that it adequately identifies and describes all offered items and spare parts.
- (c) Access to inspect the Contractor's standards, procedures, and records that are applicable to the supplied equipment shall be provided to the Employer. Documents will be inspected to verify that the Contractor has performed the required quality assurance activities.
- (d) The inspection rights described above shall also apply to sub Contractors who are responsible for supplying major components described in this Specification. These items shall be inspected and tested at the sub Contractor's factory by the Employer's representatives prior to shipping this equipment to the Contractor's facility or directly to the Employer.
- (e) The above inspection rights shall also apply to sub Contractors supplying assemblies, subassemblies and components. However, such items will

normally be inspected and tested by the Employer's representatives at the Contractor's site before acceptance.

4.1 Test Plans and Procedures

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

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

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

4.1.1 Factory and Site Test Plans

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

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

| | |
|--|---------|
| | testing |
|--|---------|

4.1.2 Test Procedures

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

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

The Contractor shall ensure that all testing will be performed by qualified testing personnel well experienced in performing such tests.

| Item: | Description: |
|-------|--|
| 1. | Test Title and Revision Level, if applicable |
| 2. | List of Standard(s) complied with |
| 3. | Function(s) / parameter(s) to be tested |
| 4. | Purpose of each test segment |
| 5. | List of required test equipment |
| 6. | Description of any special test conditions or special actions required. This includes complete descriptions, listings and user interface procedures for all special hardware and software tools and/or display formats to be used during the test. |
| 7. | Test setup including test configuration block diagrams and/or illustrations. |
| 8. | Test procedures to be followed. |
| 9. | Required inputs and expected outputs for each test segment |
| 10. | Acceptance criteria for each test segment. |

| Item: | Description: |
|-------|---|
| 11. | List of test data to be supplied by the Contractor(s) and copies of any certified data to be used |
| 12. | Format of test reports. |

4.1.3 Test Records

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

| Item: | Description: |
|-------|---|
| 1. | Test Title and Revision Level, if applicable; contract references |
| 2. | Date and time for test start and test completed |
| 3. | Test title and reference to the appropriate section of the test procedures |
| 4. | Description of any special test conditions or special actions taken (Includes test-case data). |
| 5. | Test results for each test segment including an indication of Passed, Conditional Pass, Incomplete or Failed. |
| 6. | Test procedure modifications made during testing. |
| 7. | Variance Report(s) tracking information and copies (if variance(s) was detected). |
| 8. | Contractor's test engineer(s) identification, signature and remarks |
| 9. | Employer's test witness identification, signature and remarks |
| 10. | List of all attachments |
| 11. | Attachments (including system logs, printouts, variances, hard copies of visual test result displays, etc.) |

All principle test records, test certificates and performance curves shall be supplied for all tests carried out as proof of compliance with the specifications and/or each and every specified test. These test certificates, records and performance curves shall be

supplied for all tests, whether or not they have been witnessed by the Employer within the specified duration after the completion of test. Information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificates refer, and shall also bear the Contractor's reference and heading.

4.1.4 Rejection of Elements

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

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

4.1.5 Test Periods Defined

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

Pre-Commissioning & Commissioning Period - The Site Acceptance Test (SAT)

Operational Acceptance - Successful completion of SAT

4.2 Type Testing

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. Type Testing shall comply with the conditions specified in Chapter 2-GTR.

4.2.1 List of Type Tests

The type testing shall be conducted on the following equipment

- (a) SDH/MPLS-TP Equipment with all types of cards (optical card, Tributary card or any other equipment as part of repeater less links)
- (b) Primary Multiplexer & Drop – Insert Multiplexer with subscriber interface card

4.2.1.1 List of type test to be conducted on Telecom equipment

The type tests for SDH/MPLS-TP Equipment with all types of cards, Primary Multiplexer & Drop – Insert Mux with subscriber interface card are described below:

4.2.1.1.1 Temperature and Humidity Tests

The tests listed below are defined in IEC Publication 60068.

(a) Low Temperature Test: Operation to Specifications

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

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for sixteen (16) hours. Its performance is checked during the test.
- (2) Degree of Severity: Test shall be done at 0°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 60068-2-1, test method Ad, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 72 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (*Post-test*).
- (2) Degree of Severity: Test shall be done at -10° 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 60068-2-2, test method Bd, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test.
- (2) Degree of Severity: As per operation to specification range.

- (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 60068-2-2, test method Bd, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test 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 60068-2-3 with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 10 days. Its performance is checked during the test.
- (2) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

(f) Temperature Variation Test

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

- (1) Number of cycles required is five (5)
- (2) The degree of severity: temperature TL:0°C, TH: As per operation to specification range
- (3) Cycle duration for each temperature is three (3) hours.
- (4) Ramp : 1 °C/minute.
- (5) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

4.2.1.1.2 Power Supply and EMI/EMC tests

The test procedure and acceptance criteria shall be as defined in IEC 60870-2-1.

(a) Immunity Tests

The list of Immunity tests are specified below in Table below.

Recommended Immunity Tests

| S. No. | Immunity Test | AC Power Supply | DC Power Supply | Control & Signal | Telecom Line | Para-metres |
|--------|-----------------------------------|-----------------|-----------------|------------------|--------------|---|
| 1 | Voltage Fluctuations | Yes | Yes | N/A | N/A | Table 11 of IEC 60870-2-1: 1995 - Level : 1 |
| 2 | Voltage dips and Interruptions | Yes | Yes | N/A | N/A | |
| 3 | 1.2/50 - 8/20 μs surges | Yes | Yes | Yes | N/A | Table 12 of IEC 60870-2-1: 1995 - Level : 4 |
| 4 | Fast transient bursts | Yes | Yes | Yes | Yes | |
| 5 | Damped oscillatory waves | Yes | Yes | Yes | Yes | |
| 6 | 10/700 μs surges | N/A | N/A | N/A | Yes | |
| 7 | Electrostatic discharge | Yes | | | | Table 13 of IEC 60870-2-1: 1995 - Level : 4 |
| 8 | Power frequency magnetic field | Yes | | | | Table 14 of IEC 60870-2-1: 1995 - Level : 4 |
| 9 | Damped oscillatory magnetic field | Yes | | | | |

Recommended Immunity Tests

| S. No. | Immunity Test | AC Power Supply | DC Power Supply | Control & Signal | Telecom Line | Para-metres |
|--------|---|-----------------|-----------------|------------------|--------------|--|
| 10 | Radiated electromagnetic field | Yes | | | | Table 15 of IEC 60870-2-1: 1995 - Level : 4 |
| 11 | Power Frequency voltage on control and signal lines | N/A | N/A | Yes | Yes | IEC 61000-4-16 : 2002-07 Level : 4 |
| 12 | DC voltage on control and signal lines | N/A | N/A | Yes | N/A | IEC 61000-4-16 : 2002-07 Level : 4 |
| | | | | | | |

(b) Emission Tests

The list of Emission tests are specified below in Table.

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

| S. NO. | Emission test | AC Power Supply | DC Power Supply | Control & Signal | Telecom Line | Parameters |
|--------|--------------------------------|-----------------|-----------------|------------------|--------------|------------|
| 4 | RF radiated fields CISPR 22 | Yes | | | | |

(c) Insulation Withstand Voltages

As per section 6 of IEC 870-2-1. Recommended class: VW1 of Table 18.

4.2.1.1.3 Mechanical Tests

(a) Mechanical Vibration Test

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

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

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

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

(b) Shock Test

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

The recommended severity shall be $A = 294 \text{ m/s}^2$, $D = 18 \text{ ms}$. Three shocks per axis per direction shall be applied to the equipment packed according to the Contractor's specifications.

Or Free Fall Test

This test could be performed as an alternative to the shock or Bump test. The procedure is defined in IEC publication 60068-2-32. The equipment shall be packed

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

Or Bump Test

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

4.3 Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out on SDH/MPLS-TP Equipments, associated line & tributary cards, Termination Equipments (Primary Mux, Drop/Insert, associated Subscriber Line Interface Cards etc) and all other items for which price has been identified separately in the Bid Price Schedules.

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

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

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

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

Factory Acceptance Testing Requirements for Termination Equipment (MUX)

| Item | Description: |
|------|--|
| 1. | Physical Inspection for conformance to DRS, BOQ, drawings and appearance of equipment |
| 2. | Performance of supervision, alarm, control and switching systems, diagnostics, loopbacks, Craftsperson interface etc. |
| 3. | Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for the channel banks/low-level multiplexers |
| 4. | Framing, signaling, and operational and maintenance tests consistent with applicable ITU-T requirements |
| 5. | Simulation of failure conditions and failover of each redundant unit |
| 6. | Test of spare card slots and test of spare parts/modules/cards as per applicable tests |
| 7. | Checks of power supply/converter voltage margins and short circuit and overvoltage protection |
| 8. | Random inspections to verify the accuracy of documentation |

FAT on Craft Terminal

| | |
|---|---|
| 1 | Physical inspection of Craft Terminal hardware for conformance to approved BoQ, DRS & drawing |
| 2 | Testing of Craft Terminal to demonstrate proper operation of all functions |

4.4 Site Acceptance Tests

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

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. At a minimum Site 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.

4.4.1 Phases for Site Acceptance Testing

The SAT shall be completed in following phases:

4.4.1.1 Installation Testing

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

In the installation test report, the Contractor shall include a list of all hardware or components 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 fiber optic transmission subsystem, Termination equipment sub-system are provided in respective Tables in this section.

4.4.1.2 Link Commissioning Tests

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

For Ethernet interface: At a minimum the following test requirements shall be demonstrated

as per RFC 2544:

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

10% of the total links (Chosen by the Employer, generally to cover links from all configurations used) shall be tested for a duration of 12 Hours. Rest of the links shall be tested for 1 Hour. In case a link does not meet the performance requirements during 1 hour, then the duration of the test shall be increased to 12 hours.

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

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

4.4.1.3 Integrated Testing

Prior to commencement of integrated testing the overall system shall be configured as required to provide all the data and voice channel required to interconnect the various User's interfaces. The integrated testing for a batch shall include end-to-end testing of back-bone network included in that batch. Integrated testing for last batch shall include testing of the entire back-bone. The intent of integrated testing is to demonstrate that the equipment is operational end to end under actual conditions, that all variances identified during factory and field installation and communications testing have been corrected, and that the communication equipment is compatible with other equipment at all locations. The Integrated System Test shall include all fibre optic transmission equipment, termination equipment, the network management subsystem and other components.

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

- (1) Equipment configuration shall be checked to establish that it supports the channel routing.
- (2) End to end testing of all individual voice circuits
- (3) End-to-end testing of all individual Data Circuits.
- (4) Demonstration of Protection switching and synchronization of equipment as per synchronization plan.

Fibre Optic Transmission system Installation 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) |

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| | output voltage measurements |
| 3. | Terminal transceiver performance testing (Tx power, Tx spectrum, receive signal strength, connector losses etc.) |
| 4. | Service channel performance |
| 5. | Craftsperson interface, alarm and control functional performance |
| 6. | Rack and local alarms: No alarms shall be present and all alarms shall be demonstrated to be functional |
| 7. | Network management interface and supervision performance |
| 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. |
| 10. | Simulation of failure conditions and failover of protected components. |

Termination Equipment Sub-system Installation Testing

| Item: | Description: |
|-------|--|
| 1. | Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling |
| 2. | Power supply/converter voltage measurements |
| 3. | Muldem performance testing |
| 4. | Craftsperson interface, alarm and control functional performance |
| 5. | Rack and Local alarms |
| 6. | Network management interface and supervision performance |
| 7. | Channel performance |
| 8. | Safety and signalling earthing system |
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| 9. | Simulation of failure conditions and failover of protected components. |
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NMS Installation Testing (if Applicable)

| Item: | Description: |
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| 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 |

5.0 TRAINING FOR OPERATIONAL STAFFS

The Contractor shall design and arrange a training programme at his own cost at the manufacturer's premises at least for five (5) days for the Fibre Optic Based Communication system and its NMS for three concerned NEA personnel so as to make them competent enough to operate and maintain the proposed equipment/system. The overview of such programme shall be proposed by the prospective contractor along with its technical proposal. The Employer and the Project Manager or their designated representatives shall be entitled to attend such training at their own cost.