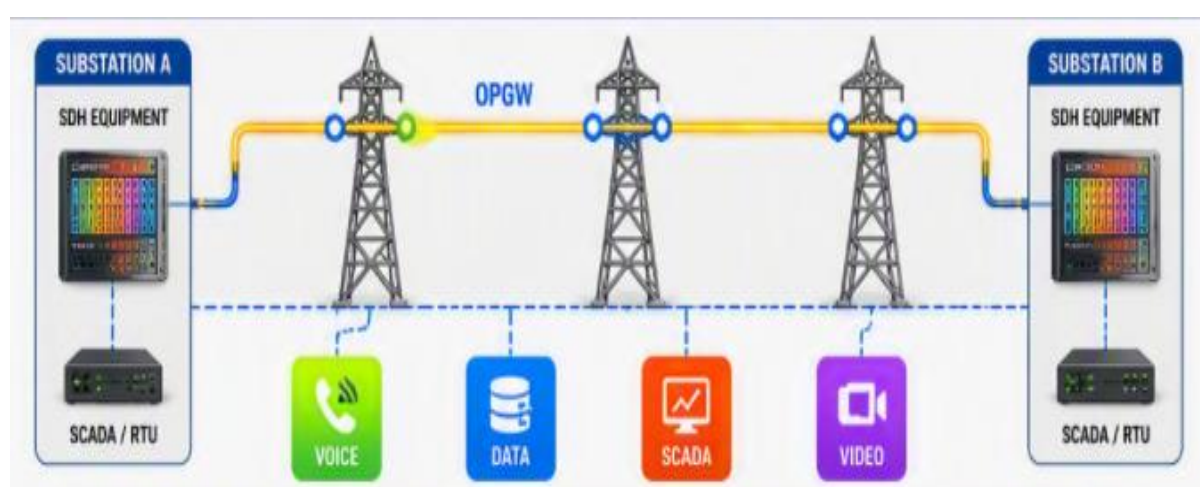


POWER GRID CORPORATION OF INDIA LTD.

(A Government of India Enterprise)

VOLUME II

TECHNICAL SPECIFICATION FOR COMMUNICATION EQUIPMENT PACKAGES



Consolidated Technical Specification — Sections 1–10 and Appendices A–L

Revision: **Ver 3** | **September 2026**

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Abbreviations

The following abbreviations are used across this Technical Specification. This list was compiled by scanning Sections 1–10 and Appendices A–L; the project team should review and supplement it with any package-specific terms not captured here.

Abbreviation	Full Form
AC	Alternating Current
ACDB	AC Distribution Box
AMC	Annual Maintenance Contract
AMF	Auto Mains Failure
APS	Automatic Protection Switching
BER	Bit Error Rate
BOM	Bill of Materials
BOQ	Bill of Quantities
BPS	Bid Price Schedule
CCITT	International Telegraph and Telephone Consultative Committee
CERT	Computer Emergency Response Team
CIP	Clearance Inspection (Certificate)
CISPR	International Special Committee on Radio Interference
DACS	Digital Access Cross-connect System
DC	Direct Current
DCDB	DC Distribution Box
DCN	Data Communication Network
DCPS	DC Power Supply (System)
DDF	Digital Distribution Frame
DG	Diesel Generator
DoT	Department of Telecommunications
DRS	Data Requirement Sheet(s)
EMC	Electromagnetic Compatibility
ES	Error Seconds

EMI	Electromagnetic Interference
EOL	End of Life
EOW	Engineering Order Wire
ESD	Electro-Static Discharge
EUT	Equipment Under Test
FAT	Factory Acceptance Test
FDS	Functional Design Specification
FO	Fibre Optic
FODP	Fibre Optic Distribution Panel
FOTE	Fibre Optic Transmission Equipment
FOTS	Fibre Optic Transmission System
FQP	Field Quality Plan
FRP	Fibreglass Reinforced Polymer
FTC	Fibre Termination Closure
GPS	Global Positioning System
GR	Generic Requirement (TEC)
HBOM	Hardware Bill of Materials
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IPMS	Integrated Power Management System
IPR	Intellectual Property Right
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JV	Joint Venture
LAN	Local Area Network
LC	Local Content
LCT	Local Craft Terminal
MCB	Miniature Circuit Breaker
MICC	Material Inspection Clearance Certificate
MLC	Minimum Local Content
MoP	Ministry of Power
MQP	Manufacturing Quality Plan
MTBF	Mean Time Between Failures
MTCTE	Mandatory Testing and Certification of Telecom Equipment
MUX	Multiplexer
NABCB	National Accreditation Board for Certification Bodies
NBI	North Bound Interface
NDA	Non-Disclosure Agreement
NE	Network Element
NMS	Network Management System
OEM	Original Equipment Manufacturer
PABX	Private Automatic Branch Exchange
PCC	Plain Cement Concrete
PMI	Prescribed Minimum Import (content threshold, as per DoT PMI/LC order)
PVC	Polyvinyl Chloride
RCC	Reinforced Cement Concrete
RF	Radio Frequency
RFC	Request for Comments
RTU	Remote Terminal Unit
SAT	Site Acceptance Test
SBOM	Software Bill of Materials
SCADA	Supervisory Control and Data Acquisition
SES	Severely Errored Second
SDH	Synchronous Digital Hierarchy
SFP	Small Form-factor Pluggable (transceiver)
SMPS	Switch Mode Power Supply
SNMP	Simple Network Management Protocol
STM	Synchronous Transport Module
TEC	Telecommunication Engineering Centre
TNMS	Transport / Telecommunication Network Management System
VC	Virtual Container (SDH)
VLAN	Virtual Local Area Network
VRLA	Valve Regulated Lead Acid (battery)

Section 1 – Introduction, General Information and General Requirement

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1.1 Introduction and General Information

This Volume II of the Tender Documents describes the technical specifications for Communication Equipment Package which includes Fibre Optic Terminal Equipment (SDH Equipment), DC Power supply system, Repeater Shelter etc. This specification describes the functional and performance requirements of the Communication Equipment Package.

The intent of this Package is to implement a communication system network based on OPGW in India for “Power Grid Corporation of India Limited”(POWERGRID), a Govt. of India Enterprise, (herein referred as ‘Employer’).

The purpose of this section of the specification is to provide scope of work, general information about the existing systems and the proposed system under this project, requirements, responsibilities & obligations of contractor & Employer and general bidding requirements for the project.

1.2 Proposed Communication System

The proposed communication system shall be fibre optic based and shall consist of fibre optic links with a bit rate of Synchronous Transport Module-4 (STM-4)/ Synchronous Transport Module-16 (STM-16)/ Synchronous Transport Module-64 (STM-64). The communication systems shall support Real time data and voice communication between Sub- stations/Generating stations and Control Centres.

1.3 Scope of Works

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

- (i) SDH Equipment along with suitable interfaces & line cards etc.
- (ii) Network Management System (NMS) (if mentioned in BPS): Supply (where applicable), installation, configuration, integration, testing and commissioning of the Network Management System (NMS) at the designated Control Centre and Backup Control Centre locations, including establishment of connectivity with all supplied and designated existing network elements, database creation, network provisioning, alarm and performance monitoring configuration, user account creation, training, and demonstration of all specified functionalities.(at locations as specified in the BPS).
- (iii) All cabling, wiring, Digital Distribution Frame patch facilities and interconnections to the supplied equipment at the defined interfaces.
- (iv) 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, MUX, NMS & UNMS etc.
- (vi) Integration of supplied system with existing and new PMUs, RTUs, SCADA system, PLCC equipment, PABX etc.
- (vii) Reconfiguration of communication channel in existing communication equipment.
- (viii) Repeater Shelter along with associated subsystem (if mentioned in BPS)
- (ix) Maintenance And Support services of all supplied devices and systems supplied under the project as specified in Section-7 of this specification
- (x) Integration of offered SDH Equipment (new) under the package with the FODP.
- (xi) Integration of new SDH equipment with the existing SDH/PDH equipment
- (xii) NMS channel of existing PDH/SDH equipment to be transported on new interconnected FO links.
- (xiii) Power supply connection to new equipment with existing/new 48 V DCPS.
- (xiv) Patch Management system shall be provided by contractor for all the systems and devices supplied under the project. Details of patch management have been specified at Appendix-H.

- (xv) Cyber Security Requirements as specified in Section-10 of this specification.
- (xvi) Cyber Security Audit Support and Implementation of Audit Recommendations as specified in Section-7 and Section-10 of this specification during FAT, SAT and Maintenance Period.
- (xvii) All other associated works/items described in the technical specifications for a viable and fully functional communication network.

In addition to above mentioned works, any other work, required for fully functional system, shall also be in the scope of contractor.

1.4 General Technical Requirements

List of items, goods, services or works from Class-I Local supplier meeting the Minimum Local Content notified in Annexure-1 of Ministry of Power (MoP) order on 'Public Procurement (Preference to Make In India) to provide for purchase preference (linked with local content) in respect of Power Sector' dated 16.11.2021 is enclosed at Appendix-F to this Technical Specifications.

List of items, goods, services or works from Class-I local supplier must meet the Minimum Local Content (MLC) requirement specified against each item in Table-A. Table A also specifies the maximum ceiling of LC percentage for design out of total LC against each item. The conditions for the inputs to be qualified as Local Content (LC) are specified in Table- B. For the products, services or works listed in Table-A shall have relevant TEC GR/IR as the minimum requirement as per DOT notification dated 21.10.2024 " is enclosed at Appendix-G to this Technical Specifications.

1.4.1 Local Supplier Requirement

All equipment, systems and services covered under this package, including NMS, Repeater Shelter System, Battery Bank for DC Power Supply System (DCPS), SMPS-based DCPS for Communication Equipment and Annual Maintenance Contract (AMC) for Communication Equipment, shall be offered/supplied/carried out by manufacturers/firms who are "Local Suppliers" as per the latest DPIIT and DoT notifications and amendments issued thereto from time to time.

1.5 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 in this specifications are indicative only. The Contractor shall verify the design data during the site surveys & detail engineering and finalize the BoQ as required for ultimate design & system performance. The Employer reserves the right of execution of works within the stipulated quantity variation provision at places (anywhere inside the Region) other than those indicated in the appendices at the same rates, terms and conditions.

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.

The Bidder's proposal shall clearly identify all features described in the specifications or in any supporting reference material that will not be implemented; otherwise, those features shall become binding as part of the final contract.

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 such that a viable and fully functional Communication System is implemented that meets or exceeds the capacity, and performance requirements specified. Such materials 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 in their proposal.

All communication equipment provided shall be designed to interface with existing communication 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 Contractor shall demonstrate a specified level of performance of the offered items during well-structured factory and field tests.

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. Contractor shall carry out the survey in accordance with the formats attached in Appendix-L and submit a survey report to the Employer for each link and site. The survey report shall include, at a minimum, the following items:

- a) Proposed layout of all Communication equipments in the existing rooms and buildings.
- b) Proposed routing of power, earthing, signal cables and patch cords etc.
- c) Identification of facility modifications, if required.
- d) Confirmation of adequacy of Space and AC/DC Power supply requirements
- e) Proposals for new rooms/buildings if required
- f) Availability of Air-conditioning, Earthing and MCBs for AC Power Supply Input.
- g) Identify all additional items required for integration for each site/location. Survey to be done as per formats attached in Appendix-L

1.6 Communication System Integration

The Contractor shall be responsible for integration with various communication network subsystems viz. Fibre Optic transmission subsystem, Termination subsystem, and also integration with existing fibre optic communication network to ensure satisfactory overall SDH network performance. The Contractor shall ensure that the SDH communication network, including the Ethernet/E1 interfaces and bandwidth provisioned under this contract, is capable of supporting the specified data and voice communication requirements. Integration shall consist of activities at SDH nodes as listed but not limited to the following:

- (i) All necessary interconnections and interfacing including supply and installation of cables, wires, DDF to DDF cross connects, additional cards/equipment required for establishing proper inter connections for data, voice, synchronization etc. Connections may also be required between DDF located in different building/nearby sites.
- (ii) Detailed channel routing at subscriber channel level, E-1 channel plan etc. and equipment configuration.
- (iii) SDH Network synchronization
- (iv) Consolidated floor plans indicating the location (to be approved by the Employer) of supplied equipment as well as the equipment which interfaces are required/provided.
- (v) Necessary programming/modifications to ensure compatibility between signaling for voice channels interfaces with other equipment.
- (vi) The contractor shall integrate new termination equipment sub-system with the existing termination equipment. Alternatively, contractor may also provide any other solution for seamless transmission of communication channels.

All the above activities to be designed, approved and Executed in line with the SOP approved by the employer, The details for the interconnection & integration shall be collected from each site during the survey and shall be finalized during detailed engineering. SOP's to be proposed by the contractor during detailed Engineering. The details for the interconnection & integration shall be collected from each site during the survey and shall be finalized during detailed engineering.

1.7 General Responsibilities and Obligations

This section describes the general responsibilities and obligations of the Contractor and the Employer.

1.7.1 Responsibilities for the Implementation Plan

The Bidder's technical proposal shall include a project implementation plan and schedule that is consistent with the implementation plan detailed in this specification. The implementation plan shall be modelled such that it provides fibre optic cabling and communication system support for the activation of this Project. The Implementation plan shall include the activities of the Contractor & Employer, showing all key milestones such as facilities readiness and clearly identifying the nature of all information and project support expected from the Employer. The Employer and Contractor shall finalise the detailed Implementation plan following award of the contract.

1.7.2 Contractor's Responsibilities and Obligations

The Contractor shall be responsible for the implementation of the communication system under the package. The Contractor shall be responsible for all cabling 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) Provide a working system that meets the functional and performance requirements of this specification.
- (2) Engineering and design specific to each location including review of, and conformance with local environmental and earthing requirements.
- (3) Project management, project scheduling, including monthly progress reports documenting progress during the contract period.
- (4) Coordination with other Project Contractors for phased implementation and system integration & commissioning of the overall communications network
- (5) Engineering and technical assistance during the contract and warranty period and Annual Maintenance Contract (AMC) period.
- (6) Site visits, surveys, and studies necessary to identify and provide all equipment needed to implement the communication network.
- (7) For any renovation, expansion or construction of facilities required to be carried out by Employer, the Contractor shall provide in the survey report the details necessary to enable such work to be carried out.
- (8) Intimate source power requirements within 30 days after receipt of the order for each cabinet/rack of equipment provided at each location.
- (9) An availability analysis showing MTBF (Mean Time Between Failure) and MTTR (Mean Time To Repair) figures for all system components.
- (10) Factory and site acceptance testing of all items including hardware, software & firmware provided.
- (11) Conduct type tests or provide documented evidence of satisfactory valid Type Test performance to the Employer.
- (12) Provide a Quality Assurance Plan ensuring the Employer access to the manufacturing process.
- (13) Providing earthing system Under scope of "Repeater Shelter" and extension of earthing system for supplied equipment in case of other items.
- (14) Shipment of all equipment and documentation to the Employer designated locations and/or staging areas.
- (15) Storing, Staging, maintenance, and security of the staging area up to the operational acceptance including the full responsibility for protection from fire and theft of the supplied equipment.
- (16) Inter-connection among provided equipment.
- (17) All cabling, wiring including supply, laying and termination etc. of the cables at terminal equipment nodes required for full interconnectivity and proper operation of the telecommunications network including equipment supplied under this package and the connectivity and interfacing of equipment supplied separately (PABX, SCADA interface, RTUs etc).

- (18) Connectivity with the FODP and SDH equipment.
- (19) All Fibre Optic Distribution frame patch facilities.
- (20) Installation and integration of network management software, hardware, and firmware.
- (21) Provide all additional Equipment necessary to ensure compatibility with the equipment to be interconnected.
- (22) Implement all minor civil works as per Technical Specification.
- (23) All hardware, software, and firmware required to satisfy the requirements of this Specification.
- (24) Overall integration of communication equipment/subsystem procured under this package
- (25) All documentation and drawings as specified “All documentation and drawings shall be submitted for approval through Dreams portal”.
- (26) All required spare parts, maintenance aids, etc.
- (27) Training of Employer personnel
- (28) Maintenance and support of the items through final acceptance, and maintenance throughout the warranty period.
- (29) Hardware, software, and firmware maintenance, debugging, and support of the equipment through final acceptance, and maintenance on all new equipment throughout the warranty period and for a period of six (6) years after warranty period.
- (30) Due diligence in properly planning and executing the work to minimize any physical damage.
- (31) The Contractor shall appoint key personnel for the project such as Project Manager, Site Manager, Design Engineer, Installation Engineer, and Commissioning Engineer only after approval of the experience data by the Employer. Approval of the Employer shall be obtained, whenever the Contractor wants to change key personnel.
- (32) Availability of service, spare and expansion parts for the supplied items for the designed life of the communication 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.
- (33) In case, any hardware / software / equipment / component items of the systems supplied under the contract shall reach its End-of-Life (EOL) or End-of-Support (EOS) before Taking Over or scheduled end date of AMC period, the contractor shall replace such item with new Hardware or Software without any financial implication to employer. The contractor shall submit documentary evidence certified by OEM for the validity of End-of-Life/ End-of-Support during detailed engineering phase.
- (34) Notification services for field updates to the hardware, software, and firmware for ensuring the availability of the supplied hardware & software including NMS for entire lifespan.
- (35) The Contractor shall ensure following things and at their own cost,:-
 - (i) Any imported equipment/material/item/parts/component to be supplied under the contract shall be tested in the certified laboratories to check for any kind of embedded malware/trojans/cyber threats and for adherence to Indian Standards as per the directions issued by Ministry of Power/Govt. of India from time to time. In case of such import from specified “prior reference” countries, the requirement of prior permission from the Govt. of India including protocol for testing in certified and designated laboratories by Ministry of Power/Govt. of India shall also be complied with by the contractor.
 - (ii) The equipment offered by the contractor shall at least conform to the requirements specified under relevant IS standard. In case of discrepancy between IS and other international standard, provisions of IS shall prevail. The Contractor shall also note that the list of standards presented in this specification is not complete. Whenever necessary, the list of standards shall be considered in conjunction with specific IS. If the IS standard is not available for an equipment/material, then other applicable International standard (IEC/Equivalent), as per the specification, shall be accepted.”
 - (iii) The bidder/contractor shall list out the products and components producing Toxic e-waste under the contract and shall furnish to the Employer the procedure of safe disposal at the time of closing of the contract.
 - (iv) The Bidder shall have to furnish a certificate regarding cyber security/safety of the equipment/process to be supplied/services to be rendered as safe to connect.
- (36) Mandatory Testing and Certification of Telecom Equipment (MTCTE)’ under the provision of Indian Telegraph (Amendment) Rules 2017 shall apply on all equipment to be supplied under

subject Package. Contractor has to supply only certified equipment as per MTCTE. Please refer the weblink <https://www.mtc.tec.gov.in> for more details. Detailed descriptions of the Contractor's obligations, in relation to individual items and services offered, are delineated in other sections of this specification.

1.7.3 The Employer Responsibilities and Obligations

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

- 1) Review and approval of the Contractor's designs, drawings, survey reports and recommendations.
- 2) Participation in and approval of "Type", factory and site acceptance tests.
- 3) Review and approval of training plans.
- 4) Assistance in obtaining statutory clearances from regulatory bodies.
- 5) Approval of key personnel for the project.
- 6) Overall project management of the project

1.8 General Bidding Requirements

The Bidder shall be responsive to the technical requirements as set forth in this specification. The Bidder's proposal shall include the following:

- (1) The Technical Proposal including the documents listed in the Table 1-1: Bid Documents Checklist shall be provided in the bid.
- (2) A detailed project implementation plan and schedule that is consistent with the scope of the project and Employer's specified objectives. The plan shall include the activities of both the Contractor and Employer, show all key milestones, and clearly identify the nature of all information and project support to be provided by Employer.
- (3) A commitment and a clearly defined plan to develop a system support organization, based in India and capable of providing a full range of local services (including software and hardware maintenance and upgrade support) for the life of the delivered telecommunications systems.
- (4) The bidder may offer the bought-out items from more than one manufacturer. In the case of QR items and the items for which General Technical Requirements has been specified in this section, the bidder shall provide supporting qualification document also.
- (5) The General Technical Requirements data of the Manufacturer (in support of meeting the requirements at clause 1.5 of this section) shall be furnished in the bid.

Table 1-1; Bid Documents Checklist

S. No.	Description:	Enclosure Reference	
1	Completed Data Requirement Sheets (As per Appendix of Technical Spec Volume II)	Page no. Ref no.	
2	Quality Assurance Program (As per relevant Sections of Technical Specs Volume II)	Page no. Ref no.	
3	Detailed Project Implementation Plan (As per relevant Sections of Technical Specs Volume II)	Page no. Ref no.	
4	General Technical Requirements data of the Manufacturer. (As per relevant Sections of Technical Spec Volume II)	Page no. Ref no.	

1.9 Organization of the Technical Specification Document

Sections 2 through 10 and Appendices provide the project requirements of the communication system to be provided.

1.10 Applicable Standards

The applicable standards are mentioned in the respective technical section. The offered equipment shall conform to the standards mentioned in the specification except to the extent modified by this specification. In case of any discrepancy between the description given in the specification and the standards, the provisions of the technical specification shall be followed. The parameters not specifically mentioned in this specification shall conform to the standard mentioned in this specification.

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

- (i) IEEE 802.3, 1138-2021
- (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, IEC 60801-2/3/4/5, IEC-60255-4, IEC-60255-5, IEC-60870-2-1, IEC-60721-3-3, IEC-60529.
- (ix) International Electrotechnical Commission standards, IEC 1000-4-xx series.
- (x) IEC publication 60068, 60068-2-2, 60068-2-3, 60068-2-14, 60068-2-27, 60068-2-32.
- (xi) ITU-T/CCITT Recommendations K.11, K.17, K.20.
- (xii) International CISPR standards

The Cyber Security Requirement as specified in Section-10 shall be complied with by the contractor.

----- End of this Section -----

Section 2 – Network Configuration and Equipment Characteristics

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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 Equipment (FOTE)
- (2) Network Management System (NMS)
- (3) DDF and Cabling

The requirements described herein are applicable to and in support of network configurations for Equipment's and Network Management System (NMS) for monitoring and control of this communication network.

2.2 General Network Characteristics

2.2.1 Description

The proposed fibre optic communication network shall support the voice & data communication requirements of RTUs, SCADA/EMS, Teleprotection, VOIP, Metering system and other Power system operational requirements. The communication system shall provide data & voice connectivity across the various locations or connectivity of RTUs with Control Centers. The proposed communication system shall provide connectivity of RTUs over TCP/IP protocol using Ethernet interface. The offered communication System shall support the communication requirements of RTUs and the SCADA/DMS system described in point to multi point and/or multipoint to multipoint configurations using Ethernet over SDH.

The fibre optic network shall be based on the Synchronous Digital Hierarchy (SDH) having bit rate of STM-4/ STM-16/STM-64. The network shall consist of overhead fibre optic links with a minimum bit rate of Synchronous Transport Module-4/16/64. The tentative list of Fiber Optic links to be implemented under this package are given in Appendix-A of this volume. The Contractor can propose a system based on higher bit rate systems, if required, so as to meet the link budget requirements or any other specification requirement. The detailed BOQ is described in Price Schedules.

2.2.2 Functional Requirement

The primary function of the equipment is to provide a highly reliable voice and data communication system for grid operation in support of the Power System Operation such as Substation Automation System. A brief summary of the communication system requirements is as follows:

- (a) High speed E1 channel support
- (b) Integration with Employer's/RLDC's EPABX system.
- (c) Data transport supporting Network Management channels.
- (d) The connectivity envisaged between Substation and Control Centre over TCP-IP using Ethernet interface for various services of data and voice Requirements.

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 all the new equipments under the contract using NavIC (with fallback option to GPS) based time reference clock.

In addition to NavIC/GPS input reference, the synchronization clock must have provision to take INPUT reference coming from other clock. 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 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 NMS control. Such testing shall not affect the functional operation of the system. Preventive and problem-oriented maintenance of the communications system shall be performed using diagnostics tools such as NMS and test equipment. They shall support complete maintenance of all system elements and shall permit the diagnosis of any fault without requiring additional test equipment. The Contractor shall provide specialized training required to operate above mentioned diagnostic tools. For all redundant systems, disconnection and repair of any failed device shall not interrupt the operation of the system.

2.2.3.3 System Upgradeability and Expandability

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

2.2.3.4 Equipment Availability

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

- (1) The availability of each fibre optic link (E1 to E1) shall be at least 99.999%.
- (2) The availability of network end to end (E1 to E1) shall be at least 99.998%.
- (3) The average per link subscriber to subscriber availability shall be at least 99.97%. The per link subscriber to subscriber availability is defined as the availability between any two data or voice subscribers between RTU to reporting Control Centre and between control centres.
- (4) The network-wide subscriber to subscriber availability shall be at least 99.8% . The network-wide subscriber to subscriber availability is defined as the availability between any two data or voice subscribers on the wideband network.

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

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

2.2.4 General Equipment Characteristics

All Contractor-supplied equipment shall be new and of the finest production quality. The Employer will not accept modules or printed-circuit boards that are modified by the addition of wires or components. Any required hardware configuration options, jumpers, or strap links shall be incorporated into the original PCB design and manufacturing process.

All applicable requirements stated in this section shall equally apply to the NMS equipment as specified in this Section.

2.2.4.1 Revision Levels and Modifications

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

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

2.2.4.2 Equipment Capacities

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

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

2.2.4.3 Redundancy Requirements and Protection Schemes

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

Table 2-1 Equipment Redundancy Requirements Summary

Fiber Optic transmission Equipment : SDH equipment Power Supply & Converters ----- Common Control* Cards ----- * = Common control cards which are essentially required for operation of the equipment.	1:1 APS or distributed power supply 1:1 APS
--	---

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

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

2.2.4.4 Lost Signal Recovery

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

2.2.4.5 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. Also refer Section-7 of the specification.

2.2.4.6 General Site Considerations

All fiber optic links upto 175 kms (as per link budgeting criteria given in clause 2.3.2.1) for STM-64, upto 225 kms transmission line length for STM-16 and upto 250 kms transmission line length for STM-4 shall be implemented by the Contractor without repeaters. In order to meet the link budget requirement, the Contractor shall provide all the necessary equipments only in the end stations. The

contractor may provide the optical amplifier, wave length translator, FEC (Forward error correction), optical cards or high capacity SDH equipment with suitable rack/subrack to meet the maximum distance limit. All the provided equipments shall be monitored by centralized NMS.

2.2.4.7 Secure Development and Deployment Practices

a. The Contractor shall follow secure software development life cycle (SDLC) practices, including but not limited to requirements analysis, secure design, secure coding, code reviews, testing, and secure deployment processes. b. The Contractor shall implement secure configuration management practices, including version control, change management, and separation of environments (development, testing, and production). c. The Contractor shall maintain detailed documentation of the software development and deployment processes, including security controls, configurations, and changes made throughout the SDLC.

2.2.5 Fibre Optic Link Lengths

The Optical fibre link lengths shall be provided during detailed engineering. The same shall be used by the Contractor for final link design during the detailed engineering of the project as per the link budget criteria specified in the TS. In case of change in the specified BoQ, the contract price shall be adjusted accordingly.

2.2.6 Bill of Materials (BOM)

SBOM & HBOM requirement: The Vendor shall provide and maintain an updated Software/Hardware Bill of Materials (SBOM/HBOM), including firmware and third-party components, in accordance with applicable CERT-In guidelines. A sample format with minimum requirement to be filled and supplied by contractor is attached at Appendix-J and Section-7.

2.3 Fibre Optic Transmission System

The Fibre Optic Transmission System (FOTS) is defined herein to include Network SDH Element(NE). The FOTS shall be based on SDH technology. Minimum aggregate bit rate shall be STM-4/16/64 equipped:

- with E1 interface cards with minimum 16 interfaces (G.703) per card.
- Fast Ethernet interface card with minimum 8 interface per card (IEEE 802.3/IEEE b) 802.3u) supporting layer 2 switching as tributaries.
- Gigabit Ethernet interface shall also be required as specified in the BPS. Ethernet shall support LCAS(Link Capacity Adjustment Scheme) feature.it shall support full throughput upto1000 Mbps on Ethernet port by virtual concatenation of requisite no. of VC-12. There shall be the provision of “Auto Negotiation” and “Flow control” Enabling/disabling through NMS of the system. Also there shall be provision of configuring the equipment for unrestricted nxVC12 bandwidth (upto 1000Mbps). The Ethernet interfaces shall support VLAN (IEEE 802.1P/Q), spanning tree (IEEE 802.1D) quality of service. Protection scheme for Ethernet traffic should be ERPS (Ethernet ring protection scheme) based as per ITU-T G.8032.
- All software and hardware shall support IPv4 and IPv6 simultaneously (dual stack).The Contractor shall provide (supply and install) connectorized jumpers (patch cords) for FODP-to-equipment and equipment-to-equipment connection. The communication equipment shall support multiple users and access levels at least the following for CLI/NBI access for maintenance purpose.
 - i. Administrator: Configuration/troubleshooting
 - ii. Read only access : Only see the equipment status
 - iii. Operator- Can create configuration but cannot delete

2.3.1 SDH Equipment

2.3.1.1 Functional Requirement

There is a requirement for different types of equipment under this project which are described in this section. The BOQ is provided in the Price Schedules. For the purpose of BOQ, the SDH Equipment is

considered to be divided in three parts i.e. Optical interface/SFP, Tributary interfaces (Electrical tributaries such as E1, Fast Ethernet 10/100 Mbps, Gigabit Ethernet interface & Optical tributaries such as Gigabit Ethernet etc.) and Base Equipment (Consisting of Common Cards, Control Cards, Optical base card, Power supply cards, sub-rack, cabinet, other hardware and accessories required for installation of equipment i.e. everything besides optical interface/SFP and tributary cards).

If bidder is offering equipment with multifunction cards such as cross-connect or control card with optical interface/SFP or tributary interface, such type of multifunction card shall be considered as Common control card and shall be the part of base equipment. In case optical interface/SFP is embedded with control card, the adequate number of optical interface/SFPs shall be offered to meet the redundancy requirements of the specifications. Further, main and protection channel shall be terminated on separate cards and there should be no single point of failure.

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

1. STM-4 (MADM) with MSP protected direction (as specified in BPS).
2. The aggregate interfaces shall be (at least) STM-4 towards at protected directions (Protected as specified in BPS). At present the equipment shall be equipped with two (2) nos. E1 interface card with minimum 16 interfaces per card & two (2) nos. Fast Ethernet interface card with minimum 8 interfaces per card, as tributaries. The equipment shall provide non blocking cross connect capability of 64 STM-1 (bi-directional) at high order VC-4 level and as well as at low order VC-12 level.
3. STM-16 (MADM) with MSP protected direction (as specified in BPS)..
4. The aggregate interfaces shall be (at least) STM-16 towards at protected directions (Protected as specified in BPS). At present the equipment shall be equipped with two (2) nos. E1 interface card with minimum 16 interfaces per card & two (2) nos. Fast Ethernet interface card with minimum 8 interfaces per card, as tributaries. Gigabit Ethernet (optical/electrical) interface shall also be provided if specified in BPS. The equipment shall provide non blocking cross connect capability of 256 STM-1 (bi- directional) at high order VC-4 level and 128 STM-1 (bi-directional) at low order VC- 12 level.
5. STM-64 XC (100G XC) with MSP protected direction (as specified in BPS). The equipment shall support STM-64, STM-16 with MSP protected direction (as specified in BPS). At present the equipment shall be supported with Minimum 2 nos of Gbe 1000 Mbps Ports, Minimum 8 nos of FE 10/100 Mbps ports per card , and Minimum 16 E1 interfaces per card or a combination of above. The Cross Connect Equipment shall be capable of high order level Cross Connection of at least 640 STM1 equivalent (bi-directional). The Equipment shall be capable of low order (VC-3 and VC-12) level single stage Cross Connection upto 512 STM-1s (bi-directional) equivalent out of total 640 STM-1s. Bidder to supply above mentioned cards in the equipment as per BOQ.
6. Optical Interface/SFP to be implemented in the existing SDH equipment
The bidder shall be required to provide only Optical Interface/SFP to be installed in the existing/third party SDH equipment at few locations. The bidder has to ensure compatibility of the supplied Optical Interface/SFP for the same.

2.3.1.2 Redundancy and Protection

Two fibre rings shall be implemented wherever the network permits. On linear sections of the network, protected links using 4 fibres shall be implemented using MSP protection with redundant Optical cards.

2.3.1.3 Service Channel

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

2.3.1.4 Supervision and Alarms

ISM (In Service Monitoring) circuitry shall be provided as a function of the SDH equipment. Local visual alarm indicators shall be provided on the equipment, as a rack summary alarm panel. Alarms

shall be as per ITU-T Standards G.774, G.783 and G.784. Additionally, F2/Q2 interfaces for a local 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 NMS.

2.3.1.5 Synchronisation

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

2.3.1.6 Electrical and Optical I/O Characteristics and General Parameters

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

Table 2-2 Electrical and Optical I/O Characteristics and General Parameters	
Optical Wavelength NOTE (1)	1310/1550nm
Optical Source NOTE (2)	Laser
Optical Source Lifespan	Better than 5 X10 ⁵ hours
Optical Fibre Type	G.652 D
Optical Connectors	Type FC-PC
Transmission Quality	Per ITU-T G.821, G.823, G.826
Source Primary Power	-48 Vdc
Equipment Specifications	Per ITU-T G.783
Tributary, Electrical Interface	Per ITU-T G.703, 75 Ω
Ethernet Interface	10/100 Mbps
SDH Bit Rates	Per ITU-T G.703
Optical Interfaces	Per ITU-T G.957, G.958
Frame and Multiplexing Structure for SDH	Per ITU-T G.707
Synchronization	Per ITU-T G.811, G.812, G.813, G.803
Management Functions	Per ITU-T G.774, G.784
Protection Architectures	Per ITU-T G.841
Built In Testing and Alarms	Per ITU-T G.774, G.783, G.784

NOTE (1) Optical wavelength shall be selected considering the characteristics of the optical fibre and the link budget. NOTE (2) Eye Safety for Laser Equipment: To avoid eye damage, when a receiver detects a line interruption, it is required that the optical power of the laser shall be reduced to safe limits on the transmitter in the opposite direction as per ITU-T G.958. NOTE (3) In case other than FC-PC connector is provided in the equipment, suitable patch cord with matching connector are to be provided to connect with FODP.

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 SDH equipment, an End of Life Margin of at least 2 dB shall be considered and a similar margin shall be considered for optical amplifiers.
- (5) Optical path Penalty: An optical path penalty of at least 1 dB shall be considered to account for total degradations due to reflections, inter symbol interference, mode partition noise and laser chirp.

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

(7) Other losses: Other losses, if any required specifically for system to be supplied shall also be suitably considered.

(8) Dispersion: The fibre dispersion shall be taken to be the guaranteed maximum dispersion i.e. 18 ps/nm.Km @1550 nm & 3.5 ps/nm.km @ 1310 nm for DWSM fibres.

(9) Bit Error Rate: The link budget calculations shall be done for a BER of 10⁻¹⁰.

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

For finalizing the FOTE 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 SDH Equipment

The Contractor shall be responsible for connectivity between the FODP and the SDH equipment. The Contractor shall provide FC PC coupled patch cords. The location of FODP shall be finalized during detailed engineering.

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

2.4 DDF and Cabling

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

2.4.1 DDF Patching Facilities

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

- (i) DDF for termination of new SDH equipment E-1 ports
 - (ii) Cabling (including connectors) for E1 level connections from DDF to existing / new SDH equipment. To the extent possible, existing cable at site shall be used.
 - (iii) All Ethernet ports shall be terminated with RJ-45 connector. Provision for 100% expansion with connector for terminating additional Ethernet ports shall be provided.
 - (iv) Cabling and connectors required to enable subscriber-to-subscriber circuits over the telecom network.
 - (v) Any other cables, connections etc required for a fully functional, integrated telecom system.
- The connections amongst various equipments such as FOTE, etc shall always be routed through DDF to provide maintenance access.

2.4.2 Digital Distribution Frame Functional Requirements

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

- (i) "Normally thru" circuit routing

- (ii) Circuit rerouting via patch cord assemblies
- (iii) Circuit disconnect and termination All DDFs shall be sized and equipped to support the offered configuration of the provided equipment. Independent Transmit and Receive patch jack assemblies (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 Patch Cords

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

2.6 Network Management System

The Contractor shall provide a Network Management System, in main and backup configuration, for operational support to the FOTS. This NMS 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 NMS 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.

Network Manager & Element Manager System Hardware & Software

The item identified in the BPS as "Network Manager & Element Manager System - Hardware & Software" shall comprise the NMS/EMS server(s), operator workstation(s), network switch(es), required software licences, operating system licences, database software (if applicable), and all other hardware, software, accessories, interfaces and associated components necessary to fully meet the functionalities and performance requirements specified in this Technical Specification. The Contractor shall supply, install, configure, integrate, test and commission the complete NMS/EMS system. Any item not explicitly stated in the BPS but required for satisfactory operation and compliance with the specified functional requirements shall be deemed to be included in the Contractor's scope without any additional cost to the Employer.

2.6.1 Applicable Standards

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

2.6.2 NMS Architecture

2.6.2.1 NMS shall provide

- (a) Collection of Management data from all Network Elements (NEs) supplied under this package. The minimum monitoring and control requirements for the communication equipment shall be as defined in this section.
- (b) Processing of above management data by using processor(s) located at Control Centre and additional intermediate station processor(s), wherever required.
- (c) Monitoring and control of the NEs as defined below:
 - i) The Control Centre for all the network elements being procured under this package (including local operator console) shall support management of all equipment supplied under this package. At minimum functions of Network management layer (NML) and Element management layer (EML) as defined in CCITT M3010. The detailed functions are listed in TS.
 - ii) Monitoring and control of NEs using Craft Terminals as defined in this Section.

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

- I) Intrusion Detection Alarms
- II) Power Failure
- III) Fire and Smoke Detection
- IV) Environmental Control (Temperature, Humidity etc.)
- V) Communication channel support for NMS System as specified in Technical Specifications (TS).

2.6.2.2 NMS Capacity and Independence

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

2.6.2.3 NMS Hardware Reliability

The NMS system hardware shall be so designed that failure of single processor/component (router, switch, converter etc.) shall not inhibit any of the functionality of the NMS system.

2.6.2.4 NMS Architecture Submission

The Contractor shall submit for Employer's approval the NMS architecture describing in detail the following subsystems/features:

2.6.2.5 NMS Architecture Subsystems/Features

- (a) Database used in NMS
- (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 NMS Processor(s)
- (g) Routers/Bridges
- (h) Expansion Capabilities

2.6.2.6 Integration with Centralized Network Management System (UNMS)

a. The offered NMS system shall be capable of integration with Centralized Network Management System (UNMS) upwardly through standard North bound interface (NBI) protocol such as SNMP, CORBA, XML, REST etc. as per standards (as per the requirement of the UNMS system) TMF814/TMF 864/RFC standard/XML etc.. The interface shall support all functionalities such as NE Inventory, Hardware Inventory – Shelf/Slot/Card/SFP/Port, Topology, Protections, Alarms, Performance- real time & periodic, Performance KPI parameters (E-1, STM, Ethernet) , Remote Configuration, Cross Connects, Trails & Circuits, Services Provisioning (NE), E-1 , STM, Ethernet , TX & RX Trace, loop back and details are published in the NBI guide for the configuration parameters. Integration with U-NMS shall be under the scope of the U-NMS provider (such as M/s NMS Works and M/s Everest Make U-NMS Systems). However, the Contractor shall provide all necessary support, coordination, interfaces, protocols, and technical assistance required for integration of the supplied NMS and SDH equipment with the U-NMS. All participating OEMs shall have the capability to integrate their respective NMS and SDH equipment directly with the U- NMS and shall be obligated to facilitate such integration during the implementation phase as well as throughout the AMC period, in accordance with the requirements of the U-NMS provider and the Employer.

2.6.2.7 Documentation for UNMS Integration

Contractors shall provide/share all necessary documentations such as NBI Guide, MIB, IDL, WSDL, API files etc. (as per the requirement of the UNMS system), to facilitate centralized supervision, centralized inventory management, centralized provisioning of bandwidth/services, availability computation, monitoring of events and alarm handling etc. of supplied NMS/NEs through UNMS.

2.6.2.8 Contractor Support for UNMS Integration

The following support shall be provided by the Contractor for integration of the supplied equipment with UNMS:

1. Enabling & activating NBI license in their EMS/NMS and providing NBI login access along with User credentials
2. Assist in verifying NBI Connectivity with UNMS vendor for the successful communication and retrieval of data.
3. Assist in troubleshooting (if required) for NBI connectivity along with UNMS vendor for the communication and retrieval of data

2.6.3 Management Functions

The NMS shall support following Management functions:

2.6.3.1 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/Provide verification testing to support new equipment installation.

2.6.3.2 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.

2.6.3.3 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 (at least for SDH).
- b. Monitor point to point & end to end signal quality and history. Provide operator controls to monitor performance of specified events, measures, and resources (at least for SDH). Specifically provide displays to permit the operator to:
 1. Select/deselect network equipments, events, and threshold parameters to monitor
 2. Set monitoring start time and duration or end time
 3. Set monitoring sampling frequency
 4. Set/change threshold values on selected performance parameters
 5. Generate alarm events when thresholds are exceeded.
 6. Set multiple thresholds on certain performance parameters. Alarm categories include as a minimum a warning and a failure.
 7. Calculate selected statistical data to measure performance on selected equipment based on both current and historical performance data maintained in performance logs. Performance data provided is limited to what is available from the equipment Contractors.
 8. Provide graphical displays of point to point and end to end current performance parameter values. Provide tabular displays of current, peak, and average values for performance parameters.
 9. Generate reports on a daily, weekly, monthly, and yearly basis containing system statistics.

2.6.3.4 Security Management

The NMS 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 NMS 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.

2.7 Communication Channel Requirement and Integration

Communication requirements for NMS system have not been considered in Appendices and the Contractor shall provide these as a part of NMS system. The Contractor shall provide all required interface cards / devices, LAN, routers/bridges, channel routing, cabling, wiring etc. and interfacing required for full NMS data transport.

The NMS 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 NMS station processors, the NMS 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 NMS data channel support.

In case supervisory channels are not available, the Contractor shall provide suitable interfaces in their supplied equipment for transport of NMS data. The Contractor shall also be responsible for providing suitable channels with appropriate interfaces to transport the NMS data.

The NMS information of new SDH system shall be transported through the existing communication network, wherever required, up to the NMS location. The NMS information of the new SDH system being procured under the package shall be transported through the existing communication network

using 2Mbps (G.703) interfaces. Any hardware required for above interfacing shall be provided by the Contractor.

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

2.8 Hardware Requirements

2.8.1 Master Processor, Server/Workstation

NMS Hardware		
Sl. No.	Parameter	Minimum Requirement
1	Processor	16-Core Processor, ≥ 2.4 GHz
2	Memory (RAM)	128 GB
3	Storage	Dual 480 GB SSD (or higher) configured in RAID-1
4	Optical Drive	DVD-RW Drive (where applicable)
5	Keyboard	101/104-Key Enhanced Keyboard
6	Mouse	Optical Mouse
7	Display Monitor	Minimum 23-inch TFT/LCD Colour Display
8	Resolution	Minimum 1920 $\times$ 1080 Pixels
9	Power Supply	Dual Redundant Hot-Swappable Power Supply Modules
10	Data Protection	NMS Software shall support data mirroring/replication on redundant disk drives
11	Interfaces	Standard Ethernet, USB and other interfaces required for NMS operation
Workstation Hardware		
Sl. No.	Parameter	Minimum Requirement
1	Processor	8-Core Processor, ≥ 3.0 GHz
2	Memory (RAM)	64 GB
3	Storage	500 GB SSD (or higher)
4	Keyboard	101/104-Key Enhanced Keyboard
5	Mouse	Optical Mouse
6	Interfaces	USB, Serial and other standard interfaces required for NMS operation
7	Display Monitor	Minimum 23-inch TFT/LCD Colour Display
8	Resolution	Minimum 1920 $\times$ 1080 Pixels
9	Operating System	Latest supported operating system compatible with the supplied NMS application
10	Network Connectivity	Ethernet Interface(s) as required for NMS access

2.8.2 Local Operator Consoles

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

2.8.3 Power Supplies

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

2.9 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.

2.9.1 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.

2.9.2 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.

2.9.3 Software Utilities

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

2.9.4 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.

2.9.5 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 NMS system.

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

2.9.6 Help

All applications shall be supported by USER accessible HELP commands that shall assist the user in the performance of its tasks. HELP commands for an application shall be available to the user from within the active application and shall not interfere with the activities of the application.

2.9.7 Licences

All interfaces and features specified in the Technical Specifications of the respective products shall be equipped with perpetual licenses (Not a subscription model).

2.9.8 IP Address.

The Successful Bidder shall be responsible for configuring and assigning IP addresses to all supplied equipment in accordance with the IP addressing scheme provided by the Employer. The Contractor

must ensure that all devices are assigned IP addresses as per that scheme, verify connectivity, and document the assigned IPs in the final network configuration report.

-----End of the Section-----

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3 Introduction

This section describes the functional requirement, major technical parameters and all the testing requirements for telecom shelter system, including its sub-systems, Air-conditioning system, DG Set & PIU.

3.1 Repeater Shelter Requirements

3.1.1 Shelter Dimensions

The minimum internal and external dimensions of the shelters shall be as per Table 4.1 as specified below:

Table 3.1 All dimensions are in mm

SNo.	External/Internal	Length (L)	Width (W)	Height (H)
1	External	4500	2700	3160
2	Internal	4340	2540	3000

3.1.2 General

The shelters shall be protected and insulated to achieve sound proof, thermal resistance and impact withstand capabilities. The shelters shall be 100% leak and water proof with IP 55 protection. The shelters shall be maintenance free having minimum life of 15 years. These shelters shall be suitable for outdoor and may be mounted at any location including ground and rooftop and in any climatic conditions throughout India. The shelters shall be easily assembled and installed at site. The shelters shall be re-locatable as and when required.

3.1.3 Shelter Panels

The shelter shall be made of “sandwich insulated panels” 80 mm thick with Poly Urethane Foam (PUF) as filler material between polyester pre-coated cold rolled aluminium sheets. The insulation characteristics of PUF material shall conform to Clause no. 3.1.9 of these specifications.

For Steel shelters, the thickness of the inner-side and outer steel sheets except floor panel sheets shall be minimum 0.8 mm and 0.6 mm respectively. For Aluminium shelters, the thickness of both inner side and outer side aluminium sheets except floor panel sheets shall be minimum 0.91 mm. The outer bottom sheet shall be hot dip galvanised steel sheets and aluminium sheets of minimum

1.0 mm and 1.2 mm thickness respectively to avoid rusting of the bottom panel. The sandwich

panels shall be manufactured by high pressure injection technique. The panels to be provided with tubular element precast in panels while foaming to form an integral part through this precast element GI steel rods of required sizes shall be inserted and fastened to top and bottom structures. The steel and aluminium sheets of standard and reputed make shall only be used.

3.1.4 Floor

The floor shall consist of standard PUF sandwich panels suitably reinforced to support the kg/m² minimum load capacity of 2000 and having at least 19 mm Marine plywood covered with anti static PVC flooring. In case of floor panel, 19 mm Marine plywood shall be provided on top of the panel and no steel or aluminium sheet shall be provided inside the panel. The anti static flooring shall be provided with pacific blue anti static vinyl robust rolls of at least 2 mm thickness. The floor shall be even surfaced, scratch proof having long life. The installation of various proposed equipment shall be possible either by direct placement on the floor or by grouting to the floor or through C rails. The Contractor shall submit the reinforcement and other details calculations in support of the meeting the load capacity.

3.1.5 Roof

Roofs shall be made of the panels same as specified for walls. A secondary slanting roof of suitable material shall be provided to protect the primary roof from direct sunlight and rainwater. A minimum down slant of 1:50 shall be maintained from front to back. The secondary roof shall have minimum projections and shall be hidden by angular profiles on the rooftop to decrease the aerodynamic effect and improve on aesthetics. The secondary roof shall be suitably clamped/ bolted to the shelter panels to withstand the specified wind load. The cable tray shall be attached suitably from the roof and the roof shall have sufficient strength to support the load of cable trays and the cables installed on the cable tray.

3.1.6 Door

The Shelters shall have one door for main entrance. The door dimensions shall be 1000 mm (W) X 2200 mm (H). Main door opening outwards shall be provided with external and internal handles/knobs respectively. The door can be opened from inside when locked. Door, when locked cannot be removed even if the hinges are removed. The door shall generally be hinged at right, however, other option may be also required at some sites to meet the actual site condition. The door shall have aluminium biddings extrusions in door/jamb profile, replaceable and suitable neoprene rubber gaskets around its border for proper weather proofing. The door shall also be equipped with a hydraulic auto closure and the door latch / stopper shall be provided to keep the door in open position. The door shall have a limit switch to indicate intrusion and switch on one light provided inside the shelter. A canopy of minimum size 1200 mm X 500 mm shall also be fixed up above the external light / door for protection from direct sun/rain. The canopy shall suitable slope and shall be covered from both sides.

3.1.7 Jointing

All panel to panel connections shall be made with eccentric cam locks or suitable locking system. The wall to floor and wall to roof jointing shall be made with angular frames of suitable size. The panel to panel jointing at the corners shall either be suitably angular frames of suitable size or a single corner panel may be provided. All internal corners shall be jointed suitable angles. All the joints shall be suitable sealed with PU or silicon sealant to provide 100 % leakage and water proofing. The Contractor shall submit the drawing indicating details of all joints in support of meeting the specified requirement.

3.1.8 Opening

The shelter shall have provision for openings for required air-conditioners, piping and all electrical and optical cablings on the wall panels. The details of openings required for different applications and the locations of the openings shall be decided during detail engineering. All openings shall be custom built based upon the actual application required at each site. The Contractor shall provide the required cut outs for above purpose. Any sealed cut outs required for future use may also be provided and the size of this cut out shall be finalised during detail engineering. All the openings shall be sealed for water and leak proof with suitable flexible sealing arrangement for the proposed cable connections and also for addition and deletion of cables/pipes in future. The sealing arrangement shall be fire retardant and type/make/details shall be got approved by the Employer.

3.1.9 Insulation

The PUF to be used for insulation of the panels shall be CFC free and conforming to latest IS 12436 standards. The other parameters shall be as per Table 3.2 as given below:

Table : 3.2

SNo.	Items	Required Parameter
1	Thickness	78.6 mm
2	Density	40 kg/m ³
3	Compressive Strength	1.2 kg/cm ²
4	Tensile Strength	3.6 kg/m ²
5	Bending Strength	4.0 kg/m ²
6	Adhesion Strength	2.9 kg/m ²
7	Dimensional Stability	At (-) 25 oC : 0.1%, at 38 oC : 0.1% and at 100 oC : 0.4%
8	Temperature Range	(-)15 oC to 95 oC
9	Thermal Conductivity	0.02 kcal/hr/m/oC

10	Fire Resistance	As per BS-4735 horizontal burn < 125 mm
11	Water Absorption	0.2 % @100% RH
12	Vapour Permeability	0.08/0.12 g/hr/m2
13	Self Extinguishing	Yes
14	Biodegradable	Yes

The Contractor shall submit the earlier carried out type tests reports for PUF material. In case the contractor does not submit the reports or the submitted reports are not meeting the requirements, the contractor shall carry out the type test

s on PUF material for the following: Thickness, Density, Compressive strength, Tensile Strength, Dimensional Stability, Thermal Conductivity and Fire resistance.

3.1.10 Heat Transmission Coefficient

The installed shelter with one door shall have the heat transmission coefficient $K \leq 0.3$.

3.1.11 Color

The shelter panels shall be factory coated with good quality and long life paints. The finished panels shall be provided with suitably protection to avoid scratches during transportation, handling and installation. The colour shall be stabilised grey on all external sides and off white on all internal sides. The colour of the slanting roof shall also be stabilised grey. However, the actual colouring scheme shall be finalised during detail engineering.

3.1.12 Fire and Smoke Detection System

Suitable fire & smoke detection system shall be provided in each of the shelters. The offered fire & smoke detection system shall work on DC supply (-48V) being provided by the Contractor under this contract. In case, the smoke detector and fire alarm system requires other voltage than the above stipulated voltage (-48V DC) for operations, suitable converter & hardware shall also be provided by the Contractor. The Contractor shall provide all required cabling & accessories for full functioning of the offered system with both power supplies. At least two ionisation type smoke detectors along with fire detection panel shall be provided below the roof panel in strategic locations inside the shelter. The alarm should activate only if both fire detectors are actuated to avoid any false alarm. The details, locations and its various logistics shall be finalised during detail engineering. The operation/activation of the fire detector shall result in the following:

a. An external visual signal and audible alarm sounded outside the shelter. b. A signal to be given to the telecom equipment panel through potential free dry contact as a local alarm for its remote monitoring in the control centre. c. Suitable pilferage proof enclosure for visual and audio alarm outside the shelter. Fire detectors shall be approved by FOC-London or similar International authorities and also by Tariff Advisory Committee of India. The set point shall be adjustable. All the detectors installed shall be tested for actuation and its required operations during SAT. The exact method of the testing shall be detailed in SAT procedures.

3.1.13 Lighting system

Normal and emergency lighting shall be provided inside the shelters. The normal lights shall consist of two nos. (36 Watts) of reputed make fluorescent lights along with requisite fittings and shall be powered with ac supply from ACDB. Two nos. emergency light with requisite fittings shall also be provided which shall be powered with dc supply available (-48 V DC) for telecom equipment from DCDB. In the event, the emergency lighting system requires other voltage than the above stipulated voltage for operations; suitable converter & hardware shall be provided by the Contractor. The outside light shall be bulk head type, powered with ac power supply from ACDB, provided at top of the door and covered with the door canopy. The bulk head type shall be provided with metallic guard to prevent pilferage. The switch of both internal and external lights shall be inside the shelter but adjacent to the entrance for easy accessibility. Additionally, at least one of the normal lights inside the shelter shall be lit up with

the opening of the shelter door. One 5 A / 15 A duplex socket with switch shall also be provided in addition to the requisite switches for the normal and emergency lights.

3.1.14 Cable Tray

The cable tray of size minimum 300 mm width made of Fibre glass Reinforced Polymer (FRP) material shall be provided inside/outside the shelter for supporting various cables and shall be attached to the roof top/wall panels. The alternate material for the cable tray, if required shall be with specific approval of the Employer. The cable trays shall have sufficient strength to take loading of various cables like fibre optic cables, various power, signal & control cables, earthing flats etc. The rungs along the cable ladder shall be separated by not more than 300 mm. The color of the cable tray shall match with the inside color of the shelter. The Contractor shall submit the cable tray details for Employer's approval. The cable tray shall run along the four sides just below the ceiling with smooth curvatures at the bends/corners. The actual routing including length and height of the cable tray for each site shall be finalized during detail engineering. The Contractor shall clamp the cables suitably with the trays after installation of the cables.

3.1.15 C – Rails

C-rails made of extruded aluminum alloy of suitable size along with required number of lock-nuts shall be provided inside and outside the shelter to support various items like lighting, AC Distribution Box (ACDB), DC Distribution Box (DCDB), Fire detector along with the panel, cables and all other accessories. The C-rails may also be used for supporting cable trays from the roof, mounting equipment on the floor and on the wall. The requirement of C-rails shall be finalized during detail engineering.

3.1.16 Energy Meter Box

An IP 55 compliant weatherproof box shall be provided for housing the energy meter along with MCBs and fuse units. The energy meter box shall have two different doors and compartments, one for accessing/housing energy meter and another for accessing/housing MCBs and fuses. The energy meter box shall have glass for view of meter reading from outside. The energy meter box shall be of Fibreglass Reinforced Polymer (FRP) material. The alternate material, if required, shall be with specific approval of the Employer. The box shall be provided with pad lock arrangement and shall be installed on external shelter panels with suitable fittings. Proper sealing shall also be done to avoid any water leakage into the panel. The size and locations of meter installation shall be finalised during detail engineering.

3.1.17 Loading Capacity

kg/m²

- Minimum roof loading capacity : 250
- Minimum floor load capacity : 2000 kg/m² kg/m²
- Minimum wall load capacity : 300

The above load capacities have been identified as minimum requirement. However, during detail engineering, to meet the actual load requirement for cable tray, ACDB, DCDB, C-rails, Air-conditioning system, battery, batteries chargers, telecom equipment, lighting etc. to be supplied and installed inside the shelter, the actual localized loading requirement may be higher and the supplied shelter loading capacity shall meet the actual localized loading requirement at no additional cost to POWERGRID.

3.1.18 Structural Stability

- Resistant to various volumes of rain, dust & sand impinging from various directions over different durations and different speeds.
- Resistant to corrosion against water, industrial air and saline air.
- Resistant to decomposing vegetation, rodents, termites and micro-organisms.

3.1.19 Survival wind speed

The shelter shall be designed to withstand a wind load of 200 kmph.

3.1.20 Cables and Cabling

All cables and cabling of required size and capacity shall be supplied, installed and terminated with necessary and required accessories among all the equipment/systems being supplied under this Package. The cables from cable ladder to equipment cable entry height shall be installed in the wall of the shelter in PVC cable conduits and in flexible conduits from shelter wall to equipment. The cables shall be dressed properly and suitably attached with the shelter panel. No hanging cables shall be allowed.

3.1.21 Structural

All structural steel shall conform to latest IS: 2062. The ISMBs shall conform to IS – 808. The structural MS pipes shall conform to IS:1161. The steel work shall be galvanised after full fabrication as per latest IS standards and the coating thickness shall be greater than 127 micron. All welding shall be as per IS – 816. All nuts and bolts shall be galvanised and conform to IS : 6639. All fittings and hardware used in the shelters shall be made of corrosion-resistant aluminium or galvanised steel as specified in the relevant clauses of this specification.

The requirement of steel/aluminium sections shall also be provided and no separate payment shall be made in this regard.

3.1.22 Earthing

For satisfactory operation of the equipment inside the shelter, good and proper earthing is required at each site. The earthing resistance generally varies depending on soil resistivity. The earthing system at each site shall be provided by the Contractor with earthing resistance not exceeding the five (5) ohms. The Contractor shall provide the pipe type earthing along with the necessary hardware and accessories required. Minimum two earth pits shall be made at each location. However, if required resistivity is not met, then, sufficient nos. of pipe type earthing shall be provided by the Contractor.

An earthing ring of copper strip of minimum size 25mmX3mm shall be made inside the shelter. Each equipment shall be connected to above earthing ring through 70sqmm copper cable. The connectivity from earthing pit to the shelter earthing ring shall be made by the Contractor through two (2) nos. of 50 X 6 mm GI strips. The connection of GI strips with the copper strips shall be made through flexible copper cable and bi-metal washers for proper connectivity. The GI strips for earthing pit to shelter shall be buried inside the ground.

All the equipment shall be connected properly to this earthing system for their safe operation.

3.1.23 Foundation System for Shelter

The Contractor shall design and construct complete foundation system for all finalised shelter locations depending on the type of soil, including supply and furnishing all the material & labour, tools & tackles, plant and machineries etc. as required for successful completion of the job. The foundation system shall also include the following:

- Site preparation
- Soil characteristics assessment as required for foundation design for each site including detail soil investigation, if required.
- Water level assessment
- Raising of site level above maximum flood limit level to avoid any water logging in the shelter area.
- Concrete pedestals (in situ) along with base slab for the foundations located on ground and concrete pedestals for roof top locations along with supply and fixing of necessary holding down / anchor bolts.
- PCC and finish of surface below and around shelter location with suitable slope.
- Installation of base frame and sub-frames on the pedestals through ISMB channels.
- Stair access for shelter.

3.1.24 Site Preparation at Shelter locations

For each of the shelter to be installed on the ground, the Contractor shall execute the work for site preparation, such as clearing of the site, levelling of the site, the supply and compaction of fill material

(if required), excavation and compaction of backfill for foundation, trenches etc with available excavated earth. At certain locations, the finished ground level (FGL) site shall be fixed above High flood level (HFL) to avoid water logging in the shelter area. The site shall be prepared to meet the specified requirement for each site. If fill material is required for site preparation, the fill material shall be provided with suitable protection so as to prevent the erosion by wind and water from its final compacted position or the in-situ position of undisturbed soil. Backfill material around foundation and shelter shall be suitable for the purpose for which it is used and compacted to the satisfaction of the Employer. Excavated material not suitable for use or not required for backfill shall be disposed off in area as directed by the Employer, including all leads and lifts.

Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling.

For roof top shelters, the Contractor shall also prepare the site suitably for shelter installation on the pedestals. In all cases, each site shall be fully prepared before start of foundation activities up to satisfaction of the Employer.

3.1.25 Concrete Pedestals and Foundation system

Two types of foundations are envisaged for shelters viz. (i) required for shelters to be installed on ground & (ii) required for shelters to be installed on roof top of a building.

The foundation of shelters to be installed on the ground shall consist of RCC pedestals of minimum 600 mm above levelled ground. The depth of pedestals below the ground shall be minimum 1500 mm including bottom slab. The size of bottom RCC slab of the foundation shall be minimum 600 mm X 600 mm for a minimum 250 mm depth. The reinforcement shall be as stipulated at clause 2.4.4 below. The PCC (1:4:8) of minimum depth 75 mm shall be provided below the bottom slab of minimum size 750 mm X 750 mm. The size of the pedestals shall be minimum 300 mm X 300 mm. The grade of concrete shall be M20 (1:1.5:3). The concrete cover for the reinforcement shall be minimum 50 mm.

The foundation of shelters to be installed on the roof top shall consist of RCC pedestals of size minimum 300 mm X 300 mm and 300 mm above roof surface of M20 (1:1.5:3) grade. The bottom of the pedestal shall be connected and attached with the existing roof structure/slab. The reinforcement shall be as stipulated at clause 4.1.26 below.

The exposed portion of the concrete pedestals shall be plastered with 1:4 cement plaster for smooth finish.

The above pedestal dimensions are minimum requirement and the Contractor shall provide the required size of pedestals depending upon the soil bearing capacity and other soil parameters of each site to support the installed shelter along with all equipment.

The shelter shall be fixed to the pedestals through ISMBs 200 mm minimum and sufficient number of sub-frames with suitable anchor bolts. The required ISMBs and sub-frames shall be provided by the Contractor as part of shelter/foundations. The required number of pedestals shall be provided for shelter installations, however, minimum one pedestal is to be provided at each corner of the shelter. The Contractor shall provide the required and necessary foundation system at each site irrespective of soil to meet the requirement. All required foundation system and related works shall be in Contractor's scope and no additional payment shall be paid to the Contractor irrespective of soil characteristics and site conditions.

The suitable staircase shall be provided at each shelter location in front of the door for easy entry into the shelter as a part of foundation/pedestal system and no separate payment shall be made in this regard.

3.1.26 Concreting

After completion of foundation work at each shelter location, PCC (1:2:4) of depth minimum 100 mm shall be provided throughout the floor inside shelter boundary (approximate dimension of shelter location has been considered as 10x10 sq. m). There shall be adequate slope in the Shelter area PCC to avoid water logging.

The Contractor shall also provide the RCC platform of about 600 mm height for installation of DG set. The exact area and the height of RCC required for DG set and shelter area shall be finalised during detailed engineering. PCC Area

3.1.27 Properties of Concrete

The cement concrete used for foundation shall be of grade M-20 corresponding to 1:1.5:3 nominal mix ratio with 20 mm coarse aggregate. All the properties of concrete regarding its strength under compression, tension, shear, punching and bend etc. as well as workmanship will conform to latest IS standards.

The Portland cement used in concrete shall conform to 33 grade (IS:269) or 43 grade (IS:8112) or 53 grade (IS:12269).

The Pozzolana cement used in concrete shall conform to IS : 1489. The curing time of Pozzolana cement shall be decided at the time of execution of the work under the contract based on the certificate from a reputed laboratory which will be obtained and submitted by the Contractor. Cement of only POWERGRID approved make shall be supplied.

Concrete aggregate shall conform to IS: 383.

The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials or other deleterious substances. Portable water is generally preferred.

Reinforcement shall conform to IS: 432 for MS bars up to 6 mm and hard drawn steel wires and to IS : 1139 and IS : 1786 for deformed and cold twisted bars 8 mm and above respectively. All reinforcement shall be clean and free from loose mill scales, dust, loose rust and coats of paint, oil or other coatings, which may destroy or reduce bond. Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out the intent of drawings and specifications. Reinforcement of only POWERGRID approved makes shall be supplied.

3.1.28 Mixing, Placing and Compacting of Concrete

Mixing shall be continuous until there is uniform distribution of material and the mix is uniform in colour and consistency. Normal mixing shall be done close to the foundation, but exceptionally the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.

Form boxes shall be used for casting all types of foundations and pedestals.

The concrete shall be laid down in 150 mm layers and consolidated well, so that the cement cream works, up to the top and no honey-combing occurs in the concrete. Preferably, a mechanical vibrator shall be employed for compacting of concrete. However, in case of difficult terrain, manual compaction may be permitted at the discretion of the Employer. Monolithic casting of foundations must be carried out. After concreting the pedestal portion to the required height, the top surface should be finished smooth.

Wet locations shall be kept completely dewatered, both during and 24 hours after placing the concrete, without disturbance of the concrete.

If the concrete surface is found to be defective after the form work has been removed, the damage shall be repaired with rich cement sand mortar to the satisfaction of the Employer before the foundation is back filled.

3.1.29 Curing

The concrete shall be cured by maintaining the concrete wet for a period of at least 10 days after placing. Once the concrete has set for 24 hours, the pit may be backfilled with selected moistened soil and well consolidated in layers not exceeding 200 mm thickness and thereafter both the backfill earth and exposed pedestal shall be kept wet for the remainder of the prescribed 10 days. The exposed concrete chimney shall also be kept wet by wrapping empty cement bags around it and wetting the bags continuously during the critical 10 days period.

3.1.30 Other associated civil works

The Contractor shall also carry out other minor civil works in the shelter area for the equipment/system being supplied under the Contract at no additional cost to the Employer.

3.1.31 Installation

The shelter shall be installed on the foundation system as specified above and to meet the actual requirement as per actual site/soil conditions. The installation of shelters shall be carried out in such a way that it shall meet all specified requirement. The installed shelters shall be suitable for transporting in assembled condition to another location and dismantling, transporting to another site and reassembling there.

The Contractor shall make their own arrangement for AC supply / DG set during installation/testing of the system.

3.1.32 Finish

The final finish of the installed shelter system shall show good workmanship. The panels and floor shall be totally scratchproof. The floor shall not have any uneven surface. The total shelter shall be air tight, the roof and all joints shall be leak and water proof and the door shall be easily lockable & unlockable.

3.1.33 Environmental Conditions

As indicated in the appendices, the shelters shall be installed all over India. The environmental conditions required are as under:

oC Normal Internal Temperature : $+24 \pm 1$ Maximum Outside Temperature : $+50$ oC Minimum Outside Temperature : 0 oC Maximum Inside Temperature : $+55$ oC Humidity : Up to 100 %.

3.1.34 Wire Mesh Fencing System for Outside Protection

To protect the shelters along with the installed equipment, air-conditioners, DG sets etc. from vandalism, wire mesh fencing shall be constructed at each of the shelter locations installed at ground. The wire mesh size shall be of 75 mm, the nominal dia of the mesh wires shall be 3.5mm and fencing shall be at least 2.0 m height from ground level. The pipes/angles of adequate size and capacity shall be provided to support the fencing. An iron gate of minimum size of 2 m or as per site requirement with pad locking facility shall also be provided at each location to enter the protected area. The fencing system shall also be painted (one coat of primer and 2 coats of final paint) for better reliability. All associated civil works for the fencing shall also be carried out by the Contractor. The Contractor shall submit the layout of the shelter and other equipment and the barbed wire fencing for each of the locations for Employer's approval.

3.1.35 External Alarms

The Communication equipment being provided under this package shall have provision of taking input of external alarms from various equipment e.g. DG set, air-conditioning system, DCPS, fire & smoke detection system, PIU unit etc. The Contractor shall provide necessary dry contacts at all the equipment being provided under this package and shall wire up these up to the Communication equipment.

3.1.36 Testing of Shelter system along with all sub-systems

a) Type testing

The Contractor shall provide the earlier carried type test reports for the PUF material and other sub systems of the shelter.

b) Factory Acceptance Testing (FAT)

The following tests shall be carried out during Factory Acceptance testing (FAT): i. Dimensional and checks as per approved DRS/drawings ii. BOQ verification as per approved drawings/documents iii. Test certificates from the Original Equipment Manufacturer. iv. Density test, Compression test and Thermal Conductivity test on the PUF material. FAT on other items shall be carried out as specified in this specifications and relevant standards.

c) Site Acceptance Testing (SAT)

The site acceptance testing shall be carried out for each site. The installed system shall be powered up and all the equipment shall be tested and commissioned. The various installed system shall be tested for the specified functional requirements and shall be as per approved drawings. The SAT shall be carried

in an integrated way and not individual equipment basis to demonstrate the integrated functioning of the installed system. The tests shall be carried out on following minimum items during SAT:

- i. Site preparedness, PCC and RCC.
- ii. Civil Pedestals and Steel structure for Base of Shelter System
- iii. Shelter (including water proof test)
- iv. Air-Conditioning System
- v. Cable Tray
- vi. Lighting System
- vii. Fire and Smoke Detector System
- viii. C-Rails ix. Earthing System x. Wire Mess Fencing

The detailed SAT procedure shall be submitted for Employer's approval.

3.1.37 Marking

The following information shall be provided outside the shelter and near the door engraved on a steel metal plate:

- a. POWERGRID logo and name. b. Project Name c. Shelter location name d. Identification no. e. Year of Manufacture f. Shelter dimension

3.2 Requirements of Air Conditioning System

3.2.1 General

The air conditioning system shall be provided in the shelters to be used for housing Telecom equipment, power interface unit, VRLA batteries, battery charger etc. throughout the country. Repeater Shelters are placed for amplification of telecom signals in between the fibre optic links. The Contractor may note that these shelters are generally located in unmanned areas; therefore, the air-conditioning system shall be rugged, reliable, maintenance free and designed for long life.

Bidder shall furnish the details/document in support of above Technical experience of manufacturer along with bid.

3.2.2 Operational Requirements

The air-conditioning is required for critical applications i.e. for maintaining the temperature of the critical telecom equipment inside the shelters on 24hours, 365 days of the year operation basis. Thus, to provide redundancy for such critical applications, Contractor shall offer twin circuit air conditioning system comprising of two air conditioning units packed in a single frame working in conjunction, controlled by the single inbuilt Micro processor based controller for desired operation.

Depending upon the size and location of shelter, following type of air conditioning systems shall be supplied:

- i) 2X2TR capacity air conditioning system with free cooling unit
- ii) 2X2TR capacity air conditioning system without free cooling unit
- iii) 2X1.5TR capacity air conditioning system with free cooling unit
- iv) 2X1.5TR capacity air conditioning system without free cooling unit

Both units shall be independent of each other. The units shall run one by one in pre settable time bound cyclic ON/OFF mode. However, during running of AC unit 1, if the inside temperature of the shelter reaches to a predefined value, the AC unit 2 shall also start running to maintain the oC. inside temperature to specified 24 After achieving this temperature, the other unit shall again shut off.

Problem/ fault in one of the unit shall not hamper the working of other unit and during such fault in any of the unit; the alternate unit shall take over and continue to operate till the faulty unit is operational again.

Both units shall never start at the same time. If the condition is such that both units shall start together then internal time delay of at least 10sec shall be provided in starting of each unit to avoid surge.

In free cooling mode, the refrigerant cycle of AC unit shall be switched off and outside air (after filtration) shall be circulated inside the conditioned space through the operation of dampers provided with suitable sensors. It should be possible to run the Free Cooling Unit (FCU) on both AC & -48V DC Power supplies. This mode shall come into operation in the following conditions;

- i. When the ambient temperature is below a preset value, which is to be decided during detailed engineering.
- ii. In case of failure of refrigeration system of both the units.

The failure of free-cooling feature shall not hamper the normal operation of Air Conditioning units.

3.2.3 Operational Life

The air conditioning system to be supplied shall have operational life of 10 years. These air conditioning systems shall be installed in telecom shelters on pan India basis in climatic conditions prevailing in India.

3.2.4 Construction

The air-conditioning system shall be completely self-contained, consisting of two AC units of rated capacity, their components and a common microprocessor based controller in a powder coated single cabinet. The color of the cabinet shall be finalized during detailed engineering. The system shall be assembled, wired, piped, charged with refrigerant, and fully factory tested to ensure trouble free installation and start-up. Each AC Unit shall be so placed inside the cabinet so that it could be maintained/repaired/ taken out from the cabinet without affecting the running of the other unit. The body of the cabinet shall be rust proof.

3.2.5 Layout

The layout of air-conditioning system shall be finalised during detail engineering to have a better circulation of the air inside the shelter to avoid any hot air pockets.

3.2.6 Codes & Standard

The design, manufacturing, inspection and testing of the air-conditioning system shall comply with all currently applicable statutes, regulation and safety codes in the locality, where the equipment are to be installed. The equipment shall conform to the latest edition of IS: 8148 with suitable provisions for the offered type of air-conditioning system.

3.2.7 Design

The air-cooled self contained package AC system shall be designed as per following conditions:

- Rated Capacity : 1.5TR/2TR
- Type of Discharge : Free Flow.
- Air inlet Temp (Return Air) : 24 0C (DB) RH : 50 0C
- Temperature Variation allowed : $\pm$ 1 0C
- Ambient Air Design Temp : 45 (entering the Condenser)
- No. of Refrigeration Circuits : Two
- Type of load Factor : High sensible heat load (SHR>0.9)

3.2.8 Required Features of various components

Both the compressors of twin circuit air conditioning system shall be hermetically sealed Scroll type of reputed make, very reliable, trouble free and long operating life. Both Compressors shall be installed on vibration isolated mountings or manufacturer's recommended approved mounting. Valves shall be provided for charging / topping up of refrigerant. The Bidder shall furnish the details of their compressors indicating the MTBF, life of the compressor and continuous run time of the compressors without failure. The Contractor shall also furnish details of all accessories i.e. refrigeration system, evaporator coil, condenser coil, evaporator blower, filter, cabinet, indoor supply and return grills etc during detail engineering. All compressors shall have minimum 5 years Warranty from the date of commissioning

3.2.9 Micro processor based Controller

The air conditioning system shall have a common microprocessor based controller for both AC units, packed within the same cabinet. The microprocessor based controller shall have the following features;

Controller	Common for AC1+AC2
Mode of Operation	RUN/TEST/ Standby mode
Temperature Setting	16 -30 deg. C with 1 deg C resolution
Temperature variation from set temperature:	$\pm 1^{\circ}\text{C}$
Cycle Time, Duty Changeover	2, 4, 6, 8, 10, 12 hours.
Unit Changeover	Both the AC units shall operate in pre-settable cyclic mode. Also, if one unit is faulty the controller shall be able to detect & put the other unit in operation automatically.
Running of both units:	Start of II nd unit along with Ist unit in case sensor senses high temperature.
Memory	Non-volatile memory for various settings supported by Battery backup eg. Set temp., working hours & ON / OFF Status
Alarms Displays:	Signals to be given to the telecom equipment panel through potential free dry contact as a local alarm for its remote monitoring in the control centre/NOC - AC unit1 fails alarm - AC unit2 fails alarm - High Temp inside shelter alarm - Power Fail alarm - Indication for free cooling In addition to the above, following minimum LED Indications shall also be available in the Controller Mimic Panel for local indication; - Alarm. - Power Healthy. - Blower Working. - Compressor Working.
Time Delay	On / Off sequence delay shall be available.
Cumulative hours run	For each compressor of Air-conditioning system
Free Cooling	Operates the blower fans & changeover damper position to circulate outside air.
Enthalpy/Temperature Sensor	: As required along with free cooling.
Further, the free cooling function may be enabled/ disabled with help of the controller.	

3.2.10 Earthing

The AC equipment shall be properly earthed by connecting it to the earthing system.

3.2.11 Power Supply

The offered air-conditionings equipment shall work satisfactorily for the power supply range as mentioned at mentioned below:

Nominal Voltage: 230 V (Single phase) Variations: $\pm 10\%$ System frequency: 50 Hz ($\pm 5\%$)

Supply and installation of all required cabling, wiring and termination and accessories including surge arrestors, motor starters, circuit breakers and switches from the power supply point/ Meter point to the various units via ACDB shall be carried out by the Contractor.

3.2.12 Testing

a) Type Testing

The type testing of the air-conditioning system shall conform to latest IS: 8148 standards.

b) Factory Acceptance Testing

The factory acceptance testing shall be carried out as per latest IS: 8148 standards.

c) Site Acceptance Testing (SAT)

The site acceptance testing for air-conditioning system shall be carried out by the Contractor after successful installation of the air conditioning system. The SAT shall demonstrate all its functions properly. The detailed SAT procedure shall be submitted by the Contractor for Employer's approval.

3.2.13 Installation

The transportation of air conditioning system and its complete installation at respective sites shall be carried out by the Contractor. Entire air conditioning system cabinet containing both the cooling and condensing units (for both the units) shall be kept outside the conditioned area, shall not protrude inside the shelter. Only the supply air/ return air grill area along with microprocessor based controller display shall come into the conditioned space. The support arrangement and associated civil works required for proper installation of the air-conditioning system shall also be provided by the Contractor. The exact cut outs required in the shelters to mount the air- conditioning units shall be taken care properly before installation of the units. The cut outs in the shelters for air-conditioning system shall be properly sealed. The details of mounting and support arrangements shall be submitted for Employer's approval

3.3 Requirements for DG Set

3.3.1 General

The DG sets shall generally be installed on ground and the required RCC/PCC floor shall be provided by the Contractor. Single Phase DG sets of rated capacity without AMF panel are required. AMF panel shall be the part of Power Interface Unit (PIU). Most of these DG sets shall be installed at unmanned sites located in rural/remote villages/towns. The DG set shall have an operational life of 10 years.

3.3.2 Technical Experience

The DG set shall be offered from a manufacturer of Diesel Generator set and Diesel Generator set manufactured by such manufacturer should have been in operation for at least one (1) year as on the originally scheduled date of NOA. Bidder shall furnish the details/document in support of above Technical Experience of manufacturer along with bid.

3.3.3 Generator Set Configuration

The generator set shall consist of a diesel engine directly coupled to an electric generator, together with the switchgear, controls, battery and other associated accessories required to provide continuous electric power for any duration of failure of the normal AC source. The DG sets shall be rated for continuous operation.

3.3.4 Diesel Engine

The Contractor shall provide diesel engines of standard designs of original manufacturers in their DG sets. It shall be from reputed manufacturers i.e. Kirloskar Oil Engine / Cummins / Ashok Leyland / Mahindra / Crompton Greaves / Eicher makes conforming to latest BS 5514/ ISO 3046 standards. The bidder shall submit the details of the engine along with their bid.

The diesel engine shall be direct injection, 4 stroke cycles, multi cylinder, air-cooled/ water- cooled, naturally aspirated/ turbo charged, instantly started, operating at a nominal speed of 1500 R.P.M. and capable of developing requisite Brake Horse Power. In addition, the horsepower rating shall take into account the generator efficiency, losses and maximum rated environmental conditions stipulated in Clause 4.3.19. All moving parts of the engine shall be mechanically guarded in such a manner that a human finger cannot touch a moving part. The diesel engine shall be equipped with a dry type air filter system.

3.3.5 Governor

The engine shall be equipped with class A-1 governor or better as per IS 10000 Part-VII. The speed regulation shall be as per the above governing class.

3.3.6 Engine Cooling

The bidder may offer air-cooled or water-cooled type DG sets. However, no preference / compensation shall be applicable for any particular type of offered DG sets. The cooling system shall provide adequate cooling to the generator set when operated on full load for prolonged periods of time at the maximum environmental conditions stated in Clause 4.3.19. In case of water-cooled engine, necessary breathing arrangement shall be provided with the radiator to take care of the expansion/ contraction of the coolant water in the radiator.

3.3.7 Fuel System

The engine shall operate on a commercial grade diesel fuel; no premium fuel shall be required. The DG set shall be provided with inbuilt fuel storage tank with capacity to last 12 hrs on 100% load. The fuel tank shall be so mounted within the enclosure that it shall be possible to refill the fuel while DG is running and shall have a lockable cap to prevent unauthorised access. The fuel tank shall be provided with suitable stopcock towards the fuel supply lines to engine. The tank shall have overflow pipe, air vent pipe with air filter, drain pipe & fuel level indicator. It shall be equipped with low level fuel alarm potential free contacts for connection to the Equipment NMS system.

The engine shall be equipped with necessary fuel filters, fuel pumps, fuel lines, and fuel shut-off valves necessary to supply the diesel fuel to the engine under the environmental conditions stated in Clause 4.3.19. Braided high pressure tubes shall be used for connections to the engine, fuel tank, and where necessary to endure proper connection for engine and generator set vibrations.

The Contractor shall also indicate the fuel consumption of the offered DG sets at 25%, 50%, 75% and 100% of rated loads along with their bid in the DRS format.

Fuel required to carry out all kind of tests including site acceptance tests shall be supplied by the Contractor.

3.3.8 Exhaust System

The DG set shall be provided with a suitable exhaust system capable of carrying exhaust gases from the engine and dissipate them to the atmosphere as quickly and silently as possible meeting the latest noise and emission norms of CPCB. The exhaust system shall be equipped with proper heat shielding to protect personnel and facilities.

3.3.9 Starting System

The engine shall be equipped with an electric starting system with a 12/24 volt heavy duty lead acid battery of suitable AH capacity sufficient to provide a minimum of twelve (12) successive abortive starts of the engine without recharging. A suitable battery charger complete with voltage regulator, float or booster selector switch, on-off switch, digital voltmeter and ammeter shall be supplied (along with the battery) for charging the battery from mains. The battery charging system shall operate on an input of 240 V AC, 50 Hz from the ACDB. The battery shall be housed within the DG enclosure suitably.

The engine control shall provide for multiple crank start-up cycles. Each cycle shall be approximately 10-seconds of cranking followed by 10-seconds of rest. The starting circuit shall automatically be disconnected after the start up of the engine. If the engine does not start after three (user adjustable number) attempts, the starting circuit shall be disabled and an alarm indication ("over crank") shall be provided. A potential free contact shall be provided to interface these alarms with the Equipment NMS. The starting time of the DG set in 'AUTO' mode shall be continuously and linearly adjustable from 5 minutes to 8 hours from the time of power failure sensing. The starting of DG set shall be based on the condition of the 48V DC battery voltage (being used for telecommunication equipment) and temperature inside shelter. For this purpose, the required auxiliary contacts from DC power supply system shall be available in DCPS cabinet and for sensing temperature inside shelter, the required thermostat shall be provided by the DG Contractor. The exact time setting and other settings of DG start up shall be finalised during site acceptance on site-to-site basis based on the actual site conditions.

3.3.10 Instrumentation and Controls

The Employer shall procure DG sets with the capability to extend the controls to external PIU unit equipped with AMF control panel. The microprocessor based AMF (Automatic Mains Failure) panel shall be equipped with standard instrumentation including interlock and protection arrangement, suitable annunciation and indications etc. for proper start up, monitoring, control and safe operation of the DG set. The AMF shall start the DG set in case of AC mains failure and transfer the load from normal source to diesel generator without any human intervention. Similarly on restoration of mains supply it shall be able to transfer the load to mains supply and switch off the DG automatically.

The AMF panel shall be equipped with following minimum instrumentation:

- a). Microprocessor based relay with composite meter for digital display of;
 - i. AC mains Voltage & Generator Voltage
 - ii. Generator Current
 - iii. Power Factor
 - iv. Output KW meter
 - v. Output AC frequency meter
 - vi. RPM indication
 - vii. Over speed indication
 - viii. Engine hours indication (Cumulative)
 - b). Mode selector switch for setting the panel on any one position such as OFF or Auto/ Manual/ Test. The operation of the DG set shall be possible in any of the modes.
 - c). Engine ON/OFF switch (Push button type)
 - d). Emergency Stop switch (Push button type)
 - e). ON delay timer for load change over.
 - f). ON delay timer for engine shut off.
 - g). Indicating lamps to indicate 'Mains ON', 'Load on Mains', 'DG Running', 'Load on DG', 'Battery charger ON'
 - h). Audio visual alarm for
 - i. Low lubricating oil pressure
 - ii. High water temperature (for water cooled DG)
 - iii. High cylinder head temperature (for air cooled DG)
 - iv. Start failure v. DG over load.
 - i) Suitable battery charger complete with voltage regulator, float or booster selector switch, on-off switch, digital voltmeter and ammeter for charging the battery from mains operating 240V/ 50 Hz
 - j) MCCB of suitable rating.
 - k) Two no. contactors of suitable ratings (one for DG set and one for AC mains) with overload relay.
 - l) Under voltage relay for Mains.
 - m) Instrument and control fuses.
 - n) Any other switch, instrument, relay or contactor etc. essential for smooth and trouble free functioning of DG set with AMF panel. (To be specified by the bidder with complete detail of the item). Standard colour codes and numbered ferrules shall be used for wiring the AMF panel. Sensing and control relays shall be of continuous duty, industrial control grade type. The transfer breaker shall be rated for continuous duty. The breaker shall be interlocked to ensure non-paralleling SEB power supply and DG supply.
- Following automatic shut down protection system for DG set shall also be integrated in the control panel;
- Low lubricating oil pressure shut down.
 - High coolant (water) temperature shut down.
 - Engine over speed shut down.
 - Over load shut down.
 - Short Circuit shut down.
 - Over Voltage shut down
 - Low Fuel Level
 - Earth Fault shut down.
 - Emergency Stop

The AC mains supply shall be of either single Phase or three Phase. The loads connected shall be single phase in nature.

3.3.11 Alternator

The Contractor shall supply alternators in their offered DG sets only from the reputed manufacturers i.e. Crompton-Greaves / Kirloskar / FG Wilson / ELGI / KEL makes as per latest BS 5000/ IS 4722 standards. Details of alternator shall be submitted by the Contractor along with the bid.

The alternator shall be self excited, self regulated, screen protected, double bearing, brushless type, drip proof, continuous duty type, synchronous and suitable for 1500 RPM. 0.8 P.F lagging, horizontal foot mounted, with class H insulation.

The alternator shall also have a solid state type Automatic Voltage Regulator (AVR) suitable for single running with control limits of 1% from no load to full load under normal load changes. It shall be of static type and complete with cross current compensation. The regulator shall be provided with voltage adjusting potentiometer and shall be complete with all alarm contacts, internal wiring etc.

The alternator shall be capable of carrying 50% overload for a duration of one minute.

The alternator shall be suitable for 20% over speed for two minutes.

The alternator shall be capable of carrying 10% overloading for one hour in any period of 12 hrs running without injury.

3.3.12 Mounting Arrangement

Engine and alternator shall be mounted on a common MS fabricated base frame with anti vibration pads.

3.3.13 DG set Enclosures

a) A suitable weather-proof enclosure which shall be provided for protection from rain, sun, dust etc. Further, in addition to the weather proofing, acoustic enclosures shall also be provided such that the noise level of acoustic enclosure DG set shall meet the requirement of MOEF The diesel generator sets should also conform to Environment (Protection) Rules, 1986 as amended. The enclosure shall allow sufficient ventilation to the enclosed D.G. Set so that the body temperature is limit to 50°C. The air flow of the exhaust fan shall be from inside to the outside the enclosure. The exhaust fan shall be powered from the DG set supply output so that it starts with the starting of the DG set and stops with the stopping of the DG set. The enclosure shall have suitable viewing glass to view the local parameters on the engine.

b) Fresh air intake for the Engine shall be available abundantly; without making the Engine to gasp for air intake. A chicken mess shall be provided for air inlet at suitable location in enclosure which shall be finalized during detailed engineering.

c) The Enclosure shall be designed and the layout of the equipment inside it shall be such that there is easy access to all the serviceable parts.

d) Engine and Alternator used inside the Enclosure shall carry their manufacturer's Warranty for their respective Models and this shall not degrade their performance.

e) Exhaust from the Engine shall be let off through Silencer arrangement to keep the noise level within desired limits. Interconnection between silencer and engine should be through stainless steel flexible hose/ pipe.

f) All the Controls for Operation of the D.G. Set shall be easily assessable. There should be provision for emergency shutdown from outside the enclosure.

g) Arrangement shall be made for housing the Battery set in a tray inside the Enclosure.

3.3.14 Construction Features:

a) The enclosure shall be fabricated from at least 14 Gauge CRCA sheet steel and of Modular construction for easy assembling and dismantling. The sheet metal components shall be pre-treated by Seven Tank Process and Powder coated (PURO Polyester based) both-in side and out side – for long life. The hard-ware and accessories shall be high tensile grade. Enclosure shall be given a lasting anti-rust treatment and finished with pleasant environment friendly paint. All the hardware and fixtures shall be rust proof and able to withstand the weather conditions. b) Doors shall be large sized for easy access

and provided with long lasting gasket to make the enclosure sound proof. All the door handles shall be lockable type. c) The suitable material of required density and thickness shall be used with fire retardant thermo – setting resin to make the Enclosure sound proof as per CPCB standards. d) Points for Neutral/Body earthing shall be available at two side of the enclosure with the help of flexible copper wires from alternator neutral, and electrical panel body respectively. The earthing point shall be isolated through insulator mounted on enclosure.

3.3.15 Main Circuit Breaker of DG

The DG set shall be connected to the Input ACDB buses through main circuit breaker (MCCB type). Separate cables from DG set to the breaker shall be laid to extend DG power supply.

3.3.16 DG Set Mode of Operation

Operation of DG set shall only be allowed when the selector switch is in the Manual/Automatic/Test positions. Moving the selector switch to the OFF position shall properly shut down the generator set, remove it from the AC loads and inhibit it from starting in any mode. The DG set shall be capable of operation in the following modes;

- a) Start Operation
 - i. Auto Mode
 - ii. Manual Mode
 - iii. Test Mode

- b) Auto Mode

In the ‘AUTO’ mode, the DG Set shall start only after a set time delay when either the primary AC source has failed or conditions prevail as indicated below;

When the main source power fails, the DG set shall include detection and control to automatically disconnect the primary AC source, start the DG set and extend power to ACDB after the set time period of the timer. The time delay is continuously & linearly adjustable at site from 5 minutes to 8 hours as specified at Clause 5.2.6. The engine shall also start automatically after detecting a predefined temperature (20 oC to 55 oC continuous) inside the shelter or initiation from 48V DC under-voltage contact from DCPS. All required control like thermostat, extension of potential DC under-voltage contact from DCPS shall be provided by the Contractor to support the above controls.

All phases of primary AC sources voltage shall be monitored. The automatic start-up system shall detect failure or abnormal conditions specified and start the generator set. At the time of loss of primary voltage or an abnormal condition of low phase voltage, a start control shall be initiated. The automatic start shall try the start-up of the generator set for three successive attempts. If the primary AC returns during the start-up attempt, the start-up sequence shall be stopped.

If at any time during operation of the generator set the selector switch is set to ‘OFF’ position, the generator shall shut down and be disabled from starting.

- c) Test Operation

A test operation of DG set shall be possible by putting the control switch in “TEST” position from where the generator shall initiate an automatic start, just as if there had been a power interruption to the primary power. Upon removal of the selector switch from “TEST” position, the generator shall initiate an automatic shutdown sequence. However, there shall be interlock such that Main circuit breaker of DG set is in ‘OFF’ condition while the engine is started in “TEST” position.

- d) Manual Operation

When the control switch is in “MANUAL” position, the generator set can be started using the manual start push-button on the control panel. The generator set will be stopped by setting the control switch back to the “OFF” position or by pressing stop button on the AMF panel. During manual operation, all main and AC source breakers must be operated manually to transfer load to or from the generator set.

- e) Automatic Shutdown

When the primary power is restored and remains normal continuously for a period of 5 minutes (locally user adjustable from 0 to 15 minutes), the load will be switched over from DG set to primary power and the generator shall be automatically stopped and be enabled for another future start-up request.

3.3.17 Remote and Local Monitoring

The DG set shall be capable of being monitored from remote as well as local.

a) Visual Annunciation

The following minimum visual annunciation shall be provided for DG set shut down due to:

(i) Low fuel level (ii) Engine failed to start (failed to start in 60 sec. after receiving the first start impulse)

b) Remote Monitoring

The above parameters shall also be monitored remotely through telecom equipment NMS or any other independent remote monitoring arrangement. Suitable potential free dry contacts (NO) for this purpose shall be provided by the Contractor. The contractor shall do all the required wiring for such purpose.

3.3.18 General Requirements

The DG sets shall be generally installed at outdoor positions near to the shelter locations. The DG sets shall be installed either on ground near to Shelter installed at ground or on rooftop near to shelter installed at roof top. However, in some cases, the DG sets may be installed on ground and shall be connected to shelter installed on rooftop. The exact requirement shall be finalised during detail engineering based on actual site conditions.

a) Mounting and Installation

The generator set shall be skid mounted using anti vibration pads. At some locations, DG set may be installed on the rooftop. The required RCC floor/ PCC pedestals shall be provided by the Contractor.

b) Earthing

The Contractor shall suitably connect the DG sets with the integrated earthing system being provided by the Contractor under this package. The neutral of alternator shall be earthed separately.

c) Trenching

The Contractor shall prepare necessary cable routes for installing cables and earthing system from DG set to the shelter and earthing pits. The cables shall always be installed inside the GI pipes of suitable size embedded properly with PCC finish. In case the DG set is installed on ground and the shelter is installed at roof top, the necessary cable trenching/ GI pipe shall be provided from DG set to the building ground from where the cables shall be installed in the wall of the building. The cable trays with proper cover and supports shall be provided from bottom of the trench at the ground near the building up to the shelter installed at the roof top. The Contractor shall submit the detail drawings for the same for Employer's approval.

3.3.19 Operating Environment

The generator sets shall operate within the following ambient environmental requirements:

(a) Operating temperature range: +2°C to +50°C

(b) Maximum relative humidity at 23°C of 95% (non-condensing)

(c) In non-filtered air containing a high proportion of dust

(d) In a corrosive atmosphere (at high humidity)

(e) At altitudes of up to 500 metres above sea level

(f) The equipment must withstand mechanical vibrations as defined in the IEC 68-2-6 test requirements.

3.3.20 Cables and ACDBs

All cables of required size and ratings for proper functioning of the DG set including all accessories shall be supplied, installed and terminated by the Contractor.

a) AC Distribution Boards

The contractor shall provide AC Distribution Boards associated with each system. The AC distribution boards shall distribute power to the equipment and provide protection against failures on feeder circuits. Generally, ACDBs shall be part of Power Interface unit (PIU), however, at few locations, Standalone ACDB shall be required where PIU is not required. ACDBs shall be wall mounted enclosure/panel as finalized during detailed engineering. They shall have indicating lamps and voltmeter to indicate three phase voltage on the bus.

The MCCB and sub-assemblies shall be easily replaceable and maintainable. The MCCBs of requisite ratings must conform to IEC-60947-2 and IS 13947-2/IEC 60947-2. All MCCBs shall provide over-current, short circuit protection and coordinate with associated breakers in upstream & downstream such that faults are cleared reliably with discrimination.

The contractor shall extend safety earth connections from Input ACDB panel & Output ACDB panel to nearest earthing system being provided under this contract.

3.3.21 Testing of DG sets

a) Type Test

The Contractor shall submit the earlier carried type test reports for the engines, Alternator & enclosure of the offered DG sets for the highest rating of offered DG set as per the latest relevant IS standards for Employer's approval. The type tests on Alternators shall be carried out as per Table 5.10(a) as given below.

b) Factory Acceptance Test

A complete DG set shall be assembled and installed at factory as being envisaged at site and shall be run to check proper installation and assembly of all items of the DG set. It shall demonstrate all specified design features and functional requirements as per specifications, for adopting the same at sites. Manufacturer's internal test reports of Alternators for each DG set shall be submitted during FAT.

Table-3.3(a) List of Tests for DG Set

SNo.	Test	Type Test	Factory Acceptance Test	Site Acceptance Test
A. ALTERNATOR				
1.	Measurement of resistance	√		
2.	Regulation test	√	√	√
3.	Measurement of open circuit characteristics	√		
4.	Measurement of short circuit characteristics	√		
5.	Efficiency test	√		
6.	Temperature rise test	√		
7.	Occasional excess current test	√		
8.	Over speed test	√		
9.	Insulation resistance (both before & after high voltage test)	√		
10.	High Voltage test	√		
11.	Determination of deviation of voltage waveform sinusoidal	√		
Note : All the above tests as per IS: 4722				
B. DG Set (including Alternator)				
1.	Noise and vibration test	For all		√
2.	Load Test	Type tests	√	√ (Note)
3.	Functional tests on control panel, starting provision AVR and speed governor		√	√
Note: SNo. 1 above: As per standard IS 12065/12075.				
1) During FAT, Load test shall be conducted on each rating of DG sets before dispatch to site as follows:				
a) No load test for 15 minutes				
b) 100% Load test for 8 hrs				
c) 110% load test for 1 hr				
2) During SAT, 6 hours load test shall be carried out with existing load.				
3) The Oil consumption, governing, noise and vibration shall be recorded during the testing period.				
Further during above test, AMF panel associated with highest rating DG set shall be integrated to check all the functional requirements and other requirements as per technical specifications.				
---End of Table---				

c) Site Acceptance Test

After successful installation of the DG set, Site Acceptance Testing for each DG set shall be carried out at respective site. The total installed system in power up condition shall be tested for the specified functional requirements. The minimum requirements for SAT are given in Table 4.3(a) above. The timer setting for automatic DG set starting after normal power supply failure and for automatic shut off

after restoration of normal supply shall be done at each site based on the actual site conditions. The detailed SAT procedure shall be submitted by the Contractor for Employer's approval.

3.3.22 Marking

The following information shall be provided on each DG sets:

- a. POWERGRID and its logo
- b. DG Set location name
- c. Identification no.
- d. Year of Manufacture
- e. DG set dimension I. DG set weight
- f. KVA rating, HP Rating
- g. Voltage, Per phase current

3.4 Requirement of Integrated Power Management System (IPMS)

Integrated Power management system (IPMS) shall be consist of Micro controller based true RMS Static Voltage Regulator (SVR), SMPS based DCPS Charger and AMF panel for DG control, etc. in the single unit to ensure the regulated supply to Air-Conditioners and DC supply to Telecom equipment and manage all the components automatically to maximize the utilization of the site resources with maintaining the site up time.

Integrated solution shall be designed for the energy sources from Grid, Battery and Diesel Generator (DG). The Controller of IPMS has wide range of battery charging current limit and shall be suitable for both Li-ion battery and VRLA battery charging. Battery should be charged with a higher current if Grid is available and limit the charging current if the site is on DG so as to protect the DG getting over loaded.

The IPMS shall be installed indoor or outdoor. The ingress protection for indoor & outdoor cabinet shall be minimum IP-20 and IP-55 respectively.

The IPMS in all the locations may be installed in an uncontrolled atmosphere and the ambient temperature may vary from min 0°C to 50°C, and maximum humidity of 95% (non- condensing). The IPMS will operate without any degradation of performance throughout range of the ambient condition so specified.

The SMPS based DCPS Charger shall be designed for ultimate capacity in the offered IPMS. The rating of SVR shall be as specified in the BOQ. AMF Panel and phase selector along with Distribution/Switching/ Alarm unit, contactor/fuse/ MCBs/wiring etc. shall be provided for the ultimate capacity. For DCPS, bus-bar should be sized for ultimate capacity, however, wiring, circuit breaker, fuse etc for Load and battery path shall be kept minimum 70% of ultimate capacity.

The IPMS has also provision to integrate external Single Phase/Three phase DCPS (up to 300A rating) supplied under this contract or existing available at site as redundancy of DC supply. At site all input AC source (EB/DG) connection will be terminated in IPMS. In case of failure/Shutdown of IPMS, AC mains (EB/DG) supply to external DCPS should not be interrupted.

The IPMS shall have an operating life of not less than 15 year.

3.4.1 Technical Experience

The IPMS shall be offered from a Manufacturer who has been manufacturing IPMS units for the last two (2) years and at least 10 nos. of IPMS units manufactured by such manufacturer should have in satisfactory operation for at least one (1) year as on the originally scheduled date of NOA.

The Bidder shall furnish the details/document in support of above Technical Experience of manufacturer along with bid.

3.4.2 System Configuration

IPMS unit shall consist of following subsystems integrated in a single cabinet suitable for indoor and outdoor installations.

- a) SMPS based DCPS Charger
- b) Static Voltage Stabilizer (three to one)

- c) Main controller modules with inbuilt SNMP
- d) AMF Panel and DG control and protection system
- e) Healthy phase selector
- f) Lighting & Surge Protection
- g) Smoke and fire detector
- h) High temperature sensor device
- i) Input cabling and AC & DC termination

a) SMPS based DCPS

SMPS based rectifier is intended to be used in Auto Float-cum-Charge mode as a regulated DC Power source in the IPMS. The system employs Switched Mode Rectifier (FR/FC) in a modular configuration for flexible provision of DC power. The contractor shall provide minimum two nos of rectifier modules to achieve ultimate capacity

Description	Specification
Input MCB	For Individual Modules of suitable rating.
Output	-42 to -57V
Low Voltage Disconnection Provision	Provision for disconnection of Non- Priority load in case of low battery voltage
Current Limit in Battery Path	Required. Should be settable through Controller.
Short Circuit Protection	Required
Output Voltage Measurement	Required
Output Current Measurement	Required
Battery Current Measurement	Required
Battery Temp Measurement	Required
Battery Temp Compensation	Required
Float/ Equalize Mode	Required
Battery Test Function	Required
Charge Equalization	Required (settable)
Battery health monitor and charging Current limit.	Required (settable)
Energy Efficiency Mode for Rectifier modules by switching ON / OFF rectifier modules automatically depending upon load.	Required.
Efficiency (25% to 100 % load)	Not less than 90%

b) Static Voltage Stabilizer (three to one)

SVR shall be used for air-conditioner, lighting and other AC loads. Technical requirements are given below:

Description	Specification
Control System	Micro Controller based static voltage regulator in sync with control system of IPMS
Rated input voltage range	240 - 480(L-L), AC

Description	Specification
Rated Output Voltage	220 V $\pm$ 10%, AC
Input Frequency Range	47-53 Hz
Total Harmonic Distortion (THD) % of Voltage/Current	<3%
efficiency on complete voltage range of 240 – 480 volts and at loading : 25 to 100 % load	>95%
Response Time	<10 millisecond
Protections:	
Voltage protection at incoming power input	Required
Voltage protection at SVR output	Required
Current protection at SVR output	SVR should have overload protection.
Additional Protection	i. SVR bypass under healthy phase condition ranging 195-245 with 15 v hysteresis.

c) Main controller modules

Micro controller	IPMS system Shall have high end central 32 / 64 bit controller with Real time Operating System. Able to measure true RMS for all voltage & current, all the inputs to the measurement board shall be duly protected against surge IEC standard 61643-2009-1 including protection of all electronics cards and boards. The measurement circuit shall be rated at least twice of the maximum input range. All critical setting of IPMS controller shall be through authorised user having password protection.
Time	Real time & date-programmable
Event logs	Last 500 events (minimum) for data analysis of complete IPMS data log for critical and recordable data including major alarms, energy data etc. The same shall be downloaded in excel format.
Local Configuration	Support Minimum Ethernet and USB interface
Energy measurement	• Shall be able to measure the DG energy (Cumulative KWH Hrs) • Shall be able to measure EB energy(Cumulative KWH Hrs) • Shall be able to measure Battery energy(Cumulative KWH Hrs) • Shall be able to store data of DC energy meter. • EB and DG cumulative running Hours and KWH for each calendar month/Daily to be recorded for last 2 month.
Smoke sensing and Actuation	The controller should ensure the complete input (mains and DG) shutdown of IPMS in case of fire/smoke alarm. The actuation shall be with latch-able and require physical hard reset and fault acknowledgment at IPMS.
IPMS Enclosure Temperature alarm management	Required (Settable)
LCD display of controller module	It shall display various site conditions like Mains ON, DG ON, Smoke/ Fire Alarm, Over Load, Charger MODULE fail, DG Fuel Low, DG fail to start, DG fail to stop, Alternator fail, LLOP, DG overload, Mains Fail, Site battery low, DG battery low, HCT/HWT, High Shelter temperature etc

In the IPMS, contractor shall integrate and extend the Potential Free Contacts for monitoring through NMS for following minimum alarms;

- i) Mains Fail
- ii) Door Open
- iii) High Room Temperature
- iv) Battery Low
- v) Rectifier Fail
- vi) Fire and Smoke
- vii) DG Fail to Start
- viii) LLOP
- ix) Fuel Low
- x) DG ON LOAD
- xi) DG ON
- xii) HCT/HWT
- xiii) DG Over speed
- xiv) DG Fail to Stop

d) Automatic Mains Failure Panel (AMF Panel) and DG control and protection system

The IPMS unit shall support AMF panel for integration with DG set. The capacity of AMF panel shall be as per ultimate capacity of IPMS. The AMF shall start the DG set and transfer the AC load from normal source to diesel generator automatically in case of AC mains failure without any human intervention. Similarly on restoration of mains supply it shall be able to transfer the load to mains supply and switch off the DG automatically. Provision for a suitable delay shall be kept for starting of DG and changeover of load between DG & Mains. The AMF shall be site configurable for single and three phase generator options. Default arrangement shall be done considering single phase DG. The IPMS

shall be equipped with suitable instrumentation, interlock and protection arrangement, suitable annunciation and indications for proper start up, monitoring, control and safe operation of the DG set. There shall be a power based over load protection in the DG path. Load on DG shall be dynamically controlled to ensure optimum utilization of capacity

An option for selection of Auto / Manual Mode operation should be provided on the front panel of the IPMS. Operation (Start / Stop) of the DG set in manual mode should be available on the IPMS. In manual mode, AMF logic will be totally bypassed. However during manual mode, the DG protections will not be bypassed. A change over switch shall also be provided for total bypassing the AMF.

The AMF panel of IPMS shall be equipped with following minimum instrumentation:

- a. Microprocessor based controller with composite meter for digital display of:
 - i. AC mains Voltage & Generator Voltage
 - ii. Generator Current
 - iii. Output KW meter
 - iv. Output AC frequency meter
 - v. RPM indication/frequency measurement
 - vi. Over speed indication
 - vii. Engine hours indication (Cumulative)
- b. Mode selector switch for setting the panel on any one position such as Auto/ manual/ Test. The operation of the DG set shall be possible in any of the modes
- c. Engine ON/OFF switch (Push button type)
- d. ON delay timer for load change over.
- e. ON delay timer for engine shut off.
- f. LED to indicate 'Mains ON', 'Load on Mains', 'DG Running', 'Load on DG', 'Battery charger ON'
- g. LED indication alarms for:
 - i. Low lubricating oil pressure
 - ii. High water temperature (for water cooled DG)
 - iii. Start failure
 - iv. DG over load
- h. Suitable DG battery charger complete with voltage regulator, on-off switch, digital voltmeter and ammeter for charging the DG battery from 48VDC Operated.
- i. MCCB of suitable rating
- j. Contactors of suitable ratings for DG set and AC mains.
- k. Under voltage relay for Mains.
- l. Any other switch, instrument, relay or contactor etc. essential for smooth and trouble free functioning of DG set with AMF panel. (To be specified by the bidder with complete detail of the item).

Standard colours codes and numbered ferrules shall be used for wiring the AMF panel. Sensing and control relays shall be of continuous duty, industrial control grade type. The transfer breaker shall be rated for continuous duty. The breaker shall be interlocked to ensure non-paralleling SEB power supply and DG supply.

Following automatic protection system for DG set shall also be integrated in the control panel of IPMS;

- Low lubricating oil pressure shut down.
- High coolant (water) temperature shut down.
- Engine over speed shut down.
- Over load shut down.
- Short Circuit shut down.
- Over Voltage shut down /Alternator Fail
- Low Fuel Level /Alternator Fail
- Emergency Stop

e) Healthy Phase selector

- IPMS system should have Healthy Phase selectors for SVR Section. All Input AC source (EB/DG) connection will be terminated in IPMS, However, appropriate termination shall also be provided to

external power plant up to 300A (Single phase/Three phase) through the IPMS . IPMS shall automatically changeover power supply to External DCPS as per availability.

- IPMS system should work automatically on 3 phases, 2 phases and Single phase with neutral, in the sequence of 3/2/1 phase as per availability.

f) Lighting & Surge Protection

The IPMS shall be equipped with lightning and surge protection devices to provide protection to all the equipment being connected and integrated against incoming lightning and low voltage surges.

The protection system for both the above stages shall be reusable after clearance of surge. In case of fault, provision for manually bypassing the protection system should be available to ensure the operation without protection system. The manufacturer shall give complete details of the arrangement provided for the purpose during detail engineering.

Class B Protection:

- KEMA/VDE/UL/CE/TUV certified class 1/Type 1(Class B) pluggable protection devices, using encapsulated metal spark gaps, having safe and fire proof operation as per IEC 61643-1:2005 or EN 61643-11:2002+A11 :2007 test standards for discharge of direct lightning strikes and also during sustained high voltage. The device should have mechanical visual indication indicating the health of SPD.

Between Requirement R, Y, B & N $I \geq 25$ kA, $10/350 \mu\text{S}$ for each phase imp N & PE $I \geq 100$ kA, $10/350 \mu\text{S}$ imp I = Value of Lightning Impulse Current imp

- Shall be capable to coordinate directly with Class II/Type 2 (Class-C) arrester.
- During neutral shift or abnormally high voltage in neutral, device should not catch fire.
- Response Time: ≤ 100 ns (L-N & N-PE)
- Short circuit withstand and follow up
- current extinguishing capacity without back up fuse (Isc): 25 KA rms
- Operating Voltage Range: 120-300 VAC
- Technology: Single Spark Gap / Single Block MOV / Single Spark gap & Single MOV
- Indication: Required

Class C Protection:

Between Requirement R, Y, B & N $I \geq 10$ kA, $8/20 \mu\text{S}$ for each phase n N & PE $I \geq 20$ kA, $8/20 \mu\text{S}$ n I = Value of Nominal Discharge Current n

- Class C protections needs to be installed at the distribution bus bar. It should be installed to take of protection at both EB and DG paths.
- KEMA/VDE/UL/CE/TUV certified, pluggable with visual indication showing the health of SPD.
- During neutral shift or abnormally high voltage in neutral, device should not catch fire.

Class D Protection:

- Class D surge protection at Rectifier module level

g) Smoke and fire detector

The contractor shall provide smoke and fire detector device inside cabinet for avoiding fire and any damages inside IPMS.

Smoke detector	Photoelectric type installed in IPMS cabinet only for enclosure fire
Operating voltage	48 VDC
Compliance	with BS 5839 Part – 4

h) High temperature sensor device

The IPMS should have high temperature sensor device inside cabinet for thermal Management.

i) Input cabling and AC & DC termination

System Input cabling should be 3 Phase 4 wire System with earth ensuring appropriate cable rating internally considering safety factors, bolted termination for external cable correction, working space and input cable armoured earthing.

Depending upon the system requirements and manufacturer's design, All IPMS racks shall be provided with a distribution/switching/Control and Alarm unit (arrangement) for the ultimate system capacity.

The unit shall comprise of the following:

- i. Termination for the batteries (VRLA/lithium)
- ii. Termination for the load.
- iii. Interconnecting arrangement for power equipment.
- iv. Battery switching Arrangement (Connection to/isolation from system)
- v. Termination for AC input to the IPMS.
- vi. Termination for AC and DC to modules.
- vii. Termination for DG set.
- viii. Termination for external DCPS
- ix. Circuit breakers/fuses etc.

j) ACDB for load distribution

There shall be AC distribution panel for termination of the load. The Air conditioners, lighting system, etc. shall be connected to this AC distribution panel through suitable MCBs. The ratings of the MCBs shall be selected to provide safe and continuous operation of the IPMS system.

ACDB 2x63A, 2x32A, 2x16A, 2x10A, 2x6A rating MCBs

k) DCDB for load distribution

DC distribution shall be provided with adequate number of feeders and appropriate MCBs of different rating for termination of the load in the suitable DCDB. The DCDB shall be wall mounted installed inside shelter and make arrangement for connection of DCDB with DC bus bar of IPMS. There shall be separate DCDB for critical and non-critical load. In the outdoor IPMS there shall be provision to install DCDB inside outdoor cabinet.

For indoor IPMS (300A)

Feeders for critical load: 1x100A, 2x63A, 2x32A, 2x20A & 2x10A MCB Feeders for non-critical load: 63A, 32A, 20A & 10A MCB

For outdoor IPMS, the requirements of MCB of different ratings are mentioned in the BOQ.

3.4.3 Constructional Features of Enclosure

Only a single enclosure shall accommodate all the systems that include phase selector, surge protection devices, static voltage stabilizer, AMF panels, SMPS based rectifier modules, main controller, smoke and fire detector, digital displays and meters, wires and cables, associated sub systems etc. The dimensions of the enclosure should be such that it shall accommodate all components inside the cabinet and suitable for installation at inside & outside area of Telecom shelter. The outdoor & indoor cabinet shall meet IP-55 & IP-20 standard respectively and minimum height of cabinet should be 2200mm.

The enclosure (rack) shall be freestanding type of design and shall have sufficient structural strength to withstand the ultimate mechanical load capacity without any deformity. All the component and materials used in IPMS must be non-combustible and fire retardant.

For indoor IPMS, proper thermal engineering of hardware design shall be done by the Contractor so as to ensure the uninterrupted use of the equipment. Forced cooling is permitted (DC Fans are permitted in the rack or FR/FC module). If cooling is provided at rack level it shall be provided with additional fan with facility for manual switch over. Proper filtering shall be provided to control dust ingress. There shall be an arrangement for automatic Switching-OFF of fans during AC input failure. If required individual modules may be separated by air baffle to provide effective convection. The contractor shall also ensure that the failure of fan does not cause any fire hazards. The failure of any of the fans shall draw immediate attention of the maintenance staff.

For outdoor IPMS, Temperature sensing based forced Air Cooling shall be provided to keep temperature difference of 10 degree (Ambient Temperature-10 degree) with auto fan cut off to meet temperature inside IPMS and ensuring minimum power utilization by cooling fans. Common alarm for high IPMS temperature needs to be provided with auto shutdown protection of IPMS crossing temperature beyond threshold limits. Minimum one fan redundancy shall be considered in design of thermal management. Auto fan shutdown as safety should be provided in case of back door open.

IPMS shall have enough space for heat dissipation, air circulation and ease of service under prevailing ground conditions and maintenance criteria.

a) Components

The component parts of the equipment shall be of professional grade from reputed manufacturer to ensure continuous and safe operation of the equipment including its sub systems. The component shall conform to relevant IEC/IS standards and Complete IPMS unit shall ensure compliance to safety as per IEC-60950 or any other international standard.

3.4.4 Make:

All accessories items likes cable, MCB, PVC etc should be relevant latest IS standard.

3.4.5 Earthing

The equipment shall be properly earthed by connecting it to existing available earthing system.

3.4.6 MTBF

The mean time between the faults of the IPMS and its subsystems shall be more than 70,000 hrs.

3.4.7 Testing

Type Testing IPMS shall conform to EMI/EMC requirements as per IEC-870-2-1 standards. It shall also conform the Environmental requirements as per the TEC Standard for Environmental testing i.e. SD: QM-333 Mar 2010 (with amendments, if any) in category B2 and also comply IS- 8448 standard for transformer of IPMS.

Electrical and mechanical safety and Performance test shall also be carried out on IPMS as per specification. The Contractor can also submit the earlier carried out type test reports on the offered system for above tests. Factory Acceptance Testing The Contractor shall submit the detailed format of factory acceptance testing plan for IPMS unit incorporating various tests for testing of all its systems and sub systems and get it approved from the Employer. The FAT shall be conducted on the offered IPMS units as per approved FAT tests and procedure.

Site Acceptance Test After successful installation, the site acceptance testing for IPMS unit including its subsystems shall be carried out by the Contractor for each site demonstrating all its functions properly. The detailed SAT procedure shall be submitted by the Contractor for Employer's approval.

3.5 Technical Specifications for lithium-Ion Battery

This section specifies the technical requirements of 48 V Lithium-Ion batteries, which shall be used for meeting the backup requirements of Telecom equipment i.e. DWDM Equipment, SDH Equipment, Optical Line Amplifier, Regenerator/Repeater and other associated equipment located indoor at Repeater Shelter.

The offered Lithium-Ion battery shall meet the requirements specified in Standard for generic requirements TEC 67030:2024 of March 2024 or latest.

3.5.1 Scope of Work

The scope of work includes survey, manufacturing, supply, installation, commissioning, and integration of Li-ion batteries with existing SMPS/IPMS. The contractor shall supply Li-ion battery bank and CBMS (along with display unit) in the same cabinet as specified in the BOQ. The CBMS shall be capable of monitor and display status of battery parameters by collecting the data from each module. The Battery modules shall be suitable to accommodate in a 19" standard rack. The contractor shall install and commission the Li-ion battery banks & integrate with existing SMPS/IPMS. Also, the contractor shall provide all required accessories and make all necessary connections between SMPS/IPMS and Li-ion battery banks.

The offered Li-ion battery modules shall be supplied along with indoor cabinet (IP-20, Max height of 2200 mm) for sites, where Li-ion batteries are allocated for existing DCPS/IPMS. In case of 1200Ah Li-ion batteries, if 12 modules of 100Ah cannot be accommodated in a single rack, using up to two racks is acceptable.

It is to be noted here that in case Li-ion battery module (up to 600Ah) is allocated along with DCPS (up to 600A) for any site, the contractor needs to supply both the DCPS and Li- ion battery together in the same cabinet, fully interconnected. The cabinet height may not exceed 2200mm. As the Li-ion battery and DCPS are integrated within the same cabinet, the DC cable required for interconnection shall be inclusive and no separate BoQ will be issued. The Contractor shall supply DC Cable of suitable rating along with the Li-Ion Battery banks.

The bidder shall replace or repair any faulty battery module at free of cost, in case if any battery module becomes faulty during warranty period.

3.5.2 Testing Requirements

3.5.3 Type Testing

Certification:

The contractor shall submit a final valid TSEC, in compliance with new TEC GR TEC 67030:2024 of March 2024 or latest, prior to supply.

In case the TSEC has expired / is not available, the contractor/ manufacturer shall apply to BSNL QA for a new TSEC. As an initial proof of application, BSNL form QF103 will be acceptable. However, the contractor/ manufacturer shall submit a valid TSEC prior to supply of equipment

3.5.4 Factory Acceptance Tests (FAT)

Factory acceptance tests shall be performed as per the approved FAT procedure, which shall be finalized during detailed engineeringin.

Sampling for FAT

The Sampling rate for the FAT of Li-ion batteries shall be as per IS-8320. In case any of the selected samples fail, the failed sample is rejected and two times for battery cells/modules shall be selected randomly and tested. In case any sample from the additional cells/modules also fails the entire batch may be rejected. Since FAT testing provides a measure of assurance that the Quality Control objectives are being met during all phases of production, the Employer reserves the right to require the Contractor to investigate and report on the cause of FAT failures and to suspend further testing/ approvals until such a report is made and remedial actions taken, as applicable

3.5.5 Site Acceptance Tests

After installation of the battery bank, the Contractor shall start up and conduct site acceptance tests to check the performance of the battery at site. The tests shall be conducted as per approved SAT procedure

----- End of Section 3 -----

Section 4 – DC Power Supply System Requirements

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DC Power Supply System Requirements

In order to provide reliable power supply to communication equipment at various locations, 48 V DC Power Supply (DCPS) system is to be provided as a part of this project. This section describes the technical requirement of DC power supply & associated Battery.

The DC Power Supply system shall be capable of meeting the load requirements for various Telecom equipments. The required load (in Amps) for each location along with the Battery capacity is indicated in the Appendices. The rating of offered SMPS modules shall meet Employer's requirements of DCPS system as stipulated in the BoQ.

The DC Power supply system shall have a single DCPS system as per conceptual configuration diagram given in Fig.4-1, shall be supplied.

Surge protection devices shall be installed in the DCPS panel to provide adequate protection against current and voltage transients introduced on input mains AC due to load switching and low energy lightning surges. These protection devices shall be in compliance with IEC 61312, IEC 61024 and VDE 0100-534 for following surges:

It shall be provided with Class 'B' & 'C' type surge protection device. The device must be provided with Class B type lightning current arrester (Switching Type) with a discharge current capacity of at least 50 kA, 10/350 μ s, and Class C type surge arrester (linear device) as per IEC 61643-1. The blind spots shall be avoided in accordance to IEC 61312. The Class 'C' surge protection device should be pluggable type, equipped with features of thermal disconnection, & health indication and potential free contacts for surge arrestors connected between phase & neutral.

The surge protection device shall comply to IEC 61643.

a) Lightning Electromagnetic impulse and other High Surges (Class B):

Between Requirement Ph & N $I \geq 50$ kA, 10/350 μ S for each phase imp N & PE $I \geq 100$ kA, 10/350 μ S imp I = Value of Lightning Impulse Current imp Rated input voltage of Class 'B' surge arrestors shall not be less than 320 V.

b) Low Voltage Surges (Class C)

Between Requirement Ph & N $I \geq 10$ kA, 8/20 μ S for each phase n

N & PE $I \geq 20$ kA, 8/20 μ S n

I = Value of Nominal Discharge Current. n

Voltage rating of Class 'C' surge arrestors shall be minimum 320 V.

The Class 'B' & 'C' Surge protection devices shall work in tandem and in perfect co-ordination to give complete protection to the DCPS system against lightning and switching surges.

4.1 General Technical Requirements for SMPS based DC power supply units

SMPS based DC power supply system is to be used in Auto Float-cum-Boost Charge mode as a regulated DC Power source. DCPS system is to be installed indoors and shall be provided with IP21 panels. The System shall consist of the following:

(a) SMPS modules

(b) Controller module to control and monitor all DCPS modules.

The Panel, Distribution/Switching arrangement shall be provided for the ultimate system capacity. Ultimate System capacity is defined as 150% of the present capacity specified in BoQ. The ultimate capacity is over and above the requirement of redundancy wherever specified. All factory wiring for the panel shall be for the ultimate capacity so that only plugging-in of SMPS module shall enhance the DC power output.

The size of fuses, MCBs, switch, bus etc shall be suitable for the ultimate capacity.

The system shall be sufficiently flexible to serve any load depending on manufacturer's design, rating and number of SMPS modules used in panel and system configuration. To cater for higher load requirements, same type of SMPS modules mounted in the same rack or different racks shall be capable of working in parallel load sharing arrangement. The SMPS modules of DCPS system shall be suitable for operation from single phase A.C. mains/DG set supply. However, the input AC mains supply to DCPS system shall be 3-phase, 4 wire which shall be evenly distributed among all the offered SMPS modules.

4.1.1 Operational/Component Requirements

The basic modules shall operate at specified ratings and conform to requirements stipulated in this specification. The DCPS system shall meet requirement of the latest TEC specification / IEC/BS for other parameters as applicable. The component parts of the equipment shall be of professional grade of reputed manufacturer to ensure prompt and continuous service and delivery of spare parts. The component shall conform to relevant IEC/IS standards. The contractor shall obtain Employers approval of major component before procurement of the same.

4.1.2 Wiring

All insulated conductors except those within the confines of a printed circuit board assembly shall be of the rating enough to withstand the maximum current and voltage during fault and overload. All insulated conductors/cables used shall conform to IS 1554 or equivalent international standard.

All wiring shall be neatly secured in position and adequately supported. Where wires pass through any part of metal panel or cover, the hole through which they pass shall be suitably secured.

4.1.3 Bus Bars

High conductivity Cu bus bar shall be provided and shall be sized to take care of the current of ultimate DCPS system capacity for which it is designed. However, it shall not be less than 25mm X 5mm.

4.1.4 Earthing

Two earth terminals shall be provided in the frame of the system. The Contractor shall connect these earth terminals to the earth bus. All modules and devices shall be connected to these earth terminals. The hinged door, if provided shall be connected to the panel with braided Cu at two points at least.

4.1.5 Finish and Painting

The finish of Steel/Aluminium alloy structure and panels shall conform to relevant IS specification (or equivalent international specifications). The colour code scheme for Panel & Door (if provided) shall be decided during detailed engineering.

4.1.6 Marking and Labelling of Cables

The Contractor shall propose a scheme for marking and labelling the inter panel cables by Halogen & Silicon free labels of polyamide ensuring scratch proof labelling with the use of solvent free ink & latest UV Technology making it environment friendly printing with a WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1 and get it approved from the Employer. A cabling diagram, screen printed or any other better arrangement ensuring better life expectancy shall be placed in the inside of the front door or any other convenient place for ready reference of the maintenance staff.

4.1.7 Name Plate

A name plate etched, engraved, anodized or any other better arrangement ensuring better life expectancy shall be suitably fixed on each panel /module and contain at least the following information :

- (a) Specification Number
- (b) Type of the Unit
- (c) Manufacturer's Name and identification
- (d) Model No
- (e) Unit serial No
- (f) Input voltage and phase
- (g) Output Voltage and Current
- (h) Year of manufacture

4.1.8 System and Panel Configuration

The mechanical and electrical requirements of the Panel are described as below:

4.1.9 System Configuration

The SMPS modules shall be accommodated in panels. The system shall employ a modular configuration to provide flexibility, keeping in view the future load requirements of DC Power. The system shall be configured for ultimate capacity as brought out in Section 4.1. The Control, Monitoring, Alarm arrangement and DC & AC distribution shall be provided suitably in the panel.

The SMPS modules shall be provided as per the load requirement stipulated in the Appendix, BOQ. The DCPS system shall comprise of N+2 Modules. In case of DCPS system having N=1, the SMPS shall comprise of N+1 modules. Here N refers to number of SMPS modules to meet the load requirements specified BOQ and battery charging current. The current rating of each module shall be considered as output current of the SMPS module at nominal voltage (48V).

Total current = load current + battery charging current

Where, battery charging current is equal to the 20 % AH of the battery supplied.

Total Current N = Current rating of each SMPS module at 48 V

The Distribution/switching/Alarm unit shall be provided for the ultimate system capacity. All AC, DC or control/alarm cabling/wiring shall be pre-wired for the ultimate capacity so that mere plugging-in of SMPS module shall add to the DC power output.

It shall be possible to easily mount/remove the modules from the front side of the panel. The SMPS modules/SMPS module sub-racks shall be designed to slide into the panels and fixed securely by a suitable mechanical arrangement.

4.1.10 Constructional Features of Panel

Panel (Enclosure) shall be freestanding type of design, in case if specifically it is not mentioned in the relevant section. Cable entry shall be from the bottom/top of the enclosures (to be finalized during detailed engineering). For the enclosures/panel, the front door (if provided) shall not be wider than 80 cm and rear door may be of hinged or removable type with locking as per standard design of the manufacturer. Keyed locking is required with identical keys for all enclosures. The enclosures shall not exceed 220 cm in height. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for others shall be minimum 1.6 mm. The panels/boards shall be equipped with necessary cable gland plates. The Contractor shall state the type, size, and weight of all enclosures and indicate the proposed manner of installation. The degree of protection of DCPS enclosures shall preferably be IP21, however in case no door is provided then the top of the enclosure/panel shall be fully covered except for proper ventilation and bus bar or cable entries.

Wiring within panel shall be neatly arranged and securely fastened to the enclosure by non-conductive fasteners. Wiring between all stationary and moveable components, such as wiring across hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wire. Conductors in multi conductor cables shall be individually colour coded, and numbered at both ends by Halogen & Silicon free labels of polyamide ensuring scratch proof labelling with the use of solvent free ink & latest UV Technology making it environment friendly printing with a WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1 within enclosures.

The enclosures shall be painted inside and outside. The finish colour of all enclosures shall be an aesthetically pleasing and shall be approved by the Employer. Further, finish colour of external surfaces shall be preferably of same colour for all enclosures/panels.

Each panel shall be supplied with 240 VAC, 50Hz single-phase sockets with switch and lighting lamp for panel illumination.

The manufacturer so as to ensure the uninterrupted use of the equipment shall do proper thermal engineering of hardware design. The Panel shall be designed to allow cooling preferably by natural convection. The Contractor shall submit detail design of proposed Panel/enclosure and heat dissipation calculations during detailed engineering. Forced cooling is permitted (DC Fans are permitted in the Panel or SMPS module) for equipment mounted indoors (buildings/rooms/shelters). If cooling is provided at Panel level it shall be provided with additional fan with facility for manual switch over. Proper filtering shall be provided to control dust ingress. There shall be an arrangement for automatic Switching-OFF of fans during AC input failure. The required individual modules may be separated by air baffle to provide effective convection. The manufacturer shall also ensure that the failure of fan does

not cause any fire hazards. The failure of any of the fans shall draw immediate attention of the maintenance staff.

4.1.11 Electrical Requirements:

AC input supply: The nominal input frequency is 50 Hz, which may vary from 47.5- 52.5Hz. The input voltage shall be as mentioned below:

Field Site Application – Three phase/4Wire (Nominal 415/240 V): $415 + 10\% - 15\%$. However, at site the voltage may vary from 160V to 300V (Ph-N). An Auto-Mains Changeover unit shall be provided for each field site DC power supply system. The Auto-Mains Changeover unit shall accept input from two AC sources and extend any one of the available healthy sources to the DC Power supply system. The suitable HVD (High Voltage Disconnecter) Protection shall be provided at input of each DCPS system. This HVD protection shall protect the SMPS modules of DCPS system against the sustained over voltage at the input.

There shall be an automatic arrangement for shutting off of the SMPS module whenever the input voltage is beyond the specified operating limits with suitable alarm indication. The SMPS module shall resume normal working automatically when the input is restored within the working limits. Hysteresis within specified working limits shall not cause shutting down of the SMPS. A tolerance of $\pm 5V$ may be acceptable for protection & alarm operation.

4.1.12 DC output Characteristics of Modules

The module shall be capable of operating in “Auto Float-cum-Boost Charge” mode depending on the condition of the battery sets being sensed by the Control unit.

(a) The float voltage shall be continuously adjustable & pre-settable at any value in the range of -48 to $-56V$ or as per battery manufacturer recommendations either at the module or may be set from the common controller configuration. Further, the prescribed float voltage setting shall be based on recommendations of the battery supplier.

(b) In Boost charge mode, DCPS shall supply battery & equipment current till terminal voltage reaches set value, as recommended by the battery supplier & shall change over to constant voltage mode

(c) The DC output voltage variation shall not be more than 2% for load variation from 25% load to full load.

4.1.13 Current Limiting (Voltage Droop)

The current limiting (Voltage Droop) shall be provided in DCPS SMPS modules in float and boost charge modes of operation. The float/boost charge current limiting shall be continuously adjustable between 50 to 100% of rated output current for output voltage range of -44.4 volts to -56 Volts or as per manufacturer's specified catalogue.

The float and boost charge current limit adjustment shall be provided in the DCPS system. The SMPS modules shall be fully protected against short circuit. It shall be ensured that short circuit does not lead to any fire hazard.

4.1.14 Soft/Slow Start Feature

Soft/Slow start circuitry shall be employed such that SMPS module input current and output voltage shall reach their nominal value within 10 seconds.

The maximum instantaneous current during start up shall not exceed the peak value of the rectifier input current at full load at the lowest input voltage specified.

4.1.15 Voltage Overshoot/Undershoot

The requirements of (a) to (c) given below shall be achieved without a battery connected to the output of SMPS modules.

(a) The SMPS modules shall be designed to minimize DC output voltage Overshoot/Undershoot such that when they are switched on the DC output voltage shall be limited to $\pm 5\%$ of the set voltage & return to their steady state within 20 ms for load variation of 25% to 100%.

- (b) The DC output voltage overshoot for a step change in AC mains as specified in clause 4.1.11 Electrical Requirements shall not cause shut down of SMPS module and the voltage overshoot shall be limited to $\pm 5\%$ of its set voltage and return to steady state within 20ms.
- (c) The modules shall be designed such that a step load change of 25 to 100% and vice versa shall not result in DC output voltage Overshoot/Undershoot of not more than 5% and return to steady state value within 10 ms without resulting the unit to trip.

4.1.16 Electrical Noise

The Rectifier (SMPS) Modules shall be provided with suitable filter at output with discharge arrangements on shut down of the modules. The Psophometric Noise (e.m.f weighted at 800Hz) with battery connected across the output should be within 2 mV at full load at nominal input AC supply. For test purposes, this shall be taken as equivalent to 4mV when the battery is not connected and in accordance to ITU-T Rec. O.41.

Voltage at the output of the Rectifier (SMPS) module, without battery connected, shall not exceed 300 mV at the switching frequency measured by an Oscilloscope of 50/60 MHz bandwidth (Typical).

4.1.17 Parallel Operation

SMPS modules shall be suitable for operating in parallel with one or more modules of similar type, make and rating, other output conditions remaining within specified limits.

The current sharing shall be within $\pm 10\%$ of the average current per rectifier module individual capacity of each rectifier module in the system (mounted in the same or different Panels) when loaded between 50 to 100% of its rated capacity for all other working conditions.

4.1.18 Protection

The SMPS module, which has failed (for any reason) shall be automatically isolated from the rest of the modules and an alarm shall be initiated for the failure.

4.1.19 DC Over voltage protection

DCPS shall be fitted with an internal over voltage protection circuit.

In case output DC voltage exceeds $-57V$ or as per the recommendations of the manufacturer of batteries, the over voltage protection circuit shall operate & shut off the faulty module. A tolerance of $\pm 0.25V$ is permitted in this case.

Shutting off of faulty SMPS module shall not affect the operation of other SMPS modules operating in the Panel. Operation of over voltage shut down shall be suitably indicated and extended monitoring/control unit. The circuit design shall ensure protection against the discharge of the Battery through the SMPS module in any case. The over voltage protection circuit failure shall not cause any safety hazard.

4.1.20 Fuse/Circuit Breakers

Fuses or miniature circuit breakers (MCB) shall be provided for each SMPS module as follows: 1. Live AC input line 2. Control Circuit All fuses/circuit breaker used shall be suitably fault rated.

4.1.21 AC Under/Over Voltage Protection

AC input Under/Over voltage protection shall be provided as per clause 4.1.11 for Electrical Requirements. The DC side of the SMPS should also be provided with surge protection device to protect the SMPS in case of transients being generated by the loads or due to induction in the DC line from the AC line running parallel together. The Surge protection device should be able to discharge a current of at least 10 kA of 8/20 μs (Class 'C' surge arrester), pluggable and should have indication to show its health to facilitate the replacement on fault condition.

4.1.22 Over Load/Short Circuit Protection

The SMPS shall be protected for Over load/Short circuit as per clause 4.1.13 Current Limiting (Voltage Drop).

4.1.23 Alarms and indicating lamps

Visual indications/display such as LEDs, LCDs or a combination of both shall be provided on each SMPS module for detection of SMPS module failure.

4.1.24 Termination

Suitable termination arrangements shall be provided in the panel for termination of inter cubicle cables from other equipment such as Employers ACDB, Telecom and other associated equipments and alarm cables. All the termination points shall be easily accessible from front and top. AC and DC terminals shall be separated by physical barriers to ensure safety. All the terminals except AC earth shall be electrically isolated.

4.1.25 DC Terminations

All terminations including through MCBs shall be through lock and screw type terminations. Load and batteries shall be connected to DCPS through appropriate MCBs. The isolation of any of the batteries from the load shall create an alarm. DC distribution shall be provided with adequate no. of feeders with appropriate MCBs (6 Amp through 32 Amp) for termination of the loads. Actual rating of the MCBs shall be finalized during the detail engineering. The no. of feeders shall be minimum 10 (ten) nos.

DC distribution may be done either on wall mounted panel or on the DCPS panel. The proper rated MCB shall be provided at the combined output of the SMPS modules (if not provided at each SMPS module). All the AC, DC and Control/alarm cabling shall be supplied with the Panel. All DC +ve and –ve leads shall be clearly marked. All conductors shall be properly rated to prevent excessive heating.

4.1.26 Earthing Cables

mm² Earthing cables between equipment and grounding bus bars shall be minimum size 70 stranded conductors copper/copper strip, rated at 300 volts. All hinged doors shall be earthed through flexible earthing braid. Signal and Safety earthing shall be provided separately.

4.1.27 Alarms

Following Visual indications/display such as LEDs, LCDs or a combination of both shall be provided to indicate :

Functional Indications for local monitoring:

- a) Mains available
- b) DCPS/SMPSs in Float charge Mode
- c) DCPS/SMPSs in Boost Charge Mode

Alarm Indication for local monitoring:

- a) Load Voltage High /Low
- b) DCPS module/SMPS fail
- c) Mains out of range
- d) System Over Load
- e) Mains “ON”/Battery Discharge
- f) Battery fail/isolated

All the protections/alarms shall be within tolerance of 0.25V in case of DC voltage, 1% in case of DC current and $\pm 5V$ for AC voltage

Alarm Indication for remote monitoring:

- a) Input AC mains supply fail alarm
- b) Battery low voltage (Pre cut off) alarm
- c) DCPS module fail

Potential free Contacts in two numbers for each of the above remote monitoring alarms (one for remote alarm interfaced through communication equipments and one redundant for local monitoring at suitable location) shall be provided. All these potential free contacts are to be wired and terminated at the suitable location for interfacing purpose.

4.1.28 Digital Meters/Display Unit

There shall be provision to monitor the following parameters through digital meters or digital display units:

- (a) Input AC voltage.
- (b) Out put DC voltage
- (c) Output DC current of charger
- (d) Battery current
- (e) Load current.

31/ The Digital display of meters or LCD based display unit shall be with minimum digital 2 display of height 12mm and shall have accuracy 1.5% or better.

4.2 Cabling & Enclosure Requirements

The contractor shall supply, install and commission all power cables, control cables, network interface cables and associated hardware (lugs, glands, cable termination boxes etc.) as required for all equipment. The contractor shall be responsible for Cable laying and termination at both ends of the cable. The Contractor shall also be responsible for termination of feeder cables at contractor's equipment end including supply of suitable lugs, glands, terminal blocks & if necessary cable termination boxes etc. All cabling, wiring, and interconnections shall be installed in accordance with the following requirements.

4.2.1 Power Cables

4.2.2 The contractor shall supply, install and commission all power cables, grounding cables, control cables, network interface cables, MCBs, fuses etc. of required size and capacity including associated hardware (lugs, glands, cable termination boxes, PVC pipe etc.) required to mechanically and electrically complete the installation of equipment and their successful operations.

4.2.3 The Contractor shall be responsible for cable laying and termination at both ends of the cable. The Contractor shall also be responsible for termination of feeder cables at Contractor's equipment end including supply of suitable lugs, glands, terminal blocks, PVC pipe, etc.

4.2.4 The requirement of quantities of AC & DC cables for Equipment and DCPS have been identified in BoQ and for other accessories including grounding cables, control cables, network interface cables, PVC pipe, MCBs (AC & DC) etc and others associated hardware (lugs, glands etc) shall be supplied by the contractor as per actual requirement without any extra financial implication to PowerTel. The AC & DC cables as per BoQ will be ordered for following:

4.2.4.1 Connection from Equipment to existing DCPS of PowerTel/ Customer (Only Equipment is supplied).

4.2.4.2 Connection from Rack (DCDB) to existing DCPS of PowerTel/ Customer (Equipment along with Rack is supplied).

4.2.4.3 Connection from DCPS to AC mains (Equipment along with Rack & DCPS is supplied)

4.2.5 The DC cable for s.no.(a)&(b) of suitable rating out the cable in BoQ, shall be supplied as per the quantity mentioned in BoQ. The cables shall be suitable for laying in racks, cable trays, ducts, trenches and conduits.

4.2.6 Earthing connection for Equipment/ DCPS/ Rack will be Extend from Site existing Earth pit.

4.2.7 All AC power cables shall be stranded Aluminium conductor armoured XLPE/ PVC insulated and sheathed conforming to IS 1554 Part-1/IS 7098. The cables shall be suitable for buildings and underground buried installations with uncontrolled backfill and chances of flooding by water.

4.2.8 All DC power cables shall be stranded Copper conductor, armoured XLPE/PVC insulated and sheathed, 1100V grade as per IS 1554 Part-1/IS 7098.

4.2.9 All wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality and free from defects. The filler and inner sheath shall be of non-

hygroscopic and shall be softer than insulation. Outer sheath shall be suitable for operating temperatures of cable. Repaired cables shall not be accepted.

4.2.10 All cables shall conform to relevant IS.

4.2.11 Each length of complete cable between electrical and mechanical assemblies, enclosures and distribution frames shall be identified at each end with an indelibly marked shrink-on sleeve which indicates the cable number, and the near-end and far-end destination.

4.2.12 All the required MCBs, fuses etc. required for safe operation of the equipment shall also be supplied and installed by the Contractor. Separate cables shall be laid for AC and DC. The cables shall be suitable for laying in cable trays, ducts, trenches, and conduits.

4.2.13 Enclosure/Panel Earthing

Each enclosure shall include suitable earth networks within the enclosure. Earth network shall be a copper bus bar, braid or cable inside enclosures.

The safety earth network shall terminate at two/more studs for connecting with the earthing grid. Safety earthing cables between equipment and enclosure grounding bus bars shall be minimum size 6 sq. mm, stranded copper conductors, rated at 300 volts. All hinged doors (if provided) shall be earthed through flexible earthing braid.

For all enclosures requiring AC input power, the green earthing wire from the AC input shall be wired to the safety earthing stud. The Contractor shall provide all required cabling between enclosures for earthing. The contractor shall connect safety and signal earths (as applicable) of each enclosure to the Employer provided nearest earth grid/earth riser through suitable 50X6 sq. mm. GI strips or suitably sized copper cable.

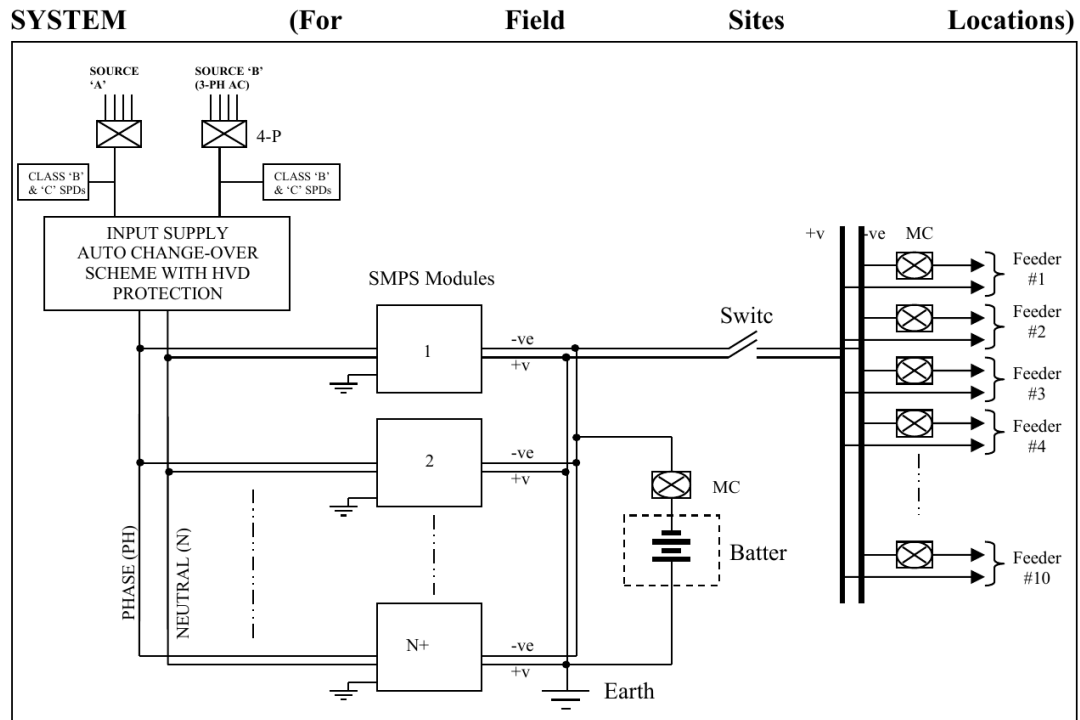
The signal earthing network shall terminate at a separate stud connection, isolated from safety ground. The stud connection shall be sized for an external earthing cable equipped with a suitable lug.

All earthing connections to equipment shall be made directly to each equipment chassis via earthing lug and star washer. Use of the enclosure frame, skins, or chassis mounting hardware for the earthing network is not acceptable.

4.3 Temperature Compensation for Battery

There shall be provision for monitoring the temperature of battery and consequent arrangement for Automatic temperature compensation of the SMPS output voltage to match the battery temperature dependant charge characteristics. The output voltage of the rectifier in Float/Charge operation shall decrease or increase at the rate of 72 mV (3mV/cell, 24 cell battery) per degree increase or decrease in temperature over the set voltage or as may be recommended by the VRLA Battery supplier. A tolerance of +/- 5mV may be acceptable over the specified rate of 72 mV/degree C. The output voltage shall decrease till the open circuit voltage of the battery is reached. The open circuit voltage range shall be settable between 2.1V/cell to 2.2V/cell. The increase in output voltage due to decrease in temperature has been taken care of by the tripping of the unit due to output voltage high (57V) protection. Failure of temperature compensation circuit including sensors shall create an alarm and shall not lead to abnormal change in output voltage. The nominal distance between the battery & DCPS system may be 20 metres. The Contractor shall provide the necessary sensor and cord for the purpose with DCPS system to sense the Battery temperature.

Fig. 4-1: Conceptual Configuration of DC Power Supply (DCPS) System (For Field Site Locations)



4.4 Battery Requirements

4.4.1 Valve Regulated Lead Acid (VRLA) maintenance free Battery

The contractor shall supply Valve Regulated Lead Acid (VRLA) maintenance free Battery. Each battery set shall have sufficient capacity to maintain output at full rated load as indicated in BOQ. The battery shall be capable of being recharged to 90% State of Charge (SOC) from the fully discharged condition (1.75V/cell) within 10 hrs. In all cases, the battery is normally not allowed to discharge beyond 80% of rated capacity (80% DOD) at 10 hours rate of discharge.

The supplier, supplying the cells/batteries as per this document shall be responsible to replace/repair free of charge, the battery/cell becoming faulty, owing to defective workmanship or material as per the provisions of the bid document.

4.4.1.1 Constructional Requirements

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections.

4.4.1.2 Containers

The container material shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28%. The porosity of the container shall be such as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling. The containers shall be enclosed in a steel tray.

4.4.1.3 Cell Covers

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the

cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

4.4.1.4 Separators

The separators used in manufacturing of battery cells, shall be of glass mat or synthetic material having high acid absorption capability, resistant to sulphuric acid and good insulating properties. The design of separators shall ensure that there is no misalignment during normal operation and handling.

4.4.1.5 Pressure Regulation Valve

Each cell shall be provided with a pressure regulation valve. The valve shall be self re-sealable and flame retardant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

4.4.1.6 Terminal Posts

Both the +ve and –ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

4.4.1.7 Connectors, Nuts & Bolts, Heat Shrinkable Sleeves

Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge.

Nuts and bolts for connecting the cells shall be made of copper, brass or stainless steel. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion. Stainless steel bolts and nuts can be used without lead coating.

All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

4.4.1.8 Flame Arrestors

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

4.4.1.9 Battery Bank Stand

All batteries shall be mounted in a suitable metallic stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

4.5 Capacity Requirements

When the battery is discharged at 10 hour rate, it shall deliver 80% of C (rated capacity, corrected at 27°Celsius) before any of the cells in the battery bank reaches 1.85V/cell.

All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life. Float voltage of each cell in the string shall be within the average float voltage/cell +0.05V band.

The capacity (corrected at 27°Celsius) shall also not be less than C and not more than 120% of C before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at C/10 rate:

- (a) After Six minutes of discharge : 1.98V/cell
- (b) After Six hours of discharge : 1.92V/cell
- (c) After 8 hours of discharge : 1.85V/cell

(d) After 10 hours of discharge : 1.75V/cell Loss in capacity during storage at an average ambient temperature of 35° Celsius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within +0.05V of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt hour efficiency shall be better than 80%.

4.6 Expected Battery Life

Under ideal conditions i.e. moderate ambient temperature (10° C to 35° C), charging not faster than C/10 rate, minimum expected service life of battery, on true float shall be fifteen (15) years. However, the same battery at an average temperature of 35° C in cyclic discharge application to 80% DOD (depth of discharge) will give 1200 cycles. Depth of Discharge (DOD) is defined as the ratio of quantity of electricity (in Ampere hour) removed from a cell or battery on discharge to its rated capacity.

4.7 Testing requirements

The Contractor shall submit type test reports for the battery for the same make, model & rating as offered as per the IEC 60896 or equivalent IS/EN/BS/TEC standards. In the event, the type test reports for exact rating is not available, the Contractor shall submit type test reports for higher rating Battery.

-----End of this Section-----

Section 5 – Environment, EMI, Power Supply, Cabling and Earthing

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Section - 5 : Environment, EMI, Power Supply, Cabling and Earthing

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

5.1 Environmental Requirements

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

5.1.1 Temperature and Humidity

Most of the equipment will not be installed in environmentally controlled shelters. Therefore, equipment shall operate in accordance with the limits shown in Table 5-1.

Table 5-1 Environmental Operating Limits

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

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

5.1.2 EMI and Electrostatic Interference

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

5.1.3 Vibration and Shock Resistance

As per testing requirements indicated in this specification.

5.1.4 Tropicalization

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

5.1.5 Contaminants

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

5.2 Primary Source AC/DC Power Requirements

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

5.2.1 Primary Source AC Power

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

All equipment and components provided under this specification requiring Primary AC Power, shall be designed for normal operation under the above stated tolerances for 240 VAC supply.

The Contractor shall provide in their Bid as well as in the survey report to the Employer the projected 240 VAC Primary Power load requirement per equipment and totals, by location, for equipment provided under this specification.

5.2.2 -48V DC Power

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

5.2.3 Power Distribution and Protection

The Employer will furnish only one source primary 240 VAC and/or -48 VDC power. It shall be the Contractor's responsibility for the connection and distribution of all Primary AC and -48V dc source power, in full compliance with all local and national electrical codes.

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

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

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

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

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

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

5.3 Equipment Construction, Assembly and Installation

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

5.3.1 Identification

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

5.3.1.1 Equipment

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

Where custom components and parts are provided, each component/part shall be marked to specifically identify that component/part. Printed circuit card cages are defined as an equipment component and as such, shall be clearly identified as stated within this specification. Equipment chassis and printed circuit card cages having wired backplanes, shall be clearly marked with the manufacturer's part number, serial number, month/year of manufacture, revision level and an additional identifier corresponding directly to the applicable backplane wiring diagram/list.

5.3.1.2 Power Distribution

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

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

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

All power distribution identification shall utilize heat-resistant permanent marking techniques such as stamped non-metallic tags, embossed labels, etc. Marking techniques are subject to approval by the Employer. Power distribution identifiers and information shall agree with the Contractor's power cable plant drawings.

5.3.1.3 Signal Cabling

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

Signal cable/wiring installed on terminal blocks requires marking with the cable identifier and distant end location. The cable tag shall be clearly visible at the cable fanout point.

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

5.3.1.4 Equipment Racks and Enclosures

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

5.3.2 Installation Hardware

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

5.3.2.1 Equipment Sub-Racks and Cabinets (Enclosures)

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

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

(A) Equipment Sub Rack Construction

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

- Equipment Sub Racks shall be steel/aluminum fabricated and finished on all surfaces. All metal and welds shall be thoroughly cleaned and sanded to obtain a smooth finish. All

surfaces shall be treated for rust and primed to form a bond between metal and the finish coats of paint.

- Equipment covers shall be provided for exposed components mounted in equipment sub Racks.
- Dust and moisture protection shall meet or exceed IP20 standards.

(B) Equipment Cabinet (Enclosure) Construction

- Equipment cabinets (enclosures) shall be steel/ steel & Aluminum extrusion fabricated and finished on all surfaces. All metal and welds shall be thoroughly cleaned and sanded to obtain a smooth finish. All surfaces shall be treated for rust and primed to form a bond between metal and the finish coats of paint.
- Equipment cabinets (enclosures) shall be designed 19 inch, free-standing but shall be mounted to the floor. The Dimension of the cabinet shall be minimum 2200mmx600mmx600mm. Cabinets (enclosures) shall have secure fitting, lockable, full-length front doors for access to hardware and wiring. Equipment covers for exposed components mounted inside cabinets are not required unless specifically recommended.
- All doors and removable panels shall be fitted with long life rubber beading. All panels shall be fabricated from minimum 2.0mm thickness steel sheet. However, for racks with load bearing Aluminum extrusion frame, door panels and side panels may be fabricated from minimum 1.6mm thickness steel sheet and the top & bottom panels shall be fabricated from minimum 2.0mm thickness steel sheet.
- Equipment cabinets (enclosures) shall be dust and moisture-proof as per IP41 specification, or better (supporting certificates/documents shall be submitted during detailed engineering).

5.3.2.2 Cable Raceways

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

- (1) Signal cabling and power cabling shall require separate cable raceways. Signal and power cabling shall not share the same raceways and shall be installed as far apart as is practical. Adequate shielding shall be provided as required.
- (2) All cable raceways shall be sized to support full loading requirements plus at least a 200% safety loading factor.
- (3) Outdoor cable raceways shall be of corrugated construction and shall be fitted with solid covers overlapping all sides of the cable raceways.
- (4) Outdoor cable raceways shall be fabricated from construction grade aluminum, galvanized iron or anodized sheet metal or any other suitable material approved by the Employer. Suitable anti-corrosion measures shall be taken. Steel fabricated raceways shall be finished inside and out, treated to resist rust and to form a metal-to-paint bond.
- (5) Indoor cable raceways fabricated of aluminum or galvanized iron, shall not normally need special finishing or painting, unless otherwise stipulated by the Employer. Steel fabricated raceways shall require a red oxide primer coat at a minimum.

5.3.3 Signaling Distribution

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

- (1) All signal wiring connections to the communications equipment shall be via Krone type or equivalent terminal blocks.
- (2) The Contractor shall provide subscriber level wiring and patching wherever required.

5.3.4 Lightning and Transient Voltage Protection

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

- (1) At the outside cable plant point-of-entry of all cabling penetrations for all cabling installed by the Contractor, the Contractor shall provide lightning and transient voltage isolation for the inside plants cabling, wiring, and all terminations and equipment.
- (2) All equipment installed under this specification that requires 240VAC primary power, shall be surge protected.

5.3.5 Station Safety Earthing and Signal Grounding

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

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

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

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

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

5.3.6 Interconnections

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

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

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

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

5.3.7 Finish Colors

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

5.4 Location of Equipment, Cable Routes and Associated Civil Works

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

5.4.1 Locations for Supplied Equipment

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

5.4.2 Associated Civil Works

The Contractor shall provide all required minor civil works necessary for full connectivity as required in the Contractor's scope of work as follows:

- (1) All wall and floor penetrations necessary for the installation of all cabling to be performed in accordance with the requirements of this specification.
- (2) Installation of racks, cabinets, cable raceways, and cabling supplied as part of this contract.

5.4.3 Cable Trenches

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

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

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

-----End of this Section-----

Section 6 – Inspection & Testing

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Section – 06 Inspection & Testing

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

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

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

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

Type tests shall not be required to be carried out if supplier has conducted these tests earlier on the same type of equipment and valid type test certificates are available. The test certificate shall be considered valid if,

1. Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/IEC 17025 by the National Accreditation body of the country where laboratory is located) or witnessed by POWERGRID/representative authorized by POWERGRID/representative of Utility /representative of accredited test lab/ representative of The National Accreditation Board for Certification Bodies (NABCB) certified agency.
2. Type test reports contain valid Calibration reports/certificates of the relevant testing equipment, information pertaining to ratings, the relevant drawings, model number, test circuit, calculations (if any), photos, acceptance criteria/values specified in Technical Specification/ relevant standards (IS/ IEC) and compliance to the same. And
3. The Equipment shall be supplied from the same manufacturing works, where from the sample was manufactured and successfully type tested as per relevant standard or at the works of Parent organization in case of technology transfer/ Joint Venture(JV) for the initial period of 03 years from the date of establishment of manufacturing plant for offered equipment provided that the design, material, and manufacturing process of the offered equipment are identical to those of the type-tested sample of the original facility. In such cases, while submitting the Type, Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking with it declaring that there is
 - a) No change in the Design,
 - b) No change in the material,
 - c) No change in manufacturing process, and
 - d) No amendment/revision in the relevant standard as regard to type test conditions, since

the type test

4. In case of own manufacturing plant at different location within India, the type test of the original manufacturing works shall also be acceptable for the equipment manufactured and supplied from the different location subject to the following conditions:
 - a. the relevant standard does not bar the same,
 - b. the equipment being manufactured at different locations shall be identical in design, drawings, specifications, ratings to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),
 - c. the equipment being manufactured at different locations shall be identical in material & critical components, manufacturing process/ practices, and quality control to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),
 - d. Also, while submitting the Type Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking for above conditions (a), (b) and (c).

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

The Employer reserves the right to require the Contractor to perform, at the Employer's expense, any other reasonable test(s) at the Contractor's premises, on site, or elsewhere in addition to the specified Type, Acceptance, Routine, or Manufacturing tests to assure the Employer of specification compliance. All Cyber tests shall be carried out during FAT , SAT in compliance to latest Central Electricity Authority (Cyber Security in Power Sector) Regulations, 2026.

6.1 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.

6.2 Test Plans and Procedures

Test plans for both factory and site acceptance tests shall be provided by the Contractor. Test plans shall be modular to allow individual test segments to be repeated upon request.

Procedures for type test, factory acceptance test, and site acceptance test for communication equipment (wherever applicable) have been provided in Appendix C, D & E respectively.

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.

6.2.1 Factory and Site Test Plans

A test plan for factory and site acceptance tests shall be submitted for approval, at least four (4) weeks before the start of testing. The test plan shall be a single overview document that defines the overall

schedule and individual responsibilities associated with conducting the tests, documenting the test results, and successfully completing the test criteria. Test Plans shall include, at a minimum, the information contained in Table 6-1.

Table 6-1
Factory & field Test Plan Requirements

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

6.2.2 Test Procedures

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.

6.2.3 Test Records

Complete and indexed records of all factory and site acceptance tests results shall be maintained and provided to the Employer by the Contractor in hardcopy. The records shall be keyed to the steps enumerated in the test procedures. The minimal items required in test records are described in Table 6-2.

Table 6-2
Test Record Requirements

Item:	Description:
1.	Test Title and Revision Level, if applicable; contract references
2.	Date and time for test start and test completed
3.	Test title and reference to the appropriate section of the test procedures
4.	Description of any special test conditions or special actions taken (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.

6.2.4 Rejection of Elements

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

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

6.2.5 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

6.3 Type Testing

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

- All equipment being supplied shall conform to type tests as per technical specification.
- Validity period of type tests conducted on the equipment i.e. the period for which Type Test Reports shall remain valid and acceptable to employer provided no major change has been introduced in the basic design/technology/material/mechanical construction/functionalities of the equipment/performance characteristic/manufacturing process of the equipment, with validity period as per Guideline for the Type Tests for Major Equipments in Power Plant. Type test validity and other requirement for type testing shall be governed from the "Guideline for the Type Tests for Major Equipments in Power Plant".

Sl.no	Name of Equipment	Validity of type test (in years) from date of the original schedule last date of Bid submission
1	SDH Equipment	10
2	Battery, Battery charger	10
3	Cable (Power, Control)	10
4	DG set	10

The type test report for DG Set comprising of diesel engine and alternator are not required to be submitted for the makes listed in Compendium of Vendors of POWERGRID. For the new makes, type test reports of engine and alternator as per relevant standard shall be submitted for purchaser's approval. The type tests of the equipment shall be repeated during its validity period, if there is change in technology, basic design, construction, electrical/thermal/mechanical stress, performance characteristics or materials employed or changes in manufacturing process, setup or combination of any of above.

In case the type Test reports are not valid as per the conditions stipulated in this specification, the Contractor shall repeat the type tests at no extra cost to the employer/purchaser.

- The Contractor shall submit, within 30 days of Contract Award, copies of previous test reports for Type Tests specified in the Technical Specifications. These reports may be accepted by the Employer only if they apply to materials and equipment that are due to be delivered under the Contract and are similar in design only if test procedures and parameter values are identical to those specified in this specifications carried out at accredited labs and witnessed by third party / customer's representatives.

In the event of any discrepancy in the test reports or any type tests not carried out same shall be carried out by Contractor without any additional cost implication to the Employer.

- Tests conducted earlier is also acceptable if it was either conducted in accredited laboratory (accredited based on ISO/IEC 17025 by National Accreditation body of the country where laboratory is located) or witnessed by POWERGRID/representative authorized by POWERGRID/representative of Utility/representative of accredited test lab/representative of The National Accreditation Board for Certification Bodies(NABCA) certified agency.

- Contractor shall submit the details of laboratory(s) for the type tests.

(i) Type Tests on indigenous equipment, for which testing facility is available in India, should have been conducted in any independent laboratories approved by Government or accredited by National Accreditation Body of the Country, like Central power Research Institute(CPRI), Electrical Research and development Association(ERDA) etc.

(ii) Type Tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National Accreditation Body of that country.

- (iii) Type tests on imported equipment should have been conducted in an Indian Laboratory or foreign laboratory accredited by National Accreditation Body of respective country.
- (iv) Type tests conducted in-house by manufacturers shall also be acceptable provided the laboratory is accredited by national Accreditation Body of the country and the tests have been witnessed by a representative of NABL accredited laboratory/Power Utility.
- (f) All the type tests shall be certified or performed by reputed laboratories using material and equipment data sheets as per procedures provided in under this technical specification.
- (g) The Contractor shall provide a detailed schedule for performing all specified type tests at least 30 days prior to planned commencement of each type test. These tests shall be performed in the presence of a representative of the Employer.
- (h) The Contractor shall ensure that all type tests can be completed within the time schedule offered in his Technical Proposal.
- (i) In case of failure during any type test, the Supplier is either required to manufacture a fresh sample lot and repeat all type tests successfully or repeat that particular type test(s) at least three times successfully on the samples selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected. In case of failure in any particular type test(s) or type testing not done during the visit of employer representative, then all the expenses for re-deputation of Inspector/ Employer representative for type testing shall be borne by Contractor.

6.3.1 Type Test Samples

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

6.3.2 List of Type Tests

The type testing shall be conducted on the following equipment/items

1. SDH Equipment with all types of cards (optical card, Tributary card or any other equipment as part of repeater less links)
2. Optical Amplifier solution
3. DCPS & Battery

Further, tests on various items other than those listed in this section of technical specifications but otherwise mentioned in relevant general requirements (GR) issued by Telecommunication Engineering Centre (TEC), DoT are also to be completed in compliance to Department of Telecommunications(DoT), Ministry of Communications order dated 29.08.2018 on 'Public Procurement (Preference to Make In India) Order 2017 –Notification of Telecom products, Services or Works – regarding”.

6.3.2.1 List of type test to be conducted on Telecom equipment

The type tests for SDH Equipment with all types of cards are described below:

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 table 5-1: 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. Degree of Severity: Test shall be done at $(40 \pm 2) ^\circ\text{C}$ & $(93 \pm 3) \% \text{ RH}$
3. Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

(f) Temperature Variation Test

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

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

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 6-3:

Table 6-3: 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 μ s surges	Yes	Yes	Yes	N/A	Table 12 of IEC 60870-2-1: 1995 - Level : 1	
4	Fast transient bursts	Yes	Yes	Yes	Yes	Table 12 of IEC 60870-2-1: 1995 - Level : 4	
5	Damped oscillatory waves	Yes	Yes	Yes	Yes	Table 12 of IEC 60870-2-1: 1995 - Level : 1	
6	Electrostatic discharge	Yes				Table 13 of IEC 60870-2-1: 1995 - Level : 4	
7	Radiated electromagnetic field	Yes				Table 15 of IEC 60870-2-1: 1995 - Level : 3	
-End of Table-							

(b) Emission Tests

The list of Emission tests are specified below in Table 6-4

Table 6-4: Recommended Emission Tests						
S. NO.	Emission test	AC Power Supply	DC Power Supply	Contr ol & Signal	Telecom Line	Para- metres
1	RF disturbance voltages CISPR 22	Yes	Yes	N/A	N/A	Table 17 of IEC 60870-2-1:
2	RF disturbance currents CISPR 22	N/A	N/A	N/A	Yes	1995 - Class : B
3	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.

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 68-2-6. 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.

6.3.2.2 Type Testing of DCPS

The test reports for Immunity, Emission and safety must be in accordance with relevant IEC/CISPR standards shall be submitted. The Contractor shall submit the DCPS type test reports of earlier conducted tests on the same make, model, type & rating which shall include the following tests listed in Table 6-5.

Table 6-5 Type Tests on DCPS	
Sl. No.	Test requirements
1	Surge immunity (Level 4- as per IEC 61000-4-5)
2	Electrical Fast Transients/Burst (Level 4 – as per IEC 61000-4-4)
3	Electrostatic Discharge (Level 4 – as per IEC 61000-4-2)
4	Radiated Electromagnetic Field (Level 3 – as per IEC 61000-4-3)
5	Conducted disturbances induced by radio-frequency field (Level 3 – as per IEC 61000-4-6)
6	Damped oscillatory magnetic field (Level 3 – as per IEC 61000-4-10)
7	Voltage dips, short interruptions and voltage variations (Level 2 – as per IEC 61000-4-11)
8	Conducted Emission (Level - Class A, Group 1 as per IEC CISPR 11)
9	Radiated Emission (Level - Class A, Group 1 as per IEC CISPR 11)
10	Safety Tests (as per IEC 60950)

6.3.2.3 Testing requirements of Battery

Table 6-6 List of tests for VRLA battery

Sl. No.	Test	Type Test As per IEC 60896	FAT	SAT
1.	Verification of marking - Visual observation - Dimensional inspection - Polarity checking	√	√	√
2.	Capacity test	√	√	√
3.	Suitability for floating battery operation	√		
4.	Endurance in discharge/charge cycles	√		
5.	Charge Retention	√		
6.	Short-circuit current and internal resistance	√		
7.	Stability against mechanical abuse of units during installation	√		
NOTE : The batteries shall meet the general requirements as per IEC 60896 or equivalent.				

6.4 Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out on SDH Equipments, associated line & tributary cards, Network Management System, DCPS, Battery etc. and all other items for which price has been identified separately in the Bid Price Schedules.

Material 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 CIP Clearance/Interim Inspection Report. 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, , NMS, DCPS and Battery 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.

During FAT stage, the employer has to verify all type test reports/certificates including Communication Protocol and security conformance tests of the devices offered for FAT as part of essential cyber security tests. The equipment/system besides for functionality shall also be tested in the factory for vulnerabilities, design flaws, parts being counterfeit or tainted, so as to minimize problems during on-

site testing and installation. Cyber security conformance testing are to be carried out in the designated lab as identified by GoI/MoP.

The following auditor report and audit recommendations are to be verified during FAT. 1. Vulnerability assessment 2. Risk assessment a. Network architecture validation with respect to design documents. b. Penetration testing c. System Hardening test

6.4.1 Sampling for FAT

From each batch of equipment presented by the Contractor for Factory acceptance testing, the Employer shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples. The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum 1) for all items. The physical verification shall be carried out on 100% of the offered quantities as per the approved FAT procedure. In case any of the selected samples fail, the failed sample is rejected and additional 20% samples shall be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected. In case a number of equipments are required for demonstration of the performance of any equipment during FAT, the sample size shall be taken as that number of equipments which are necessary to demonstrate the performance, irrespective of the percentage.

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

6.4.2 Production Testing

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

The production tests would normally not be witnessed by the Employer. However, the Employer reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

6.4.3 FAT of Communication Equipments

Table 6-7: Factory Acceptance Testing for Fibre Optic Transmission System	
Item:	Description:
1.	Physical inspection for conformance to DRS, BOQ, drawings and appearance of equipment
2.	Optical output power
3.	Transmitter light wave spectral analysis
4.	Low receive level threshold
5.	Generation of bit error rate curve
6.	Measurement of analog and digital service channel parameters as well as service channel functionality
7.	Performance of supervision, alarm, Craftsperson interface, diagnostics, loop backs etc.
8.	Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for multiplexers
9.	At a minimum tests on Ethernet interface shall include demonstration of ping test, throughput test, Latency test, Packet Loss test as per RFC 2544
11.	Simulation of failure conditions and failover of each redundant unit.
12.	VLAN (Layer-2 switching) feature testing with at least three equipments configuration
13.	Protection scheme for Ethernet Traffic (ERPS)
14.	Test of spare card slots
15.	Checks of power supply/converter voltage margins
16.	Random inspections to verify the accuracy of documentation
17.	Test of spare parts/modules/cards as per applicable tests
18.	Comprehensive Cyber Security Tests in compliance to latest Central Electricity Authority (Cyber Security in Power Sector) Regulations, 2026

Table 6-8 FAT on NMS	
1	Physical inspection of NMS hardware for conformance to approved BoQ, DRS & drawing
2	Test to demonstrate the expansion capability of the NMS system
3	Test to demonstrate the functionality of North bound interface
4	Testing of NMS to demonstrate proper operation of all functions: Configuration Management, Performance Management, Fault Management and Security Management. All standard features and required customization of the NMS shall be demonstrated for proper functioning.
5	Test to demonstrate NBI port enablement in order to show full Fault, Configuration, Performance and Security functionality.
6	Comprehensive Cyber Security Tests in compliance to latest Central Electricity Authority (Cyber Security in Power Sector) Regulations, 2026

6.4.4 FAT/SAT of DCPS

The factory/site tests to be carried out on DCPS system/module in the factory and site are listed respectively in Table below.

Table 6-9 Lists of tests for FAT/SAT of DCPS			
S.No.	Test	FAT	SAT
Tests on DCPS System			
1.	Mechanical & Visual Check Tests	√	√
2.	Insulation Test.	√	
3.	High Voltage Withstand Test	√	
4.	Switch On Test	√	√
5.	DCPS Low voltage & High voltage limits check Test	√	√
6.	Pre-alarm test for Battery Voltage Low	√	√
7.	Battery Low Voltage Disconnect Level Test	√	√
8.	AC Input Low and High voltage limits check Test	√	
9.	Rectifier Fail Alarm Test	√	√
10.	Voltage Regulation Test	√	
11.	Current Sharing Test	√	
12.	Total Output Power Test	√	√
13.	Hot Plug In Test (if applicable)	√	√
14.	Calibration & Parameter settings	√	√
15.	Automatic Float cum Boost Charge Mode Change Over Test	√	√
16.	Battery Path Current Limiting Test	√	√
17.	Battery Charging and full load Current Test	√	√
18.	Total Harmonic distortion Test	√	
19.	Burn in Test at 50 ° C (for 8 hrs duration)	√	
Tests on SMPS module			
20.	Mechanical & Visual Check Test	√	
21.	Module-On Test	√	
22.	Input low/high voltage cut-off test	√	
23.	Voltage Drop Test	√	
24.	Voltage Regulation Test	√	
25.	Power Output & Current Limit Test	√	
26.	DC High Voltage Test	√	
27.	O/P Voltage Ripple Test	√	
28.	Psophometric Noise Test	√	
29.	Efficiency Test	√	
30.	Power Factor	√	
31.	Input Current Limit	√	
32.	Input AC Frequency Range Test	√	
33.	Rectifier Dynamic Response	√	

Table 6-9 Lists of tests for FAT/SAT of DCPS			
S.No.	Test	FAT	SAT
34.	Output Short Circuit Test	√	
35.	Hold up Time Test	√	

6.5 Site Acceptance Tests

The Contractor shall be responsible for the submission of all equipment & test equipment supplied in this contract for site tests and 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, NMS etc. is outlined in following section. This testing shall be supplemented by the Contractor's standard installation testing program, which shall be in accordance with his quality plan(s) for Telecom equipment installation. The tests to be conducted during SAT of PABX, DCPS and Battery are specified in respective section.

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.

6.5.1 Phases for Site Acceptance Testing for Communication Equipments

The SAT shall be completed in following phases:

6.5.1.1 Installation Testing

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

In the installation test report, the Contractor shall include a list of all hardware or components 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 and NMS are provided in respective Tables in this section.

During Installation testing, the employer has to verify all type test reports/certificates including Communication Protocol and security conformance tests of the devices as part of essential cyber security tests

The following auditor report and audit recommendations are to be verified during SAT. 1. Vulnerability assessment 2. Risk assessment a. Network architecture validation with respect to design documents. b. Penetration testing c. System Hardening test

6.5.1.2 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.

6.5.1.3 Integrated Testing

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

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

- (1) Installation testing for NMS as per tables below
- (2) Equipment configuration shall be checked to establish that it supports the channel routing.
- (3) End to end testing of all individual voice circuits originating from PLCC, PABX or Phones and to establish proper interfacing with PLCC\PABX\Phones and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of quality of voice, call initiation and call termination processes. The requirements for integrated testing for PLCC\PABX system is described separately below.
- (4) End-to-end testing of all individual Data Circuits originating from PLCC, RTU and SCADA Front Ends and to establish proper interfacing with PLCC\RTU\Front End and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of monitoring of BER/packet loss.
- (5) Testing of NMS to demonstrate proper operation of all functions: Configuration Management, Performance Management, Fault, Management and Security management. All the standard features of the NMS shall be demonstrated for proper functioning. Further, testing of integration of supplied NMS with regional UNMS/OSS (if available) is required to be demonstrated.
- (6) Demonstration of Protection switching and synchronization of equipment as per synchronization plan.
- (7) Comprehensive Cyber Security Tests in compliance to latest Central Electricity Authority (Cyber Security in Power Sector) Regulations, 2026.

Table 6-10 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) 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.
11.	Comprehensive Cyber Security Tests in compliance to latest Central Electricity Authority (Cyber Security in Power Sector) Regulations, 2026

Table 6-11 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
9.	Simulation of failure conditions and failover of protected components.

Table 6-11 Termination Equipment Sub-system Installation Testing		
10.		Comprehensive Cyber Security Tests in compliance to latest Central Electricity Authority (Cyber Security in Power Sector) Regulations, 2026.
Table 6-12 NMS Installation Testing		
Item:	Description:	
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	
4.	Comprehensive Cyber Security Tests in compliance to latest Central Electricity Authority (Cyber Security in Power Sector) Regulations, 2026	

6.6 QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work as applicable, are in accordance with the specifications, the Contractor shall ensure suitable quality assurance programme to control such activities at all points necessary. A quality assurance programme of the Contractor shall be in line with ISO requirements & shall generally cover the following :

- The organisation structure for the management and implementation of the proposed quality assurance programme.
- System for Document and Data Control.
- Qualification and Experience data of Bidder's key personnel.
- The procedure for purchases of materials, parts, components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- System for shop manufacturing and site erection controls including process controls, fabrication and assembly control.
- System for Control of non-conforming products including deviation dispositioning, if any and system for corrective and preventive actions based on the feed back received from the Customers and also internally documented system for Customer complaints.
- Inspection and test procedure both for manufacture and field activities.
- System for Control of calibration of testing and measuring equipment and the indication of calibration status on the instruments.
- System for indication and appraisal of inspection status.

- j) System of Internal Quality Audits, Management review and initiation of corrective and Preventive actions based on the above.
- k) System for authorising release of manufactured product to the Employer.
- l) System for maintenance of records.
- m) System for handling, storage and delivery.
- n) A quality plan detailing out the specific quality control measures and procedure adopted for controlling the quality characteristics relevant to each item of equipment furnished and /or service rendered.
- o) System for various field activities i.e. unloading, receipt at site, proper storage, erection, testing and commissioning of various equipment and maintenance of records. In this regard, the Employer has already prepared Standard Field Quality Plan for transmission line/substation equipments as applicable, Civil/erection Works which is required to be followed for associated works.

The Employer or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

Quality Assurance Documents

The Contractor shall ensure availability of the following Quality Assurance Documents:

- i) All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication, and reports including radiography interpretation reports.
- ii) Welder and welding operator qualification certificates.
- iii) Welder's identification list, welding operator's qualification procedure and welding identification symbols.
- iv) Raw Material test reports on components as specified by the specification and in the quality plan.
- v) The Manufacturing Quality Plan(MQP) indicating Customer Inspection Points (CIPs) at various stages of manufacturing and methods used to verify that the inspection and testing points in the quality plan were performed satisfactorily.
- vi) Factory test results for testing required as per applicable quality plan/technical specifications/GTP/Drawings etc.
- vii) Stress relief time temperature charts/oil impregnation time temperature charts, wherever applicable.

6.7 Inspection, Testing & Inspection Certificate

Contractor shall procure bought out items from sub-vendors as per the list in (a) "Compendium of Vendors" available on POWERGRID web-site www.powergrid.in after ensuring compliance to the requirements/conditions mentioned therein. Contractor shall explore first the possibilities of procuring the bought out items from POWERGRID approved existing vendors. In case of their unavailability / non-response, Contractor may approach POWERGRID for additional sub-vendor approval. In that case, the assessment report of proposed sub vendor by Contractor along with the enclosures as per Annexure-I shall be submitted within 60 days of the award. The proposal shall be reviewed and approval will be accorded based on the verification of the document submitted and/or after the physical assessment of the works as the case may be. The physical assessment conducted by POWERGRID, if required, shall be on chargeable basis. Charges shall be as per the POWERGRID norms prevailing at that time, which shall be intimated by POWERGRID separately. If proposal for sub-vendor is submitted after 60 days, the

- Contractor shall ensure that order for items where MQP/ITP/FAT is required will be placed only on vendors having valid MQP/ITP/FAT and where the supplier's MQP/ITP/FAT is either not valid or has not been approved by POWERGRID, MQP shall be generally submitted as per POWERGRID format before placing order. A Copy of MQP format is placed at Annexure – III.
- Items not covered under MQP/ITP/FAT shall be offered for inspection as per POWERGRID LOA/technical Specifications/ POWERGRID approved data sheets/ POWERGRID approved drawings and relevant Indian / International standards.

- Inspection Levels: For implementation of projects in a time bound manner and to avoid any delay in deputation of POWERGRID or its authorized representative, involvement of POWERGRID for inspection of various items / equipment will be based on the level below:
- Level –I: Contractor to raise all inspection calls and review the report of tests carried out by the manufacturer, on his own, as per applicable standards/ POWERGRID specification, and submit to concerned POWERGRID inspection office/Inspection Engineer. CIP/MICC will be issued by POWERGRID based on review of test reports/certificates of manufacturers.
- Level – II: Contractor to raise all inspection calls and carry out the inspection on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during inspection, the same would be intimated to Contractor and CIP/MICC will be issued by POWERGRID. Else, Contractor would submit their test reports/certificates to POWERGRID. CIP/MICC will be issued by POWERGRID based on review of test reports / certificates.
- Level - III: Contractor to raise inspection calls for both, stage (as applicable) & final inspection and carry out the stage inspections(if applicable) on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during stage inspection, the same would be intimated to Contractor and CIP will be issued by POWERGRID. Else, Contractor would submit the test reports / certificates of stage inspection after their own review and CIP will be issued by POWERGRID based on review of test reports / certificates. Final inspection will be carried out by POWERGRID and CIP/MICC will be issued by POWERGRID.
- Level – IV: Contractor to raise inspection calls for both, stage (as applicable) & final inspections. POWERGRID will carry out the inspection for both stage & final inspection as per applicable standards/specification and CIP/MICC will be issued by POWERGRID.
- Contractor shall ensure that to implement the above inspection levels, particularly for the quality control and inspection at sub-vendor's works, they would depute sufficient qualified & experienced manpower in their Quality Control and Inspection department. Further, to assure quality of construction, Contractor shall have a separate workforce having appropriate qualification & experience and deploy suitable tools and plant for maintaining quality requirement during construction in line with applicable Field Quality Plan (FQP).
- The Employer, his duly authorised representative and/or outside inspection agency acting on behalf of the Employer shall have at all reasonable times access to the Contractor's premises or Works and shall have the power at all reasonable times to ensure that proper Quality Management practices / norms are adhered to, inspect and examine the materials & workmanship of the Works, to carry out Quality/Surveillance Audit during manufacture or erection and if part of the Works is being manufactured or assembled at other premises or works. The Contractor shall obtain for the Employer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. The item/equipment, if found unsatisfactory with respect to workmanship or material is liable to be rejected. The observations for improvements during product/ process inspection by POWERGRID shall be recorded in Quality Improvement Register (available & maintained at works) for review & timely compliance of observations.
- Contractor shall submit inspection calls over internet through POWERGRID website. The required vendor code and password to enable raising inspection call will be furnished to the main Contractor with in 30 days of award of contract on submission of documents by Contractor. After raising the inspection calls, Contractor shall then proceed as per the message of that particular call which is available on the message board.
- The Employer reserves the right to witness any or all type, acceptance and routine tests specified for which the Contractor shall give the Employer/Inspector Twenty one (21) days written notice of any material being ready for testing for each stage of testing as

identified in the approved quality plan as customer inspection point(CIP) for indigenous inspections. All inspection calls for overseas material shall be given at least forty five (45) days in advance. Such tests shall be to the Contractor's account except for the expenses of the Inspection Engineer. The Employer/inspector, unless witnessing of the tests is waived by Employer, will attend such tests within Twenty one (21) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector three copies of tests, duly certified. Contractor shall ensure, before giving notice for type test, that all drawings and quality plans have been got approved. The equipment shall be dispatched to site only after approval of Routine and Acceptance test results and Issuance of Dispatch Clearance in writing by the Employer. CIP/Material Inspection clearance certificate (MICC) shall be issued by the Employer after inspection of the equipment or review of test reports as applicable. Employer may waive off the presence of Employer's inspecting engineer. In that case test will be carried out as per approved QP and test certificate will be furnished by the supplier for approval. CIP/MICC will be issued only after review and approval of the test reports.

- Contractor shall generally offer material for inspection as per supply bar chart approved by POWERGRID and not before 30 days from schedule indicated in the bar chart. In case Contractor offers material(s) for inspection prior to 30 days from the scheduled date with necessary approval of POWERGRID, POWERGRID shall inspect the material and issue CIP only. However, in such an exceptional case, MICC shall be issued only as per provision of original / revised approved supply schedule.
- Contractor shall minimize the number of inspection calls by offering optimum quantities in each inspection call at the respective manufacturer's works.
- Contractor shall inspect the material themselves and only after they are fully convinced about the Quality, they shall offer the material for POWERGRID inspection and shall also ensure that relevant portion of LOA/NOA, approved drawing and data sheets along with applicable Quality Plans are available at the works of Contractor or their Sub-vendor before the material is offered for inspection.
- Contractor shall ensure that material which has been cleared for dispatch after inspection will be dispatched within 30 days in case of domestic supplies and within 60 days in case of Off-shore supplies from the date of issuance of CIP. Material which is not dispatched within stipulated time as above will be reoffered for POWERGRID inspection or specific approval of POWERGRID QA&I shall be obtained for delayed dispatch .
- The Employer or IE shall give notice in writing to the Contractor, of any objection either to conformance to any drawings or to any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Employer/Inspection Engineer giving reasons therein, that no modifications are necessary to comply with the Contract.
- All Test Reports and documents to be submitted in English during final inspection of equipment by POWERGRID or as and when required for submission.
- When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer/Inspection Engineer(IE) shall issue a certificate to this effect within fifteen (15) days after completion of tests & submission of documents by Contractor/manufacturer but if the tests are not witnessed by the Employer/IE, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Employer/IE. Contractor shall, on completion of all tests, submit test

reports within Ten (10) days to POWERGRID IE. Failure of the Employer/IE to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Employer to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract.

- In all cases, where the Contract provides for tests whether at the premises or works of the Contractor or of any Sub- Contractor, the Contractor, except where otherwise specified, shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Employer/Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Employer/Inspection Engineer or to his authorised representative to accomplish testing.
- The inspection and acceptance by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract, or if such equipment is found to be defective at a later stage.
- The Employer will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.
- The Employer reserves the right for getting any additional field tests conducted on the completely assembled equipment at site to satisfy that material complies with specifications.
- Rework/ Re-engineering, if any, on any item/equipment shall be carried out only after mutual discussions and in accordance with mutually agreed procedure. Contractor shall submit Joint Inspection Report of equipments under Re-Work/Re-Engineering alongwith procedure for the same to POWERGRID for approval, before taking up the Re-Work/Re-Engineering, failing which POWERGRID reserves the right to reject the equipment.
- Contractor may establish a field test Laboratory to execute Civil Construction testing requirements at site with the condition that all testing equipment shall be calibrated from POWERGRID approved accredited Testing laboratories, with calibration certificates kept available at site and all testing personnel employed in the Field Testing Laboratories to be qualified and experienced Engineers or testing to be carried out at POWERGRID approved Third Party Laboratories.
- Contractor shall ensure that all possible steps are taken to avoid damages to the equipment during transport, storage and erection.
- The Employer reserves the right to increase or decrease their involvement in inspections at Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work based on performance of Contractor/sub Contractor.

Annexure-I

Assessment report from Contractor for proposed sub-vendor along with following enclosures (to the extent available):

- A) Registration / License of the works
- B) Organization chart with name and qualification of key persons
- C) List of Plant and Machinery.
- D) List of testing equipment with their calibration status.
- E) List of Raw material, bought out items with sourcing details
- F) List of out-sourced services with sourcing details.
- G) List of supply in last three years.
- H) Third party approval, if any (viz. ISO, BIS),
- I) Pollution clearance wherever applicable
- J) Energy Conservation & Efficiency report
(Applicable to industries having contract load more than 100 KVA)
- K) Formats for RM, in process and acceptance testing
- L) Type test approvals conducted in last 5 years, if applicable
- M) Performance Certificates from customers
- N) Photographs of factory, plant and machinery & testing facilities

Annexure-II

MQP & INSPECTION LEVEL REQUIREMENT

Sl. No.	Item / Equipment	Requirement of MQP/ITP/FAT	Inspection Level
1	Battery	No	II
2	Battery Charger	Yes	III
3	Test Equipment	No	I *
4	FO Cable	Yes	III
5	OPGW & H/W	Yes	III
6	FODP including pigtail	No	II
7	Hardware Fittings for Fibre Optic approach cable	Yes	III
8	SDH Equipments (ADM)	Yes	IV
9	Main Distribution Frame	No	I
10	HDPE Pipe	No	II
11	NMS, TMN	Yes	IV
12	Synchronization Equipment	No	Level-I
13	48V DCPS	Yes	III
14	Furniture	No	I

Note: * MICC for test and measuring equipment shall be issued only after actual verification/demonstration of satisfactory performance at site. ** Though level-2 items, CIP can be issued also on review of TCs and visual inspection of these items.

Annexure- III

MANUFACTURING QUALITY PLAN

Page 1 of 2

	Manufacturers Details (Name, Works Address etc.)	Customer POWERGRID	Vendor's Code:	Item:	Q.P. No. Rev. No. Date:	Valid From: Valid Upto:
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Sr. No.	Components / Operations & Description of Test	Type of check	Quant um of Check / Sampl ing with basis	Referen ce docume nt for Testing	Acceptan ce Norms	Format of Record	Applicable Codes						Remar ks
							1	2	3	4	5	6	

A. Section: RAW MATERIAL INSPECTION B. Section : IN PROCESS INSPECTION C. Section: FINAL TESTING D. Section: PACKING & DISPATCH													
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MANUFACTURING QUALITY PLAN
Page 2 of 2

		Customer POWERGR ID	Vend or's Code:	Item:	Q.P. No. Rev. No. Date:	Valid From: Valid Upto:
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Code 1 Indicates place where testing is planned to be performed i.e. Inspection location A At Equipment Manufacturer's works B At Component Manufacturer's works C At Authorised Distributor's place D At Independent Lab E At Turn Key Contractor's location F Not specified		Code 2 Indicates who has to perform the tests i.e. Testing Agency The Equipment Manufacturer The Component Manufacturer The Third Party The Turnkey Contractor M Contractor	
Code 3 Indicates who shall witness the tests i.e. Witnessing Agency P Component Manufacturer itself Q Component Manufacturer and Equipment Manufacturer R Component Manufacturer, Equipment Manufacturer and Contractor S Equipment Manufacturer T Equipment Manufacturer and Contractor U Equipment Manufacturer, Contractor and POWERGRID V Third Party itself		Code 4 Review of Test Reports/Certificates By Equipment manufacturer during raw material/bought out component inspection. W By Contractor during product/process inspection X Y By POWERGRID during product/process inspection By Contractor and/or POWERGRID during product/process inspection Z	
Code 5 Whether specific approval of sub-vendor / Component make is envisaged? E Envisaged Not Envisaged		Code 6 Whether test records required to be submitted after final inspection for issuance of CIP/MICC Y Yes N No	

Section 7 – Training, Maintenance and Support Services

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Training and Support Services and AMC

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

7.1 Training

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

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

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

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

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

7.1.1 System Design & Overview Training

This training shall provide a functional description of the telecommunication subsystems for fibre optic transmission system and a discussion of the failover and alternate routing schemes inherent in the configuration. The training shall include an overview of the network configuration and indicate the functional responsibilities of all major subsystems including the network monitoring system hardware and software. The training shall highlight all significant methodologies or concepts utilized by the hardware and software to perform the required functions. High-level hardware configuration block diagrams and network/sub-network block/flow diagrams shall be included to enhance the understanding of the overall capability incorporated into all network and sub-network equipment.

The training shall be oriented to a user's point of view. The Employer/Owner users will include managers, design & planning personnel, communication support staff and maintenance personnel. As part of the proposal, the Contractor shall identify the number of days deemed appropriate for this training. In addition, the contractor shall also provide the training on the DCPS & Battery for the supplied system. The training shall cover aspects covering installation, testing & commissioning of DCPS & Battery. Proper emphasis of the training shall be for effective operation & maintenance of DCPS & Battery on routine & emergency basis by the Employer's personnel.

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

7.1.2 Installation & Maintenance Training of Communication Equipment & DCPS

System

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

- (1) FO Transmission System Training
- (2) Network Management System Training

(3) DCPS System

The installation & maintenance trainings shall enable the Employer/Owner to be self-sufficient in preventive & restorative maintenance of the respective communications subsystems purchased by the Employer/Owner. The training courses shall cover equipment installation, testing & commissioning, operation, interfaces and cabling between equipment, preventive maintenance, diagnostic tools and troubleshooting procedures, corrective maintenance, and expansion procedures for all equipment. The courses shall provide theoretical background and extensive hands on experience.

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

7.1.3 Network Management Training

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

The Network Management training course shall provide the course participants with hands-on experience using the actual system being supplied. Table 7-1 summarizes the minimal Network Management training requirements.

Table 7-1: Network Management System Training

Item :	Description:
1.	Features of the software being supplied
2.	System generation and configuration procedures, including memory allocation, operating system parameterization, and buffer sizes
3.	Operating system concepts, including resource allocation, priority level processing, performance monitoring, diagnostic messages, and restoration procedures.
4.	Concepts and techniques for generating, modifying, and saving database, CRT displays, and reports
5.	Utilities, techniques, and equipment used for editing, debugging, testing, integrating, expanding and documenting new programs and subsequent implementation in software and/or firmware.

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

7.1.4 Training Course Requirements

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

7.1.4.1 Class Size

The Employer/Owner plans to send a number of participants to the training courses for a specified duration as described BPS in one or more batches.

7.1.4.2 Training Schedule

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

The training courses shall be offered in one cycle, such that none of the courses within the cycle overlap. The Contractor shall take the above requirements into account in developing the preliminary training schedule. Contractor shall develop a final training schedule in consultation with the Employer/Owner after contract award.

7.1.4.3 Manuals and Equipment

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

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

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

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

7.1.4.4 Cyber Security Awareness and Training

a. The Contractor shall provide regular security awareness and training programs to all personnel involved in the handling of POWERGRID's data and information, covering topics such as data protection, incident response, secure handling and disposal procedures, and relevant security policies and procedures. b. Personnel deployed for operation and maintenance of critical systems shall undergo power-sector specific cybersecurity training as mandated by applicable regulations. c. The Contractor shall maintain detailed records of security awareness and training activities, including attendance logs, training materials, and assessments, and make such records available to POWERGRID upon request for auditing and monitoring purposes.

7.2 MAINTENANCE AND SUPPORT SERVICES

Maintenance after operational acceptance during maintenance period (i.e. Warranty/defect liability period & AMC Period) has been specified at Annexure-I

7.2.1 System Maintenance

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

7.2.2 Warranty Period

The one year period commencing immediately after the operational acceptance is called the Warranty Period/Defect liability Period. In addition to the responsibilities covered under Vol-I Condition of Contracts during Defect Liability Period, the Contractor shall also be responsible for maintenance of the Fibre Optic Cabling System, Fibre Optic Transmission System, Termination Equipment, NMS & DCPS System supplied under this Package. The specification for the maintenance of the system after Operational Acceptance is enclosed at Annexure-I.

7.2.3 Contractor's Maintenance Responsibility

The Contractor shall be responsible for carrying out "Comprehensive Maintenance" of the Communication System (supplied under the contract) for a period of six years after warranty period for ensuring the successful operation of the system. The Contractor shall be responsible for achieving the system availability and the response time mentioned in technical specifications. The bidder shall quote the Annual Maintenance Charges for six years after Warranty Period which shall be considered in the bid evaluation. Bidder shall submit the detailed procedure for achieving above in the bid. The

specification for the maintenance of the system is enclosed at Annexure-I. Upon expiry of the six years AMC period Employer may, at its discretion, extend this Maintenance for additional one year at the same price & terms and conditions.

7.2.4 Cyber Security Requirements During AMC

7.2.4.1 Patch Management

Patch Management system shall be provided by contractor for all the systems and devices supplied under the project during AMC period. Digitally signed or validated and authenticated, security patches and updates for all systems as well as components supplied under the project shall be made available throughout contract period or useful life of such systems, whichever is later. Details of patch management has been specified at Appendix-H.

7.2.4.2 Backup policy and requirements

Backup policy shall be implemented to ensure that online or offline backup data or both, as applicable, of all critical systems is up to date, but not older than a month, and retained in a separate and safe environment for the period as specified in the data retention policy. Contractor shall ensure that at least last two working data backups are available. Backup architecture shall include immutable or offline backup capability and periodic restoration testing to demonstrate recovery from ransomware incidents.

7.2.4.3 Recovery and Restoration

The Vendor shall provide documented and periodically tested recovery procedures and disaster recovery plans for all supplied systems to enable restoration from cyber incidents and cyber crisis situations.

7.2.4.4 Logs requirements

The Logs of the supplied system and device including applications, network activities shall be maintained for at least 180 days. The contractor shall ensure that the logs associated with an incident including logs pertaining to one hundred and eighty days prior and post to such incident are available for at least three hundred and sixty-five days from occurrence of such incident.

7.2.4.5 Asset Register

Asset register shall be maintained by contractor, recording the details of all critical systems along with the requisite details including its configuration, hardware, software, network architecture depicting data flows and communication protocols used in the project.

7.2.4.6 Vulnerability Disclosure and Management

The Contractor shall maintain an effective vulnerability management process and provide the Employer with details of all identified vulnerabilities affecting the supplied products, systems, firmware, operating systems, applications, and associated components, including CVE ID, CVSS Base Score, Temporal Score, Environmental Score, Impact assessment, Available patches or mitigation measures. The Contractor shall also disclose vulnerabilities identified internally by the OEM/Contractor, including vulnerabilities not yet publicly disclosed, to the extent permitted by applicable confidentiality, legal, and responsible disclosure requirements. The Contractor shall promptly assess, mitigate, and close vulnerabilities reported by CERT-In, NCIIPC, CSIRT-Power, Other Government agencies, OEM security advisories, Audit agencies engaged by the Employer. The Contractor shall provide the Employer with details of the OEM's official vulnerability disclosure and security advisory channels. A formal structured process to report vulnerabilities in the products and services should be established. Further, the vendor shall furnish such vulnerabilities to the Computer Security Incident Response Team - Power, through its vulnerability disclosure and management program. Remediation timelines shall be based on vulnerability severity, exploitability, operational risk, and applicable regulatory requirements.

7.2.4.7 Components without CVE/CVSS Publication

The Contractor shall provide and periodically update a list of software, firmware, operating systems, libraries, and components supplied under the Contract for which CVE identifiers and/or CVSS scores

are not published by the OEM or are otherwise unavailable. The Vendor shall provide digitally signed or otherwise authenticated security patches, firmware updates, and software updates for all supplied products throughout the contract period or useful life of the system, whichever is later. For such components, the Contractor shall perform its own risk assessment and submit suitable compensating controls, mitigation measures, and recommended security practices for approval by the Employer.

7.2.4.8 Baseline Configuration Management

The Contractor shall establish, document, and maintain approved baseline configurations for all cybersecurity-relevant hardware, software, operating systems, applications, network devices, security appliances, and system components supplied under the Contract. The baseline configuration documents shall be reviewed at least annually and shall be made available for verification during periodic audits conducted by the Employer or its designated auditors.

7.2.4.9 Security Incident and Vulnerability Notification

The Contractor shall promptly notify the Employer of any cybersecurity vulnerability, security advisory, exploit, compromise, malware incident, security breach, or cyber incident affecting products, services, software, firmware, or systems supplied under this Contract within six hours of detection and provide detailed RCA and corrective action report. Such notification shall be made in accordance with applicable Government of India regulations, CERT-In directions, sectoral cybersecurity guidelines, and timelines prescribed by the Employer. The notification shall include impact assessment, mitigation measures, workaround recommendations, and remediation timelines.

7.2.4.10 Cybersecurity Point of Contact

The Contractor shall nominate and maintain throughout the Contract period one or more qualified cybersecurity coordinators as single points of contact i.e Chief of Information Security Officer for vulnerability management, incident response, audit coordination, patch management, compliance reporting, and cybersecurity-related communications. The Contractor shall provide and keep updated the names, designations, email addresses, and contact numbers of such personnel.

7.2.4.11 End-of-Life/Support Notification

The Vendor shall notify the Purchaser of the End-of-Support (EOS) and End-of-Life (EOL) status of all supplied hardware, software, firmware, and third-party components, along with recommended replacement or migration options.

7.2.4.12 Change Management Requirement

Contractor shall maintain documented change management procedures for all software, firmware, security patches, configuration changes and cyber security updates with version control, rollback capability and approval records.

7.2.4.13 System Hardening Policy

All the Hardware, Operating Systems (OS) and Application software shall be hardened based on OEM recommendations and industry standards. Policy implementation check must be conducted periodically (quarterly) by the contractor and report to be submitted to owner.

7.2.4.14 Documentation to be maintained

Contractor shall maintain following documents of supplied Systems and devices during maintenance period:

- FAT Reports
- SAT Reports
- Cyber Security Audit Reports (as provided by Employer)
- Asset Register

7.2.5 Contractor's Future Hardware/Software Changes

The Employer shall be informed of all alterations or improvements to the hardware supplied under this Specification. The Employer shall be placed on the Contractor's mailing list to receive announcements of the discovery, documentation, and solution of hardware/software problems as well as other improvements that could be made to supply equipment. The service shall begin at the time of contract award, and shall continue for a minimum period of 15 years from operational acceptance by the Employer or 7 years after the declaration of withdrawal of equipment from production whichever is earlier. The Contractor shall also include a subscription to the hardware subcontractors' change notification service from the time of contract award through the warranty period, with a Employer renewable option for extended periods.

7.2.6 Support Services

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

The Contractor shall be responsible for minor facility renovation, and maintenance of the supplied system up to and including successful completion of the Site Acceptance Test.

After final acceptance of the communications equipment, the Contractor shall offer continuing technical support and spare parts for the communications equipment for a minimum period of 15 years from operational acceptance by the Employer or 7 years after the declaration of withdrawal of equipment from production whichever is earlier. However the termination of production shall not occur prior to Operational Acceptance of the system by the Employer.

7.2.7 Technical Support

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

7.2.8 Spare Parts and Test Equipment

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

7.2.8.1 Mandatory Spare Parts

BoQ provides the Mandatory Spare Parts Requirements described in subsystem sets. The mandatory spare parts table represents the minimum spares the Contractor shall be required to supply. The subsystem set of spare parts is defined to include all equipment modules, subunits ,parts, E1 and Ethernet cable required to effect replacement, repair and restoration to full operational status of a defined unit of a subsystem.

7.2.8.2 Miscellaneous Supplies

The Contractor shall provide all required consumable and non-consumable supplies necessary to support all installation and test activities through final operational acceptance. However, if there are any problems in the SAT and additional consumables are required, the same shall also be supplied by the Contractor at no additional cost.

7.2.9 Personnel Security

a. The Contractor shall conduct background checks, including criminal record checks and employment verification, on all personnel who will have access to POWERGRID's data and information, in accordance with applicable laws and regulations. b. The Contractor shall ensure that all personnel who have access to POWERGRID's data and information receive regular security awareness training, covering topics such as data protection, handling of sensitive information, and incident reporting procedures. c. The Contractor shall ensure that all personnel who have access to POWERGRID's data

and information are bound by appropriate confidentiality agreements and are aware of their obligations to protect the confidentiality, integrity, and availability of such data and information.

7.2.10 Declarations and Undertakings

The Contractor shall duly fill, sign, and submit all Declarations and Undertakings in the format prescribed at Appendix-K. The Non-Disclosure Agreement (NDA) shall be executed on the requisite Stamp Paper/e-Stamp Paper and submitted to the Employer.

7.2.11 Third-Party Service Providers

a. If the Contractor engages any third-party service providers or subcontractors to perform services involving the handling of POWERGRID's data and information, the Contractor shall ensure that such third parties comply with the same security requirements and obligations as set forth in Non-Disclosure Agreement. b. The Contractor shall conduct due diligence on any third-party service providers or subcontractors to assess their security practices, certifications, and compliance with relevant standards and regulations. c. The Contractor shall remain fully responsible and liable for the acts and omissions of its third-party service providers or subcontractors concerning the security and protection of POWERGRID's data and information.

Annexure-I

Technical Specifications for Maintenance after Operational Acceptance during Maintenance period (i.e. Warranty/defect liability period & AMC Period)

A -1.0 GENERAL

The Contractor shall be responsible for comprehensive maintenance of the Fibre Optic communication equipment including PABX, NMS, Repeater Shelter & DCPS system supplied & installed under this Contract. The maintenance contract shall commence after completion of the project i.e. after Operational Acceptance. Contractor shall meet system availability of 99.9% for fibre optic system. Contractor will have to make their own assessment of the network and deploy manpower accordingly. However, it is to be ensured that specified manpower of requisite qualification are deployed.

Contractor's maintenance engineer/service engineer shall have minimum qualification of graduate in Computer or IT or Electronics & Telecommunication with minimum one year experience or Diploma with three years maintenance/testing & commissioning experience on the equipment proposed to be supplied & installed. The Degree/Diploma must be recognised Indian professional qualification. This staff shall be supported by head office technical staff for restorative problem or other assistance as may be required. Maintenance engineer shall have technical background and trained in first & second level maintenance on the supplied PABX, Fibre Optic communication system, Repeater Shelter, DCPS & Battery and NMS system of their own without technical assistance from Head Office.

Contractor will arrange for adequate transportation for their staff as per the work demand. Contractor's staff (at all locations) should be equipped with necessary tool kits, mobile phones, vehicle etc.

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

A - 1.1 RESOURCE DEPLOYMENT

In order to cover the entire network, it is imperative that Contractor's maintenance engineers are strategically located so as to reach the site within shortest possible time frame. Thus a minimum of two (2) engineers will be deployed at two (2) locations, this however, does not relieve contractor from its obligation to maintain required system availability of 99.9% for Fibre Optic System. Accordingly, Contractor shall assess the actual manpower requirement and place them suitably at locations, if required. The exact location for deploying engineer shall be finalised during detailed engineering. The central control and monitoring of communication system will be performed from centralized location by means of the centralized NMS. The other locations will work under the control/instruction of the Co-ordinator located at Centralized NMS system.

A 1.2 MONITORING

Network will be monitored through centralized NMS. Network Monitoring Team (NMT/UNMS CO-ORDINATOR), whenever, notices any fault/abnormality in the system (including the third party optical interfaces/SFPs supplied & commissioned under a subsequent different package in the Communication equipment commissioned by the bidder under the current package) shall notify to the Contractor's maintenance Co-ordinator at NMS location, over phone with an event no. An event report shall be generated as per the enclosed formats. On issuance of Event report by NMT/UNMS CO-ORDINATOR, corrective action(s) shall be carried out by Contractor's maintenance personnel for rectification. Contractor's representative must report within four (4) hours at locations where Contractor's engineers are stationed and within reasonable time at all other location which shall in no case exceed more than 12 hours (including travel time). Time mentioned here is irrespective of normal working hours or holidays. The NMT/UNMS CO-ORDINATOR shall co-ordinate and control any site visits to ensure that communication network is operating with a minimum of disruption during these visits. The NMT/UNMS CO-ORDINATOR will inform to facilitate the access to the site/equipment where fault is suspected.

The main responsibilities of the Employer's Network Monitoring Team are:

Communication Network monitoring through Network Management System (NMS) a) Detect faults, prioritizing them and notifying to the Contractor for immediate b) corrective actions.

c) Follow up on corrective actions to verify that the agreed time frames are met.

- d) Record all faults in the fault record sheet and summary of action taken for fault rectifications. Co-ordinate all planned / breakdown site visits to minimize disturbance of service. e) Update status information of operated network to users communication network.

A 1.3 MAINTENANCE

Maintenance activities are either Event Based (Fault/breakdown maintenance,) or planned site visits (Semi annual site visit, testing of channel/s, augmentation and modification in the network if end equipment for data/speech does not communicate with corresponding equipment as and when required. Planned visits shall mainly carried out during working days.

Event based work is to be carried out round the clock seven days a week, A start status shall be jointly filled by Employee & Contractors representative at 10.00 Hrs of commencement date of maintenance contract.

Planned site visits shall be carried out twice in a year (semi-annually) at all the sites in the network or time to time if speech/data is affected at a particular site. Thus, in a year, not less than two planned site visits to all locations will be undertaken.

Contractor will maintain record of events during the maintenance services ; simultaneously Employer shall also record the events in the LOG BOOK available in the NMS control room.

The tasks during the planned site visits for the system include but are not limited to following:

- Visual inspection of equipment
- Alarm measurement verification
- Status report of site
- Updating of log records
- Cleaning the equipment
- Tightening of connectors
- Sealing of cabinets to arrest entry of rodents etc.
- Measurement of earth resistance

Work to be taken up during semi-annual site visits is given in enclosed Format.

Fault/Breakdown maintenance is a process of fault correction / trouble shooting/interfacing with other contractor (for data & Speech connectivity of existing RTUs & EPABXs etc.) as per the fault reported by NMT/UNMS CO-ORDINATOR. Contractor will maintain a log of activities carried out at all locations and necessary History will include site name, visit date, actions taken and site condition. Detailed report in this respect shall be submitted by the contractor in the monthly meeting. Whenever fault is reported in the third party interfaces/SFPs supplied & commissioned under a subsequent different package in the Communication Equipment commissioned by the bidder under the current package, the same shall be reported to the optical interface/SFP supplier by the Contractor's maintenance personnel for necessary resolution/corrective measure.

The POWERGRID/Constituent representatives will associate in trouble shooting, change of unit as per program notified/intimated by the contractor however, due to any reason if POWERGRID/Constituent can not depute their representative, contractor will proceed for the work so as to attend the breakdown/testing as per their program.

The scope of corrective maintenance is as follows:

- Troubleshooting on a network element and its interfaces as and when required and directed by NMT/UNMS CO-ORDINATOR, engineer/coordinator of POWERGRID/Constituent.
- Diagnostics on interfaces to locate problems in network elements. If required, the contractor shall depute maintenance engineer for joint inspection with other vendors for pin-pointing the fault.
- Identification of the faulty hardware unit, replacing it.
- Performance of function verification in co-ordination with the NMT/UNMS CO-ORDINATOR operators
- Handing over of faulty unit to POWERGRID/Constituent at site or Control Centre.

MAINTENANCE OF AUXILLARY SYSTEM

The Repeater Shelter includes all shelter items such as Air-Conditioner, DG Set, Static Voltage Stabilizer, Integrated Power Management System (IPMS) & Batteries etc. DCPS system includes

charger, Batteries, DCDB and other associated cables/connectors, Meters, relays, switches, surge protection devices etc.).

The Contractor shall carry out both preventive and break down maintenance of the supplied DCPS & Battery System.

Preventive Maintenance (PM)

This consists of necessary measures to maintain the equipment in the proper operating condition.

Preventive maintenance includes functional checking, cleaning and necessary repair/replacement/adjustments etc. It will be carried out quarterly at mutually agreed dates.

- Break Down Maintenance of DCPS

Break Down Maintenance is to be carried out in the event of malfunctioning of DCPS equipment, which blocks the normal operation of the DCPS. Break down maintenance includes faultfinding, repair or replacement of defective parts and functional checking.

Immediately on noticing the fault, the fault will be reported by the constituent/POWERGRID on phone to the contractor. The fault reporting time on phone shall be taken as reference time for the purpose of RT and TAT.

- Break Down Maintenance of Repeater Shelter:

Break Down Maintenance is to be carried out in the event of malfunctioning of Repeater Shelter or any of its associated subsystem such as AC, DG, IPMS, Battery Bank etc., which blocks the normal operation of the Shelter. Break down maintenance includes faultfinding, repair or replacement of defective parts and functional checking

- Battery-operated Maintenance

Capacity test @ C10 shall be done periodically (yearly), for assessment of health of the battery bank to determine charge holding capacity of battery bank. The conditions for batteries/battery bank replacement for entire period of contract (including extension of contract, if any) is as follows:

1. Scope of Maintenance of Batteries shall be tested and maintained as per the code mentioned in Indian Standard IS: 14782:2000. Capacity test @ C10 shall be done periodically (yearly), for assessment of health of the battery bank to determine charge holding capacity of battery bank. The supplier, supplying the cells/batteries as per this document shall be responsible to replace/repair free of charge, the battery/cell becoming faulty, owing to defective workmanship or material during entire period of contract (including extension of contract, if any), without any cost implication to the Owner.
2. Irrespective of the design/expected life of the supplied battery banks, If the battery bank capacity is less than 80% of its design value at end cell voltage of 1.75V/cell in any of the cases, Replacement of faulty battery cells/battery banks shall be in the scope of the contractor, without any cost implication to the Owner.
3. If the number of cells replaced (cumulative) in the supplied battery bank exceeds more than 25% of total batteries, then contractor shall replace that entire battery bank without any additional cost implication to the Owner. RT is Response Time when contractor's person report at site after reporting of fault in system. TAT is Turn- Around-Time when system is brought back in service after necessary rectification/replacement works.

A 1.4 HARDWARE SERVICES

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

The Contractor shall be responsible for providing all the spares (cards/modules/accessories etc.) for supplied & installed equipment such as SDH, MUX, NMS etc. The spares shall be provided/arranged by the contractor at no extra cost to Employer. For early restoration during the emergency condition, if

spares are made available by Employer, the same shall have to be replenished by the Contractor within thirty (30) days.

Contractor's hardware services shall also cover support for the NMS hardware & Software supplied to Employer as part of the Contract. Contractor shall be responsible for providing spares for the supplied NMS system, if required, during maintenance period at no additional cost to the Employer.

Contractor will carry out the following tasks for hardware services:

- a) Handover the faulty unit/s to Employer
- b) Replace faulty units from their own spares stock.
- c) Send faulty units to Original equipment supplier's representative in India on Employer behalf with the correctly completed Failure Report with site information and symptoms of failure. Test the repaired unit for their healthiness after the same is rectified by the original d) manufacturer.

A 1.5 MAINTENANCE SERVICES SUMMARY

The Maintenance Services are summarised below:

ON SITE SUPPORT / MAINTENANCE	
Scope	To maintain required system availability of 99.9% for Fibre Optic System and specified response time.
Availability	On all working days of week except on Sundays & holidays during office hours. After office hours / Holidays, duty phone to be contacted (with co-ordinator)
Task	Troubleshooting & Fault rectification
MAINTENANCE FAULT/BREAKDOWN	
Equipment Scope	As per approved BoQ
Scope	Rectification /Corrective maintenance
Availability	On call basis as mentioned above in TS
PLANNED SITE VISIT	
Equipment Scope	As per approved BoQ
Scope	Visual inspection of equipment, alarms measurement verifications, status report of site, updating of log record, cleaning the equipment, modification & augmentation
Availability	Semi-annual / planned visits

A 1.6 OUTAGE TIME DEFINITION:

An outage time refers to period in which loss of communication is detected on any part of the telecommunication network / equipment and continues until the fault is cleared by taking into account conditions listed below.

- a) Time of unavailability excludes running with faulty equipment on specific instruction from POWERGRID/Constituent (not affecting communication or monitoring of other units other than faulty unit).
- b) The time of unavailability excludes the transportation time to a faulty site average of twelve (12) hours and time to get authorization for access to the telecommunication room and to the equipment.
- c) An event would not be considered as failure when the system features allow to continue the data/voice transmission utilizing redundancies available in the subsystem/equipment.
- d) In case of failure of any E1, no consequential lower level channel failure shall be accounted for.
- e) In case a loss of communication is detected in system of third party (PLCC/PABX equipment, RTU/SCADA, existing SDH equipment procured under separate contract) and no corresponding alarm is detected in NMS the event will be jointly studied with the parties and plan/schedule of fault finding will be made. However, under such conditions of fault attribution to the third party, it would be contractor's responsibility to logically establish such attribution.
- f) If it is needed to identify the fault, it is allowed to disconnect/loop circuits for trouble shootings. This testing time shall not be counted in the outage time calculations. However, interruption time for healthy channel should not exceed 10 minutes. Proper planning and coordination with all concerned may be required while carrying out this activity so as to minimize outage time.
- g) Outage due to force majeure conditions (Not attending fault due to war, curfew, earthquake at the location of fault, serious accident during traveling for attending fault) or outage due to failure in power system equipment (or AC/DC).
- h) Outages which are not attributable to equipment faults such as fault in fibre optic cable will not be considered for calculation in system availability.

A 1.7 DOCUMENTATION DURING MAINTENANCE PERIOD

Events shall be recorded by using of event form. The forms shall be filled in duly dated, timed and signed by representatives of both the parties. Absence of one or the other party's representative shall not render the record invalid but assumes only that such representative signs the record at his earliest convenience. The initial condition of the system shall be recorded on the start status form to constitute or reference for later events. All the events recorded in the start status form shall have to be rectified within 15 days. Faults not attended within 15 days will be considered as outage. Any and all events such as incoming and existing alarms, fault occurrence, action taken for remedies etc. shall be recorded in the event report forms. If a unit is replaced or repaired both the new and the replaced or repaired unit is to be recorded in the event report form. Contractor shall submit the detailed report for fault occurrence after the cards/equipment is rectified at the works of supplier.

A 1.8 CALCULATION OF NETWORK AVAILABILITY

TREATMENT OF COMMUNICATION SYSTEM OUTAGES:

- A.** Outage time of communication system elements (i.e. channels) due to acts of God and force majeure events beyond the control of the communication provider shall be considered as deemed available. However, onus of satisfying the Member Secretary, RPC that element outage was due to aforesaid events shall rest with the communication provider.
- B.** Any outage of duration more than one (01) minute in a time-block shall be considered as not available for the whole time-block. Any outage of duration less than or equal to one (01) minute in a time-block shall be treated as deemed available provided such outages are not more than ten (10) times in a day.

Illustration: If a channel is out for a duration less than or equal to one (01) minute in a time-block, and such outages are more than ten (10) times in a day, all the time-blocks with such outages shall be treated as not available.

- C.** All other outages not covered under **A** and **B** shall be considered as not available during the whole block for the computation of channel availability.

Availability of Communication System (**A_{CS}**) shall be calculated as under:

$$A_{CS} = \frac{\sum_{i=1}^N A_i}{N}$$

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Where - N is total number of communication channels
 - A_i is Availability of i^{th} Channel
 Availability of i^{th} Channel (A_i) shall be arrived as under:

$$A_i = \frac{B_T - B_{Ni}}{B_T} \times 100$$

Where B_T is Total number of time-blocks in a month

B_{Ni} is the total number of time-blocks, in which i^{th} channel was not available after considering deemed availability status of **A & B** above.

$$B_{Ni} = B_{ANi} - B_{Gi} - B_{LTTi},$$

Where- B_{ANi} is absolute number of time-blocks in which the i^{th} channel was 'not available' on account of any reason.

- B_{Gi} is Number of time-blocks out of B_{ANi} , in which i^{th} channel was 'not available' on account of act of God as specified in **A** above.

- B_{LTTi} is Number of time-blocks out of B_{ANi} , in which i^{th} channel was 'not available' for a duration less than or equal to one (01) minute in a time-block and not more than ten (10) times in a day as specified in **B** above.

Illustrations:

Case1: If there are 2880 time-blocks (B_T) in a month, and a particular channel is not available for a total of 70 time-blocks; and out of this, the above mentioned channel was not available for 20 (B_{Gi}) time-blocks due to act of God, six (06) time-blocks for less than one (01) minute (B_{LTTi}), then $B_{ANi}=70$, $B_{LTTi}=06$, $B_{Ni}=70-20-06=44$, and $A_i = (2880-44)/2880 = 98.47\%$

Case 2: If there are 2880 time-blocks (B_T) in a month, and a particular channel is not available for a total of 70 time-blocks; and out of this, the above mentioned channel was not

available for 20 (B_{Gi}) time-blocks due to act of God, 11 time-blocks for less than 1 minute, then $B_{ANi}=70$, $B_{LTTi}=0$, $B_{Ni}=70-20-0=50$, and $A_i = (2880-50)/2880 = 98.26\%$.

A 1.9 AVAILABILITY REQUIREMENT

The availability of wideband communication equipment shall be measured in categories as below:

- a) Channel (Voice, Asynchronous & Synchronous data circuits and management data channels)
- b) E-1 /Ethernet channels
- c) Availability of NMS system

The availability requirement for type of channels for wideband communication equipment and NMS systems shall be 99.9%. However not withstanding the commutation of availability of the communication system as specified above, the prompt restoration of the faulty equipment/part of the network is also of equal importance and any delay in restoration of the faulty system shall be governed as per terms & condition of the contract.

A 1.10 SCOPE OF WORK DURING MAINTENANCE PERIOD

Sl.no.	Description	Detailed Scope
1	Overall Infrastructure	Infrastructure includes the building, air conditioners, AC/DC system, UPS, cable trenches, Earthing etc provided by Employer. They will be maintained by Employer.
1.1	Equipment site	
1.1.1	General conditions	General checking during semi annual / troubleshooting site visits and advise
1.1.2	Cleanliness of the room	General checking during semi annual / troubleshooting site visits and advise.
1.1.3	Earthing interconnections	Checking, connector cleaning, redoing the connection during semi annual / troubleshooting site visits (limited to the earthing of equipment under scope of maintenance)and as required specifically. Earthing interconnection will be checked upto earthing star point). Earthing interconnection shall also be checked and corrected during troubleshooting site visits if it is considered the probable cause of fault. Measurement of earth resistance during semi-annual site visit
1.1.4	Air conditioning	General checking during semi annual / troubleshooting site visits and advise
1.1.5	Cable route	General checking during semi annual / troubleshooting site visits and advise
1.1.6	EMI issues	Contractor shall study in special case of repeated faults if the probable cause is earthing interconnection at the station or possibility of spurious signals through various cable connections to the wideband equipment and advise.
1.2	Interfacing with others	Checking interfacing with other equipment and take corrective actions on its MDFs if required. The scope will be limited to the MDFs where the cables of wideband communication system have been terminated. Report and advise on others' if it is the probable cause of fault.
1.3	Indoor cabling	Checking terminations, re-kroning, if necessary, during semi-annual/troubleshooting site visits. It shall also be checked during troubleshooting site visits if it is the probable cause of faults.
1.4	Out-door cabling	Checking terminations, re-kroning, if necessary, during semi-annual/troubleshooting site visits. It shall also be checked during troubleshooting site visits if it is the probable cause of faults.
1.8	Fibre Optic Cable	Checking with OTDR. Rectification if fault is found to be in the approach cable, patch cord etc. up to DDF.
2 Main Equipment		
2.1		
2.2	Fibre Optic terminal SDH	Faulty equipment to be replaced at site as per conditions of Maintenance Plan.
2.3	GPS Clock	Faulty equipment to be replaced at site as per conditions of Maintenance Plan. Contractor shall be responsible for providing hardware , if required, during maintenance without any additional cost implication to Employer.
2.4	NMS	
2.4.1	Computer hardware and Routers	Faulty equipment to be replaced at site as per conditions of Maintenance Plan. Comprehensive maintenance with hardware suppliers to be tied up by the Contractor. Contractor shall be responsible for providing all hardware & software required during maintenance without any additional cost implication to Employer.

2.4.2	Alarm handling, Backups etc. - software part	Alarm deletions, Backups as per maintenance plan. Consumables to be provided by Employer. Software corruption to be corrected as per actual requirement.
2.5		
2.5.1		
2.5.2		
2.5.3	Monitoring and general operation of communication link	Regular monitoring of the communication link operations through NMS in association with the Employer's staff. Investigations for abnormal behaviour and take corrective actions.
2.5.4	Provisioning/ Re- provisioning of channels	As per requirement.
2.6	Repeater Shelter & it's associated subsystem	Regular monitoring of the Repeater Shelter & it's associated subsystem in association with the Employer's staff. Investigations for abnormal behaviour and take corrective actions.
3	Contractor's set-up	Generally in consonance with the set-up mentioned in the maintenance plan.
4	MAINTENANCE OF DC POWER SUPPLY SYSTEM (DCPS includes charger, Batteries, DCDB and other associated cables/connectors, Meters, relays, switches, surge protection devices etc.)	
Details of Job to be carried out during Preventive Maintenance 1 Physical inspection of DCPS at all specified locations 2 Cleaning of System 3 Tightening of all the power and control connections including checking the input power cable terminations at both ends. 4 Checking of DC Voltage 5 Checking for AC Voltage L-L, L-N 6 Checking AC Current 7 Checking for ripple Voltage 8 Functional checking Of DC System For Normal Operation including battery charging 9 Checking for Normal operation of each Module 10 Checking of earthing of the system by measurement of earth to neutral potential. 11 Checking of charging condition of the batteries 12 Checking of the physical conditions of the batteries 13 Checking of each battery voltage during quarterly visits & battery impedance/resistance measurement twice during the contract during 2nd & 4th quarterly visit. 14 Three discharge tests per year at normal load for three hours during 1st, 2nd and 4th quarterly visit. 14 Checking of present load on charger. 15. Matching of DCPS parameters with SCADA system 16. Proper guidance to the operation staff for satisfactory working of the equipment and its proper upkeep. 17. Checking of battery terminals for corrosion and cleaning thereof, torquing and greasing. 18. Capacity test @ C10 shall be done periodically (yearly) during 3rd quarterly visit. Above observations shall be recorded as per enclosed format and duly signed at site by Employer Engineer. Details of Job to be carried during Break Down Maintenance 1 Repair and replacement of Faulty Module 2 Repairing and replacement of faulty components in the system 3 Analysis report of the fault 4 Plan for preventive measure to arrest recurrence of such faults		

5. MAINTENANCE OF REPEATER SHELTER(Quarterly)

Site Name: DG Rating:

i. DG set Preventive Maintenance

Sr No.	Description of Jobs to be done	Remark (OK/Not OK)
1	DG running hours (meter reading)	

2	Check the engine thoroughly	
3	Check oil level in the crank case, top up if necessary	
4	Clean the air cleaner (change the oil if found dirty) when working in dusty condition	
5	Check and adjust the tension of the V-belt driving the blower fan & dynamo	
6	Check & rectify any leakage of oil & fuel	
7	Check & tighten all nuts & bolts	
8	Check the level of the electrolyte in the battery and top up with the distilled water if necessary	
9	Clean the battery terminals and smear with petroleum jelly (optional accessory)	
10	Change the air cleaner oil, wash the detachable strainer element and clean centre tube. (If required)	
11	Clean the cooling air duct & space between cooling fins	
12	Change engine oil & filter element (If required)	
13	Add 2 to 3 drops of lube oil to the dynamo and starter bearing	
14	Drain fuel filter bowl for any water / sludge	
15	Replace secondary fuel filter element (If required)	

ii. Preventive maintenance of AC

Sr No.	Description of Jobs to be done (by authorized service agent)	Remark (OK/Not OK)
1	Cleaning by Air compressor	
2	Cleaning of condenser coil and freezer coil	
3	Checking condition of compressor	
4	Checking card and electrical circuits	
5	Checking of cooling of AC	

A 2.0 Cyber Security Audit The Employer shall engage CERT-In empaneled auditors for conducting Cyber Security Audits, Vulnerability Assessment and Penetration Testing (VAPT), configuration reviews, and compliance assessments during Factory Acceptance Testing (FAT), Site Acceptance Testing (SAT), and throughout the Defect Liability Period and Maintenance Period.

The supplied system is also subjected to Audit by Statutory auditors, internal auditors, or any other authorized third-party agency for conducting cyber security audits. The Contractor shall extend all necessary support, assistance, documentation, system access, test environment access, and technical cooperation required for completion of such audits.

A 2.1 Implementation of Audit Recommendations The Contractor shall implement all applicable observations, recommendations, corrective actions, mitigations, patches, updates, configuration modifications, and remedial measures arising from such audits within timelines mutually agreed upon with the Employer based on the criticality and operational requirements of the system.

Critical and High-risk vulnerabilities identified during cyber security audits shall be remediated within one month and Medium/Low vulnerabilities within three months unless compensating controls approved by Employer are implemented.

The Contractor shall submit a compliance report and closure status against each audit observation/recommendation within the stipulated timeframe. Failure to submit the required compliance report or failure to address agreed audit findings shall constitute a Severity-2 non-compliance under the Contract.

All software updates, security patches, firmware upgrades, configuration changes, and modifications required to address vulnerabilities or audit observations in the products, systems, applications, and services supplied under the Contract shall be carried out by the Contractor at no additional cost to the Employer.

Where implementation of an audit recommendation necessitates procurement of additional third-party hardware, software licenses, or security appliances not included in the original scope, such items shall be provided by the Employer. The Contractor shall, however, be responsible for integration, configuration, testing, and implementation support thereof.

A 3.0 PENALTY FOR DEFAULT IN SERVICES

- a) Contractor will maintain an adequate level of qualified staff for carrying out this maintenance contract, failing which Rs 50,000/- per month will be deducted by Employer from the amount due to contractor under this contract. In addition 5% of the total payable amount shall be deducted for every fall of 1% or part thereof in the specified availability.
- b) In addition to above, a penalty of Rs 1000/- per day shall be imposed for not attending the fault in specified period for all non-communication equipment. For non-communication equipment maximum allowable restoration time shall be 48 Hrs.
- c) Employer shall have the right to terminate the contract after giving notice of two month if the availability of the system is not attained as per specification consecutively for two months.

A 4.0 CO-ORDINATION REQUIREMENTS

A 4.1 MEETING PRACTICE Regular meeting between Employer and the Contractor is vital for communication and information flow between these two organisations. The purpose of the meeting is to tackle the essential issues concerning the services and network performance. The suggested schedule for meeting is once in every month. The meeting agenda shall be decided between Employer and Contractor and could for example consist of the following issues:

- Services and network performance according to the report during last month
- Review of emergency situation
- Status of spare
- Action plan
- Next Meeting
- Alarms/events unattended till the date of meeting The following participants should be present in this meeting:
- Co-ordinator (Contractor)
- Members of the Contractor team as needed
- Co-ordinator Employer representative
- Operation and maintenance staff as designated to attend (Employer)

A 4.2 EMERGENCY MEETING Whenever a major outage occurs in any part of the network, an emergency meeting may be called if desired by Employer. In the meeting, the outage will be discussed in the context of cause, correction and prevention.

A 4.3 REPORTING PROCEDURE The purpose of report is to summarize the activities performed during the reporting period. The report provides the information on the performance of the services and describes the current status of the network. The report is a monthly report from Contractor to Employer which shows the trends in the network and services provided by the Contractor. By analysing the report data, management and expert of Employer and contractor are able to focus attention on the areas where further improvement is needed. **Emergency Reports:** Contractor reports to Employer every time the emergencies call up and call out service is invoked. In these cases, on termination of the emergency all details of the fault and clearance information are submitted within five working days.

A 4.4 INTERFACE BETWEEN EMPLOYER AND CONTRACTOR

Contractor Interfaces

Contractor shall submit detail of personnel deployed in the enclosed format through which all problems identified by Employer are to be reported to contractor via duty phone

Description			
Name			
Telephone			
Fax			
Email			

Co-ordinator :

Telephone no : Mobile no:

FAX No : E-mail address:

(Details to be provided later)

Contacts in Employer

Name	Responsibility	Phone number (Residence) (mobile)	Phone number office	Fax number, E- mail address
------	----------------	--------------------------------------	---------------------	--------------------------------

Form-I**EVENT REPORT FORM**

Event Report No _____

Date: _____

Station: _____

Constituent: _____

Affected Path:

Fault Description: _____

A) Event start time (as per NMS)

date _____ time _____

B) Reporting time by NMT/UNMS CO-ORDINATOR

time _____

date _____

REPORT

i) Failure within contractor system

Yes _____ No _____ (If No then date _____ time _____)

ii) Entrance to site and room for rectification date _____ time _____

iii) Rectification start time by Contractor date _____ time _____

iv) Fault fixed date _____ time _____

Total Outage time

Comments:

Faulty unit Sl. No: _____

New Unit Sl. No.: _____

Date:

POWERGRID/Constituent _____ Contractor _____

Form-II**START STATUS FORM**

Page: (1)

Report no:

Start: Date : _____

Time : 10.00 Hrs:

	Station	Description
1	_____	_____
2	_____	_____
3	_____	_____
4	_____	_____
5	_____	_____
6	_____	_____
7	_____	_____
8	_____	_____
9	_____	_____
10	_____	_____

Special test conditions or action:

Attachments:

Initials:

POWERGRID/Constituent _____

Contractor _____

Form-III**FORMAT TO BE FILLED DURING SEMI ANNUAL SITE VISIT****SITE INFORMATION:**

Site name :-----
Address :-----
Contact Person :-----
Telephone & Fax :-----

GENERAL CLEANLINESS**Communication room air conditioner**

Is air conditioner on? Yes/No
Are filters clean? Yes/No
Is air conditioner cooling O.K? OK/NOT OK
Action Required by Employer-----

Communication room cleanliness

Check if communication room is in good condition (Over all)

Check if regular cleaning of telecom room done.

Check if room is manned.

Check if AC/DC sully has been tapped for other uses.

Is the room having any damp wall.

Action required by Employer.

EQUIPMENT RACK CLEANLINESS:

Check if cabinets are closed and key available with room in charge.

Key available Not Available Cabinet ClosedOpen

Clean the equipment with vacuum cleaner. Cleaned

Actions required by Employer:-----

Action required by Contractor:-----

Contractor's representative

POWERGRID/Constituent representative

3.0 TEMPERATURE MEASUREMENT:

Room temperature

- Check the room temperature (25oC is recommended) _____
- Temperature very near equipment cabinet _____
- Temperature inside the telecom equipment rack _____

Action Required by Employer : _____

4.0 POWER SUPPLY MEASUREMENT

- Input DC Voltage at MCB _____
- Input DC Voltage at Cabinet TB _____
- AC Voltage at the time of station visit (Primary source): _____
- Availability of AC Supply in 24 hours _____
- Charger Voltage _____
- Battery Voltage (Charger AC Supply off) _____

Actions required by Employer _____

4.0 MULTIPLEXER & SDH EQUIPMENT ALARM CHECK

Visual check for the alarm on Mux & SDH equipment, in case of any alarm present further investigation and corrective action.

Healthiness of spare Fibre Fibre no: Colour : Form-III contd/-

From :

To :

Condition :

Equipment used :

Action required by Contractor: _____

5.0 CABLE CHECK

- Check the cable terminations at all MDFs visually. Recrone if any loose wires.
- Check cable route for any abnormality.
- Are cable trenches covered properly?

6.0 DOCUMENTS AND TEST INSTRUMENTS

- Check the following documents at site.

Documents	Available (Yes/No)
FAT Report	
SAT Report	
Cyber Security Audit Report (as provided by Employer)	
Asset Register	

7.0 EARTHING CHECK

- All the cables are connected properly with the ground point.
- Clean the end points if required while removing the earth cable first put temporary earth cable. After correction place the original cable and remove loop cable.
- Clean star point with sand paper and put petroleum jelly.
- Measurement of earth resistance: _____ Ω

**Contractor's representative
representative**

POWERGRID/Constituent's

Form-

IV
Format

DC POWER SUPPLY EQUIPMENT MAINTENANCE FORMAT TO BE FILLED AT SITE
SITE INFORMATION
SITE NAME : _____

ADDRESS : _____

TELEPHONE AND FAX NO : _____

	DESCRIPTION	VALUE,IF ANY	REMARKS
1	Cleaning done		
2	Power connections checked for tightening & over heating		
3	Control Connections are all tight		
4	All indications/meters/display on the panel are working		
5	Input frequency		
6	Rectifier LEDs		
7	Normal Operation on each module		
8	Float voltage		
9	Checking for ripple Voltage		
10	Checking for AC Voltage L-L, L-N		
a	R - Y		
b	Y - B		
c	R - B		
11	Checking AC Current		
12	Checking of DC Voltage		
13	Checking of earthing		
14	Battery voltage/resistance measurement done & enclosed		
15	Load test done on batteries as enclosed		
16	Check functioning of hooter/Buzzer (Alarm Annunciation)		
17	Parameters checked in SCADA system		
18	Proper guidance given for normal day to day operation.		

Suggestions from Contractor :

Remarks from Customer :

CONSTITUENT/POWERGRID representative

Form -V

CONTRACT NO./DATE :
DESCRIPTION OF JOB :
CONTRACTOR :

BIO-DATA OF CONTRACTOR'S EMPLOYEES

NAME :
AGE :
TRADE :
RESIDENTIAL ADDRESS :
TEMPORARY :
PERMANENT :
LANGUAGES KNOWN :
SPEAK :
READ :
WRITE :
QUALIFICATION :
POLICE VERIFICATION NO :
NON DISCLOSURE AGREEMENT :
TRAINING IN SAFETY :
/ HEALTH / ENVIRONMENT
QUALITY/TRADE :
JOB EXPERIENCE :

PHOTO**DATE:****SIGNATURE:**

-----End of this Section-----

Section 8 – Documentation and Deliverables

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Section-08 Documentation and Deliverables

This section describes the documentation requirements and provides a list of deliverable that the Contractor shall provide to the Employer. Complete documentation necessary for the operation and maintenance of the communication system is required. All the documentation shall be provided in hard copy and also on Hard disk in full compliance with the specification. Conditions pertaining to Document Review and Approval Rights and Document Submission Scheduling are specified in this specification. As detailed in subsequent sections the documentation shall include the following:

- a) Detailed list of the deliverables
- b) Description of the products
- c) Technical particulars
- d) Installation manuals
- e) Maintenance manuals
- f) (Quality assurance manuals, Manufacturing Quality Plan (MQP) & Field Quality Plan (FQP)
- g) Tests (type test, production, FAT, SAT) documentation

8.1 System Functional Description Document

The document shall include an overview of the system configuration. This document shall be designed to serve as a complete introduction to the supplied system and to the more specific documents that are defined in technical specifications. The document shall be oriented to the Employer user's point of view and be subject to the Employer's review and approval. Users will include Employer's operating personnel communication support staff and maintenance personnel.

8.2 System Documentation

A detailed documentation plan and document submission schedule shall be prepared and submitted for approval. The guidelines specified in Table 8-1 and 8-2 shall be followed.

8.3 Supplementary Documentation

If during the training courses or while performing maintenance on such equipment during the warranty period, the Employer determines that additional information is required to perform the maintenance function, the Contractor and/or its subcontractors shall provide the specific supplemental information necessary to perform the maintenance function. This information shall be documented in a form suitable for incorporation into the appropriate maintenance document.

8.4 SOPs pertaining to Cyber Security System of Supplied Systems

The Contractor, in association and consultation with the Employer, shall develop, submit, and maintain Standard Operating Procedures (SOPs) covering all relevant cyber security aspects of the supplied Operational Technology (OT) systems. The Contractor shall prepare, at a minimum, the following SOPs:

- User Access and Password Management
- Patch and Security Update Management
- Backup, Restoration and Recovery Mechanism

8.5 Test Documentation

The Contractor shall provide documentation for all factory and field tests. The test documentation shall include the following:

- (a) Test Procedure Document
- (b) Type test documents
- (c) Factory Acceptance Test Documents
- (d) Site Acceptance Test Documents

8.6 Drawings

All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component, break-up for packing and shipment, shipping arrangement required, the dimensions required for installation and any other information specifically requested in the Specifications.

Each drawing submitted by the Contractor shall be clearly marked with the Employer name, the unit designation, the specification title, the specification number and the name of the Project. All titles, notes, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in metric units. The drawing revision level/ issue no, issue date shall be marked on each drawing and the drawing shall carry issue history information and appropriate signatures (eg: originator, checker and approving authority).

Nomenclature: The contractor is responsible to follow standard naming in SDH and its services. Same shall be finalized during detailed engineering.

8.7 Drawing and Document Approval Procedure

The drawings/documents submitted by the Contractor shall be reviewed by the Employer as far as practicable within stipulated duration and shall be modified by the Contractor if any modifications and/or corrections are required by the Employer in compliance with the Specifications. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval. Any delays arising out of failure by the Contractor to rectify the drawings in good time shall not alter the contract completion date.

The drawings/documents submitted for approval to the Employer shall be in triplicate. One print of such drawings shall be returned to the Contractor by the Employer marked with one of the categories as listed below:-

Category Inference

Cat I Approved/Released for implementation.

Cat II Approved/Released for implementation subject to incorporation of comments. Revised drawing required.

Cat III To be resubmitted for approval after incorporating comments.

Cat IV For information and record.

The approval of the drawing/document conveyed vide above marked copy shall neither relieve the Contractor of its contractual obligations and its responsibilities towards weights, qualities, design details, assembly fits, performance particulars and conformity of supplies with the Indian Statutory Laws as may be applicable, nor shall it limit Employer's right under the contract.

Depending upon the category of approval the Contractor shall resubmit the drawings/documents for review by Employer after incorporating all corrections.

Further work by the Contractor shall be strictly in accordance with the Cat-I, Cat-II or Cat-IV approved drawings and no deviation shall be permitted without the written approval of the Employer.

All manufacturing and fabrication work in connection with the equipment/material prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment/material conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the Contractor of any of his responsibilities and liabilities under the Contract.

8.8 Final Documentation

Final documentation shall consist of the documents approved in Cat I and Cat IV listed in Table 8 -1. The documents will be used by the Employer personnel for operating and maintaining the equipment after acceptance.

Until acceptance of the equipment by the Employer, the Contractor shall be responsible for supplying documentation revisions or changes necessitated by inaccuracies, installation requirements, omissions

determined by usage, and design or production alterations to the equipment. All changes shall be issued in the form of replacements for the affected drawings, diagrams, charts, graphs, tables, lists, and pages in the various documentation such that all documentation describes the equipment "as delivered". For all CAT-I & CAT-IV approved documents listed in table (except Type, FAT & SAT related), Three (3) sets of the final approved documentation shall be provided to the Employer in CD-ROM and two sets in hardcopy.

All final Contractor-supplied documentation shall be easily reproducible by the Employer.

Table 8-1 Documentation Plan for Communication Equipment Package				
S. No	Document	Applicable Equipments / Item	Brief Description	Category of Approval
1.	Documentation plan & schedule		This document shall contain the list of all documents to be submitted for approval and their submission/approval schedule.	IV
2.	Survey guidelines		As per Technical Specifications	I
3.	Data Requirement Sheets (DRS) and Guaranteed Technical Parameters & Drawings	For each and every item to be supplied including SDH equipment, NMS, DCPS & Battery, Repeater Shelter, PABX power and signal cables, earthing cables, patch cords etc	These document(s) shall describe all the technical parameters of the equipment being offered.	Cat-I(for DRS) & Cat-IV (for brochure)
4.	Mechanical drawings	As applicable	This document shall fully describe the equipment racks/ enclosures, MDF, peripherals and related hardware with particular reference to mechanical construction, materials and dimensions, appearance, mounting methods, earthing clearances required from walls/roof/other panels, cable entry details, dust and moisture ingress protection provisions etc.	I
5.	Equipment Manuals & Standard Documents	For all items	Complete set of all equipment manuals (Construction, Installation, Maintenance, Reference etc) for that product. A set of product brochures, photographs etc.	IV
6.	Previous type test reports	For all items for which type testing is envisaged.	Shall be complete in all respect including all test graphs, curves, calculations, photographs etc.	Acceptance letter by Employer
7.	Manufacturing Quality Plan	For all items to be supplied		I#
8.	Type test schedule	For all items for which type testing is required.	Shall indicate the start & finish data for each test	I

			& sequence of tests if applicable, test labs.	
9.	Type test report	For all items for which type testing is required.		I
10.	Site survey reports	For each site	Link wise survey reports as per specifications,	*
11.	Link & Engineering Analysis	For each Fibre Optic link	Link budget calculations etc.	I
12.	Bill of Quantity	For each items and each line		I
13.	Numbering, Marking, labeling Document	As applicable.	Must include numbering, marking, labelling and naming conventions for channels, cables, connectors, subracks, cubicles etc	I
14.	Physical planning/site preparation manuals	As applicable.	Must contain data gathered during the site survey, including test results, if any. The document shall also contain floor plan, cable trenching/raceway drawings, station block diagrams, rack/cabinet elevation drawings, air-conditioning and power supply requirements, and power supply distribution and earthing system details.	*
15.	Channel Routing	Whole Network	E1 level Plan and Ethernet channel plan	I
16.	Synchronisation Plan	Whole Network	Locations of clocks, depiction of all interfaces, flow of synchronizing signal.	I
17.	Configuration Diagrams	Whole Network	Network configuration, Link wise and site wise equipment configuration, NMS configuration.	IV
18.	NMS Description Document	NMS	Functional description of Hardware, Description of all commonly used and major functions in detail, Reference, User, Maintenance Manuals, Interfaces and channel requirements and routing	I (for NMS description document) and
19.	Factory acceptance test report	For all Factory acceptance tests		Acceptance letter by Employer
20.	Transportation & Handling Procedures	For all items	This document shall describe the procedures & precautions to be observed during overseas & inland transportation, equipment handling during transport, storage & pre-installation. It shall also include packing details and package labelling details.	IV
21.	Equipment Installation manual	For equipment types: Mux, D/I, DACS, SDH equipment, DCPS, Battery etc	The expected content of this document are presented in table below.	IV

22.	Site Drawings	Site wise complete documentation	This document must include, general details of equipments, cubicles, cables, connectors, MDFs, DDFs, network diagram, earthing connections, power supply connections and specific details i.e. site layout, floor plans, cubicle layout, subrack layout, channel routing, signal connections, cable routing, MDF and DDF cross connections etc	IV
23.	Field Quality Plan	One Document with multiple subdocuments if required	Field Quality Plan shall describe the quality control to be exercised during the field activities. This document can include the following information: (a.) The list of performance &	I#

Table 8-1 Documentation Plan for Communication Equipment Package				
S. No	Document	Applicable Equipments / Item	Brief Description	Category of Approval
			safety checks applied to installation equipment, tools & tackles, checks, check on physical health & training records of installation crew etc. (b.) The list of Site Acceptance tests (including statement of acceptance criteria). The inclusion of list of site acceptance tests in FQP is analogous to the inclusion of list of FAT in the MQP. The formats for recording & reporting Site acceptance tests can also be reproduced	
24.	Training Manuals	System document	An advance copy of all training material.	IV
25.	Maintenance Philosophy & Procedures	System document	Shall cover breakdown maintenance procedures, preventive maintenance schedules and procedures	IV
26.	SA T reports	Per Link and per location		*
27.	SOP for User Access and Password management SOP	NMS and SDH equipment		I
28.	SOP for Patch and security update management S	NMS and SDH equipment		I
29.	SOP for Backup and restoration recovery mechanism	NMS and SDH equipment		I
30.	Asset Register(SBOM & HBOM)	All equipment's supplied under the contract	Asset register shall be maintained by contractor, recording the details of all critical systems along with the requisite details	IV

			including its configuration, hardware, software, network architecture depicting data flows and communication protocols used in the project	
--	--	--	--	--

Note *: To be reviewed & approved by site. #: To be reviewed & approved by QA&I.

Table 8-2 Expected Contents & Structure of Equipment Installation Manual		
1.	Installation procedure	Description of activities of installation gangs: Preparation & Setting up, Precautions for preventing damage etc shall be highlighted.
2.	Safety Instructions	Instructions & procedures related to ensuring installation crew safety: personnel grounding & safety, installation equipment safety, Safety for power system & environment.
3.	Description of Installation Equipment	Sketches, drawings, photographs, safe working ratings of installation equipment, tools & tackles etc., handling instructions & precautions.
4.	Cable routing	Illustrations of the various possible cable routing (Intra cabinet and inter cabinet, within the same room and located in different rooms/buildings etc.) methods.
5.	References	References to other related documents covering the installation, jointing & testing, such as ☐ SAT administrative & functional test plans & test procedures ☐ Field Quality Plan & Field Quality Audit ☐ Storage & Handling Instructions ☐ Drawings, technical parameters, DRS etc ☐ Employer & Statutory safety rules, safety manuals, standards, codes of practices etc.

-----End of this Section-----

Section 9 – Project Management, Schedule and Implementation Plan

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This section describes the project management, schedule, quality assurance, and implementation plan requirements for the package.

9.1 Project Management

The Contractor shall assign a project manager with the authority to make commitments and decisions that are binding on the Contractor. The project manager's responsibility shall include interface and coordination with the Project contractor(s). The Employer will designate a project manager to coordinate all the Employer project activities. All Project correspondence and communications between the Employer and the Contractor shall be coordinated through the project managers.

The project shall be staffed from the list of project management and engineering personnel presented in the proposal. Principal participants shall have previous experience in a similar position on at least two other projects of similar scope to this project. The assignment and reassignment of the Contractor's principal participants in the project shall be subject to the Employer's approval.

9.1.1 Reporting Period

The Project Manager shall provide updated project schedules and complete progress reports on monthly basis for the duration of the project. All references to the reporting period throughout this Specification shall refer to this monthly period.

9.1.2 Progress Meetings

The Project Manager shall schedule and attend Progress Meetings as deemed necessary but no less than once every two months.

9.1.3 Transmittals

Every document, letter, progress report, change order, and any other written or electronic media transmissions exchanged between Contractors and the Employer shall be assigned a unique transmittal number. Discussions and phone calls where project related information is exchanged shall be documented in a transmittal. The Contractor shall maintain a correspondence index and assign transmittal numbers consecutively for all Contractor documents. The Employer will maintain a similar correspondence numbering scheme identifying documents and correspondence that the Employer initiates.

9.1.4 Quality Assurance

9.1.4.1 General

The Contractor shall adhere to a Quality Assurance (QA) program for the preparation of all Contract deliverables, including documentation, hardware, firmware and software. The program shall provide for early detection of actual or potential deficiencies, timely and effective corrective action, and a The Bidder's proposal shall include the relevant ISO 9000 certificates from the main Bidder and from all subcontractors which have a major part (over 10%) of the delivery.

The relevant ISO 9000 standards to be provided are the following:

- ISO 9001: model for quality assurance in design, development, production, installation and servicing
- ISO 9002: model for quality assurance in production and installation
- ISO 9003: model for quality assurance in final inspection and testing

The Quality Assurance procedures, documentation standards, and software development procedures which were included with the Bidder's proposal will be incorporated into the Contract.

9.1.4.2 Quality Assurance System and Requirements

The ISO 9001 Certificate and the assessment and visit reports shall be available to the Employer throughout the duration of the contract.

The Quality Assurance program shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of contract. A Quality Assurance program of the Contractor shall generally cover but not limited to the following:

- a. Organization structure for the management and implementation of the proposed quality assurance program.
- b. Documentation control system.
- c. Qualification data for Contractor's key personnel
- d. The procedure for purchases of materials, parts/components and selection of sub- Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- e. System for shop manufacturing including process controls and fabrication and assembly controls.
- f. Control of non-conforming items and system for corrective action.
- g. Control of calibration and testing of measuring and testing equipments.
- h. Inspection and test procedure for manufacture.
- i. System for indication and appraisal of inspection status.
- j. System for quality audits
- k. System for authorizing release of manufactured product to the Employer.
- l. System for maintenance for records.
- m. System for handling storage and delivery
- n. A quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics of the product.

The Quality Assurance Plan shall be mutually discussed and approved by the Employer after incorporating necessary corrections by the Contractor as may be required.

This Quality Assurance plan shall then form part of the contractual documentation and shall not be changed without prior agreement with the Employer. The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Assurance Plan at the time of the Employer's inspection of equipment/material.

The Employer or his duly authorised representatives reserve the right to carry out Quality Audit and Quality Surveillance of the systems and procedures of the Contractor/his vendor's Quality Management and Control Activities.

9.1.4.3 Variance Reporting and Processing

An automated variance recording and tracking system shall be placed in service at least one month before the initially scheduled beginning of the FAT. This system shall be designed to record and track variances for documentation deficiencies, functional deficiencies, performance deficiencies, procedural deficiencies (as when deviations from contractually required QA procedures are observed), and test deficiencies (as when the System cannot satisfactorily pass a step within a test procedure).

Variances may be initiated by both Contractor and the Employer personnel and shall be classified as follows:

- a. Open (recorded but not necessarily agreed to)
- b. Assigned (denoting acceptance by the Contractor)
- c. Pending (denoting fixed, in the Contractor's opinion, and awaiting retest or verification)
- d. Resolved (denoting the Employer acceptance or verification).

For the tracking of the variances and to support the automatic printout of subset lists, the following information fields shall be stored for each variance:

- e. Variance number (automatically assigned)
- f. Date initially recorded
- g. Status (open/assigned/pending/resolved)
- h. Date current status recorded
- i. Names of the involved Employer personnel
- j. Names of assigned Contractor personnel
- k. Subsystem involved
- l. Test name (where applicable)
- m. Description (up to five lines in a full printout and part of the first line in a one-line- per-variance printout)
- n. Urgency description (1, 2, or 3).

The variance recording and tracking system shall allow full printouts of all of the above information, condensed printouts of abbreviations of the above information (one-line-per- variance) and shall produce subsets of the variances based on searches of the fields singly or in combinations. For example, it shall be possible to produce a printout of all the variances (and only those variances) that were at level

1 of 2 urgency, concerning a specific named subsystem, had open or assigned status, and were initiated within a named period.

Depending on its impact, each variance shall be assigned to one of three urgency levels by the Contractor with the Employer having level assignment approval rights.

level 1 Testing will stop for immediate evaluation and correction by the Contractor

level 2 Testing will continue and the variance will be corrected at the end of the current session or day

level 3 Testing will continue and the variance will be corrected and tested at a mutually agreed upon time (e.g., at the end of the test or later in the test period prior to shipment).

A variance status summary shall be included in the monthly project progress reports, and up-to- date variance reports shall be made available to the Employer on demand.

The variance recording and tracking system shall be subject to approval by the Employer.

9.1.4.4 Additional Quality Assurance Requirements

The Employer shall have access to the Contractor's premises at any mutually agreed time and be provided access to inspect and assess the quality system should any specific need arise. The Employer shall also be able to conduct on site reviews as mutually agreed.

The Employer shall have access to any relevant documentation for verification that quality procedures are in accordance with the contract-specific quality plan.

9.1.5 Software Configuration Management

All software development performed by the Contractor shall be under a formal, documented software configuration management procedure. The procedure shall encompass the following aspects:

- (a) Inventory control
- (b) Version control
- (c) Change control
- (d) Build management.

The software configuration management scheme shall be managed by a designated software administrator(s). In case, the software is already a developed product, software configuration management shall begin at the time software is initially installed on the system. In case of new or continuing development, software configuration management shall be immediately initiated during the earliest phases of development. The administrator(s) shall work closely with the Contractor software staff and shall be responsible for enforcing the software management procedures.

9.1.6 Document Review and Approval Rights

To ensure that the proposed systems conform to the specific provisions and general intent of the Specification, the Contractor shall submit documentation describing the systems to the Employer for review and approval.

The Employer will respond with written comments to the Contractor within thirty (30) calendar days after receipt of the documents. Documents requiring correction must be resubmitted by the Contractor to the Employer within 30 calendar days. The Employer will respond to resubmitted documents within fifteen (15) calendar days after receipt of the document. No implementation schedule relief is to be implied for documents requiring correction and resubmission to the Employer.

The Employer shall have the right to require the Contractor to make any necessary documentation changes at no additional cost to the Employer to achieve conformance with the Specification. Any purchasing, manufacturing, or programming implementation initiated prior to written the Employer approval of the relevant documents or drawings shall be performed at the Contractor risk. Review and approval by the Employer shall not relieve the Contractor of its overall responsibilities to satisfy system functions and performance requirements in accordance with the Specification.

To help the Employer manage the review and approval of documents during any given period, the Contractor shall stagger the release of documents over the time allocated in the project schedule. The number and size of documents shall be factored into the document release schedule. At any time, no more than five documents shall be submitted to the Employer for review and approval.

9.2 Project Schedule

The project schedule shall consist of an implementation schedule, a documentation schedule, and a training schedule.

9.2.1 Implementation Schedule

The Contractor shall produce and maintain the implementation schedule. A copy of the implementation schedule files in a soft copy shall also be provided to the Employer. The overall project plan shall consist of a Milestone Plan and a detailed Schedule Plan.

The Contractor shall provide a critical path analysis report and a manpower resource analysis report. Other standard reports will be defined during the Work statement.

Within two weeks of contract signing, the Contractor shall submit detailed project schedule, as described below. The project schedule shall include all tasks to track overall direction and integration of the project from inception through completion.

The Schedule Plan shall be developed utilizing the concept of Work Breakdown Structures. No task shall be greater than 3 weeks in duration.

The implementation schedule shall include the project milestones defined in Volume I, the Contractor activities and the Employer activities defined in this Section. The project schedule shall be an accurate representation of the progress and planned activities of the project.

The actual progress made to date and the scheduled delivery date for the completed systems shall be closely monitored by both the Contractor and the Employer project managers. The following information shall be reported to the Employer in a clear and concise manner using the tabular and graphic capabilities of the project management software:

- (a) An overview and general assessment of all the Employer and Contractor activities and any progress or delays in these activities since the last reporting period
- (b) Identification of tasks in the critical path together with an analysis indicating any required remedial action
- (c) The amount of contingency time (float) remaining in the schedule
- (d) Information on each task, including:
 - (1) Estimated start and finish dates
 - (2) Any change in the estimated dates since the last reporting period
 - (3) Estimated total number of calendar-days to complete the task
 - (4) Percent of task completed
 - (5) An indication of whether the start date was manually entered or computed.
- (e) Total project resources
- (f) The tasks to begin in the next two reporting periods
- (g) The tasks to be completed in the next two reporting periods
- (h) The tasks completed in the last two reporting periods

The content and format of the project schedule shall be subject to the Employer approval. The Contractor shall update and submit the project schedule to the Employer at least one week prior to each progress meeting.

9.2.2 Contractor Activities

The implementation schedule shall be compiled by the Contractor summarizing all activities, and shall include but not be limited to the following:

- (a) Survey, Design & Engineering
- (b) Hardware purchases, development, and integration
- (c) Hardware production schedules
- (d) Documentation preparation and release
- (e) Documentation revision and release following the Employer review
- (f) Software design, coding, unit testing, and integration
- (g) System integration
- (h) Type Tests and Factory testing
- (i) Shipment

- (j) Receipt, forwarding and staging
- (k) Installation
- (l) Site Acceptance testing
- (m) Availability Test

Each scheduled task shall have an estimated duration for completion and predefined relationships with other tasks. Relationships shall be used to enforce the logical progression of work in as much as certain tasks cannot start until others have been completed.

9.2.3 The Employer Activities

The implementation schedule shall contain all the Employer activities required in order for the Contractor to complete their systems and integration tasks, including the following:

- (a) Document reviews and approvals
- (b) Licensing and Regulatory Clearances, if any
- (b) Participation in all levels of testing and training
- (c) Any site preparations, if required.
- (d) Assistance NMS database, display and report definition

9.2.4 Documentation Schedule

The documentation schedule shall include an entry for each document and drawing to be delivered throughout the project. Each documentation schedule entry shall include the document or drawing title, number, revision level, actual or future submittal date for the Employer review or approval, date of completion of review or approval by the Employer, and outcome of review or approval by the Employer. When the Employer requires correction to any document, the documentation schedule shall be updated with a new entry for the next revision of the document. The content and format of the documentation schedule shall be subject to the Employer approval.

The documentation schedule shall allow for at least two submissions of each document requiring review or approval. The time schedule for document review or approval by the Employer shall be as specified in this section.

9.2.5 Training Schedule

The training schedule shall identify the dates of all of the training courses. The Contractor shall work with the Employer to determine the training schedule. The training schedule shall be subject to the Employer approval.

The appendices provide training requirement for this package. The training schedule shall accommodate the Constituent's availability of personnel in so much as it is possible.

9.3 Progress Reporting

With the intent to assure quality management and project progress as per the implementation schedule, progress reports submitted for each reporting period and Progress Review Meetings shall focus on the following:

9.3.1 Monthly Progress Reports

A Monthly Progress Report shall be prepared by the Project Manager that includes inputs from all its subsystem. The report shall be made available to the Employer as hard copy and soft copy, by the 10th working day of each month and shall include but not be limited to:

- (a) Updated project schedule highlighting any deviations from the previous issue of the project schedule
- (b) Explanation and anticipated effect of each schedule deviation and its implication to the Employer.
- (c) Schedule recovery plan for any deviation incurring a delay in delivery date. (All delays shall be factored into the project schedule as soon as they are known to the Contractor.)
- (d) A summary of activities performed by the Contractor and the Employer during the previous reporting period

- (e) An updated list of all correspondence transmitted and received by the Contractor
- (f) Updated documentation schedule
- (g) Updated training schedule
- (h) List of all Contractor personnel and the Employer personnel resident at the Contractor facility, identifying all activities performed by each person and the activities scheduled for the next two reporting periods
- (i) Updated list of Contractor and the Employer action items with status, description of required information, and required resolution dates
- (j) Summary of pending and upcoming Contractor and the Employer activities during the next two reporting periods along with required completion dates
- (k) Status of unresolved contract questions and change requests
- (l) Summary of variances
- (m) Log of invoice status
- (n) Description of current and anticipated project problems and steps to be taken to resolve each problem.

9.3.2 Quarterly Progress Review Meetings

Progress Review Meetings shall be scheduled by the project managers and attended by the Contractor and the Employer to review progress of the project. Progress meetings shall be used to review the progress reports for the previous reporting periods, written correspondence exchanged since the last meeting, and open action items.

The Contractor shall also attend technical meetings as required to discuss technical aspects of the project and to review the Employer comments on approval documents. When appropriate, these splinter meetings shall be conducted as extensions to the progress meetings.

At least one-half of all meetings shall be held at the Employer's offices. Record the minutes of each meeting shall be prepared and provided as hard copies to all attendees on the same day whenever possible, but not later than within two working days after the meeting. Table 9-1 provides a suggested agenda for Progress Review Meetings.

Table 9-1: Suggested Progress Review Meeting Agenda

Item:	Title:	Description:
1.	Meeting Minutes:	Review minutes from previous meeting, with comments
2.	Open Action Items:	Review all outstanding action items
3.	Progress Review:	Review with participating Project Managers and Contractor, most recent project schedule. Update schedule and develop Action Items.
4.	Technical Discussion:	Discuss Technical Issues.
5.	Action Items:	Assign responsibilities for new action items.
6.	Administrative Matters:	Discuss administrative matters
7.	Action Items:	Assign responsibilities for action items.
8.	Next Meeting:	Schedule time and place for next meeting and agree on agenda
9.	Adjourn:	Adjourn meeting.

9.4 Implementation Plan

The bidder shall submit a preliminary project implementation schedule along with the bid. The detail project implementation schedule shall be submitted by the Contractor after award for Employer's approval, which shall include at least the following activities:

- (a) Site Survey
- (b) Documents, DRS, Drawing submission and approval
- (c) Type Testing Schedule
- (d) Manufacturing
- (e) Factory Testing Schedule
- (f) Dispatch Schedule
- (g) Receipt, Storage, Installation Schedule
- (h) Site Testing Schedule
- (i) Training Schedule

9.4.1 Implementation Steps

The basic implementation steps pertaining to telecommunication system of the project are:

- (a) Design & parameterize the fibre optic cable network, integrated wideband network, including implementation strategies.
- (b) Conduct site & route surveys, identify equipment locations and required site preparations.
- (c) Subsystems design, manufacture, factory & type test (if applicable).
- (d) Shipping, installation and field testing for above.
- (e) Design, manufacture, factory and type test (if applicable) of termination equipment and NMS subsystems and other related equipment.
- (f) Shipping, installation and field testing of above.
- (g) Integration of FOTS, associated equipment, inside plant, PLC and integration with existing network.
- (h) Field testing of the integrated telecommunication network including the NMS subsystem.
- (i) Acceptance test and cutover support of the Project requirements of the integrated telecommunications network

Though not detailed, the above steps are intended to encompass all relevant work required to provide the Employer with a fully working integrated telecommunication network supporting all Project commitments.

9.4.2 Implementation phases

The above implementation steps shall be organized and managed in various overlapping phases

9.4.3 Implementation Schedule

Appendix to this Technical Specifications provides an implementation schedule guidelines consistent with the phased implementation plan described herein and the Implementation Schedule for this Package.

-----End of this Section-----

Section 10 – Cyber Security Requirements

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Regulations and Statutory Guidelines

The Contractor shall provide the System compliant with the Central Electricity Authority (Cyber Security in Power Sector) Regulations, 2026. The contractor shall follow and ensure compliance with all the cyber security-related statutory regulations and guidelines, directives and advisories issued by statutory authorities such as CSIRT-Power, CERT-In, NCIIPC, CEA throughout the contract period. The System shall be designed to also comply with NCIIPC guidelines for Critical Infrastructure Protection, ISO 27001, ISO 27019 and IS 16335 standards as well as additional requirements specified in this technical specification. Where implementation of these regulations/guidelines necessitates procurement of additional third-party hardware, software licenses, or security appliances not included in the original scope, such items shall be provided by the Employer/Owner. The Contractor shall, however, be responsible for integration, configuration, testing, and implementation support thereof.

Cyber Security System

Cyber Security system comprising of various modules as envisaged in the specification shall be supplied by the Contractor for the cyber security requirements envisaged in the specification. These components are identified in Bill of Quantities for of the projects.

Isolation of OT System

Physical isolation of Operational Technology system from Internet as well as Information Technology system shall be ensured. Any exchange of approved data between IT and OT networks shall be permitted only through separate communication channels and dedicated unidirectional gateways, with prior approval of the competent authority. Data flow from IT to OT and from OT to IT shall be established in accordance with applicable cyber security regulations and approved system architecture. The reference time source selected for Operational Technology system shall be, either terrestrial or India specific satellite based and independent of internet.

Patch Management

Patch Management system shall be provided by contractor for all the systems and devices supplied under the project. Details of patch management has been specified at **Appendix-H**. Also refer Section-7 of this specification.

Logs requirements

The Logs of the supplied system and device including applications, network activities shall be maintained for at least 180 days. Also refer Section-7 of this specification.

Backup policy and requirements

Backup policy shall be implemented to ensure that online or offline backup as specified in Section-7 of this specification.

Network Segmentation

Network segmentation shall be followed as per industry's best security practices. It shall include at least the following:

Separate VLAN and zones should be created for different servers, network devices as per functional requirements in consultation with Employer/ Owner.

Network Zoning shall be implemented in network architecture for enhanced security of the System. However, the Contractor may suggest other methods of network architecture for enhanced security of the System.

Network architecture shall be designed in such a way that Servers/ systems shall be placed in separate VLANs, thereby providing micro-segmentation of the network on the same switch. Any traffic flow from server to server or server to client/console must pass through firewalls except for the servers proposed in clusters, if any.

The contractor shall ensure that procured product has appropriate security, network and segregation provisions to support and enable a 'defence-in-depth' approach to the System security. The contractor shall recommend guidance on the design and configuration of network security zones within the

procured product. The contractor shall provide information on all communications (e.g., protocols) required between network security zones, whether inbound or outbound, and identify each network component of the procured product initiating communication. The contractor shall verify and document that disconnection points are established between the network security zones and provide the methods to isolate the zones to continue limited operations.

Asset Register

Asset register shall be maintained by contractor as specified in Section-7 of this specification.

System Hardening Policy

All the Hardware, Operating Systems (OS) and Application software shall be hardened based on OEM recommendations and industry standards. Contractor shall provide hardening checklists for all supplied systems in consultation with employer for incorporation of employer's policies during detail engineering. A minimum cyber security and system hardening policy to be followed in supplied system is attached at **Appendix-I**. List of ports and services enabled in each hardware device must be maintained and shared after SAT of the System.

Cyber Security Audits and Implementation of Audit Recommendations

The Contractor shall provide support and implement Audit recommendations as specified in Section-7 Annexure-I during FAT, SAT and Maintenance Period.

Vulnerability Disclosure and Management

The Contractor shall maintain an effective vulnerability management process and provide the Employer as specified in Section-7 of this specification.

Baseline Configuration Management

The Contractor shall establish, document, and maintain approved baseline configurations for all cybersecurity-relevant hardware, software, operating systems, applications, network devices, security appliances, and system components supplied under the Contract. Also Refer Section-7 of this specification

Third-Party Components

The Vendor shall provide documentation detailing all security requirements, dependencies, patches, updates, and integration processes relating to any third-party components included in the supplied solution.

Bill of Materials (BOM)

The Vendor shall provide and maintain an updated Software/Hardware Bill of Materials (SBOM/HBOM), including firmware and third-party components, in accordance with applicable CERT-In guidelines. A sample format with minimum requirement to be filled and supplied by contractor is attached at **Appendix-J**.

Declarations and Undertakings

The Contractor shall duly fill, sign, and submit all Declarations and Undertakings in the format prescribed at **Appendix-K**. The **Non-Disclosure Agreement (NDA)** shall be executed on the requisite **Stamp Paper/e-Stamp Paper** and submitted to the Employer.

Third-Party Service Providers

If the Contractor engages any third-party service providers or subcontractors to perform services involving the handling of POWERGRID's data and information, the Contractor shall ensure that such third parties comply with the same security requirements and obligations as set forth in Non-Disclosure Agreement.

The Contractor shall conduct due diligence on any third-party service providers or subcontractors to assess their security practices, certifications, and compliance with relevant standards and regulations.

The Contractor shall remain fully responsible and liable for the acts and omissions of its third-party service providers or subcontractors concerning the security and protection of POWERGRID's data and information.

Secure Development and Deployment Practices

The Contractor shall follow secure software development life cycle (SDLC) practices, including but not limited to requirements analysis, secure design, secure coding, code reviews, testing, and secure deployment processes.

The Contractor shall implement secure configuration management practices, including version control, change management, and separation of environments (development, testing, and production).

The Contractor shall maintain detailed documentation of the software development and deployment processes, including security controls, configurations, and changes made throughout the SDLC.

Encryption and Secure Communications

The Contractor shall use industry-standard encryption protocols and algorithms, such as [specify encryption standards, e.g., AES-256, TLS 1.2, or higher] for transmitting and storing POWERGRID's data and information.

The Contractor shall implement secure communication channels, such as secure file transfer protocols (SFTP) or virtual private networks (VPNs), for the exchange of sensitive data and information with POWERGRID.

The Contractor shall maintain and regularly update digital certificates, encryption keys, and other cryptographic materials used for securing communications and data.

Change Management Requirement

Contractor shall maintain documented change management procedures as specified in Section-7 of this specification

Information Security Practices

The Contractor shall implement and maintain an Information Security Management System (ISMS) that complies with industry-recognized standards, such as ISO 27001/CEA Guidelines or NIST Cybersecurity Framework or guidelines/standards issued time to time by the competent authority.

The Contractor shall implement and ensure all requirements, clauses of Information Security Practices mentioned in the POWERGRID's information security policy, procedure, and manual.

The Contractor shall regularly assess and mitigate risks to the security of POWERGRID's data and information, including but not limited to risks arising from cyber threats, human errors, and natural disasters.

The Contractor shall implement and maintain appropriate security controls, including but not limited to access controls, network security, malware protection, secure configurations, and security monitoring and logging.

All supplied servers, workstations and applicable appliances shall support integration with SIEM, Anti-Virus and SOC monitoring solutions.

Logs shall include privileged activities, configuration changes, authentication events, security events and system integrity events and shall support forwarding to central SIEM.

Compliance Verification

The Purchaser reserves the right to seek evidence of compliance with the above requirements during the contract period and support lifecycle of the supplied systems. Non-compliance shall constitute a material breach of contract.

lifecycle of the supplied systems. Non-compliance shall constitute a material breach of contract.

Appendix A – General Information & Implementation Schedule

Contents

General Information & Implementation Schedule For Package: Scheme for Installation of OPGW & associated communication systems on the existing lines of ISTS in NR region.

Table A-1 Implementation Schedule for below mentioned FOTE Locations

Execution Period: Months from the Award

S. No	Region	FOTE Location	FOTE Requirement	FOTE Configuration
Execution Period and FOTE List is Provided in Appendix A-1				
Total FOTE Requirement			—	

Addition/deletion of Locations within the provisions of contractual quantity variation may be undertaken during detailed engineering. The location-wise schedule for installation and commissioning of communication equipment shall be finalized during the engineering phase and shall be aligned with the approved OPGW installation schedule.

Table A-2

Corresponding links are the following for above mentioned FOTE locations

S. No	Region	Voltage level(kV)	Name of the Line
Link List as Provided in Appendix A-1			

Appendix B – Data Requirement Sheets (DRS)

Data Requirement Sheets

The following sets of Data Requirement Sheets are required to be filled up by the bidders to aid in the evaluation process. The response shall be brief and to the point and shall be supported by the printed product description and other literature. The DRS duly filled and the relevant drawings shall also be submitted during the detailed engineering along with the relevant technical brochures.

DRS Form-1

DATA REQUIREMENTS SHEETS for FIBRE OPTICS TERMINATION EQUIPMENT (FOTE)

Manufacturer: _____

Model #: _____

Seq	Parameter:	As per Technical Specification	As per Technical Specification	As per Technical Specification	As per Bidder Offering
		STM-4 Equipment	STM-16 Equipment	STM-64 Equipment	STM-4/16/64 Equipment
1.	SDH hierarchy level: Capacity Aggregate Bit- rate: CEPT E-1 Ports:	STM-4 620 Mbps 252 x E1	STM-16 2480 Mbps 1008 x E1	STM-64 9900 Mbps 4016 x E1	
2.	Minimum No. of protected (MSP) directions	Three	Three	STM-64 (at least 2 MSP), STM-16 (at least 5 MSP)	
3.	No. of E1 Interfaces per card	minimum 16	minimum 16	minimum 16	
4.	No. of 10/100Mbps Ethernet Interfaces per card with layer 2 switching	minimum 8	minimum 8	minimum 8	
5.	Service Channel provision a) Voice Channel b) Data Channel	Yes Minimum 1 Minimum 1	Yes Minimum 1 Minimum 1	Yes Minimum 1 Minimum 1	
6.	Cross Connection Capacity (Non-Blocking & bi-directional) High Order: Low Order	64 STM-1 64 STM-1	256 STM-1 256 STM-1	640 STM-1 640 STM-1	
7.	Power Supply cards of SDH equipment	1:1 APS or distributed power	1:1 APS or distributed	1:1 APS or distributed power supply	
	Common Control* Card of SDH equipment	supply 1:1 APS	power supply 1:1 APS	1:1 APS	

* = Common Control Cards which are essentially required for the operation of the equipment

-----End of the Appendix-----

Appendix C – Standard Type Test Procedures

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- 2. List of Test Equipment**
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- 5. Power Supply & EMI/EMC Tests**
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 - 5.1.1 Voltage Fluctuations
 - 5.1.2-a Voltage Dips
 - 5.1.2-b Voltage Interruption
 - 5.1.3 1.2/50 - 8/20 μ s Surge
 - 5.1.4 Fast Transient Bursts
 - 5.1.5 Damped Oscillatory Wave
 - 5.1.6 Electrostatic Discharges
 - 5.1.7 Radiated Electromagnetic Field
 - 5.2 Emission Tests
 - 5.2.1 RF Disturbance Voltages
 - 5.2.2 RF Disturbance Currents
 - 5.2.3 RF Radiated Fields
 - 5.3 Insulation Withstand Voltages
 - 5.3.1 Insulation Withstand Voltage Isolation Test & 1.2/50 μ s Impulse Voltage
- 6. Mechanical Tests**
 - 6.1 Mechanical Vibration Test
 - 6.2 Shock Test
 - 6.3 Free Fall

General Test Set-up for BER Testing, Ethernet testing and Alarm Signaling :

Test Set-up with detailed interconnection of cards and description for flow of signals to be provided.

List of Test Equipment:

Complete list of test equipment with serial number and validity of calibration to be provided.

Acceptance Criteria

The functional acceptance criteria for EUT are defined below:

N= the performance of equipment (EUT) in non-degraded mode (N1, N2 & N3) N1=BER test
Evaluation criteria N for BER test, the test duration / period, are 15 mins. The pass criteria for "Operation to specification tests is that the number of bit error at the end of specified measurement period shall not exceed the max number of error generated by BER is equal to 10^{-10}

N2= Alarm status:

Evaluation criteria N for alarm status. No effect 2: No change of status in the LCT & alarm contacts.

N3= Ethernet ping test:

Evaluation criteria N for Ethernet ping test. Perform ping test and there shall be no missing of pings during normal operation of ping test.

D= The performance of equipment (EUT) In degraded mode (D1, D2):

D1= BER test:

Evaluation criterion D for minor failure: Temporary degradation (with the equipment or link still in operational status) or loss of functions or performance which is self-recoverable with respect to the loss signal recovery condition.

The allowed number, of error :S Error rate up to 10^{-6} error during the BER test.

D2= Alarm Status:

Evaluation criterion D for alarm status => change of alarm status allowed. Appearance of major and minor alarm on alarm contact. The alarms can be affected during the testing period but will be self-recoverable with respect to loss signal recovery condition.

EUT performance check:

Equipment checks are made before, during and after the test as detailed in test procedures.

If functional degradation is allowed during the test then after the test, equipment under test should behave normally (i.e. without degradation with no manual intervention)

4. Temperature and Humidity Tests		
	Test Number	4.1
	Tender reference	
	Test Name	Low Temperature test: Operation to Specification
	Standard reference	IEC 60068-2-1 (2007) Method Ad
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	The Climatic chamber shall be operated at Temperature = 0° C. The rate of change of temperature within the chamber shall be 0.5°C per minute. The test duration is 16 hours excluding thermal stabilization. The equipment shall be powered on after 1 hour of thermal stabilization.
	Acceptance criteria	No degradation of performance is allowed during the test & after the test. According to evaluation criteria N1, N2 & N3 Section: "3.acceptance criteria"
	Observation	During test & After test: Non degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status. N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	4.2
	Tender reference	
	Test Name	Low Temperature test: Operation Without Damage
	Standard reference	IEC 60068-2-1 (2007) Method Ad
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	The Climatic chamber shall be operated at Temperature= -10° C The rate of change of temperature within the chamber shall be 0.5°C per minute. The test duration is 72 hours excluding thermal stabilization. The equipment shall be powered on after 1 hour of thermal stabilization.
	Acceptance criteria	Degradation of performance is allowed during the test. According to evaluation criteria D1, D2 & D3 of "3.acceptance criteria". However there shall be no degradation of performance in the post-test according to evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During test : Degraded mode For Equipment Under Test (EUT) D1= BER test D2= Alarm Status D3= Ethernet ping test After the tests :Non-Degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	

	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID
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	Test Number	4.3
	Tender reference	
	Test Name	Dry Heat Test : Operation to Specification
	Standard reference	IEC 60068-2-2 (2007) Method Bd
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	The Climatic chamber shall be operated at Temperature = 45° C. The rate of change of temperature within the chamber shall be 0.5°C per minute. The test duration is 96 hours excluding thermal stabilization. The equipment shall be powered on after 1 hour of thermal stabilization.
	Acceptance criteria	No degradation of performance is allowed during the test & after the test. According to evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During the tests & After the test :Non- Degraded mode For Equipment Under Test (EUT) N1= BER test N2= Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	4.4
	Tender reference	
	Test Name	Dry Heat test: Operation Without Damage
	Standard reference	IEC 60068-2-2 (2007) Method Bd
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	The Climatic chamber shall be operated at Temperature = 55° C. The rate of change of temperature within the chamber shall be 0.5°C per minute. The test duration is 96 hours excluding thermal stabilization. The equipment shall be powered on after 1 hour of thermal stabilization.
	Acceptance criteria	Degradation of performance is allowed during the test. According to evaluation criteria D1, D2 & D3 of "3.acceptance criteria" However there shall be no degradation of performance in the post- test according evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During test : Degraded mode For Equipment Under Test (EUT) D1= BER test D2= Alarm Status D3= Ethernet ping test After the tests :Non-Degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	

	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID
	Test Number	4.5
	Tender reference	
	Test Name	Damp Heat Test
	Standard reference	IEC 60068-2-3
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	The Climatic chamber shall be operated at Temperature = $(40 \pm 2)^\circ\text{C}$ Humidity= $(93 \pm 3) \% \text{ RH}$ The rate of change of temperature within the chamber shall be 0.5°C per minute. The test duration is 240 hours excluding thermal stabilization. The equipment shall be powered on after 1 hour of thermal stabilization.
	Acceptance criteria	No degradation of performance is allowed during the test & after the test. According to evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During the test & after the test :Non-Degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	4.6
	Tender reference	
	Test Name	Temperature Variation Test
	Standard reference	IEC 60068-2-14 (2009) Method Nb
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	The Climatic chamber shall be operated at Low temperature 0°C and at 45°C . The cycle test duration will be 3 hours for each temperature. The ramp is defined as $1^\circ\text{C}/\text{minute}$. The Number of cycle is 5. The equipment shall be powered on.
	Acceptance criteria	Equipment performance is checked during the test & after the test and no degradation of performance is allowed during the test. The evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During the test & after the test :Non-Degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

5. Power supply & EMI/EMC Test

5.1 Immunity Tests

The list of Immunity tests are specified below:

Sr. No	Immunity test	AC Power Supply	DC Power Supply	Control & Signal	Telecom Lines	Parameters
1	Voltage Fluctuation	Yes	Yes	NIA	NIA	IEC 60870-2-1:1995, Table 11 Level:1
2	Voltage dips & Interruptions	Yes	Yes	NIA	NIA	
3	1.2/150-8/120us surge	Yes	Yes	Yes	NIA	IEC 60870-2-1:1995, Table 12 Level 1
4	Fast transient Burst	Yes	Yes	Yes	Yes	IEC 60870-2-1:1995, Table 12 Level4
5	Damped Oscillator waves	Yes	Yes	Yes	Yes	IEC 60870-2-1:1995, Table 12 Level 1
6	Electrostatic Discharge	NIA	Yes			IEC 60870-2-1:1995, Table 13 Level4
7	Radiated Electromagnetic field	NIA	Yes			IEC 60870-2-1:1995, Table 15 Level3

Test Number	5.1.1
Tender reference	
Test Name	Voltage fluctuations
Standard reference	Table 11 of IEC 60870-2-1(1995) Level 1
Test setup	As per figure shown in chapter General test setup
Test Procedure	This test is applicable on DC power supply port. The three condition (Un, Un+10% and Un-10%) will be conducted. Un= (-48 VDC) U=±8% during 2.5±0.5 sec Global cycle : 1 Os for one cycle Test of sequence of three constructive cycles (Zero second delay between each cycle).
Acceptance criteria	No degradation of performance is allowed during and after the test. According to evaluation criteria NI, N2 & N3 of "3.acceptance criteria"
Observation	During test & after the test non degraded mode For Equipment Under Test (EUT) NI= BER test N2=Alarm status N3= Ethernet ping test
Result	Pass [] Fail [] Not Applicable [] Remark []
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	5.1.2-a
Tender reference	
Test Name	Voltage Dips
Standard reference	Table 11 of IEC 60870-2-1(1995) Level 1/ IEC61000-4-11
Test setup	As per figure shown in chapter General test setup
Test Procedure	This test is applicable on DC power supply port. The three condition (Un, Un+10% and Un-10%) will be conducted. Un= (-48 VDC) U=30% reduction: U= 14.4 for Un =-48V U=15.8 for Un =-48V+10% U=13.0V for Un=-48V-10% Duration of dips: ±0.5s One sequence of three dips with an interval often seconds.
Acceptance criteria	Transient disturbance, Degradation of performance is allowed during the test according the evaluation

		criteria D1, D2 & D3 as of chapter "3.acceptance criteria" However there shall be no degradation of performance in the post test according the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During the test : Degraded mode For Equipment Under Test (EUT) D1= BER test D2= Alarm Status D3= Ethernet ping test After the tests :Non-Degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	5.1.2-b
	Tender reference	
	Test Name	Voltage Interruption
	Standard reference	Table 11 of IEC 60870-2-1(1995) Level 1 and IEC 61000-4-11
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	This test is applicable on DC power supply port. The three condition (Un, Un+10% and Un-10%) will be conducted. Un= (-48 VDC) U= 100% reduction: U= 45.6 for Un =-48V U=50.2 for Un =-48V+10% U=41.0V for Un=-48V-10% Duration of interruptions: 10ms One sequence of three interruptions with an interval often seconds.
	Acceptance criteria	Transient disturbance, Degradation of performance is allowed during the test according the evaluation criteria D1, D2 & D3 as of chapter "3.acceptance criteria" However there shall be no degradation of performance in the post test according the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During the test : Degraded mode For Equipment Under Test (EUT) D1= BER test D2= Alarm Status D3= Ethernet ping test After the tests :Non-Degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	5.1.3
	Tender reference	
	Test Name	1.2/50 - 8/20 us Surge
	Standard reference	Table 12 of IEC 60870-2-1(1995) Level 1/IEC 61000-4-5
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	This test is applicable on - DC power supply port. - control and signal lines -indoor telecommunication lines. Wave : 1.2/50us - 8/20 us Level : 0.5KV common mode 0.25KV differential mode* (not applicable to balanced signal lines) 5 positive pulses and 5 negative pulses separated by 1 min are tested. Safety Insulation EUT 1 Test generator J_ Earth reference Positive polarity and negative polarity are tested, 5 positive pulse and 5 negative pulse separated by 1 min. The differential mode will not be applied on shielded lines.

	Acceptance criteria	Transient disturbance, Degradation of performance is allowed during the test according the evaluation criteria D1 & D2 of "3.acceptance criteria" However there shall be no degradation of performance in the post test according to the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During the test : Degraded mode For Equipment Under Test (EUT) D1= BER test D2= Alarm Status After the tests :Non-Degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	5.1.4
	Tender reference	
	Test Name	Fast transient bursts
	Standard reference	Table 12 of IEC 60870-2-1(1995) Level 4 / IEC 61000-4-4
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	This test is applicable on - DC power supply port. - control and signal lines -indoor telecommunication lines. Level: DC Power Line : 4KV in common mode Control & signal lines, telecom lines : 2KV in common mode Frequency repetition : SKHz Positive polarity & Negative polarity are tested. The test on the DC power line is realized with coupling/decoupling network. The test on the control & signal line, telecom lines is realized with a coupling clamp.
	Acceptance criteria	Transient disturbance, Degradation of performance is allowed during the test according the evaluation criteria D1 & D2 as of chapter "3.acceptance criteria" However there shall be no degradation of performance in the post test according the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During the test: Degraded mode For Equipment Under Test (EUT) D1= BER test D2= Alarm Status After the tests :Non-Degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	5.1.5
	Tender reference	
	Test Name	Damped Oscillatory Wave
	Standard reference	Table 12 of IEC 60870-2-1 (1995) Level: 1 / IEC 61000-4-18
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	This test is applicable on the DC power supply control & signal lines Telecommunication lines. Test level: 0.5KV: common mode voltage 0.25KV: differential mode voltage Period injection: 1µs (damped oscillatory frequency is 1MHz) Duration of test is at least 2s on each line under test. The minimum time interval between two successive tests is 10sec. acc. IEC 61000-4-1 chapter 8. Injection with the generator connected to a coupling /decoupling network, for shielded lines coupling directly onto the screen. DC

		power supply: positive pole is earthed on sub rack, therefore only common test line to earth is applied. Control & Signal lines and telecommunication lines: All are balanced lines, therefore acc. IEC 60870-2-1 the differential mode test is not applicable.
	Acceptance criteria	Transient disturbance. Degradation of performance is allowed during the test according the evaluation criteria D1 & D2 as of chapter "3.acceptance criteria". However there shall be no degradation of performance in the post test according the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During the test : Degraded mode For Equipment Under Test (EUT) D1= BER test D2= Alarm Status After the tests :Non-Degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	5.1.6
	Tender reference	
	Test Name	Electrostatic Discharges
	Standard reference	Table 13 of IEC 60870-2-1 (1995) Level: 4 /IEC61000-4-2
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	Contact discharge on vertical coupling plane and accessible metallic parts of the sub rack. Level: SKY According to IEC 61000-4-2 all the intermediate levels (1 to 3) of 2KV, 4KV and 6KV are tested before the level 4 given by IEC 60870-2-1. Positive polarity and negative polarity are tested. Time between pulses is 1s. Ten discharges of each polarity are applied on each point tested. Note: The IEC 60870-2-1 does not specify tests for air discharge.
	Acceptance criteria	Transient disturbance. Degradation of performance is allowed during the test according the evaluation criteria D1, D2 & D3 as of "3.acceptance criteria". However there shall be no degradation of performance in the post test according the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During the test : Degraded mode For Equipment Under Test (EUT) D1= BER test D2= Alarm Status D3= Ethernet ping test After the tests :Non-Degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	5.1.7
	Tender reference	
	Test Name	Radiated Electro Magnetic Field
	Standard reference	Table 15 of IEC 60870-2-1 (1995) Level: 3 /IEC61000-4-3
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	Test field strength: 10 V/m (unmodulated signal) Modulation Frequency: 1 KHz Modulation Depth: 80% Frequency Range: 80 MHz to 1000 MHz Step Size: 1% Both polarizations are tested. Distance

		between the equipment under test and the antenna: 1 meter. Four sided of the rack are tested.
	Acceptance criteria	No degradation of performance is allowed during the test & after the test. The performance is checked only during the test according the evaluation criteria N1, N2 & N3 "3.acceptance criteria"
	Observation	During test & after the test non degraded mode For Equipment Under Test (EUT) N1= BER test N2=Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

5.2 Emission Tests

The list of Emission tests are specified below:

Sr. No	Emission Test	AC Power Supply	DC Power Supply	Control & Signal	Telecom Line	Parameters
			Yes	NIA	NIA	Table 17 of IEC 60870- 2-1: 1995 - Class: B
		NIA	NIA	NIA	Yes	
		Yes				

I

	Test Number	5.2.1
	Tender reference	
	Test Name	RF disturbance voltages
	Standard reference	CISPR22 Table 17 of IEC 60870-2-1 (1995) Class: B
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	RF disturbance conducted voltages at the main ports. The voltage measurements are done with a receiver connected to a line impedance stabilization network [LISN]. The receiver has a peak average and quasi-peak detector. The test configuration for conducted measurements is floor standing equipment. Frequency range: 0.15 to 30 MHz Measurement unit: LISN Limits: Class B Frequency Range (MHz) Quasi-peak Limits (dBμV) (Class B) 0.15 to 0.5 66 to 56* 0.5 to 5 56 5 to 30 60 *The limit have a linear decrease with a logarithm frequency variation
	Acceptance Criteria	The level must be lower or equal to the limits specified in the test procedure. It is an EMC measurement, so the performance is checked only after the test according the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During test non degraded mode For Equipment Under Test (EUT) N1= BER test N2= Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	5.2.2
	Tender reference	
	Test Name	RF disturbance currents
	Standard reference	CISPR22 Table 17 of IEC 60870-2-1 (1995) Class: B
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	RF disturbance current at the telecommunication ports. The measurements are done as per CISPR 22 C.1.2 with a receiver connected to a current probe. The receiver has a peak average and quasi-peak detector. A decoupling network (Ferrite) is placed on the cable of the telecommunication line connected to the bench. The test configuration for conducted measurements is floor standing equipment. In semi anechoic Faraday room or ambient ground floor. Frequency range: 0.15 to 30 MHz Measurement unit: LISN Limits: Class B Frequency Range (MHz) Quasi-peak Limits (dBμV) (Class B) 0.15 to 0.5 40 to 30 * 5 to 30 30 * The limit has a linear decrease with a logarithmic frequency variation. The measurement shall be done with a peak detector. -if the disturbance levels are under the limits, the EUT (Equipment Under Test) is Declared in compliance with the specifications -if some disturbance levels are over the limits, detector QP (Quasi-Peak) is used to verify the compliance with the specification in the frequency range over the limit.
	Acceptance Criteria	The level must be lower or equal to the limits specified in the test procedure. It is an EMC measurement, so the performance is checked only after the test according to the evaluation criteria N1, N2 & N3 of "3. acceptance criteria"
	Observation	During test non degraded mode For Equipment Under Test (EUT) N1= BER test N2= Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	5.2.3
	Tender reference	
	Test Name	RF Radiated Fields
	Standard reference	Table 17 of IEC 60870-2-1 (1995) Class Band CISPR22 (2008)
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	The measurements are done with a receiver connected to an antenna. The receiver has peak and quasi peak detectors. Decoupling networks (DN: Ferrite) are placed on the cables connected

		to the bench. The distance (D) between the EUT and the antenna is 3m. Only the EUT and the antenna are in the semi-anechoic chamber. Frequency range: 30 to 1000MHz Measurements at 3 meters. Antenna: Broadband antenna (30 to 1000MHz) Polarization: Both polarizations are measured Turntable: 3600 Antenna mast: 1 to 4 meters above the ground plane Semi-anechoic Faraday room Frequency Range (MHz) Quasi-peak Limits (dBuV/m) (Vertical & Horizontal polarization) (Class B) 30 to 230 40 230 to 1000 47 Note: For reason of ambient noise at 10m in open area test site, the measurements will be done in a semi-anechoic Faraday room at 3m: according to chapter 10 2.1 of CISPR 22 IEC: 1997. According to CISPR 22, "An inversely proportionality factor of 20 dB/decade should be used to normalize the measured data to the specified distance for determining compliance." So it's necessary to add 10dB to the limits at 10meters indicted in the CISPR-22.
	Acceptance Criteria	The level must be lower or equal to the limits specified in the test procedure. It is an EMC measurement, so the performance is checked only after the test according the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	During test non degraded mode For Equipment Under Test (EUT) N1= BER test N2= Alarm status N3= Ethernet ping test
I Result I Pass ☐ Fail ☐ Not Applicable ☐ Remark ☐		
I Remark I		
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

5.3 Insulation Withstand Voltages

As per section 6 of IEC 60870-2-1. Recommended Class: VWI of Table 18

Test Number	5.3.1
Tender reference	
Test Name	Insulation withstand voltage isolation test & 1.2/50 μ sec impulse voltage
Standard reference	IEC 60870-2-1 (1995) VWI of Table 18
Test setup	As per figure shown in chapter General test setup
Test Procedure	This test is specified on DC power supply, control and signal ports and Telecommunication port as per table of 8 insulation with stand voltages class: VWI for DC power supply below 60V The test to applied are: a) Power supply with stand voltage : 0.5 KVRms b) Impulse: 1KV Peak for 1.2/50us impulse voltage; 5 pulse with negative polarity and 5 pulse with alternating polarity.
Acceptance criteria	During the test, the equipment is powered off. After the test, the equipment is required to function correctly in non- degraded mode according the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
Observation	After the test: Non degraded mode For Equipment Under Test £EIW N1= BER test N2=Alarm status N3= Ethernet ping test
Result	Pass ☐ Fail ☐ Not Applicable ☐ Remark ☐

Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

6. Mechanical Test

Test Number	6.1
Tender reference	
Test Name	Mechanical Vibration Test
Standard reference	IEC Publication 60068-2-6
Test setup	As per figure shown in General test setup
Test Procedure	6.1.1 5 to 9 Hz 0.3mm 9 to 200 Hz 1m/sL 1 sweep cycle per all the three axis 6.1.2 5 to 9 Hz 3.5mm 9 to 200 Hz 10m/sL 200 to 500 Hz 15m/sL 5 sweep cycle per all the three axis 6.1.3 5 to 9 Hz 0.3mm 9 to 200 Hz 1m/sL 1 sweep cycle per all the three axis Before commencing the vibration test, the EUT is switched on and functional test shall be done for 15 min period. During the test the equipment is powered off and packed. Vibration test will be conducted in the sequence 8.1, 8.2.1 and 8.1. After Completion of vibration test, EUT shall be unpacked and functional test shall be done for 15 min period.
Acceptance criteria	After the test, the equipment is required to function correctly in non- degraded mode according the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
Observation	After the test: Non degraded mode For Equipment Under Test (EUT) N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass ☐ Fail ☐ Not Applicable ☐ Remark ☐
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	6.2
	Tender reference	
	Test Name	Shock test
	Standard reference	IEC Publication 60068-2-27
	Test setup	As per figure shown in General test setup
	Test Procedure	Acceleration amplitude 294 m/sL. Duration: 18 ms Direction: Three Axis Number of shocks: 3 in each direction Direction of Shocks: 6 direction Total Number of shocks: 18
	Acceptance criteria	After the test, the equipment is required to function correctly in non- degraded mode according the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	After the test: Non degraded mode For Equipment Under Test (EUT) N1= BER test N2= Alarm status N3= Ethernet ping test
	Result	Pass ☐ Fail ☐ Not Applicable ☐ Remark ☐
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

	Test Number	6.3
	Tender reference	
	Test Name	Free Fall
	Standard reference	IEC Publication 60068-2-31
	Test setup	As per figure shown in chapter General test setup
	Test Procedure	The free fall test is applicable to specimens which during transportation, handling or repair work are liable to be

		dropped from their means of transport or from a work surface. Height of Specimen Mass Fall In integral transport cases 250mm <=75 Kg
	Acceptance criteria	After the test, the equipment is required to function correctly in non- degraded mode according the evaluation criteria N1, N2 & N3 of "3.acceptance criteria"
	Observation	After the test: Non degraded mode For Equipment Under Test (EUT) N1= BER test N2= Alarm status N3= Ethernet ping test
	Result	Pass [] Fail [] Not Applicable [] Remark []
	Remark	
	Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Appendix D – Standard FAT Procedures

Appendix-D

Standard FAT Procedures

FACTORY ACCEPTANCE TEST PROCEDURE (FAT)

SDH EQUIPMENT along with Optical Amplifier

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TPS-FOTS-001: Review of Calibration or Manufacturing Certificates

Equipment Under Test : **Test Equipment**

Test Parameters : **Review of Calibration or Manufacturing Certificates**

1.0 TEST DESCRIPTION

Prior to the commencement of system testing, the calibration certificates of all the test equipment as listed in the TPS for performing the system factory acceptance testing will be reviewed by inspection team.

2.0 LIST OF TEST EQUIPMENT

Test Equipment	Make	Model No.	Serial No.	Calibration Valid till Date

TEST RESULT RECORD

Copies of the calibration certificates will be attached along with this test sheet.

Status

() Tested – OK

—

() Tested – Failed

—

Remarks

Tested By _____
(Manufacturer/contractor)

:

Witnessed By _____
(POWERGRID)/Constituent Date

:

Date

:

TPS-FOTS-002: Inventory Verification

Equipment Under Test : **SDH Equipment**

Test Parameters : **Inventory Verification**

TEST DESCRIPTION

The aim of this test is to verify station wise inventory of offered equipment.

2.0 TEST PROCEDURE

Check station wise cards/units along with sub rack.

Verify it with the quantity of offered equipment as per approved BOM.

3.0 TEST RESULT RECORD

The quantity should be found as per the approved BOM.

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By : _____ Witnessed By : _____
 (Manufacturer/contractor) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-003: Optical Tx Output Power Measurement

Equipment Under Test : **SDH Equipment Optical Units**

Test Parameters : **Optical Output Power**

1.0 TEST DESCRIPTION

The purpose of this test is to determine whether the optical interface cards (STM-64, STM-16 and STM-4) operate at designed level of optical output power range. This test ensures that the laser providing the optical output has adequate optical output power performance in compliance with ITU-T G.957.

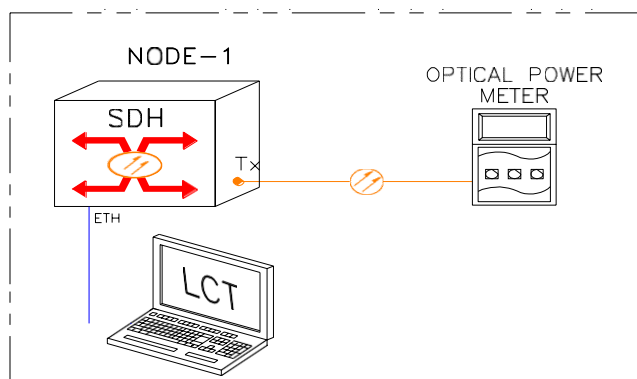
2.0 TEST EQUIPMENT

Optical Power Meter

Local Craft Terminal (LCT)

Low loss optical patch cord

3.0 TEST SETUP



4. TEST PROCEDURE

Choose SDH equipment and plug optical cards of different application code. Use Low loss optical patch cord to connect the output optical port of the tested SDH node with the input port of Optical Power Meter in turn to test the output power.

Connect the optical output port of the SDH to the input port of the optical power meter with low loss optical patch cord to test the output power as shown in above figure.

Set the optical power meter to the specified wavelength.

Measure the output power level in dBm.

Record the result showing on the optical power meter.

5.TEST RESULT RECORD

*As per approved DRS

No.	Optical interfaces/ Card tested as per approved BOQ	Min (dBm)*	Max (dBm)*	Actual (dBm)

6.Acceptance Criteria:

The measured optical output power should be within the limits as per G.957

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By : _____ Witnessed By : _____
(Manufacturer/contractor) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-004: Receiver Sensitivity Measurement

Equipment Under Test : **SDH Equipment Optical Units**

Test Parameters : **Receiver Sensitivity Measurement**

1.0 TEST DESCRIPTION

This test is performed to test the optical card of the SDH unit to ensure the minimum and maximum optical power level (sensitivity) of optical signal that can be detected and correctly re-constructed in compliance with ITU-T G.957.

2.0 TEST EQUIPMENT

Optical Power Meter

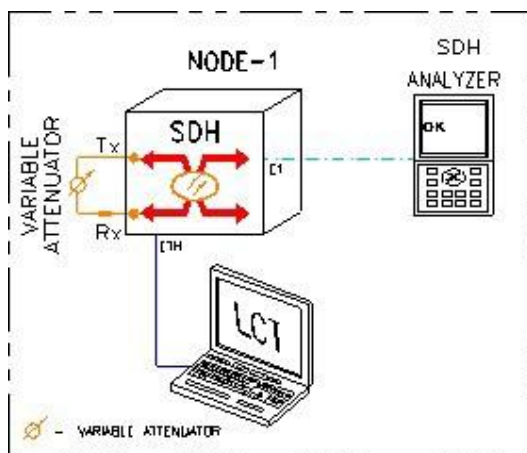
Variable Optical Attenuator (VOA)

SDH Analyzer

Local Craft Terminal (LCT)

Low loss optical patch cord

3.0 TEST SETUP



4.0 TEST PROCEDURE

Receiver Sensitivity

1. Choose the SDH equipment with STM-64, STM-16 and STM-4 optical interface cards. Use optical patch cords to connect the optical ports to SDH Analyzer and VOA as shown in above figure.
2. Setup the SDH Analyzer for BER testing.
3. Increase the attenuation till any error occurs at the tested optical interface card.
4. Decrease the attenuation gradually, so that the error just goes off.

- 5.The test should continue for a period of 90 seconds.
- 6.Disconnect the optical patch cord from the tested port (Rx) and connect to the optical power meter.
- 7.Record the result showing on the optical power meter, is the receive sensitivity.

5.0 TEST RESULT RECORD

Sr. No.	Node / Station	Slot No./ Port No./Sr.No.	Module Type	Receiver Sensitivity as per ITU-T G.957 (dBm)	Actual (dBm)
1					
2					
3					

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____
 (Manufacturer/contractor) (POWERGRID)/Constituent

Date _____ : _____ Date _____ : _____

TPS-FOTS-005: SDH Optical Units - Laser Safety Check

Equipment Under Test : **SDH Optical Units**

Test Parameters : **Laser Safety Check**

1.0 TEST DESCRIPTION

The aim of this test is to check the Laser safety (ALS: Automatic Laser Shutdown) functionality of the SDH optical interfaces. In this test it is checked if the laser shuts down automatically when the fiber link is broken.

2.0 TEST EQUIPMENT

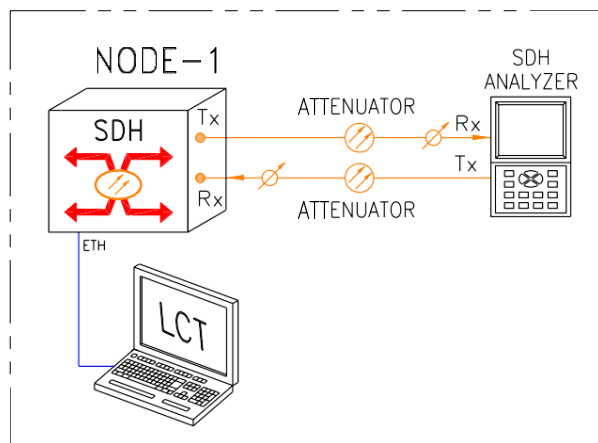
SDH Analyzer

Optical Attenuators

Local Craft Terminal (LCT)

Low loss optical patch cord

3.0 TEST SETUP



4.0 TEST PROCEDURE

1. Set up E1 / Ethernet traffic and loop back the STM-4/16/64 optical path.
2. Enable ALS in the optical ports STM-64/STM-16/STM-4) used.
3. Inject LOS alarm by breaking Rx fiber.
4. Since ALS is enabled, the transmitter will switch OFF after 500 ms or more.
5. Measure the optical power output at Tx of STM-4/16/64 optical card, no power to be shown.

6. Restore the Rx fiber, the alarm to be cleared and the transmitter should be ON.

7. Record the result.

5.0 TEST RESULT RECORD

Sr. No.	Node / Station	Slot No. / Port No/Sr. no.	Optical Interface	Test Description	Specification	Results (OK/ Not OK)
1				ALS	Optical transmitter should shut off as per G.664 when the optical port receives LOS alarm.	
2				ALS	Optical transmitter should shut off as per G.664 when the optical port receives LOS alarm.	
3				ALS	Optical transmitter should shut off as per G.664 when the optical port receives LOS alarm.	

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____
(Manufacturer/contractor) (POWERGRID)

Date _____ : _____ Date _____ : _____

TPS-FOTS-006: Electrical Interface Input Jitter Tolerance

Equipment Under Test : **E1 (2 Mbit/s) Interface Unit**

Test Parameters : **Electrical (E1) Interface Input Jitter Tolerance**

1.0 TEST DESCRIPTION

Measurement of input jitter tolerance of the electrical interface in compliance with ITU-T G.823

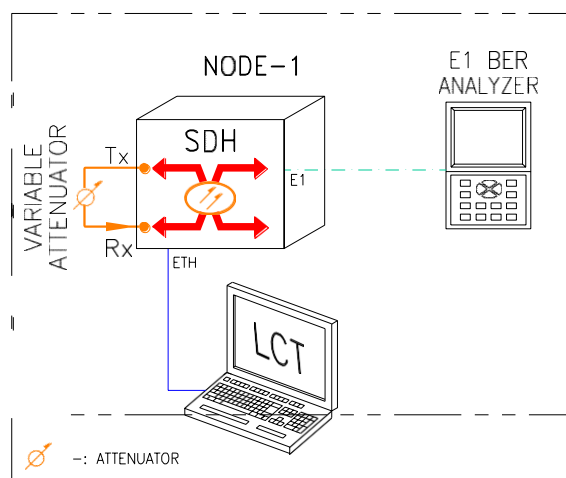
2.0 TEST EQUIPMENT

E1 Analyzer

Local Craft Terminal (LCT)

Connecting Cables

3.0 TEST SETUP



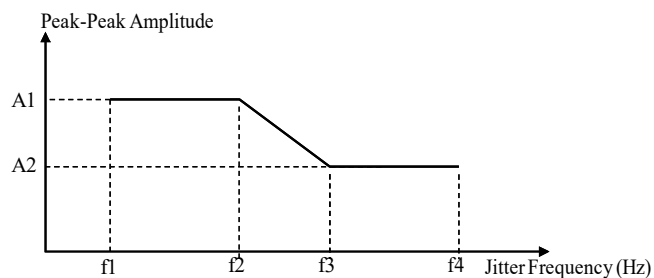
4.0 TEST PROCEDURE

1. Choose one SDH node with E1 interface card (DUT). Use cable to connect the electrical output port of the tested node to the electrical input port of E1 Analyzer and connect the electrical input port of the tested node to the electrical output port of E1 Analyzer.
2. Select relevant rate for E1 Analyzer Rx / Tx port.
3. Set up E1 Traffic from E1 Analyzer.
4. Loop back the optical port of the SDH equipment.
5. With the loop-back, there shall be no bit errors reported in the test set.
6. Setup the E1 Analyzer for jitter tolerance measurement. Choose an ITU-T G.823 mask.
7. Now go to Jitter Test Menu and perform Jitter Tolerance test by selecting Auto Tolerance Menu from the options (In Auto Jitter Tolerance test, the E1 Analyzer automatically increases the Jitter until the point of failure and plots the point on the graph and then proceeds to the next Jitter Frequency).

8. Print out the plot of the result.

5.0 TEST RESULTS

Input jitter tolerance of E1 electrical interfaces:



Measured value should be as per ITU-T G.823. The test results will be attached with this test record.

Status

() Tested – OK _____

() Tested – Failed _____

Node Details

Station _____

Unit Type _____

Remarks

Tested By : _____ Witnessed By : _____
(Manufacturer/contractor) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-007: Electrical (2 Mbit/s) Interface Output Jitter Generation

Equipment Under Test : **E1 (2 Mbit/s) Interface Unit**

Test Parameters : **Electrical (2 Mbit/s) Interface Output Jitter Generation**

1.0 TEST DESCRIPTION

The aim of this test is to measure the jitter in 2Mbit/s output signal and check if it is as per ITU-T G.823.

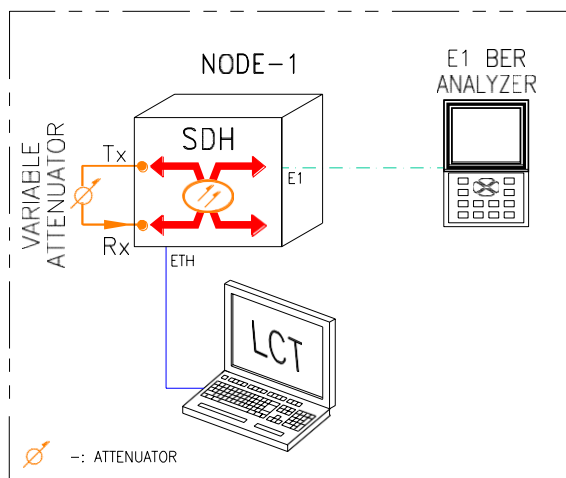
2.0 TEST EQUIPMENT

E1 Analyzer

Local Craft Terminal (LCT)

Low loss optical patch cord

3.0 TEST SETUP



4.0 TEST PROCEDURE

1. Make setup as shown in above figure.
2. Set up E1 Traffic from E1 Analyzer.
3. Loop back the optical port of the SDH equipment.
4. With the loop-back, there shall be no bit errors reported in the test set.
5. Apply E1 Analyzer to send test signals, and configure proper measurement filter at the receiving end.
6. Perform continuous test with duration of 60 seconds.
7. Record the measured maximum peak-to-peak value of jitter.

5.0 TEST RESULTS

Interface	Measuring Filter		Peak-peak Jitter
2048 Kbit/s (E1 Interface)	20Hz to 100kHz (LP+HP1)	Standard	1.50 UI
		Measured	
	18kHz to 100kHz (LP+HP2)	Standard	0.2 UI
		Measured	

The measured value should not exceed the limits given in the above table.

Status

() Tested – OK _____

() Tested – Failed _____

Node Details

Station _____

Unit Type _____

Remarks

Tested By : _____ Witnessed By : _____
 (Manufacturer/contractor) (POWERGRID)

Date : _____ Date : _____

TPS-FOTS-008: Electrical Interface Line Rate Tolerance

Equipment Under Test : **E1 (2 Mbit/s) Interface Unit**

Test Parameters : **Electrical (2 Mbit/s) Interface Line Rate Tolerance**

1.0 TEST DESCRIPTION

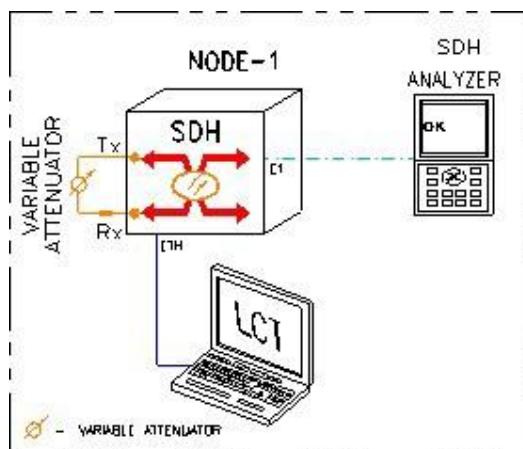
Measurement of line rate tolerance of the Electrical interface in compliance with ITU-T G.703

2.0 TEST EQUIPMENT

SDH Analyzer

Local Craft Terminal (LCT)

3.0 TEST SETUP



4.0 TEST PROCEDURE

Set up E1 traffic from SDH Analyzer and make suitable cross-connection using LCT.

Loop back optical port of SDH by means of an attenuator.

Setup the SDH Analyzer for BER testing.

Vary the offset ppm value up to the tolerable value in both positive and negative sides.

Record the result.

5.0 TEST RESULTS

Interface	Line Rate Tolerance	Measurement
E1 (2 Mbit/s)	2.048Mbits/s $\pm$ 50 ppm	

There should not be any errors during the test.

Status

() Tested – OK _____

() Tested – Failed _____

Node Details

Station _____

Unit Type _____

Remarks

Tested By	:	_____	Witnessed By	:	_____
		(Manufacturer/contractor)			(POWERGRID)/Constituent
Date	:	_____	Date	:	_____

TPS-FOTS-009: Protection Switching of Redundant Cards

Equipment Under Test : **SDH Equipment**

Test Parameters : **Equipment Protection**

1.0 TEST DESCRIPTION

To verify that the protection switching mechanisms for the Common Control & Cross-connect card of SDH node is working properly.

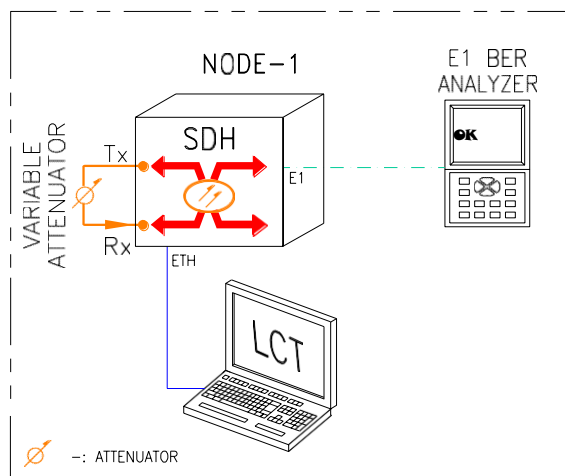
2.0 TEST EQUIPMENT

E1 Analyzer

Local Craft Terminal (LCT)

Low loss optical patch cord

3.0 TEST SETUP



4.0 TEST PROCEDURE

1. Connect the electrical (Tx, Rx) of the SDH equipment to the E1 Analyzer.
2. Loop back the optical port (Tx, Rx) of the SDH equipment.
3. Create the cross connection between the electrical port and the optical port.
4. Unplug the active Common Control & Cross-connect card of SDH node from card slot.
5. The standby Common Control & Cross-connect card should take over, and the traffic should be restored.

TEST RESULTS

Traffic is restored even if one of the Common Control & Cross-connect cards failed.

Status

() Tested – OK _____

() Tested – Failed _____

Node Details**Station** _____**Unit Type** _____**Remarks**

Tested By _____ : _____ Witnessed By _____ : _____

(Manufacturer/contractor)

(POWERGRID)/Constituent

Date _____ : _____ Date _____ : _____

TPS-FOTS-010: Multiplex Section Protection in SDH Network

Equipment Under Test : **SDH Transmission System**

Test Parameters : **Multiplex Section Protection**

1.0 TEST DESCRIPTION

The aim of this test to check the multiplex section protection scheme in compliance with the ITU-T G.841.

2.0 TEST EQUIPMENT

E1 Analyzer

Ethernet Analyzer

Cables and accessories

3.0 TEST SETUP

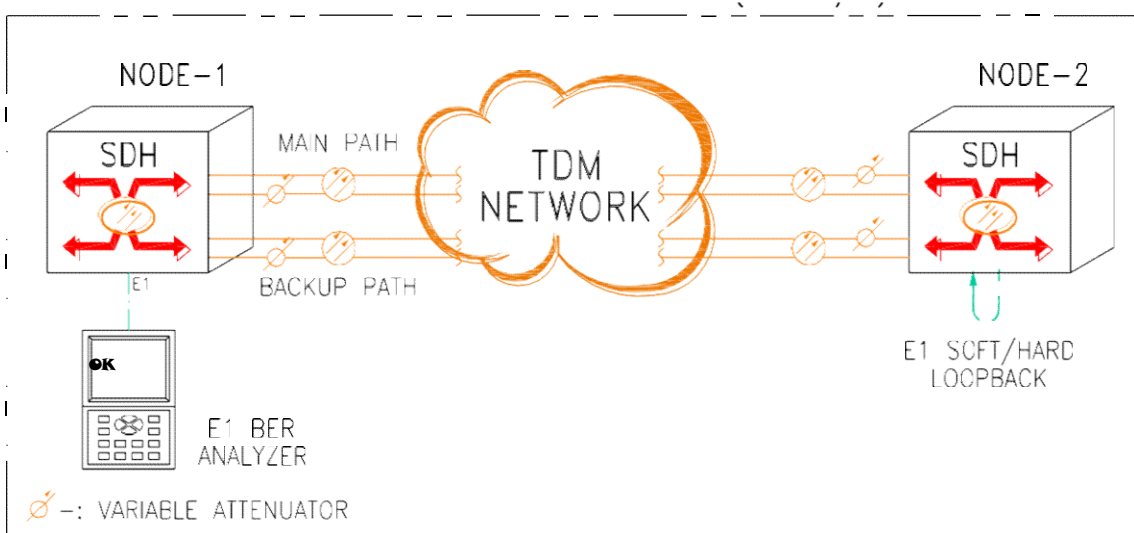


Figure 1: MSP Protection Test E1

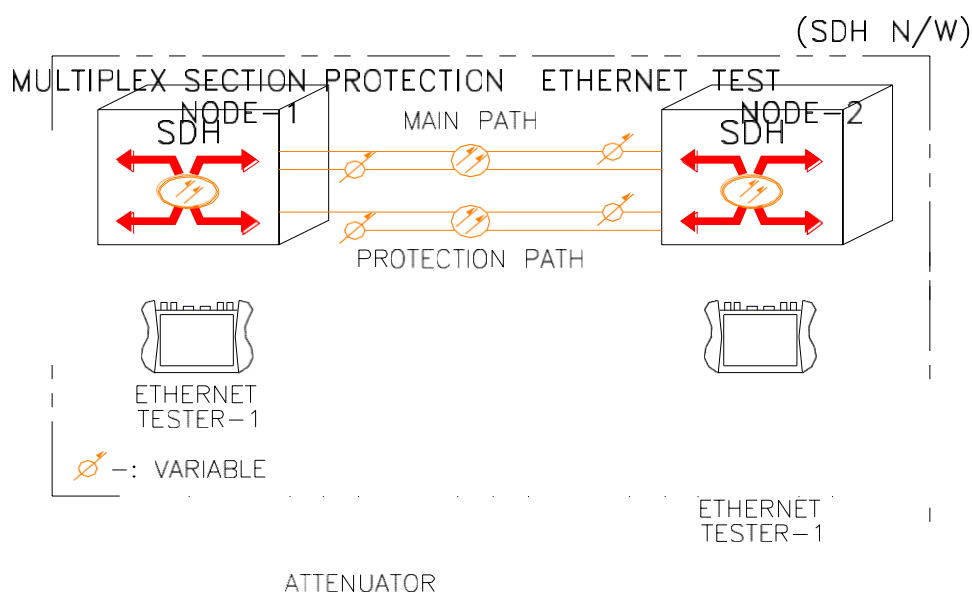


Figure 2: MSP Protection Test Ethernet

4.0 TEST PROCEDURE

E1 Protection test

- Make the test setup as shown in Figure 1.
- Create the required cross connections with Switching Protection in the SDH Nodes across the link through which the testing will be done.
- Set up an E1 from the E1 Analyzer and connect it to the local SDH node.
- Provide a soft loop / hard loop on the configured E1 of the remote SDH node.
- The tester will show “OK” with the loop back on the remote node concerning the configured channel.
- With the loop-back, there shall be no bit errors.
- Break main link between the two stations and verify that E1 signal is through over standby link.
- Verify the Cross-connect redundancy, by jacking out one of the redundant module at a time.
- Tabulate the observation in test result table at Point 1 , 2 and 3.

Ethernet Protection test

- Make the test setup as shown in Figure 2.
- Create the required cross connections with Switching Protection in the SDH Nodes across the link through which the testing will be done.
- Set up an E1 / Ethernet Traffic from the Ethernet Analyzer and connect it to the local SDH node.
- Provide a soft loop on the configured Ethernet of the remote Ethernet Tester.
- The tester will show “OK” with the loop back on the remote node concerning the configured channel.
- With the loop-back, there shall be errors.

- Break main link between the two stations and verify that Ethernet signal is through over standby link.
- Verify the Cross-connect redundancy, by jacking out one of the redundant module at a time.
- Tabulate the observation in test result table at Point 4 & 5.

5.0 TEST RESULT

Sr. No.	Test Description	Results (OK / Not OK)
1	Switching to standby path is occurred when working path failed for E1 test	
2	Switching can be auto-restored after the fail disappeared for E1 test.	
3	Switching time should be less than 50ms (Applicable to APS test)	
4	Switching to standby path is occurred when working path failed for Ethernet test.	
5	Switching can be auto-restored after the fail disappeared for Ethernet test.	

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____
 (Manufacturer/contractor) (POWERGRID)/Constituent

Date _____ : _____ Date _____ : _____

TPS-FOTS-011: Sub Network Connection Protection (SNCP) in SDH Network

Equipment Under Test : **Fiber Optic Transmission System**

Test Parameters : **Sub Network Connection Protection (SNCP)**

1.0 TEST DESCRIPTION

The aim of this test to check the sub network connection protection scheme in compliance with the ITU-T G.841.

2.0 TEST EQUIPMENT

E1 Analyzer

Cables and accessories

3.0 TEST SETUP

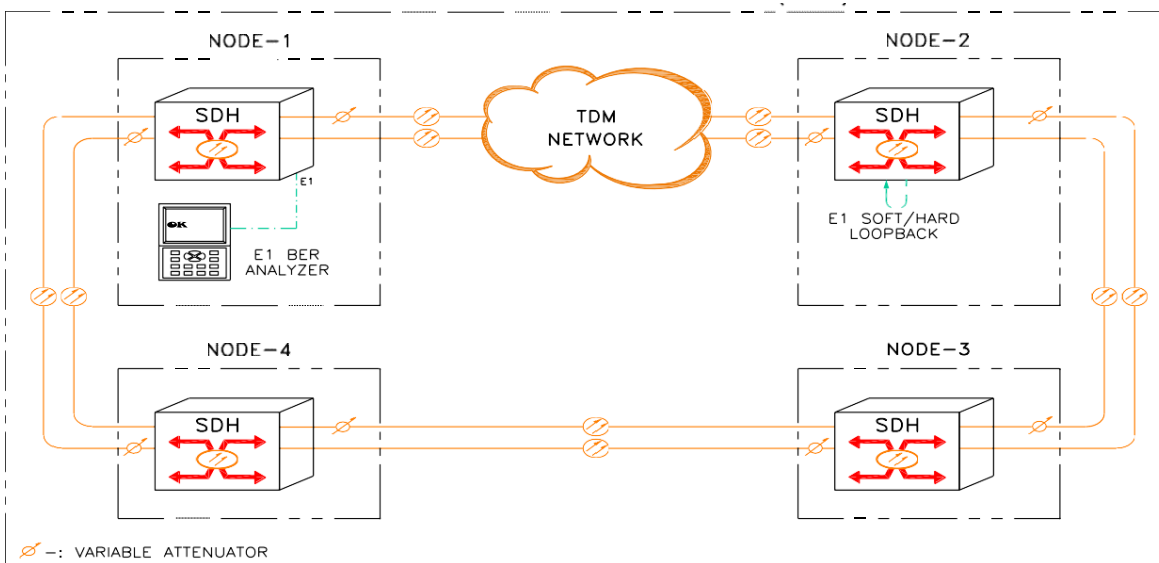


Figure 1: SNCP Protection Test

4.0 TEST PROCEDURE

Make the test setup as shown in Figure 1.

Create the E1 channel from STM node-1 to STM Node-2 via STM optical path.

Configure the protection path for the E1 channel between Node-1 to Node-2 using sub-network connection protection in that particular ring via Node-4 to Node-3 STM path as shown in above figure.

Connect the tested port (E1) at Node-1 to the E1 Analyzer and loop back the corresponding tributary at Node-2.

Setup the BER Tester for BER testing. While the BER test is in progress, now break the working fiber link (STM path) between Node-1 & Node-2, verify whether the protection to alternate path (Node-3 and Node-4 i.e., optical path in ring) occurred correctly.

Restore the working fiber links; verify whether the switching can be auto restored after the failure disappeared.

Tabulate the results as under Section 5.0.

5.0 TEST RESULT

Sr. No.	Test Description	Results (OK / Not OK)
1	Switching to alternate path is occurred when working path failed.	
2	Switching can be auto-restored after the fail disappeared.	
3	Switching time should be less than 50ms.	

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____
 (Manufacturer/contractor) (POWERGRID)/Constituent

Date _____ : _____ Date _____ : _____

TPS-FOTS-012: Measurement of Order Wire channel

Equipment Under Test : **SDH Optical Units**

Test Parameters : **EOW Station to Station Dial Testing**

1.0 TEST DESCRIPTION

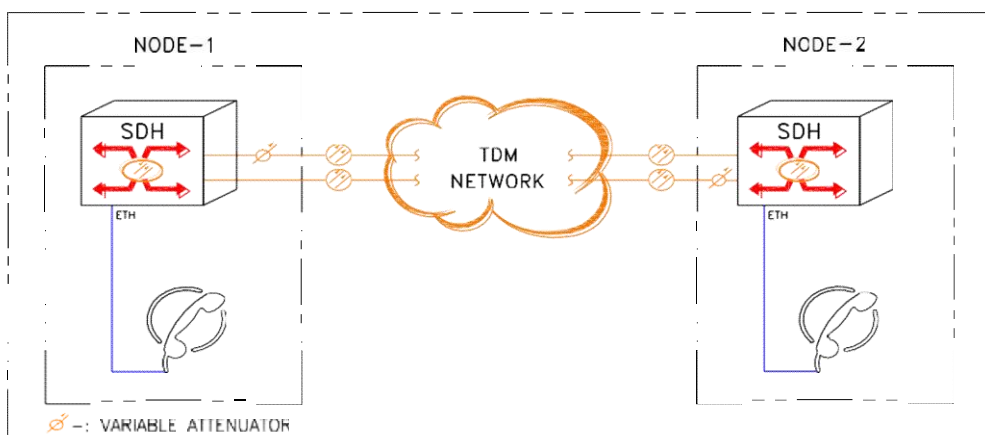
The purpose of this test will be an operational test to be performed for checking the satisfactory EOW operation.

2.0 TEST EQUIPMENT

EOW Phone.

LAN Cable

3.0 TEST SETUP



4.0 TEST PROCEDURE

By using the EOW telephone connected on SDH system, dial the telephone number of any other SDH station and check the EOW operation. Repeat the test for other stations.

Check the operation of EOW as specified above and tabulate the results as under section 5

5.0 TEST RESULT RECORD

Sr.No.	Station	EOW Number	Station	EOW Number	Results (OK / NOT OK)
1					
2					

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____
(Manufacturer/contractor) (POWERGRID)/Constituent

Date _____ : _____ Date _____ : _____

TPS-FOTS-013: SDH Equipment (STM64, STM 16 & STM 4) - Power Supply Test

Equipment Under Test : SDH Equipment (STM 64, STM 16 & STM 4)

Test Parameters : Power Supply Test

1.0 TEST DESCRIPTION

The purpose of this test is to check the operation of SDH equipment in power supply conditions as listed below of a fully equipped equipment rack.

- Test of equipment against input power variation from -40 to -60V DC.
- Automatic recovery of the equipment when the power supply is restored to normal.
- Reverse power protection test (polarity reversal) and automatic recovery.
- Short circuit protection
- Power supply protection test

2.0 TEST EQUIPMENT

- Variable DC power supply
- SDH Analyzer
- Local Craft Terminal (LCT)
- Cables and accessories

3.0 TEST SETUP

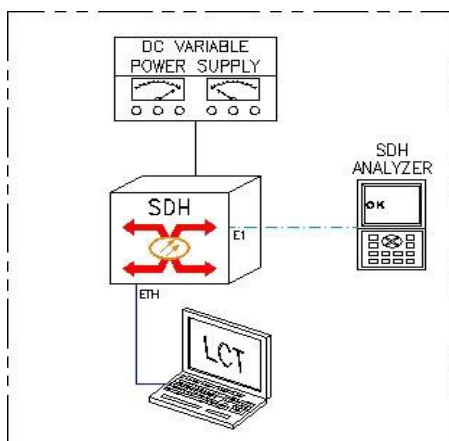


Figure 2: Test set up for Variable Power supply Measurement test

4.0 TEST PROCEDURE

a. Maximum Voltage, Minimum Voltage Test

- Connect the input supply cables from variable power supply unit and the SDH Analyzer to the equipment sub-rack as shown in above figure.
- Adjust the output voltage of the variable power supply unit to -48 VDC and switch ON the SDH equipment.
- Vary the input power supply from -48 Volts to -60 Volts (in steps) at this point check the operation of SDH equipment with the help of SDH Analyzer and it should operate as in normal condition.
- Restore the power supply to normal i.e. -48 Volts and check the operation of SDH equipment. It should operate as in normal condition.
- Vary the input power supply from -48 Volts to -40 Volts (in steps) at this point check the operation of SDH equipment with the help of SDH Analyzer and it should operate as in normal condition.
- Restore the power supply to normal again i.e. -48 Volts and check the operation of SDH equipment. It should operate as in normal condition.
- Switch off the power supply and the switch on the power supply and check the operation of SDH equipment. It should operate as in normal condition.

b. Power Supply Protection Test

- Connect both the input power supply cables to the power inputs of the SDH equipment.
- Switch ON the equipment power supply.
- Disconnect one of the power supply input from the power interface panel, the equipment should operate in normal condition.

c. Reverse Power Supply Protection Test

- Apply power with reverse polarity at the input, check if the system is protected against reverse polarity connection of the input supply. Restore the normal power supply connection and check if the system gets powered ON and working.

d. Short Circuit Protection

- Verify whether the power supply card shuts off on short circuit

5.0 TEST RESULT RECORD

Sr. No.	Test Description	Specification	Results (OK/NOT OK)
1	Operation of SDH equipment at -48 volt DC input supply	No bit errors	
2	Operation of SDH equipment at -60 volt DC input supply	No bit errors	
3	Operation of SDH equipment at -40 Volt DC input supply	No bit errors	
4	Power supply protection	Should be protected.	
5	Reverse polarity connection	Should be protected.	
6	Short Circuit test	Should be protected.	

Status

() Tested – OK _____

() Tested – Failed _____

Node Details

Station _____

Unit Type _____

Remarks

Tested By : _____ Witnessed By : _____

(Manufacturer/contractor)

(POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-014: Ethernet Parameters Measurements

Equipment Under Test : SDH Equipment along with Ethernet Interface Unit

Test Parameters : Throughput, Latency and Frame Loss Test

1.0 TEST DESCRIPTION

To verify that the Ethernet card is in compliance with the specifications of IEEE 802.3. The ethernet link shall be tested for Throughput, Latency and Frame loss as per RFC2544.

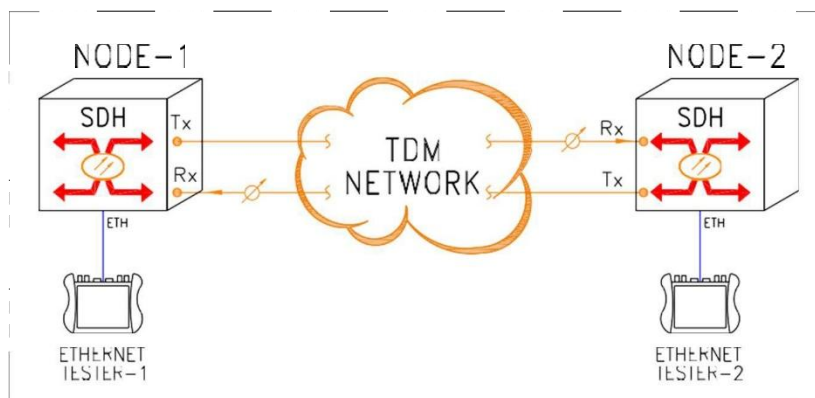
2.0 TEST EQUIPMENT

Ethernet Analyzer

Local Craft Terminal (LCT)

Low loss optical patch cord & CAT cable

3.0 TEST SETUP



4.0 TEST PROCEDURE

a. Data Channel (Throughput) Test

- Connect the two (2) SDH nodes (Node-1 & 2) with optical patch cords as shown in above figure.
- Connect one of the Ethernet Analyzer to LAN port-1 of Node-1 & another Ethernet Analyzer to LAN port-1 of Node-2 with CAT cable.
- Set the LAN ports of both the nodes on “100M full duplex” mode.
- Set the test duration to 10 seconds and the length of test frame to 1518 bytes. Measure the throughput.
- Observe and record the test results.

b) Latency Measurement

- Connect the two (2) SDH nodes (Node-1 & 2) with optical patch cords as shown in above figure.

- Connect one of the Ethernet Analyzer to LAN port-1 of Node-1 & another Ethernet Analyzer to LAN port-1 of Node-2 with CAT cable.
- Set the LAN ports of both the nodes on “100M full duplex” mode.
- Set the test duration to 10 seconds and the length of test frame to 1518 bytes respectively. Test the latency.
- Observe and record the test results.

c) **Frame Loss**

- Connect the two (2) SDH nodes (Node-1 & 2) with optical patch cords as shown in above figure.
- Connect one of the Ethernet Analyzer to LAN port-1 of Node-1 & another Ethernet Analyzer to LAN port-1 of Node-2 with CAT cable.
- Set the LAN ports of both the nodes on “100M full duplex” mode.
- Set the test duration to 10 seconds and the length of test frame to 1518 bytes respectively. Test the Frame Loss.
- There should be no frame loss, record the test results.

5.0 TEST RESULTS

Throughput

The throughput of the Ethernet card should not be less than the bandwidth configured.

Sr. No.	Bandwidth (Mbit/s)	Measured Throughput	Data Channel Results (OK / Not OK)
1	2		
2	4		
3	10		
4	100		

Latency

Sr. No.	Bandwidth (Mbit/s)	Measured Latency	Results (OK / Not OK)
1	2		
2	4		
3	10		
4	100		

Frame Loss

Sr. No.	Bandwidth (Mbit/s)	Throughput Rate%	Frame Loss	Results (OK / Not OK)
1	2			
2	4			
3	10			
4	100			

Status

() Tested – OK _____

() Tested – Failed _____

Node - 1 Details

Station _____

Unit Type _____

Node - 2 Details

Station _____

Unit Type _____

Remarks

Tested By : _____ Witnessed By : _____
(Manufacturer/contractor) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-015: Ethernet Provisioning and VLAN Separation Test

Equipment Under Test : **SDH Transmission System**

Test Parameters : **Ethernet Provisioning and VLAN Separation**

1.0 TEST DESCRIPTION

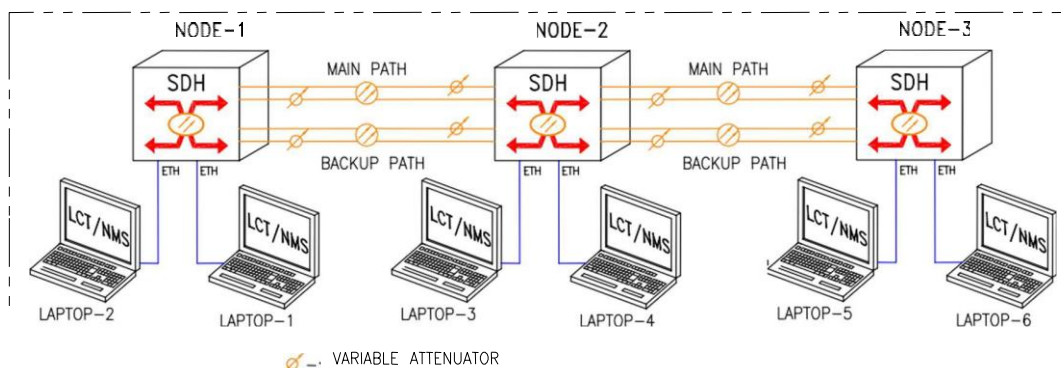
The purpose of this test is to check the provisioning of Ethernet channels and configuration of VLAN per application. Enable traffic separation at layer 2 thus segregating Broadcast domains based VLAN membership

2.0 TEST EQUIPMENT

Ethernet Analyzer

Cables and accessories

3.0 TEST SETUP



4.0 TEST PROCEDURE

- Make the test setup as per Figure 1.
- Create the required cross connections to provision an Ethernet link and assignment of VLAN in the SDH Nodes across the link through which the testing will be done.
- Ping response should be present between the two laptops.
- Tabulate the results as under Section 5
- Verify that laptops connected on same VLAN can communicate and laptops on separate VLAN's cannot communicate with each other.
- Repeat the procedure on other Ethernet Channels (if required).

5.0 TEST RESULT

The tested ports can receive continuous packet each other and WAN bandwidth capacity should be as per Ethernet channel plan.

Sr. No	Local Station	Remote Station	Slot No. / Port No.		VLAN Configuration (OK / Not OK)
			Local	Remote	
1			SL____/P____	SL____/P____	
2			SL____/P____	SL____/P____	
3			SL____/P____	SL____/P____	
4			SL____/P____	SL____/P____	

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____
 (Manufacturer/contractor) (POWERGRID)/Constituent

Date _____ : _____ Date _____ : _____

TPS-FOTS-016: E1 (2 Mbit/s) Interface Unit - Bit Error Rate

Equipment Under Test : **E1 (2 Mbit/s) Interface Unit**

Test Parameters : **Bit Error Rate**

1.0 TEST DESCRIPTION

The purpose of this test is to check Bit Error Rate (BER) in E1 (2 Mbit/s) interface unit of SDH node in compliance with ITU-T G.821.

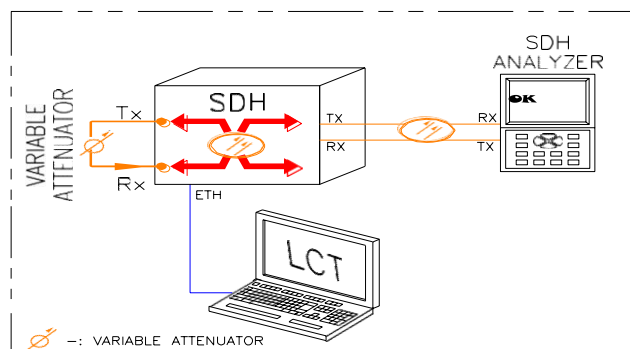
2.0 TEST EQUIPMENT

SDH Analyzer

Local Craft Terminal (LCT)

Low loss optical patch cord

3.0 TEST SETUP



4.0 TEST PROCEDURE

The test set-up will be as indicated in above figure.

Connect the SDH Analyzer to the configured E1 of the 2M tributary card of STM-4/16 node.

Create the cross connection to terminate E1 from one of the optical port. Apply soft or hard loop back on the optical port using fixed attenuator.

Set-up SDH Analyzer to perform 2 Mbit/s BER testing.

Commence the BER testing and run the BER test for 10 Minutes duration.

Record the result. The test results recorded will be as per ITU-T recommendation G.821.

5.0 TEST RESULTS

Test Description	Results (OK / NOT OK)
BER measurement on 2 Mbit/s (E1) port	BER result should be better than 10^{-10}

Status

() Tested – OK _____

() Tested – Failed _____

Node Details**Station** _____**Unit Type** _____**Remarks**

Tested By : _____ Witnessed By : _____
(Manufacturer/contractor) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-017: SDH Network - NMS & LCT Functionality Test

Equipment Under Test : SDH Network Management System & LCT

Test Parameters : NMS & LCT Functionality Test

1.0 TEST DESCRIPTION

The purpose of this test is to confirm proper operation of network management system (TNMS) and Local Craft Terminal (LCT) for SDH system for this project as indicated below.

2.0 TEST EQUIPMENT

SDH Network Management System (TNMS)

Local Craft terminal (LCT)

SDH Analyzer

Cables and accessories

3.0 TEST SETUP

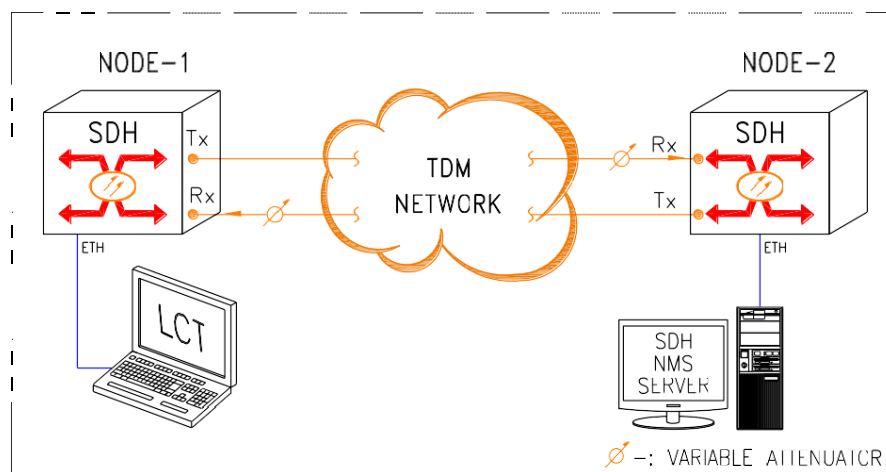


Figure 1: Remote Node Management

4.0 TEST PROCEDURE

CONFIGURATION MANAGEMENT

- Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.
- Ensure the SDH equipment is working.
- Login NMS as user of advanced level.
- Check the NMS whether it can establish and maintain the network topology.

- Check the NMS whether it provides the tools for planning, establishing and changing the static equipment configuration, this item can be conducted by changing some parameters & cross connection of the SDH equipment.
- Check the NMS whether it provide verification testing to support new equipment installation, this can be tested by adding a new NE.
- For creating the cross connection, establish the cross connection between any of the two ports in the same or different card.

FAULT MANAGEMENT

- Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.
- Ensure the SDH equipment is working.
- Login NMS as user of advanced level.
- Generate the various alarms; check the NMS for relevant alarm status.
- For example, pull out one card from SDH sub-rack; check the NMS for alarm of that fault.
- Insert the card, and then the alarm disappears.
- Check the alarm history, which includes all alarm events.
- Check the capability of alarm retrieval filter. Change the setting and retrieve.
- Check the colors for different level alarm events.
- Print alarm report.

SECURITY MANAGEMENT

- Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.
- Ensure the SDH equipment is working.
- Login as Administrator
- Add a user and define the user profile.
- Login as user and verify that user is able to perform various tasks as per profile.

LCT FUNCTIONALITY TEST

- Connect the LCT to the SDH equipment through LCT interface.
- Ensure the SDH equipment is working.
- Login the LCT.
- Change some configurations of the equipment.

- Get the fault information from the SDH equipment.

5.0 TEST RESULT

Sr. No.	Test Description	Results (OK / Not OK)
1.0	CONFIGURATION MANAGEMENT	
1.1	Capability to establish and maintain the backbone topology.	
1.2	Capability to provide graphical maps depicting the sub-rack configurations.	
1.3	Capability to plan, establish and change the static equipment configuration.	
1.4	Verification testing to support new equipment installation.	
1.5	Cross-connect capability between any of the two ports in same or different card.	
2.0	FAULT MANAGEMENT	
2.1	After generating an alarm, it is automatically displayed.	
2.2	Alarm has been shown automatically when there is card failure.	
2.3	NMS can maintain an alarm summary of unacknowledged current alarm.	
2.4	NMS can maintain an alarm history.	
2.5	Operator can acknowledge and clear alarms.	
2.6	Alarm retrieval filter is available.	
2.7	Alarms can be classified and configured as critical alarms, major alarms and minor alarms, in different colors.	
2.8	Alarm reports can be extracted.	
3.0	SECURITY MANAGEMENT	
3.1	Security Management functionality allows user addition and user profile definition.	
4.0	LCT Functionality Test	
4.1	LCT can get fault information from the connected SDH node.	
4.2	LCT is able to change the configuration of the connected SDH node.	
4.3	LCT is able to check for remote loopback & local loopback	
4.4	LCT can get fault/alarm information from the unconnected NE.	
4.5	LCT can get performance data from the unconnected NE.	

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By	:	_____	Witnessed By	:	_____
		(Manufacturer/contractor)			(POWERGRID)
Date	:	_____	Date	:	_____

TPS-FOTS-018: 150, 175, 200, 225, 250 Km Link Optical Amplifier Test

Equipment Under Test : **Optical Amplifiers**

Test Parameters : **Output Power level of optical amplifier**

1.0 TEST DESCRIPTION

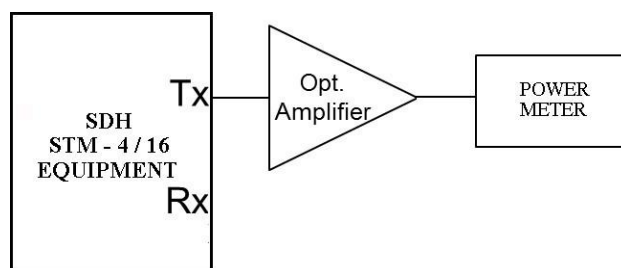
This test is performed to ensure the proper functionality of the Amplifier used for 150 km, 175 km, 200km, 225 km and 250 km link length and to measure of output power of amplifier.

2.0 TEST EQUIPMENT

Optical Power Meter

Low loss Optical Patch chord

3.0 TEST SETUP



4.0 TEST PROCEDURE:

The test procedures are as follows:

Make the test setup as shown in above figure.

Connect the output port of amplifier to the optical power meter and switch on the equipment.

Record the result showing on the optical power meter.

5.0 TEST RESULT

Sl.No.	Amplifiers as per approved BOQ	Result*	
1	The optical output power		

*As per approved DRS.

Status

() Tested – OK

—

() Tested – Failed

—

Remarks

Tested By : _____ Witnessed By : _____
(Manufacturer/contractor) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-019: Pre-Amplifier Receiver Sensitivity Measurement

Equipment Under Test : **Optical Pre-Amplifiers**

Test Parameters : **Receiver sensitivity level in dBm of Pre-Amplifier**

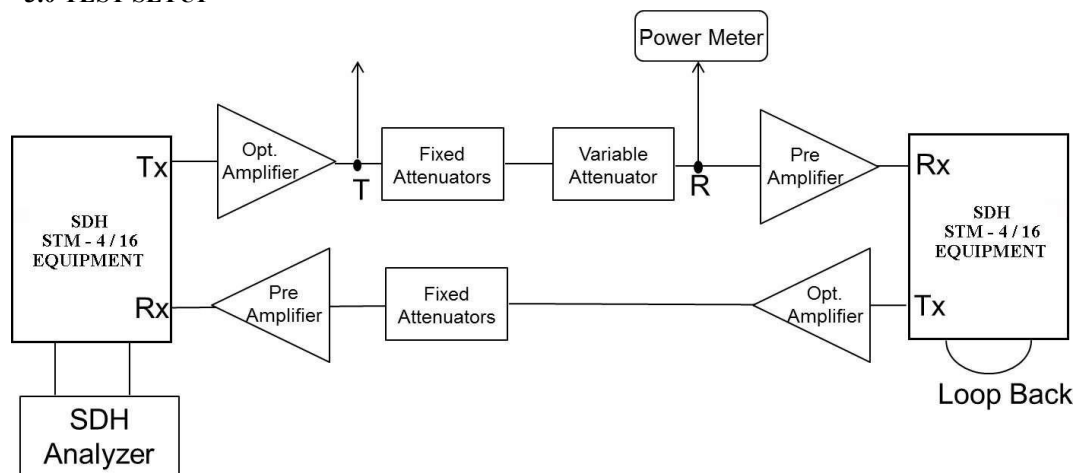
1.0 TEST DESCRIPTION

This test is performed to ensure the proper functionality of the Pre-Amplifier and to measure of receiver sensitivity of Pre-Amplifier.

2.0 TEST EQUIPMENT

- SDH Analyzer
- Optical Power Meter
- Variable Optical Attenuator
- Fixed Optical Attenuators
- Low loss optical patch cords

3.0 TEST SETUP



4.0 TEST PROCEDURE:

The test procedures are as follows:

- Make the test setup as shown in above figure.
- Set the SDH analyzer for BER testing at STM-4/16/64 level.
- Increase the attenuation by the variable attenuator till any error occurs at the tested optical interface card.
- Decrease the attenuation gradually, so that the error just goes off.

- Disconnect the optical patch cord from the R port and connect to the optical power meter, record the result showing on the optical power meter.

TEST RESULT

Sr.No.	Test Description	Actual Value (dBm)*
1	The receiver sensitivity of Pre- Amplifier.	The measured receiver sensitivity should be as per approved DRS

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By : _____ Witnessed By : _____
 (Manufacturer/contractor) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-020: Power Supply Range Measurement of Optical Amplifiers

Equipment Under Test : **Optical Amplifiers & Pre-Amplifiers**

Test Parameters : **Power supply range of Optical Amplifier & Pre-Amplifier.**

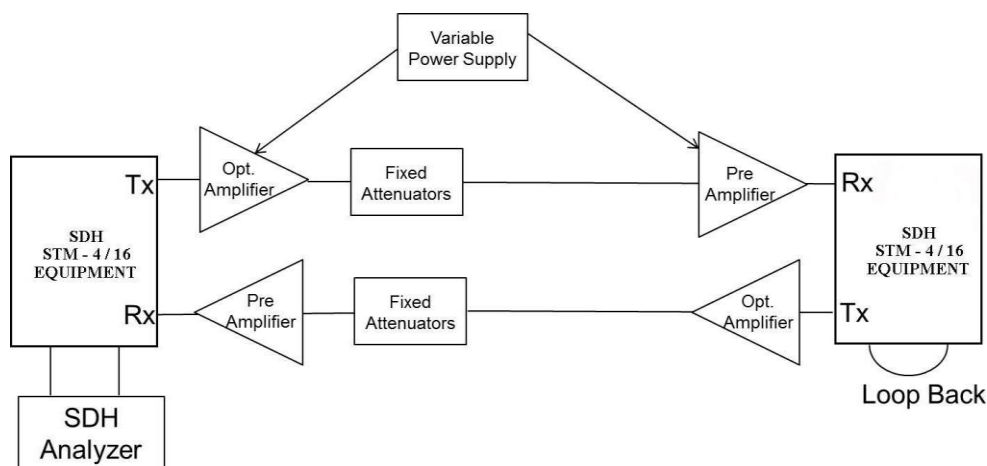
1.0 TEST DESCRIPTION

This test is performed to ensure the proper functionality of the optical amplifier & Pre-Amplifier for power supply voltage range of -40 to -60 VDC.

2.0 TEST EQUIPMENT

- SDH Analyzer
- Optical Power Meter
- Variable Optical Attenuator
- Fixed Optical Attenuators
- Low loss optical patch cords
- Variable Power Supply

3.0 TEST SETUP



4.0 TEST PROCEDURE:

The test procedures are as follows:

Set the SDH analyzer for BER testing at STM-4/16/64 level.

- Connect the variable power supply to the optical amplifier and set the output voltage of variable power supply to -40 VDC and run the BER test for 90 min.
- Vary the power supply voltage of optical amplifier from -40 VDC to -60 VDC using variable power supply and run the BER test for 90 min.
- Repeat the above steps with pre-amplifier also. The system should guarantee the performance at BER 10E-10

5.0 TEST RESULT

Sr.No.	Test Description	Result
1	Optical Amplifier Voltage @ -40 VDC	
2	Optical Amplifier Voltage @ -60 VDC	
3	Pre-Amplifier Voltage @ -40 VDC	
4	Pre-Amplifier Voltage @ -60 VDC	

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____
 (Manufacturer/contractor) (POWERGRID)/Constituent

Date _____ : _____ Date _____ : _____

TPS-FOTS-021: Electrical Interface Test

Equipment Under Test : **SDH Equipment**

Test Parameters : **Pulse Mask Test and Cable Compensation Test.**

1.0 TEST DESCRIPTION

The aim of this test is to check if the shape of 2Mbit/s pulse (of E1 signal) is as per the specifications and performance of 2Mbps tributary by introducing desired attenuation. In this test the shape of an E1 pulse is compared with a standard a G.703 pulse mask using SDH Analyzer.

2.0 TEST EQUIPMENT

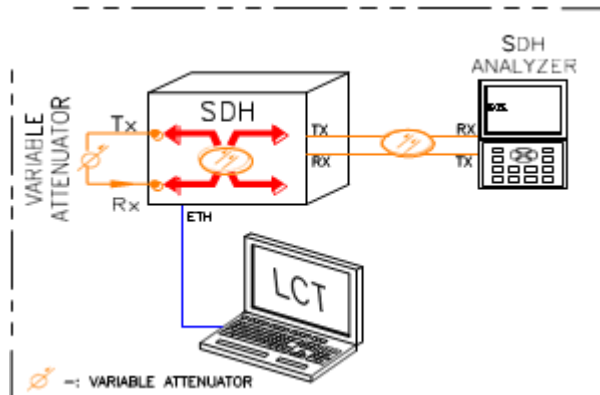
SDH Analyzer

Fixed Optical Attenuators

Low loss optical patch cords

Local Craft Terminal

3.0 TEST SETUP



4.0 TEST PROCEDURE:

The test procedures are as follows:

Pulse Mask Test

- Make the test set up as shown in the diagram
- Enable (Admin Up) on E1 tributary for which pulse shape is to be measured, using NMS.
- Set the SDH Analyzer in E1 Pulse Shape mode.
- Observe the pulse shape, record the results and verify if the results are within the specification limits.
- Repeat the test for other tributaries

Cable Compensation Test

- Make the test set up as shown in the diagram
- Set the SDH Analyzer Tester in BER Test mode.
- Use 600 meter of RG59 coaxial cable to extend the Tx interface of the E1 to the SDH Analyzer.
- Introduce a Loop back on the optical interface using a fixed attenuator.
- The tester shall display OK sign, observe that the test runs error free for 120sec.
- Repeat the test for other tributaries

TEST RESULT

Trib · No.	Module	Slot No./ Port No.	TEST DESCRIPTION	SPECIFICATION	RESULTS
1			Pulse Mask/shape	As per G.703 spec	
2			Pulse Mask/shape	As per G.703 spec	
3			Cable Compensation	As per G.703 spec	
4			Cable Compensation	As per G.703 spec	

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____

(Manufacturer/contractor) (POWERGRID)/Constituent

Date _____ : _____ Date _____ : _____

TPS-FOTS-022: Generation of Bit Error Curve

Equipment Under Test : **SDH Equipment**

Test Parameters: **Bit Error Curve**

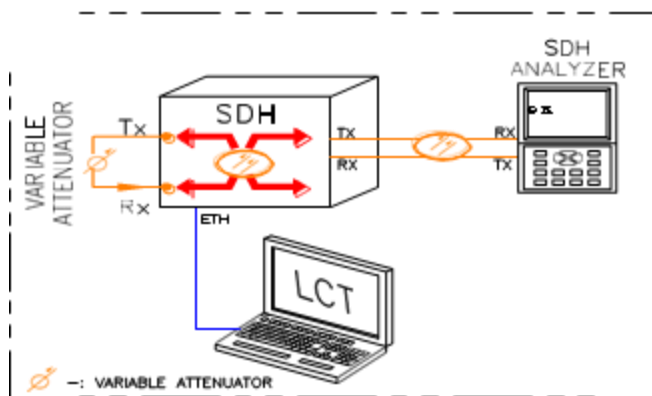
1.0 TEST DESCRIPTION

To plot a BER curve of optical interface by varying the input optical power levels and noting signal degradation values.

2.0 TEST EQUIPMENT

- SDH Analyzer
- Fixed Optical Attenuators
- Optical Variable Attenuator
- Low loss optical patch cords
- Local Craft Terminal

3.0 TEST SETUP



4.0 TEST PROCEDURE:

The test procedures are as follows:

- The test set-up will be as indicated in above figure.
- Create a cross connection to terminating E1 from one of the optical port
- Apply loop on the optical port using fixed attenuator.
- Connect the SDH Analyzer to the configured E1 of the 2M tributary card.
- Measure BER by gradually increasing the attenuation value and check the optical power at different BER values between $10E^{-10}$ and $10E^{-6}$

- Record the results and repeat the test for different optical port.

5.0 TEST RESULT

Trib · No.	Module	Slot No./ Port No./Sr no	Optical Input Power (dBm) at BER				RESULTS
			10E ⁻⁹	10E ⁻⁸	10E ⁻⁷	10E ⁻⁶	
1							
2							
3							
4							

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____
 (Manufacturer/contractor) (POWERGRID)/Constituent

Date _____ : _____ Date _____ : _____

TPS-FOTS-023: Test for Spare Cards and Spare Slots

Equipment Under Test : SDH Equipment

Test Parameters : Test for Spare Cards and Spare Slots

1.0 TEST DESCRIPTION

This test is performed to ensure the proper functionality of the blank slots in the SDH node and functionality of the spare cards supplied.

2.0 TEST EQUIPMENT

- E1 Datacom Tester
- Optical Power Meter
- SDH Analyzer
- Ethernet Tester
- Local Craft Terminal

3.0 TEST PROCEDURE:

The test procedures are as follows:

- In order to test the spare slot in the SDH node, eject the working card from the configured slot and insert it in one of the blank slot.
- Re-configure the newly inserted cards as per the initial configuration and test the functionality.
- Refer Test Procedures for receiver Sensitivity, Optical Output power, E1 BER TEST & Ethernet parameter test and check the functionality.
- In order to test the spare supplied, replace the working card with the spare card and test the functionality.
- Tabulate the results

4.0 TEST RESULT

Sr No.	Station Name	Blank Slot	Card Type	Configuration Status (OK / NOT OK)
4.1		Slot____		
4.2		Slot____		
4.3		Slot____		
4.4		Slot____		

Sr No.	Station Name	Spare Card model	Test Slot	Functionality Status (OK / NOT OK)
4.5			Slot____	
4.6			Slot____	
4.7			Slot____	
4.8			Slot____	

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____
 (Manufacturer/contractor) (POWERGRID)/Constituent

Date _____ : _____ Date _____ : _____

TPS-FOTS-024: Random Inspection to verify the Accuracy of DocumentsEquipment Under Test : **SDH Equipment**Test Parameters : **Verify the Documents and Drawings.****1.0 TEST DESCRIPTION**

To conduct additional tests to verify the accuracy of the product documentation i.e. Brochures, DRS. One or two parameters shall be chosen from the list of Parameters in Data sheet and tests shall be conducted to verify the same.

2.0 TEST EQUIPMENT

- a. As required by the Test Procedure.

3.0 TEST PROCEDURE:

The procedures followed to test the parameters / functionality shall be enclosed with the FAT report.

4.0 TEST RESULT

The test results shall confirm with the data sheet.

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By : _____ Witnessed By : _____

(Manufacturer/contractor)

(POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-025: Cable Compensation on Ethernet Interface

Equipment Under Test : **Ethernet Card of SDH Equipment**

Test Parameters : **Cable Compensation (Attenuation) Test.**

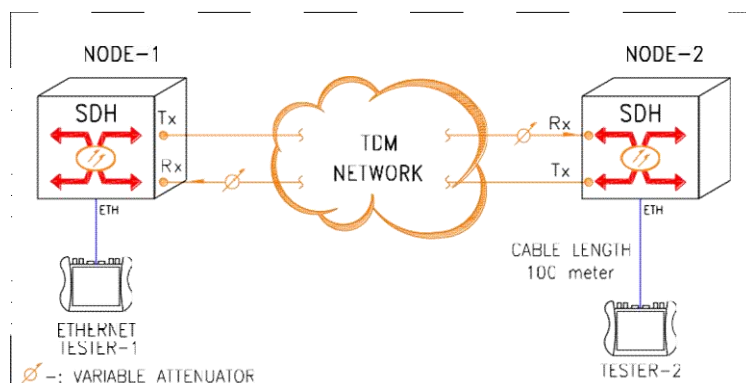
1.0 TEST DESCRIPTION

The aim of this test is to verify that the Ethernet interface functions error free until the maximum allowable cable length.

2.0 TEST EQUIPMENT

- a. Ethernet Tester
- b. Local Craft Terminal

3.0 TEST SETUP



4.0 TEST PROCEDURE:

The test procedures are as follows:

- c. Connect the two (2) SDH nodes (Node-1 & 2) with optical patch cords as shown in above figure.
- d. Connect one Ethernet Analyzer to the configured LAN port of Node-1 in loopback mode.
- e. Connect another Ethernet Analyzer in terminal mode to the configured LAN port of Node-2 using 100 meters of LAN cable.
- f. Set the LAN ports of both the nodes on “100M full duplex” mode.
- g. Verify that the Ethernet link test runs without any error and record the test results.

TEST RESULT

Sr No.	Station Name	Slot \ Port No.\Sr. No.	Ethernet link functionality @ 100 meter.	Remarks
4.1				
4.2				

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By : _____ Witnessed By : _____
 (Manufacturer/contractor) (POWERGRID)/Constituent
 Date : _____ Date : _____

TPS-FOTS-026: Spectral Characteristics & Central Wavelength (Optical Interface)

Equipment Under Test : **SDH Equipment**

Test Parameters : **Optical Spectrum and Center Wavelength**

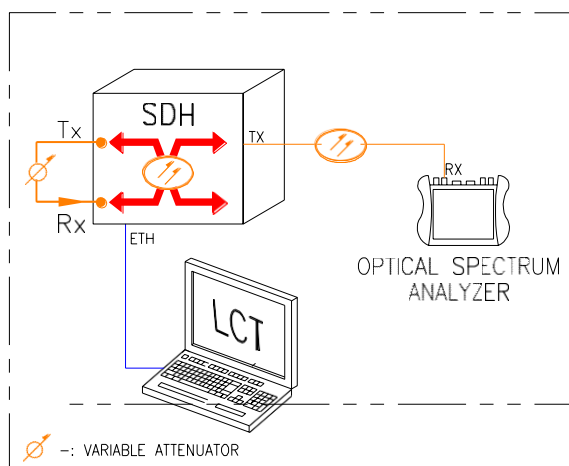
1. TEST DESCRIPTION

This purpose of this test is to measure the Spectral line width (-20 dB / RMS level) & Output Central Wavelength of the Optical Interfaces is as per specification.

2. TEST EQUIPMENT

- Optical spectrum analyzer
- Optical power meter
- Optical Patch Chords
- LCT/NMS

3. TEST SETUP



4. TEST PROCEDURE:

The test procedure is as follows:

5. Make the test setup as shown in above figure.
6. Connect the Tx port of the Optical Interface to be tested to the Optical Spectrum Analyzer.
7. Enable the admin status of the (STM-64/16/4) optical port to be tested by using LCT/NMS.
8. Measure the optical spectrum of the (STM-64/16/4) optical transmitters using optical spectrum analyzer.
9. Tabulate the results
10. Measure the Centre Wavelength of the (STM-64/16/4) optical transmitters using optical spectrum analyzer.

11. Tabulate the results

5.0 TEST RESULT

Optical Spectrum

Sr. No.	Module	Slot / Port	Specification		Result in dBm
			-20 db	RMS	

*Optical spectrum measurements shall be as per G.957 Standard

Output Centre Wavelength

Sr. No.	Module	Slot / Port	Central Wavelength (In dBm) (OK / NOT OK)

*Optical spectrum measurements shall be as per G.957 Standard

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By : _____ Witnessed By : _____
 (Manufacturer/contractor) (POWERGRID)/Constituent
 Date : _____ Date : _____

TPS-FOTS-027: Data Channel Testing

Equipment Under Test : **SDH Equipment**

Test Parameters : **Testing of Data Channel**

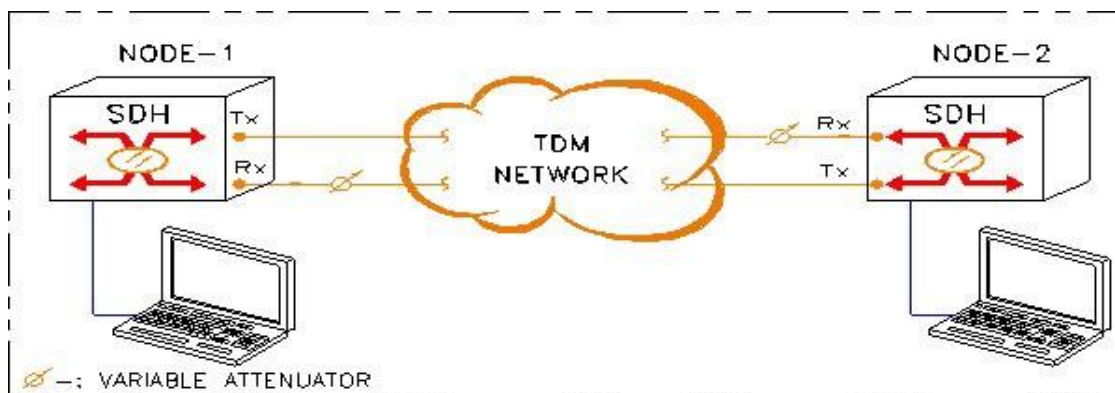
1. TEST DESCRIPTION

This purpose of this test is to verify user data channel available on SDH Equipment

2. TEST EQUIPMENT

- Laptop
- Optical Patch Chords

3. TEST SETUP



4. TEST PROCEDURE:

The test procedure is as follows:

- Make the test setup as shown in above figure.
- Connect the laptop to data channels at both the nodes.
- Run the ping test to check the data channel.

O) TEST RESULT

Both laptops ping each other thro data channel

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By	:	_____	Witnessed By	:	_____
		(Manufacturer/contractor)			(POWERGRID)/Constituent
Date	:	_____	Date	:	_____

TPS-FOTS-028: Cyber Security and System Hardening Checklist

SDH Equipment Checklist (As applicable)

Sl. No.	Verification Item	Status (Y/N)	Remarks
1	Equipment make, model, serial number and firmware version verified		
2	Default user accounts identified and changed		
3	Default passwords changed/forced to change on first login		
4	Role-Based Access Control (RBAC) supported		
5	Password complexity configuration available		
6	Account lockout feature available		
7	Session timeout feature available		
8	SSH supported and operational		
9	HTTPS supported and operational		
10	SNMPv3 supported and operational		
11	Telnet disabled or can be disabled		
12	HTTP disabled or can be disabled		
13	SNMPv1/v2 can be disabled		
14	Access restriction through ACL/IP filtering supported		
15	Unused services can be disabled		
16	Unused interfaces and ports can be disabled		
17	Login success/failure logging available		
18	Configuration change logging available		
19	Security event logging available		
20	Syslog export supported		
21	Time synchronization supported		
22	Firmware upgrade procedure demonstrated		
23	Firmware rollback procedure available		
24	Configuration backup demonstrated		
25	Configuration restoration demonstrated		
26	Hardening guide submitted		
27	Security advisory and vulnerability disclosure process submitted		

Optical Amplifier Checklist (As applicable)

Sl. No.	Verification Item	Status (Y/N)	Remarks
1	Equipment details and firmware version verified		
2	Default credentials changed		
3	Password-protected administration verified		
4	SSH/HTTPS supported (where applicable)		
5	Telnet disabled		
6	HTTP disabled		
7	SNMPv3 supported		
8	Default SNMP community strings changed		
9	Access restrictions configurable		
10	Gain setting modification restricted to authorized users		
11	Optical power setting modification restricted		
12	Configuration change logging available		
13	Optical power alarms verified		
14	Temperature alarms verified		
15	Power module alarms verified		
16	Equipment failure alarms verified		
17	Alarm integration with NMS verified		
18	Firmware upgrade procedure demonstrated		
19	Configuration backup facility available		
20	Security hardening recommendations submitted		

Remarks

Tested By : _____ Witnessed By : _____

(Manufacturer/contractor) (POWERGRID)/Constituent

Date : _____ Date : _____

FACTORY ACCEPTANCE TEST PROCEDURE

(Network Management System)

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FAT SAMPLING :

The sampling rate for the Factory Acceptance Test (FAT) shall be 10% of the batch size (minimum 1) for all the items. The physical verification shall be carried out on 100% of the offered quantities. In case any sample fails, the failed sample will be rejected and additional 20% samples will be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected. In case a number of equipments are required for demonstration of the performance of any equipment during FAT, the sample size shall be taken as that number of equipments which are necessary to demonstrate the performance, irrespective of the percentage.

ABBREVIATIONS

AC	Alternate Current
BER	Bit Error rate
DACS	Digital Access Cross Connect Switch
DC	Direct Current
DCN	Data Communication Network
EXCH	Exchange
FAT	Integrated Factory Acceptance Test
FDS	Functional Design Specification
FTC	Fiber Termination Closure
GPS	Global Positioning System
LCT	Local Craft Terminal
NMS	Network Management System
PDH	Plesiochronous Digital Hierarchy
SDH	Synchronization Digital Hierarchy
STM	Synchronous Transport Module

TPS-TMN-001: Physical Inspection

Equipment Under Test : To Physically verify Hardware& Software as per BOQ, DRS & Drawings

Test Parameters : Verification for NMS Hardware & Software

Test Description

The aim of this test is to verify hardware & software with respect to BOQ & DRS. Check & record the hardware and software configuration and also check for any physical impairment.

Reference Documents

- BOQ

Test Procedure and Expected Result

- Verify the hardware configuration and Qty. with respect to approved DRS, BOQ & Drawings
 - Tabulate results as under Section. 4.1 to 4.2
- Check the software details and License
 - Tabulate results as under Section 4.3 .
- Check the physical damage.
 - Tabulate results as under Section 4.4

Test Result Record

Sr. No.	Check Point	Acceptance Criteria	Quantity	Remarks
4.1	SDH NMS Hardware Configuration	As per Approved DRS	As per Approved BOQ	Ok/Not Ok
4.2	SDH Client Hardware Configuration	do	do	Ok/Not Ok
4.3	SDH NMS Software and Licenses	do	do	Ok/Not Ok
4.4	Physical Damage to the Server and Client PC and LCT	do	do	Ok/Not Ok

Status

- () Tested – OK : _
- () Tested – Failed : _

Remarks

Tested By : _____ Witnessed By : _____

(Manufacturer/contractor)

(POWERGRID)/Constituent

Date : _____ Date : _____

TPS-TMN-002 A: Testing of NMS (SDH) to demonstrate proper operation of all functions

Equipment Under Test : SDH Network Management System & LCT

Test Parameters : NMS & LCT Functionality Test

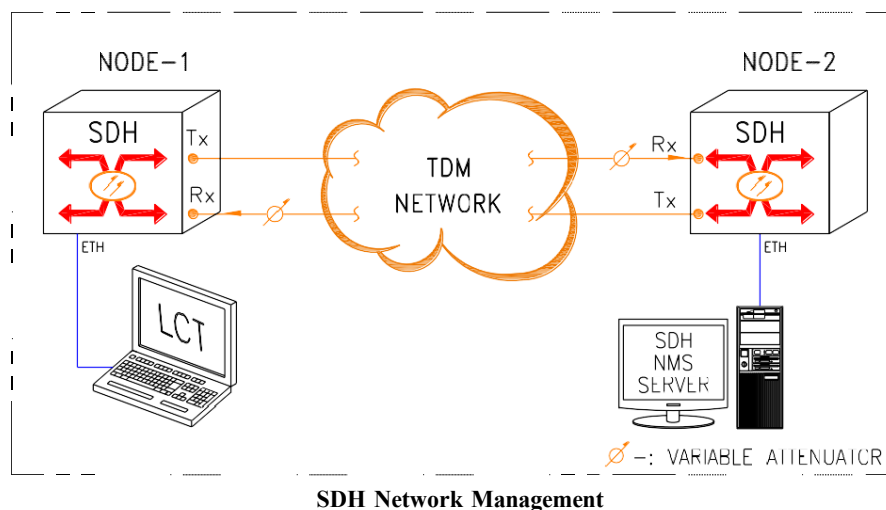
TEST DESCRIPTION

The purpose of this test is to confirm proper operation of network management system (NMS) and Local Craft Terminal (LCT) for SDH system as indicated below.

TEST EQUIPMENT

- SDH Network Management System (TNMS)
- Local Craft terminal (LCT)
- SDH Analyzer
- Cables and accessories

TEST SETUP



TEST PROCEDURE

CONFIGURATION MANAGEMENT

Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.

- Ensure the SDH equipment is working.
- Login NMS as user of advanced level.
- Check the NMS whether it can establish and maintain the network topology.

- Check the NMS whether it provides the tools for planning, establishing and changing the static equipment configuration, this item can be conducted by changing some parameters & cross connection of the SDH equipment.
- Check the NMS whether it provide verification testing to support new equipment installation, this can be tested by adding a new NE.
- For creating the cross connection, establish the cross connection between any of the two ports in the same or different card.

FAULT MANAGEMENT

- Display Equipment Status, Display graphical, topological & Map type and Display the use of colour on links and Nodes.
- Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.
- Ensure the SDH equipment is working.
- Login NMS as user of advanced level.
- Generate the various alarms; check the NMS for relevant alarm status.
- For example, pull out one card from SDH sub-rack, check the NMS for alarm of that fault.
- Insert the card, and then the alarm disappears.
- Check the alarm history, which includes all alarm events.
- Check the capability of alarm retrieval filter. Change the setting and retrieve.
- Check the colors for different level alarm events.
- Print alarm report.

SECURITY MANAGEMENT

Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.

- Ensure the SDH equipment is working.
- Login as Administrator
- Add a user and define the user profile.
- Login as user and verify that user is able to perform various tasks as per profile.

PERFORMANCE MANAGEMENT

Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.

- Ensure the SDH equipment is working.
- Configure a E1 interface and run performance management for specified interval.
- Monitor events & thresholds.

- Generate reports on daily, weekly, monthly and yearly basis containing system statistics.

LCT FUNCTIONALITY TEST

- Connect the LCT to the SDH equipment through LCT interface.
- Ensure the SDH equipment is working.
- Login the LCT.
- Change some configurations of the equipment.
- Get the fault information from the SDH equipment.

TEST RESULT

Sr. No.	Test Description	Results (OK / Not OK)
1.0	CONFIGURATION MANAGEMENT	
1.1	Capability to establish and maintain the backbone topology.	
1.2	Capability to provide graphical maps depicting the sub-rack configurations.	
1.3	Capability to plan, establish and change the static equipment configuration.	
1.4	Verification testing to support new equipment installation.	
1.5	Cross-connect capability between any of the two ports in same or different card.	
2.0	FAULT MANAGEMENT	
2.1	After generating an alarm, it is automatically displayed.	
2.2	Alarm has been shown automatically when there is card failure.	
2.3	NMS can maintain an alarm summary of unacknowledged current alarm.	
2.4	NMS can maintain an alarm history.	
2.5	Operator can acknowledge and clear alarms.	
2.6	Alarm retrieval filter is available.	
2.7	Alarms can be classified and configured as critical alarms, major alarms and minor alarms, in different colors.	
2.8	Alarm reports can be extracted.	
3.0	SECURITY MANAGEMENT	
3.1	Security Management functionality allows user addition and user profile definition.	

4.0	PERFORMANCE MANAGEMENT	
4.1	Performance Management can be enabled for specific interface.	
4.2	The Measurement interval can be selected.	
4.3	Monitor events & thresholds.	
4.4	Generate reports on daily, weekly, monthly and yearly basis containing system statistics.	
5.0	LCT Functionality Test	
5.1	LCT can get fault information from the connected SDH node.	
5.2	LCT is able to change the configuration of the connected SDH node.	
5.3	LCT is able to change the configuration of connected SDH node.	

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____

(MANUFACTURER/CONTRACT OR)

(POWERGRID)/Constituent)

Date _____ : _____ Date _____ : _____

TPS-TMN-002: Test to demonstrate the functionality of North bound interface

Equipment Under Test : **Network Management System**

Test Parameter : **NBI Functionality of NMS**

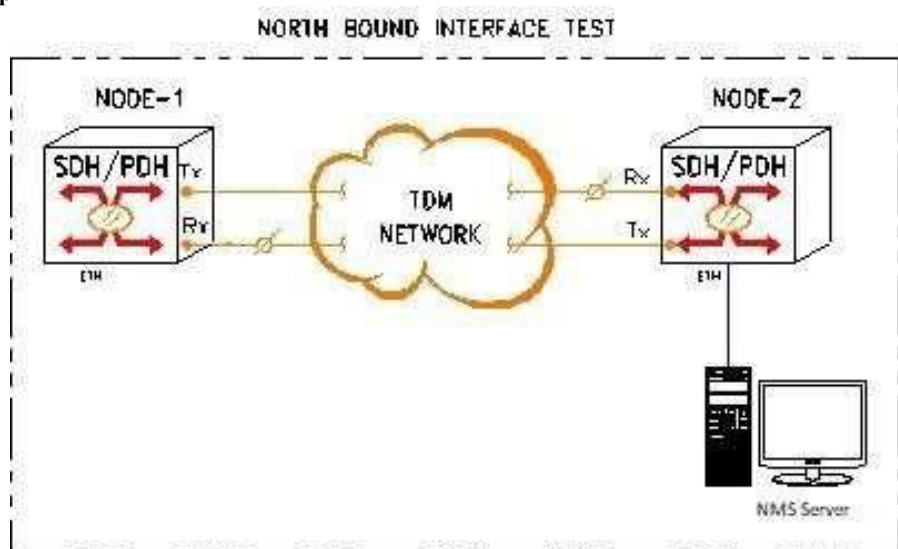
Test Description

The purpose of this test is to confirm that the supplied NMS is capable to send alarms over North Bound Interface.

Test Equipment and Accessories

Sr.No	Test Accessories	Type	Quantity	Remarks
1	NMS	PC	1	

Test Set-up



SDH Network Management

Test Procedure

- Make the test setup as shown in above figure.
- If possible connect Third party NMS in the same LAN network of the NMS Server.
- Make required configurations in the servers.
- Create an alarm on any of the NE in the network.
- Verify that the Alarm is replicated on the NMS Server and the server sends SNMP traps to the Third party NMS

Test Result Record

Sr. No.	Test Description	Results (OK / Not OK)
5.1	SDH NMS sends SNMP traps over the LAN port reserved for Third party NMS	

Status

() Tested – OK : _____

() Tested – Failed : _

Remarks

Tested By : _____ Witnessed By : _____

(MANUFACTURER/CONTRACTOR) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-TMN-004: Random Inspection to verify the Accuracy of Documents

Equipment Under Test : NMS

Test Parameters : Verify the Documents and Drawings.

• TEST DESCRIPTION

To conduct additional tests to verify the accuracy of the product documentation i.e. Brochures, DRS. One or two parameters shall be chosen from the list of Parameters in Data sheet and tests shall be conducted to verify the same.

• TEST EQUIPMENT

As required by the Test Procedure.

• TEST PROCEDURE:

The procedures followed to test the parameters / functionality shall be enclosed with the FAT report.

• TEST RESULT

The test results shall confirm with the data sheet.

Status

() Tested – OK _____

() Tested – Failed _____

Remarks

Tested By _____ : _____ Witnessed By _____ : _____
(MANUFACTURER/CONTRACT OR) (POWERGRID)/Constituent

Date _____ : _____ Date _____ : _____

TPS-TMN-005: Expansion Capability Test

Equipment Under Test : NMS

Test Parameters : Expansion Capability Test

1.0 TEST DESCRIPTION

The purpose of this test is to confirm that the expansion capacity of the supplied NMS System is 150% of the existing Networks Elements.

2.0 TEST EQUIPMENT

7. Network Management System (NMS)
8. Cables and accessories

3.0 TEST PROCEDURE

- Setup the NMS System.
- Check Total no's of Node available in the system. .
- Add virtual nodes up to 150% capacity of the exiting node.

4.0 TEST RESULT

Sr. No.	Test Description	Results (OK / Not OK)
1.0	Expansion Capacity of the supplied NMS System is 150% of the existing Network elements.	

Status

() Tested – OK _____

() Tested – Failed **Remarks**

Tested By _____ : _____ Witnessed By _____ : _____
(MANUFACTURER/CONTRACT OR) (POWERGRID) Constituent

Date _____ : _____ Date _____ : _____

TPS-TMN-06 CYBER SECURITY AND SYSTEM HARDENING TESTS

NMS Checklist (As applicable)

Sl. No.	Verification Item	Status (Y/N)	Remarks
1	Supported OS version installed		
2	Latest approved patches applied		
3	Unnecessary services disabled		
4	Unnecessary user accounts removed		
5	Host firewall enabled		
6	Individual user accounts supported		
7	RBAC demonstrated		
8	Password complexity policy available		
9	Account lockout functionality available		
10	Session timeout functionality available		
11	MFA support available (if applicable)		
12	HTTPS enabled and SSH enabled		
13	HTTP disabled and telnet disabled		
14	SNMPv3 supported		
15	Audit logging available and configuration change logging available		
16	Syslog integration supported		
17	NTP synchronization available		
18	Database backup demonstrated		
19	Configuration backup demonstrated		
20	Restoration procedure demonstrated		
21	Access restriction by IP address supported		
22	SBOM, HBOM as per Cert-IN guidelines submitted (Format Attached in Appendix J)		
23	Vulnerability assessment compliance completed and report submitted (as applicable)		
24	OEM Hardening guide submitted		
25	Patch management procedure submitted		
26	List of open ports/services submitted		
27	OEM security advisory portal details submitted		

Note: Other networking devices(Switches, routers etc.) supplied by contractor under the project shall be tested as per cyber security policy and system hardening guidelines specified in the this technical specification and industry best practices. The checklist for the same shall be submitted by contractor for approval during detail engineering.

FACTORY ACCEPTANCE TEST PROCEDURE (FAT)

DC POWER SUPPLY

List of Tests to be carried out on DCPS System and Module

SR. No	TEST	Page No.
	Test on DCPS System and Module	
01	Mechanical & Visual Check Tests.	3
02	Insulation Test.	3
03	High Voltage Withstand Test	4
04	Switch ON test	4
05	DCPS Low Voltage/Pre alarm test & High Voltage limits Check	4
06	Battery Low Voltage Disconnect Level Test	5
07	AC Input Low & High Voltage limit check tests	5
08	Rectifier Fail Alarm test	6
09	Voltage Regulation Test	6
10	Current Sharing Tests	6
11	Total Output Power Tests	7
12	O/P Voltage Ripple tests	7
13	Power Factor	7
14	Input Current Limit	7
15	Efficiency Test	8
16	Hot Plug in test	8
17	Calibration & Parameter Setting tests	8
18	Automatic Float Cum Boost Charge Mode change over test	9
19	Battery Path Current Limit	9
20	Battery Charging & Full Load Current/Voltage drop Tests.	10
21	Total Harmonic distortion tests	10
22	Burn in Test at Ambient temperature (for 8hours duration)	10
23	Psophometric Noise Test	11
24	Input AC Frequency Range Test	11
25	Rectifier Dynamic Response	11
26	Output Short Circuit Test	12
27	Hold up time Test	12
28	Source -1 & Source -2 Interlocking Test	12
29	BURNIN Test Report	14

• Mechanical & Visual Check Test (DCPS/ MODULE)

Sr. No.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
1	MECHANICAL & VISUAL CHECK TEST			
1.1	Visual Inspection of Rack Mechanical, Rack should have good finish all Nut & Bolts Must be secured.	Good Finish & Secured		
1.2	Ensure all PCBs in the rack are marked with a signed Test label & are secured properly in cabinet.	Good workmanship		
1.3	All electrical/ electronic components are secured properly in cabinet.	Good workmanship		
1.4	Ensure all cabling is neat and secured. Proper lugs with heat shrinkable sleeves, labeling have been used.	Good workmanship		
1.5	Ensure Bus Bars are cleaned without burs and fixed properly.	Good workmanship		
1.6	Ensure all electrical components are of specified valued as per work order BOM/DRS schematic diagram/GA Drawing.			
1.7	Ensure Controller module is tested and labeled.			
MODULE				
1.8	Check the fitment of Rectifier module in Rack.	Proper Fitment		
1.9	Visual check for physically damage.	No damage shall be observed		

• Insulation Test (DCPS)

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
2	Insulation Test.			
2.1	Remove Rectifier Modules, Controller Module and all PCB Cards			
2.2	Remove/ Disconnect Surge Protector and capacitors			
2.3	Perform Insulation test with 500V DC Meggar			
	'a) Between AC Input & Earth	>2 Meg Ohm		
	b) Between Output & Earth	>1 Meg Ohm		
	c) AC Input & DC Output	>5 Meg Ohm		

• High Voltage Withstand Test (DCPS)

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
3	High Voltage withstand Test			
3.1	Remove Rectifier Modules, Controller Module and all PCB Cards			
3.2	Remove/ Disconnect Surge Protector and capacitors			
3.3	Perform High Voltage Test as under			
	Between Test Voltage			
	O/P & Earth 0.5KV	should pass for 1 minute		
	O/P & I/P 3.0 KV			
	I/P & Earth 1.5KV			

• Switch On Test (DCPS/Module)

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
4	Switch On Test			
4.1	Make all external connections to the system			
4.2	Switch on the system with or without Dummy Battery (dummy battery may be 48 volt power supply) if required.			
4.3	Insert Rectifier modules and turn on the system's main MCB.	System should turn ON and shows float Voltage on display		
4.4	System shall turn ON, Controller Module shall also turn ON and read the System voltage on display.			

• DCPS Low Voltage/Pre Alarm Test and High Voltage Limit Test. (DCPS)

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
5	DCPS Low Voltage & High voltage limit test			
5.1	Shut off the system. Connect aux. adjustable power supply to the battery terminals. Adjust aux. power supply voltage to to 52 Volts			
5.2	Slowly reduce power supply voltage and check alarm for DC low/Pre alarm voltage setting.	~45 +/-5V		
5.3	Check for potential free contact status at the PFC terminal.			
5.4	Now increase voltage of aux power supply voltage to normal value (52V) slowly, DC LOW alarm /Pre alarm shall go off automatically.			

S.NO	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS		REMARK
DC High Voltage Test (DCPS/Module)			DCPS	Module	
5.5	Shut off the system. Connect aux. adjustable power supply to the battery terminals. Adjust aux. power supply voltage to 52 Volts.				
5.6	Slowly increase the power supply voltage and check alarm for DC high voltage setting.	58 +/-0.5V			
5.7	Check for potential free contact status at the PFC terminal.				
5.8	Now decrease voltage of aux power supply voltage to normal value (52V) slowly, DC High alarms, shall go off automatically.				

• **Battery Low Voltage Disconnect Level Test. (DCPS)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
6	Battery Low Voltage Disconnect Level Test			
6.1	Shut off the system. Adjust aux power supply voltage to 52 Volts			
6.2	Slowly reduce power supply voltage and check LVBD status. Low Voltage contactor shall turn off. The controller shall become off at this point	42+/-0.5V		
6.3	Now turn on the system, the Controller would turn ON and the Low Voltage contactor shall close and system will become normal			

• **AC Input High and Low Voltage Test (DCPS/ Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
7.	AC Input High & Low Voltage Test			
7.1	Ensure the system is switch ON and input voltage is within limit			
7.2	Increase AC mains slowly through variac. Main Fail alarm shall come around at the Set value.(HV Alarm)	265V+/-10V		
7.3	Now decrease AC mains slowly, alarm reset with in 10V.	265V+/-10V		
7.4	Now Decrease AC mains slowly through variac. Main Fail alarm shall come around at the Set. (LV Alarm)	160V+/-10V		
7.5	Now Increase AC mains slowly, alarm reset with in 10V.	160V+/-10V		

• **Rectifier Fail Alarm Test.(DCPS)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
8	Rectifier Fail Alarm Test			
8.1	Ensure the system is switch ON and normal. Switch off rectifier input MCB and observe the alarm for rectifier fail/ major/minor	Rectifier Fail LED shall glow		
8.2	Switch on rectifier input MCB, Rectifier fail alarm disappears.			

• **Voltage Regulation Test (DCPS/ Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
9	Voltage Regulation Test			
9.1	Insert all the modules and turn on all AC MCBs.			
9.2	Ensure input AC supply is within range.			
9.3	Put Load on Exchange bus so as equipment is loaded at its 50% capacity and adjust output voltage 53.5V $\pm 0.5V$			
9.4	Increase the load to 100% capacity and note down the DC voltage.			
9.5	Now decrease the load to 10% capacity and note down the DC voltage.			
9.6	Calculate voltage regulation DCPS/ Module	better than $\pm 1\%$		

• **Current sharing Test (DCPS)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
10	Current Sharing Test			
10.1	Insert all the modules and turn on all AC MCBs.			
10.2	Ensure input voltage is within limit and output voltage is 53.5V ± 0.5 volt.			
10.3	Put the load equal to no of modules (N) x capacity of each module			
10.4	Note down the current given by each module			
10.5	Put the 75% Load on the system and remove one module from the system.	Load shall be taken by other modules		
10.6	Calculate Current sharing of modules	Within $\pm 5\%$		

- **Total Output Power Test (DCPS/Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
11	Total output Power Test			
11.1	Ensure input voltage is within limit and adjust output voltage to float voltage i.e 53.5V.			
11.2	Put the load equal to no of modules (N) x capacity of each module.	TPO = 53.5 X Idc PORM= TPO/no. of module		
11.3	Calculate Total Power output (TPO) and Power output for DCPS and for per rectifier module(PORM)			

- **Output Ripple Test (Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
12.1	Ensure the system is running with normal input voltage and load is 100% .			
12.2	Measure the output ripple using CRO and it should be within the defined limit	< 200mv RMS		

- **Power Factor Measurement (Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
13.1	Ensure the system is running with normal input voltage and load is 100% .			
13.2	Measure Input AC power factor, through Power meter.	Power Factor Shall be >0.9%		
13.3	Repeat Test at 50% Load.			

- **Input Current Limit (Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
14.1	Ensure the system is running with normal input voltage and load is 100%.			
14.2	Measure Input AC Current, through Power meter.	Shall be less $\leq 18.6A$		

- Efficiency Test (Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
15.1	Ensure the system is running with normal input voltage and load is 100% .			
15.2	Refer the readings taken for rectifier total power output in watts, and measure the input power in watts			
15.3	Calculate the Efficiency = $\text{eff} (\text{Po/Pi}) \times 100$	Should > 90%		
15.4	Repeat test at 50% Load.	Should > 88 %		

- Hot Plug-In Test (DCPS)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
16	HOT PLUG IN TEST			
16.1	Switch on all the rectifier and pull out rectifier no. 1 in live condition again			
16.2	Plug in inside rack. The module shall become alive.			
16.3	No damage/ drift shall occur.	No Damage/ Drift		

- Calibration & Parameter setting test.(DCPS)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
17	Calibration Test			
17.1	DC Voltage: Note the DC voltage displayed on Controller display, Measure DC output Voltage with a standard Digital multimeter.			
17.2	Calculate the accuracy	+/-1.5%		
17.3	Put 100% load on system. Partly on load side and partly on Battery Side. Measure the shunt mv using standard multimeter and calculate the battery current & Rectifier Current.			
17.4	Calculate the accuracy.	+/-1.5%		

- Automatic Mode change over Float to charge (Boost) mode Test. (DCPS)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
18	Automatic Mode change over Float to charge (Boost) mode			
18.1	For testing purpose, Set the discharge AH threshold for charge as 1AH or Set the Voltage threshold i.e low voltage at which boost transfer need to be activated			
18.2	Discharge the battery for some time till battery is discharged blow for 1AH or discharge blow set value of Voltage threshold.			
18.3	Switch ON the mains when desired AH or discharge voltage is reached and observe that controller goes to boost mode.			
18.4	Charge (Boost) to Float mode transfer			
18.5	Set charge factor 90% and 1 minutes.			
18.6	Allow to battery recharge after switch on the mains.			
18.7	Observe the boost to float mode transfer. It should take place on reaching time period (max duration) or upon charge factor (%)			

- Battery Path Current Limiting Test.(DCPS)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
19	Battery path Current Limiting Test			
19.1	Connect a variable load on battery terminals. See the battery current limit setting from the controller/ connecting the controller to PC.			
19.2	Switch on the system and increase the load beyond set point and observe the output voltage. Note down the set point and actual current value at which voltage start dropping.	When load exceed the set value, the output voltage will start decreasing.		

• **Battery Charging and Full Load Current/Voltage drop Test. (DCPS)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
20	Battery Charging & Full Load Current Test			
20.1	Battery Charging test: Same as that of SI no 19 above.			
20.2	<u>Full Load/Voltage drop Test</u> Remove the load from Battery terminal and Now put the load on load terminals to the system rating and observe the overload alarm. The alarm should appear on display as overload alarm.	System Overload alarm shall come at >100% of system capacity.		
20.3	Remove the excess load and make the system normal.			

• **Total Harmonic Distortion Test (THD) (DCPS)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
21	THD Test (Voltage)			
21.1	Put nominal load at the output of the system at nominal input AC voltage.	THD should not be more than 5 %		
21.2	With power analyzer measures the voltage THD & record.			

• **Burn in Test (DCPS)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
22	Burn in test (This test shall be conducted on only one sample)			
22.1	Load the system with the nominal load at nominal input AC Voltage at temperature of 50 degree for 8 hours.	There should not be any failure of components in the system.		
22.2	Let the system run for 8 hr under above condition.	If failure is observed, same component must be replaced and system should again go for burn in		
22.3	Observe the system during test. No failure of component / drop in output voltage should take place			

- **Psophometric Noise Test (On Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
23	Psophometric Noise test			
23.1	Set Input voltage at within limit			
23.2	Put 100% load at the output.			
23.3	Read psophometric noise at DC output by using psophometer.	shall be less than 2 mV		

- **Input AC Frequency Range Test (On Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
24	INPUT AC FREQUENCY RANGE TEST			
24.1	Adjust the input voltage to nominal and put the load less than module rating.			
24.2	Decrease input frequency to 48 Hz keeping load same. Measure Output voltage.	Output voltage shall be in $\pm 1\%$ reg. Limit. Output voltage shall be in $\pm 1\%$ reg. Limit		
24.3	Increase input frequency to 51.5 Hz keeping load same. Measure Output voltage.			

- **Rectifier Dynamic Response Test (On Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
25	Rectifier Dynamic Response			
25.1	Ensure input voltage is nominal within limit			
25.2	Adjust output voltage at 53.5V ± 0.5 Volt at full load.			
25.3	Vary the load from 90% to 10% and observe the change in output voltage. The output voltage should not vary more than 5% of set value and should recover within 50msec.	The o/p voltage should increase beyond $\pm 5\%$ and should recover within 50msec		
25.4	Vary the load from 10% to 90% and observe the change in output voltage. The output voltage should not vary more than 5% of set value and should recover within 50msec	The o/p voltage should increase beyond $\pm 5\%$ and should recover within 50msec		

- Output Short Circuit Test (On Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
26	Output short circuit test			
26.1	Switch Off the module and short circuit the output terminal by solid conductor/ bus bar. This is to avoid any flash over during the testing.			
26.2	Switch ON the module	O/p shall droop & recover after removing short circuit.		
26.3	The controller will remain OFF due to short circuit and zero output voltage. RED LED will glow on rectifier module.			
26.4	Switch OFF the module and remove short circuit.			
26.5	The module should get ON and output voltage should be normal to float voltage.			

- Hold-up Time Test (On Module)**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
27.	Hold up time test			
27.1	Switch on the module at nominal input at no load condition.			
27.2	Let module develop nominal output voltage 53.5V and Switch off the mains.			
27.3	Measure the time taken to have the output voltage dropped to 42 volts using oscilloscope to measure the time to reach 42 v from 53.5 +/- 0.5V steady state. It should not reach less than 20msec.	> 20 mSec		

- Source -1 & Source -2 Interlocking Test**

SR.NO.	TEST & PROCEDURE	SPECIFICATION	OBSERVATIONS	REMARK
27.	Source -1 & Source -2 Interlocking Test			
28.1	If any source (Source -1 & Source-2) out of two available in charger .	Rectifier is on & charge the Battery & take care the load.		

Remarks

Tested By

(Manufacturer/contractor)

Witnessed By

(POWERGRID)/Constituent

Date

Date

• **BURNIN TEST REPORT**

Shelter

Float Cum Boost Charger At full load.

S.no	Time	DC Amp	Room Ambient Temp	Rectifier Temp	Inside Cabinet Temp	O/P Voltage	Remark

Remarks

Tested By _____
(Manufacturer/contractor)

Witnessed By _____
(POWERGRID)/Constituent

Date _____

Date _____

Appendix E – Standard SAT Procedures

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SCOPE OF TESTING

1. SCOPE OF TESTING

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.

Phases of Site Acceptance Testing

1.1 Installation Testing

Site Installation Test

The field installation test will be performed for all equipment at each site.

The purpose of installation test is to ensure that all the equipments and cables conform to the BOQ; the installation of equipment and cabling conform to drawings, rack elevations; the appearance of equipment meets the requirements.

1. Installation tests on FO Transmission system (SDH Equipments) :

The installation tests on FO Transmission system (SDH Equipments) mainly include:

1.	Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling
2.	Station power supply input and equipment power supply (DC-DC converter) output voltage measurements
3.	Terminal transceiver performance testing (Tx power, Tx spectrum, receive signal strength, connector losses etc.)
4.	Service channel performance
5.	Craftsperson interface, alarm , 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.
11.	Multiplexer performance testing (MUX)

2. Installation Test on NMS system.

The installation tests on NMS system mainly includes:

1.	Physical inspection for conformance to drawings, rack elevations and appearance of equipment and cabling.
2.	Workstation (Remote & Local) hardware inventory, configuration and characteristics.
3.	Demonstration of proper operation of all hardware, including workstations (Remote & Local) peripherals.

3. Link Commissioning Testing

The link 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:

- Ping test
- Throughput test
- Latency test
- Packet Loss

10% of the total links (as chosen by PGCIL/Constituent, generally to cover links from all configurations used) shall be tested for 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. Integrated Testing

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

- Installation testing for NMS as per table given below
- Equipment configuration shall be checked to establish that it supports the channel routing.
- End to end testing of all individual voice circuits originating from PLCC, PABX or Phones and to establish proper interfacing with PLCC\PABX\Phones and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of quality of voice, call initiation and call termination processes.
- End-to-end testing of all individual Data Circuits originating from PLCC, RTU and SCADA Front Ends and to establish proper interfacing with PLCC\RTU\Front End and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of monitoring of BER/packet loss.
- Testing of NMS to demonstrate proper operation of all functions: Configuration Management, Performance Management, Fault, Management and Security management. All the standard features of the NMS shall be demonstrated for proper functioning.
- Demonstration of Protection switching including ring network whereas applicable and synchronization of equipment as per synchronization plan.

2. TEST PROCEDURES

Installation Testing

Following is the list of Installation and Link Commissioning tests to be conducted on the selected equipment during the Site acceptance testing: -

Sr. No	Test Description	Test Procedure No.
1	Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling	TPS-01
2	Station power supply input and equipment power supply (DC-DC converter) output voltage measurements	TPS-02
3	Terminal transceiver performance testing (Tx power, Tx spectrum, receive signal strength, connector losses etc.)	TPS-03
4	Services channel performance Test	TPS-04
5	Craftsperson interface, alarm and control functional performance	TPS-05
6	Rack and local alarms	TPS-06
7	Network management interface and supervision performance	TPS-07
8	Correct configuration, level setting & adjustments and termination of Input/ output interfaces	TPS-08
9	Proper establishment of Safety and signalling earthing system and resistance to ground to be checked.	TPS-09
10	Simulation of failure conditions and failover of protected components.	TPS-10
11.	Multiplexer performance testing (MUX)	TPS-11

Sr. No	Test Description	Test Procedure No.
12	Physical inspection for conformance to drawings, rack elevations and appearance of equipment and cabling of NMS System Workstation hardware inventory, configuration and characteristics of NMS System	TPS-12
13	Demonstration of proper operation of all hardware, including workstations peripherals of NMS System	TPS-13

Link Commissioning Testing

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:

- Ping test
- Throughput test
- Latency test
- Packet Loss

10% of the total links (Chosen by PGCIL, generally to cover links from all configurations used) shall be tested for 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.

Sr. No	Test Description	Test Procedure No.
1	Ethernet Channel Testing	TPS-14
2	Measurement of BER For SDH Link	TPS-15
3	Delay measurement	TPS-16

Integrated Testing

Following is the list of Integrated testing tests to be conducted on the selected equipment during the Site acceptance testing: -

Sr. No	Test Description	Test Procedure No.
1	End to End testing of Voice circuits	TPS-17
2	Testing of NMS Functionality	TPS-18
3	Protection Switching and Synchronization of Equipment	TPS-19
4	End to End Data Channel testing	TPS-20
5	Interfacing with Existing Communication System	TPS-21
6	Cyber Security and System Hardening	TPS-22
7	Testing of Integration of Supplied NMS with Regional UNMS	TPS-23

Test equipment

Prior to start of testing a consolidated list of all test equipment used for the Site Acceptance Testing shall be provided along with Make/Model numbers and valid Calibration Certificates.

Test Equipment/Instruments to be used during SAT:

E1 BER Tester

Ethernet Tester

Optical Power meter

Digital Multi meter

VF Tester

Earth Tester

Any other as per testing requirements

SAT Procedure

SAT-I

TPS-01 : Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling

Equipment Under Test : FO EQUIPMENTS (SDH) & TERMINATION EQUIPMENT SUB- SYSTEM

Test Parameter : Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling

Test Descriptions

To identify correctly given equipment and verify the hardware configuration, and make the equipment ready for software configuration and commissioning.

Test Procedure

Check the hardware configuration as per the configuration drawing.
Check the installation whether it is as per the site layout drawing.
Check the workmanship and accuracy of the installation and cabling.
Check for physical damage
Check the quantity as per approved BOQ.

Test Results Records

Test Parameters	Test Criteria	Test Results
Hardware configuration	Complies with the approved BOQ	Ok / Not Ok
Equipment layout	Equipment layout complies with the approved site layout drawing	Ok / Not Ok
Installation of Rack	Location should conform to layout drawing Fixed on floor by bolts	Ok / Not Ok
Installation of subrack and card	Subrack should be firmly fixed Cards should be inserted into the slots and locked	Ok / Not Ok
Cabling and terminator	DC Power cable colour	Ok / Not Ok

processing	to distinguish the polarity Cable lays smoothly, straight and tidily, without obvious twist and cross. Cable buffer arcs are consistent. Well colligated Stripped length of cable should be consistent. Good connection. Soldering point should be smooth and tight	
Physical damage	Any physical damage in equipment	Ok / Not Ok

Make the sketch drawing of actual telecom room layout if any variance.



Test Remarks

Equipment Under Test: _____**Test Date and Time:** _____**Site Name:** _____**Tested By** _____
(Manufacturer/Contractor)**Date** _____**Witnessed By** _____
(POWERGRID/Constituent)**Date** _____

TPS-02 : Station power supply input and equipment power supply(DC-DC converter) output voltage measurements

Equipment Under Test : FO EQUIPMENTS (SDH) & TERMINATION EQUIPMENT SUB- SYSTEM

Station power supply input and equipment power supply (DC-DC converter) output voltage measurements

Test Descriptions

To check the station Power Supply Voltage and the PDP output Voltage is with in the given range.

Test Procedure

- Check the i/p voltage at PDP.
- Check the o/p voltage at PDP.

Test Equipments Required

- Digital Multimeter

Test Results Records

Test Parameters	Test Criteria	Test Results
i/p Voltage at PDP	i/p voltage should be in the range of -42V to -55V	Ok / Not Ok
o/p Voltage at PDP	o/p voltage should be in the range of -42V to -55V	Ok / Not Ok

Test Remarks

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____
(Manufacturer/Contractor)

Date _____

Witnessed By _____
(POWERGRID/Constituent)

Date _____

TPS-03: Terminal transceiver performance testing (Tx power, Receive signal strength)

Equipment Under Test : FO EQUIPMENTS (SDH)

Test Parameter : Terminal transceiver performance testing (Tx power, Receive signal strength)

Test Descriptions

To check the Tx Power, Receiving Signal Strength is within the given range.

Test Procedure

Tx Power Measurement

Connect the output port (Tx) of the tested optical interface card to the optical power meter.
Turning the optical power meter to the specified wavelength.
Measure the Tx output power level in dBm.
Record the result showing on the optical power meter.

Receiving Signal Strength

Connect the output port (Rx) of the tested optical interface card to the optical power meter.
Turning the optical power meter to the specified wavelength.
Measure the Rx input power level in dBm.
Record the result showing on the optical power meter.

Test Equipments Required

Digital Optical Power Meter

Test Results Records

Tx Power Measurement:

Sr. No.	Node / Station	Sr.No.	Optical Interface Type (As per Approved BoQ)	Minimum (dBm)*	Maximum (dBm)*	Actual (dBm)
1						
2						

3						
4						

*As per Approved DRS

The measured optical output power should be within the limits as expressed in the table given above.

Receiving Signal Strength:

Sr. No.	Node / Station	Sr.No.	Module Type (As per Approved BoQ)	Receiver Signal Strength (dBm)*	Actual (dBm)
1					
2					
3					

The measured receiver power should be within the limits as expressed in the table given above.

* As per Approved DRS

Test Remarks

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____
(Manufacturer/Contractor)

Witnessed By _____
(POWERGRID/Constituent)

Date _____

Date _____

TPS-04: Services Channel performance Test

Equipment Under Test : FO EQUIPMENTS (SDH)
Test Parameter : Services Channel performance Test

Test Descriptions

To identify correct operation of the services channels used for the EOW phones.

Test Procedure

Connect the EOW phone to services channel.
Make a call from EOW phone to any station at other end (as per EOW numbering plan)
Check the quality of voice
Make a Omnibus call to different sites and check

Test Results Records

EOW telephone works well, conversation quality is
satisfactory. Selective calling Ok / Nok
Omnibus calling Ok / Nok

Test Remarks

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____
(Manufacturer/Contractor)

Date _____

Witnessed By _____
(POWERGRID/Constituent)

Date _____

TPS-05: Craftsperson interface, alarm and control functional performance

Equipment Under Test : FO EQUIPMENTS (SDH) & TERMINATION EQUIPMENT SUB- SYSTEM

Test Parameter : Craftsperson interface, alarm and control functional performance

Test Descriptions

- Functions of LCT:
- Change configuration
- Get alarm of any fault
- Get performance information
- To simulate defects by using the measurement equipment and LCT Performance monitoring
- Loopback

Test Equipments Required

- LCT
- BER Tester

Test Procedure

Connect the LCT to equipment under test through management port

- Ensure the equipment under test is working.
- Login the LCT.
- Change some configurations of the equipment,
- Get the fault information from the equipment.
- Get and browse the performance data of the equipment.
- Change configurations of another station indirectly, get its fault information and performance data.

Loop back test

- Apply a software loop on remote end E1 channel through LCT.
- Test the loop back with E1 tester on local end.
- Record the result there should be no error during this period.

Test Results Records

Test item	Ok / Not Ok
LCT is able to change the configuration of the connected NE.	
LCT can get fault information from the connected NE.	
LCT can get performance data from the connected NE.	
LCT is able to change the configuration of any NE in the network.	
LCT can get fault/alarm information from the unconnected NE.	
LCT can get performance data from the unconnected NE.	
Check for connection of NMS and LCT on the network at the same time	
Check for remote loopback, local loopback	
Check for cross connection	
Test the loop back with E1 tester on local end	
Record the result there should be no error during this period	

Alarms should be indicated on LCT and equipment when there is some failure. Equipment can be configured by LCT.

Performance data can be monitored on LCT.

Test Remarks

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____
 (Manufacturer/Contractor)

Date _____

Witnessed By _____
 (POWERGRID/Constituent)

Date _____

TPS-06: Rack and local alarms

Equipment Under Test : FO EQUIPMENTS (SDH) & TERMINATION EQUIPMENT SUB- SYSTEM

Test Parameter : Rack and local alarms: No alarms shall be present and all alarms shall be demonstrated to be functional

Test Descriptions

To check the Rack alarm and Local alarms are correctly reflects on Equipment and LCT.

Rack Alarm

- Urgent Alarm's
- Non Urgent alarm's
- No Alarm

Local Alarms in LCT FO System

- LOS on optical port
- LOS on 2Mbit/s Port
- Card failure by pulling out some cards

Termination Equipments

- AIS (RDI)
- E1_LOF
- E1_LOS

Test Equipments Required

- LCT

Test Procedure**Rack Alarm**

- Disconnect one of the optical Rx port. There should be Urgent alarm of SDH Sub-Rack.
- Restore the optical RX port, then there should be no alarm on SDH Sub-Rack
- Remove the 2Mbps cable from the DDF (Should be working 2M), there should be Urgent alarm on SDH Sub-Rack.
- Connect the 2Mbps cable on DDF, the Urgent alarm should be cleared.

Local alarm on LCT

For LOS/LOF on SDH System

- Connect the LCT to the SDH equipment
- Pull out the optical card of SDH Equipment, check the alarm display.
- Pull out the Tributary card of SDH equipment, check the alarm display.
- Pull out the E1 link from SDH and equipments, check the alarm display.
- Verify the SDH equipment is configurable by LCT.
- Verify the performance monitoring on LCT.

Test Results Records**Rack alarm**

S.No.	Test item (SDH)	Test result
1	Urgent Alarm appearing in fault conditions	Ok / Not Ok
2	Non Urgent Alarm appearing in fault conditions	Ok / Not Ok
3	No alarms (during Normal operation)	Ok / Not Ok

Local alarm on LCT

Alarms should be indicated on LCT and equipment when there is fault condition.

Test Remarks

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____
(Manufacturer/Contractor)

Date _____

Witnessed By _____
(POWERGRID/Constituent)

Date _____

TPS-07: Network management interface and supervision performance

Equipment Under Test : FO EQUIPMENTS (SDH) & TERMINATION EQUIPMENT SUB- SYSTEM

Test Parameter : Network management interface and supervision performance

Test Descriptions

To check the Communication between NMS and Gateway NE through management interface.

Test will be carried out to check the following parameters

- Configuration
- Loopback Testing
- Laser Testing
- Alarm reporting
- Performance monitoring

Test Equipments Required

- NMS System
- BER Tester

Test Procedure

- Login to the equipment through management port.
- STM-4/16/64 Line loop back in software
- E1 Loop back in software and check on BER tester
- Laser switch off/on through software
- Monitor optical power
- Display of alarms
- Performance event collection like ES, SES, BBE for 15Min

Test Results Records

- | | |
|--|---------------|
| • Verify all the above listed test procedures is working | :Ok / Not Ok |
| • can configure and supervise the whole network | : Ok / Not Ok |
| • Diagnostics is possible on NMS | : Ok / Not Ok |
| • Alarms should be displayed if there is any failure | :Ok / Not Ok |

Test Remarks

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____ : _____
(Manufacturer/Contractor)

Date _____ : _____

Witnessed By _____ : _____
(POWERGRID/Constituent)

Date _____ : _____

TPS-08: Correct configuration, level setting & adjustments and termination of Input/ output interfaces

Equipment Under Test : FO EQUIPMENTS (SDH)

Test Parameter : Correct configuration, level setting & adjustments and termination of Input/ output interfaces

1. Test Descriptions

To check the Equipment configuration is according to approved Configuration plan. To check the Input/output termination of Optical and Electrical cables are according to approved scheme

2. Test Equipments Required

- LCT
- Approved Optical and 2Mbps distribution Diagrams

3. Test Procedure

- Connect the LCT to the SDH equipment through f interface.
- Ensure the SDH equipment is working.
- Login the LCT.
- Check the equipment configuration
- Check the Termination of Input and Output cables.
- Check different level settings in the SDH Equipment.

Test Results Records

Configuration, level setting adjustment and termination should comply with the approved documents : Ok / Not Ok

Test Remarks

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By : _____
(Manufacturer/Contractor)

Date : _____

Witnessed By : _____
(POWERGRID/Constituent)

Date : _____

TPS-09: Proper establishment of Safety and signalling earthing system and resistance to ground to be checked.

Equipment Under Test : **FO EQUIPMENTS (SDH) SYSTEM**
Test Parameters : Proper establishment of Safety and signalling earthing system and resistance to ground to be checked

HT/LT Meter Box

1. Test Descriptions

- To check the Earthing cable Terminations
- To check the Earth resistance.

2. Test Equipments Required

- Clamp Earth Tester

3. Test Procedure

- Check that all the earthing connection are terminated on the earth bus bar are tightened
- All equipments are connected with Earth bus bar
- Colour of the Earth cable is yellow-green or green
- Measure the Earth resistance Clamp Earth Tester
- Check the wrist strap is available at each station

4. Test Results Records

- | | | |
|--|---|-------------|
| • Earthing connections are properly done | : | Ok / Not Ok |
| • Earth resistance measured is less than 10 Ω | : | Ok/ Not Ok |

Test Remarks

Equipment Under Test: _____ **Test Date and Time:** _____ **Site Name:** _____

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____ :

(Manufacturer/Contractor)

Date _____ :

Witnessed By _____ :

(POWERGRID/Constituent)

Date _____ :

TPS-10: Simulation of failure conditions and failover of protected components.

Equipment Under Test : FO EQUIPMENTS (SDH)

Test Parameter : Simulation of failure conditions and failover of protected components.

1. Test Descriptions

To check the Failure conditions and protection components for following cards :

Control Cards
Optical Cards

2. Test Equipments Required

BER Tester

3. Test Procedure**Control Card**

- Control cards work on 1+1 protection. 1 protection card for 1 workingcard.
- Make the equipment work on normal status.
- Pull out the working Control card.
- The protection Control card should take over, and traffic should be restored.

Optical Card

- Optical cards work on 1+1 protection. 1 protection card for 1 workingcard.
- Make the equipment work on normal status.
- Pull out the working Optical card.
- The protection STM-4/16/64 card should take over, and traffic should be restored.

For both the cards make software loop on any E1 and put in the BER testing mode. Check that during both the test the traffic is restored automatically.

4. Test Results Records

Traffic restored automatically even if one
Control card and Optical card terms Faulty

: Ok / Not Ok

Test Remarks

Equipment Under Test: _____**Test Date and Time:** _____**Site Name:** _____**Tested By** _____
(Manufacturer/Contractor)**Date** _____**Witnessed By** _____
(POWERGRID/Constituent)**Date** _____

TPS-11: Multiplexer performance testing (MUX)

Equipment Under Test : TERMINATION EQUIPMENT SUB-SYSTEM

Test Parameter : Multiplexer performance testing (MUX)

Test Descriptions

To check the multiplexing and de-multiplexing is properly happening in MUX Equipment.

Test Equipments Required

- BER Tester
- VF Tester

Test Procedure

Loop back the main 2mbps transmission Signal of E1 card. Connect the BER Tester to any data channel of same MUX Check the loop back

Follow the following procedure for different data channels

For 4w VF E&M cards

- Connect the VF Tester to channel under test
- Send the frequency of 1 Khz, Level 4 db thro VF Tester
- Measure the return frequency and level
- Results should be same with $\pm 5\%$ variation

For Async. Data channel card

- Connect the BER tester to channel under test
- Measure the BER for 5 min.
- There should be no error during this period.

Test Results Records

Multiplexing and Demultiplexing is
happening properly in MUX equipment : Ok / Not Ok

Test Remarks

Equipment Under Test: _____**Test Date and Time:** _____**Site Name:** _____**Tested By** _____ : _____
(Manufacturer/Contractor)**Date** _____ : _____**Witnessed By** _____ : _____
(POWERGRID/Constituent)**Date** _____ : _____

TPS-12: Physical inspection for conformance to drawings, rack elevations and appearance of equipment and cabling of NMS System Workstation hardware inventory, configuration and characteristics of NMS System

Equipment Under Test: NMS System

(incl. all associated HW & SW supplied with the complete system)

Test Parameter : Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling Hardware & Software Inventory,
Configuration and characteristic

1. Test Descriptions

To identify correctly given equipment and verify the hardware configuration, and make the equipment ready for software configuration and commissioning.

2. Test Procedure

Check the hardware configuration as per the configuration drawing.
Check the installation whether it is as per the site layout drawing.
Check the workmanship and accuracy of the installation and cabling.
Check for physical damage
Check the Hardware & software inventory as per approved DRS & BOQ documents.

3. Test Results Records

Make the sketch drawing of actual NMS room layout if any variance.



No Physical Damage

Hardware & Software Inventory as per approved DRS & BOQ

Hardware Configuration as per approved DRS & BoQ

: Ok / Not Ok

:Ok /Not Ok

: Ok / Not Ok

Test Remarks

Equipment Under Test: _____**Test Date and Time:** _____**Site Name:** _____**Tested By** _____ : _____
(Manufacturer/Contractor)**Date** _____ : _____**Witnessed By** _____ : _____
(POWERGRID/Constituent)**Date** _____ : _____

TPS-13: Demonstration of proper operation of all hardware, including workstations peripherals of NMS System

Equipment Under Test: *NMS System*

Test Parameter : *Demonstration of proper operation of all hardware, including workstations peripherals of NMS System*

1. Test Descriptions

To identify all the hardware including Workstations and its peripheral devices operates correctly.

2. Test Procedure

- Check the Workstations are connected with all the peripheral devices as per the BOQ
- Power On the Workstation and devices.
- Check the operation of all devices

3. Test Results Records

All hardware associated with NMS are working properly : Ok / Not Ok

4. Test Remarks

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By : _____
(Manufacturer/Contractor)

Date : _____

Witnessed By : _____
(POWERGRID/Constituent)

Date : _____

*SAT-II***TPS-14: Ethernet Channel Testing (SDH)**

Equipment Under Test : *SDH Equipment along with Ethernet Interface Unit*

Test Parameter : *Throughput, Latency, Packet Loss Measurement and Ping test of Ethernet Interface*

1. TEST DESCRIPTION

To verify that Ethernet card is in compliance with the specifications of IEEE 802.3/RFC-2544 standards.

2. TEST EQUIPMENT

- Ethernet Analyser
- Local Craft Terminal (LCT)
- Low loss optical patch cord & LAN cable

3. TEST PROCEDURE

- Connect the SDH nodes Node-A & B with LCT.
- At Node-A and B, Configure WAN bandwidth of the Ethernet interface as per channel plan.
- Connect the Ethernet Analyser to LAN port of SDH equipment with UTP cable. Set the LAN port to Auto Negotiate mode.
- At Node-B, set the Ethernet Analyser in Layer-2 loop back mode.
- At Node-A, start the RFC 2544 test in the Ethernet analyser, set the test parameters for throughput, latency and packet loss test, set the frame length to 1518 bytes.
- Measure the throughput, latency & packet loss.
- All links will be tested for 1 min.

4. Test Result Record

a) Throughput

Anticipated result		Actual result
Bandwidth	Throughput	
2Mbps	As per applicable RFC-2544 Standard	
6 Mbps	As per applicable RFC-2544 Standard	
10 Mbps	As per applicable RFC-2544 Standard	
100 Mbps	As per applicable RFC-2544 Standard	
1 Gbps	As per applicable RFC-2544 Standard	

The throughput of the Ethernet card should not be less than the bandwidth configured.

b) Latency

Anticipated result		Actual result
Bandwidth	Latency	
2 Mbps	As per applicable RFC-2544 Standard	
6 Mbps	As per applicable RFC-2544 Standard	
10 Mbps	As per applicable RFC-2544 Standard	
100 Mbps	As per applicable RFC-2544 Standard	
1 Gbps	As per applicable RFC-2544 Standard	

The actual latency should be less than the value tolerated in the worst case.

c) Packet Loss

Anticipated result		Actual result
Bandwidth	Packet loss ratio	
2 Mbps	As per applicable RFC-2544 Standard	
6 Mbps	As per applicable RFC-2544 Standard	
10 Mbps	As per applicable RFC-2544 Standard	

100 Mbps	As per applicable RFC-2544 Standard	
1 Gbps	As per applicable RFC-2544 Standard	

The actual frame loss ratio should be less than the value tolerated in the worst case.

d) Ping Test

Connect the laptop to Ethernet port under test at both the nodes. Run the ping test

Test Result:

Both laptops ping each other thro Ethernet Channel : Ok / Not Ok

There should be No Packet Loss : Ok / Not Ok

Test Remarks

Equipment Under Test: _____ **Test Date and Time:** _____ **Site Name:**

Tested By : _____ **Witnessed By** : _____
(Manufacturer/Contractor) (POWERGRID/Constituent)

Date : _____ **Date** : _____

TPS-15: Measurement of BER For SDH Link**Equipment Under Test : FO EQUIPMENTS (SDH)**

Test Parameter : Bit Error measurements

1. Test Descriptions

To check the BER Measurements for End to End links for SDH Equipment.

2. Test Equipments Required

- LCT
- BER Tester

Test Procedure

- Configure an E1 channel from remote end to local end.
- Apply a software loop on remote end E1 channel through LCT.
- Test the loop back with E1 tester on local end for 1 hours/12 hours as required @10% of the link will be test for 12 hours.

Note: - 1. All BER have to be done for only 1 hour except for 10% of the link (12 hours).

3. Test Results Records

Test item	Ok / Not Ok
The test results recorded there should be no error during this period as per ITU-T recommendation G.821	

4. Test Remarks

Equipment Under Test: _____**Test Date and Time:** _____**Site Name:** _____**Tested By** : _____
(Manufacturer/Contractor)**Date** : _____**Witnessed By** : _____
(POWERGRID/Constituent)**Date** : _____

TPS-16: Delay measurement**Equipment Under Test : FO EQUIPMENTS****(SDH) Test Parameter : Delay measurements****1. Test Descriptions**

To Measure the transmission delay in the path of the network for SDH Equipment.

2. Test Equipments Required

- LCT
- BER Tester

3. Test Procedure

- Configure an E1 channel from remote end to local end.
- Apply a software loop on remote end E1 channel through LCT.
- Test the loop back with E1 tester on local end.
- Once there is no alarm in tester, open the delay measurement and simulate test.
- Total delay in the path is measured and displayed.

4. Test Results Records

Test item	Measured value	Ok / Not Ok
Delay measurement should not be more than 50 msec		

5. Test Remarks

Equipment Under Test: _____**Test Date and Time:** _____**Site Name:** _____**Tested By** _____
(Manufacturer/Contractor)**Date** _____**Witnessed By** _____
(POWERGRID/Constituent)**Date** _____

SAT-III**TPS-17: End to End testing of Voice circuits**

Equipment Under Test : **FO EQUIPMENTS (SDH) & TERMINATION EQUIPMENT SUB-SYSTEM**
Test Parameter : End to End testing of Voice circuits

1. Test Descriptions

To check the individual voice circuits originating from PLCC, PABX or phones are working properly.

2. Test Procedure

- a. Make a phone call to all configured voice circuits from the station under test.
- b. Check the call initiation, Quality of Voice and Call termination is happening properly.

3. Test Results Records

Call initiation is proper	: Ok / Not Ok
Quality of Voice is good	: Ok / Not Ok
Call Termination is proper	: Ok / Not Ok

4. Test Remarks

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By : _____
(Manufacturer/Contractor)

Date : _____

Witnessed By : _____
(POWERGRID/Constituent)

Date : _____

TPS-18: Testing of NMS Functionality**Equipment Under Test : FO EQUIPMENTS(SDH)****Test Parameter : End to End testing of Voice and Data circuits of Existing System****1. Test Descriptions**

To check all Data and Voice circuits originating from RTU, PLCC, PABX or phones are working properly.

2. Test Procedure

- Make a phone call to Existing configured voice circuits from the station under test.
- Check the call initiation, Quality of Voice and Call termination is happening properly.
- Check the Existing Data are reporting to corresponding Sub-LDC and SLDC.

3. Test Results Records

Call initiation is proper	: Ok / Not Ok
Quality of Voice is good	: Ok / Not Ok
Call Termination is proper	: Ok / Not Ok
Data reporting is proper	: Ok / Not Ok

4. Test Remarks

Equipment Under Test: _____**Test Date and Time:** _____**Site Name:** _____**Tested By :** _____
(Manufacturer/Contractor)**Date :** _____**Witnessed By :** _____
(POWERGRID/Constituent)**Date :** _____

TPS-19: Protection Switching and Synchronization of Equipment

Equipment Under Test : NMS System

Test Parameter : Demonstration of the standard features of the NMS System

1. Test Descriptions

To verify that the entire standard features of NMS System are working properly as per technical specifications requirements.

2. Test Parameters

1. Configuration Management
2. Performance Management
3. Fault Management
4. Security Management

3. Test Procedure**CONFIGURATION MANAGEMENT**

- Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.
- Ensure the SDH equipment is working.
- Login NMS as user of advanced level.
- Check the NMS whether it can establish and maintain the network topology.
- Check the NMS whether it provides the tools for planning, establishing and changing the static equipment configuration, this item can be conducted by changing some parameters & cross connection of the SDH equipment.
- Check the NMS whether it provide verification testing to support new equipment installation, this can be tested by adding a new NE.
- For creating the cross connection, establish the cross connection between any of the two ports in the same or different card.

FAULT MANAGEMENT

- Display Equipment Status, Display graphical, topological & Map type and Display the use of colour on links and Nodes.
- Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.

- Ensure the SDH equipment is working.
- Login NMS as user of advanced level.
- Generate the various alarms; check the NMS for relevant alarm status.
- For example, pull out one card from SDH sub-rack, check the NMS for alarm of that fault.
- Insert the card, and then the alarm disappears.
- Check the alarm history, which includes all alarm events.
- Check the capability of alarm retrieval filter. Change the setting and retrieve.
- Check the colors for different level alarm events.
- Print alarm report.

SECURITY MANAGEMENT

- Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.
- Ensure the SDH equipment is working.
- Login as Administrator
- Add a user and define the user profile.
- Login as user and verify that user is able to perform various tasks as per profile.

PERFORMANCE MANAGEMENT

- Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.
- Ensure the SDH equipment is working.
- Configure a E1 interface and run performance management for specified interval.
- Monitor events & thresholds.
- Generate reports on daily, weekly, monthly and yearly basis containing system statistics.

LCT FUNCTIONALITY TEST

- Connect the LCT to the SDH equipment through LCT interface.
 - Ensure the SDH equipment is working.
4. Login the LCT.
 5. Change some configurations of the equipment.
 6. Get the fault information from the SDH equipment.

4. Test Result Record

Sr. No.	Test Description	Results (OK / Not OK)
1.0	CONFIGURATION MANAGEMENT	
1.1	Capability to establish and maintain the backbone topology.	
1.2	Capability to provide graphical maps depicting the sub-rack configurations.	
1.3	Capability to plan, establish and change the static equipment configuration.	
1.4	Verification testing to support new equipment installation.	
1.5	Cross-connect capability between any of the two ports in same or different card.	
2.0	FAULT MANAGEMENT	
2.1	After generating an alarm, it is automatically displayed.	
2.2	Alarm has been shown automatically when there is card failure.	
2.3	NMS can maintain an alarm summary of unacknowledged current alarm.	
2.4	NMS can maintain an alarm history.	
2.5	Operator can acknowledge and clear alarms.	
2.6	Alarm retrieval filter is available.	
2.7	Alarms can be classified and configured as critical alarms, major alarms and minor alarms, in different colors.	
2.8	Alarm reports can be extracted.	
3.0	SECURITY MANAGEMENT	
3.1	Security Management functionality allows user addition and user profile definition.	
4.3	Monitor events & thresholds.	
4.4	Generate reports on daily, weekly, monthly and yearly basis containing system statistics.	
5.0	LCT Functionality Test	
5.1	LCT can get fault information from the connected SDH node.	
5.2	LCT is able to change the configuration of the connected SDH node.	
5.3	LCT is able to change the configuration of connected SDH node.	

5. Test Remarks

Equipment Under Test: _____**Test Date and Time:** _____**Site Name:** _____**Tested By** _____
(Manufacturer/Contractor)**Date** _____**Witnessed By** _____
(POWERGRID/Constituent)**Date** _____

TPS-20: End to End Data Channel testing

Equipment Under Test :TERMINATION EQUIPMENT SUB-SYSTEM

Test Parameter : End to End Data Channel testing

1. Test Descriptions

To check the channel performance of interface cards as below :

- FXO/FXS voice cards
- VF E&M 4w Cards
- Async. Data card

2. Test Equipments Required

- BER Tester
- Telephone Instrument
- VF Tester

3. Test Procedure**For FXO/FXS Voice cards**

- Connect the Telephone Instrument at station under test and any remote station
- Make a telephone call to remote station.
- Check the quality of Voice.

For 4 w VF E&M cards

- Connect the VF Tester to channel under test
- Give the loop back at remote station
- Send the frequency of 1 Khz, Level 4 db thro VF Tester
- Measure the return frequency and level
- Results should be same with $\pm 5\%$ variation
- Perform the test on 30% of all channels

For Async. Data channel card

- Connect the BER tester to channel under test
- Give the loop back at remote end of the channel
- Measure the BER for 5 min.
- There should be no error during this period.
- Perform the test on 30% of all channels

7. Test Result Records

For FXO/FXS cards

Card Serial No. : _____

Call can be established between two stations : Ok / Not Ok
Voice Quality is Good : Ok / Not Ok

For 4w VF E&M Cards

Card Serial No. : _____

Channel No	Tx Frequency (KHz) / Level (db)	Rx Frequency (KHz) / Level (db)	Test Status
1	1 KHz / 4 db		Ok / Not Ok
2	1 KHz / 4 db		Ok / Not OK
3	1 KHz / 4 db		Ok / Not OK
4	1 KHz / 4 db		Ok / Not OK

Card Serial No. : _____

Channel No	Tx Frequency (KHz) / Level (db)	Rx Frequency (KHz) / Level (db)	Test Status
1	1 KHz / 4 db		Ok / Not OK
2	1 KHz / 4 db		Ok / Not OK
3	1 KHz / 4 db		Ok / Not OK
4	1 KHz / 4 db		Ok / Not OK

For Async. data channel card

Card Serial No. : _____

Channel No.	BER	Test Status
1		Ok / Not Ok
2		Ok / Not Ok
3		Ok / Not Ok
4		Ok / Not Ok

Card Serial No. : _____

Channel No.	BER	Test Status
1		Ok / Not Ok
2		Ok / Not Ok
3		Ok / Not Ok
4		Ok / Not Ok

8. Test Remarks

Equipment Under Test: _____**Test Date and Time:** _____**Site Name:** _____**Tested By** _____
(Manufacturer/Contractor)**Date** _____**Witnessed By** _____
(POWERGRID/Constituent)**Date** _____

TPS-21: Interfacing with Existing Communication System

Equipment Under Test : FO EQUIPMENTS (SDH) & TERMINATION EQUIPMENT SUB-SYSTEM

Test Parameter : Protection Switching and Synchronization of Equipment

Pre-requisite : All the synchronization clock & associated items installed as per approved Synchronization plan

1. Test Descriptions

- To check the Failure conditions and protection switching is working properly for all protections on Control cards, Optical Cards (protection switching for ring network wherever applicable).
- To check the Failure conditions and protection switching is working properly for protections of Optical Cards/interfaces in ring network wherever applicable.
- To check the Synchronization of the Equipment is as per the approved Sync. Plan.

2. Test Equipments Required

- BER Tester

3. Test Procedure***Control Card***

- Control cards work on 1+1 protection. 1 protection card for 1 workingcard.
- Make the equipment work on normal status.
- Pull out the working Control card.
- The protection Control card should take over, and traffic should be restored.

Optical Card

- Optical cards work on 1+1 protection. 1 protection card for 1 workingcard.
- Make the equipment work on normal status.
- Pull out the working Optical card.
- The protection Optical card should take over, and traffic should be restored.

For both the cards make software loop on any data/E1 channel at remote end and put in the BER testing mode. Check that during both the test the traffic is restored automatically.

Synchronization

- Check the Synchronization Cabling/connection is as per approved Sync. Plan.
- Check the sync. Priority switching on protected path through LCT/NMS.

4. Test Results Records

- Traffic restored automatically even if one
 - Control and Optical card terms Faulty : Ok / Not Ok
- No Clock failure alarm during the protection switching : Ok / Not Ok
- Check Synchronization cabling/connection/Configuration
 - is as per the approved Synchronization Plan : Ok / Not Ok
- Check the sync. Priority switching on protected Path through LCT/NMS : Ok / Not

Test Remarks

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____ :

(Manufacturer/Contractor)

Date _____ :

Witnessed By _____ :

(POWERGRID/Constituent)

Date _____ :

TPS-21: Cyber Security and System Hardening Checklist

SDH Equipment Checklist (As applicable)

Sl. No.	Verification Item	Status (Y/N)	Remarks
1	FAT-approved equipment installed at site		
2	Firmware version matches FAT-approved version		
3	Default passwords changed		
4	Authorized accounts only configured		
5	RBAC configured and verified		
6	Password policy implemented		
7	Account lockout operational		
8	Session timeout operational		
9	SSH enabled		
10	HTTPS enabled		
11	Telnet disabled		
12	HTTP disabled		
13	SNMPv3 configured		
14	SNMPv1/v2 disabled		
15	Access restricted through ACL/IP filters		
16	Unused services disabled		
17	Unused interfaces disabled		
18	Security banner configured		
19	Login logging verified		
20	Configuration change logging verified		
21	Syslog integration verified		
22	NTP synchronization verified		
23	Alarm reporting to NMS verified		
24	Configuration backup completed		
25	Configuration restoration demonstrated		
26	Equipment rack/cabinet locked		
27	Console port protected		

Optical Amplifier Checklist (As applicable)

Sl. No.	Verification Item	Status (Y/N)	Remarks
1	FAT-approved equipment installed		
2	Firmware/software version verified		
3	Default credentials changed		
4	Authorized users configured		
5	SSH/HTTPS enabled (where applicable)		
6	Telnet disabled		
7	HTTP disabled		
8	SNMPv3 configured		
9	Management access restricted to authorized IPs		
10	Gain setting access restricted		
11	Optical power setting access restricted		
12	Configuration backup completed		
13	Optical power alarms verified		
14	Temperature alarms verified		
15	Power supply alarms verified		
16	Equipment failure alarms verified		
17	Alarm reporting to NMS verified		
18	Equipment cabinet locked		
19	Fiber access protected		

NMS Checklist (As applicable)

Sl. No.	Verification Item	Status (Y/N)	Remarks
1	NMS installed within approved OT network		
2	Internet connectivity disabled/restricted as approved		
3	Corporate IT connectivity implemented as approved architecture		
4	Supported OS version installed		
5	Latest approved patches applied		
6	Unnecessary services disabled		
7	Unnecessary user accounts removed		
8	Host firewall enabled		
9	Individual user accounts configured		
10	RBAC implemented		
11	Password complexity policy enforced		
12	Account lockout configured		
13	Session timeout configured		
14	MFA enabled where mandated		
15	HTTPS enabled		
16	SSH enabled		
17	Telnet disabled		
18	HTTP disabled		
19	SNMPv3 configured		
20	Firewall rules verified		
21	Access restricted to approved workstations		
22	Audit logging enabled		
23	User activity logging enabled		
24	Configuration change logging enabled		
25	Syslog forwarding verified		
26	NTP synchronization verified		
27	Database backup verified		
28	Configuration backup verified		

29	Restoration process demonstrated		
30	Vulnerability assessment completed		
31	Open ports reviewed and approved		
32	No critical/high vulnerabilities outstanding		

Common SAT Cyber Security Verification (As applicable)

Sl. No.	Verification Item	Status (Y/N)	Remarks
1	As-built network diagram submitted		
2	Asset inventory submitted		
3	Firmware/software inventory submitted		
4	User account list submitted		
5	SBOM, HBOM as per Cert-IN guidelines submitted (Format Attached in Appendix J)		
6	Hardening report submitted		
7	Vulnerability assessment compliance completed and report submitted (as applicable)		
8	Backup and restoration procedure submitted		
9	OEM security advisory mechanism submitted		
10	Management network segregated from operational traffic		
11	NMS segregated from Corporate IT network		
12	Internet isolation implemented as approved		
13	Time synchronization verified across all devices		
14	All FAT security observations closed		
15	Cyber security compliance verified before SAT closure		

Note: Other networking devices(Switches, routers etc.) supplied by contractor under the project shall be tested as per cyber security policy and system hardening guidelines specified in the this technical Specification and industry best practices. The checklist for the same shall be submitted by contractor for approval during detail engineering.

TPS-22 Testing of Integration of Supplied NMS with Regional UNMS.

Equipment Under Test

Supplied NMS integrated with Regional UNMS

Test Parameter

End-to-End interoperability between supplied NMS and Regional Unified Network Management System (UNMS).

Test Description

This test demonstrates successful integration of the supplied NMS with the deployed Regional UNMS and validates exchange of alarms, topology, inventory, and performance.

Test Equipment

1. Supplied NMS
2. SDH Network Elements
3. Test Workstation

Test Setup

NEs → NMS → Regional UNMS/OSS

Test Procedure

A. Connectivity Verification

1. Verify IP connectivity between NMS and UNMS.
2. Verify NBI service status.
3. Verify authentication credentials.
4. Verify time synchronization (NTP).

Expected Result

Stable communication established.

B. Alarm Integration Test

1. Generate LOS alarm.
2. Generate card failure alarm.
3. Generate power supply alarm.
4. Verify alarm visibility at:
 - NE
 - NMS

- Regional UNMS
5. Clear alarms and verify updates.

Expected Result

Alarms reflected at all layers.

C. Topology Integration Test

1. Verify NE discovery.
2. Verify topology synchronization.
3. Verify card inventory synchronization.

Expected Result

Regional UNMS displays complete topology.

D. Performance Data Integration

1. Enable PM collection.
2. Generate performance report.

Expected Result

PM data available in UNMS.

Test Result Record

Sr. No	Test Description	Result
1	Connectivity Test	OK / Not OK
2	Alarm Synchronization	OK / Not OK
3	Inventory Synchronization	OK / Not OK
4	Topology Synchronization	OK / Not OK
5	Performance Data Synchronization	OK / Not OK

Acceptance Criteria

1. All alarms generated in field devices shall be visible in Regional UNMS.
2. Topology and inventory shall match NMS records.
3. Performance reports shall be accessible from Regional UNMS.

SITE ACCEPTANCE TEST PROCEDURE FOR DCPS

1.	Test Date	
2.	Customer Name	
3.	Site Name	
4.	Equipment Manufacturer	
5.	Equipment Sr. No.	
6.	Equipment Model No.	
7.	Individual Module Capacity	
8.	No. of Modules Available	

<u>SUMMARY OF TESTS ON DCPS SYSTEM</u>			
<u>SL No</u>	<u>TEST</u>	<u>PASS/ FAIL</u>	<u>REMARKS</u>
	<u>Tests on DCPS System</u>		
<u>01</u>	<u>Mechanical & Visual Check Tests</u>		
<u>02</u>	<u>DCPS Switch ON test</u>		
<u>03</u>	<u>Rectifier Fail Alarm Test</u>		
<u>04</u>	<u>Total Output Power Tests</u>		
<u>05</u>	<u>Hot Plug in Test</u>		
<u>06</u>	<u>Calibration & Parameter settings Test</u>		
<u>07</u>	<u>Automatic Float cum Boost Charge Mode Change Over Test</u>		
<u>08</u>	<u>Battery Path Current Limiting Test</u>		
<u>09</u>	<u>Battery Charging & Full Load Current</u>		

SITE ACCEPTANCE TEST PROCEDURE FOR DCPS

Sl. No.	TEST & PROCEDURE	SPECIFICATION	OBSERVATION	REMARKS
1	MECHANICAL & VISUAL CHECK TEST			
1.1	Visual Inspection of Rack Mechanical, Rack should have good finish all Nut & Bolts Must be secured.	Good Finish & Secured		
1.2	Ensure all PCBs in the rack are secured properly in cabinet.	Good workmanship		
1.3	All electrical/ electronic components are secured properly in cabinet.	Good workmanship		
1.4	Ensure all cabling is neat and secured tightened. Proper lugs with heat shrinkable sleeves have been used. Ensure Controller Cables are properly Inserted. Check screening and labeling.	Good workmanship		
2	Switch On Test			
2.1	Make all external connections to the system including, Input mains Supply, Dummy Load.			
2.2	Connect the Site Battery Bank to DCPS.			
2.3	Check Input AC supply at DCPS Input MCB with Multimeter &.turn on the system's main MCB	System should turn ON & display DC o/p voltage 54V+/- 1% V		
2.4	System shall turn on Alarm Module shall also turn ON. Controller Display shall read the System O/P voltage.			

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____
 (Manufacturer/Contractor)

Date _____
 Date

Witnessed By _____
 (POWERGRID/Constituent)

Date _____
 :

SITE ACCEPTANCE TEST PROCEDURE FOR DCPS

Sl. No.	TEST & PROCEDURE	SPECIFICATION	OBSERVATION	REMARKS
3	Rectifier Fail Alarm Test			
3.1	Switch Off Input MCB of one Rectifier & Verify that Rectifier fail Alarm will Appear on respective PFC Terminal (45) & Controller Display.	Rectifier Fail LED shall glow		
3.2	Switch On Rectifier MCB & Verify that Alarm will get reset.			
4	Total output Power Test			
4.1	Insert all the modules and turn on all Input AC MCBs of SMPS Modules.			
4.2	Put External Load on DC bus so as equipment is loaded at its 50% capacity			
4.4	Adjust float voltage to 54.5 Volts			
4.5	Increase the load to 100% capacity and note down the DC voltage & Current	Based on DCPS Output Current rating		
4.5	Note Down the Total Current (Load +Battery) & verify that O/P Voltage of PP shall be Constant.	System output power will be based on system Module Rating i.e. n x (3.1KW/1.4KW)		
4.6	Disconnect the external Load Bank			

Equipment Under Test: _____**Test Date and Time:** _____**Site Name:** _____**Tested By** _____ :

(Manufacturer/Contractor)

Witnessed By _____ :

(POWERGRID/Constituent)

Date _____ :**Date** _____ :

SITE ACCEPTANCE TEST PROCEDURE FOR DCPS

Sl. No.	TEST & PROCEDURE	SPECIFICATION	OBSERVATION	REMARKS
5	HOT PLUG IN TEST			
5.1	Switch on all the rectifier and pull out rectifier no. 1 in live condition again			
5.2	Plug in inside rack. The module shall become alive.			
5.3	No damage/ drift shall occur.			
6	Calibration Test			
6.1	DC Voltage: Note the DC voltage displayed on Alarm Module, Measure DC output Voltage with a standard Digital multimeter			
6.2	Calculate the accuracy	$\pm 1.5\%$		
6.3	Rectifier Current: Put 50% load on the Load terminals, Note the Rectifier current displayed on PC, Measure current through Standard shunt and multimeter			
6.4	Calculate the accuracy.	$\pm 1.5\%$		
6.5	Battery Current: Put 50% load on the Battery terminals, switch OFF SMPS AC Input MCB, measure the battery current reading on controller through standard shunt & multimeter.			
6.6	Calculate the accuracy.	$\pm 1.5\%$		

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____
 (Manufacturer/Contractor)

Witnessed By _____
 (POWERGRID/Constituent)

Date _____

Date _____

SITE ACCEPTANCE TEST PROCEDURE FOR DCPS

Sl. No.	TEST & PROCEDURE	SPECIFICATION	OBSERVATION	REMARKS
7	Automatic Mode change over Float to charge (Boost) mode			
7.1	Connect external load bank to DCPS output.			
7.2	Switch off the SMPS AC Input MCB & Switch on Load.			
7.3	Reset the automatic boost change over threshold setting at 5Ah			
7.4	Discharge the battery for sufficient time, based of battery capacity & threshold setting. level.			
7.5	Switch On SMPS Input MCB & Verify the all the modules are working fine.			
7.6	Observe the charging mode.	Should be the boost mode		
7.7	Boost mode shall be change to float mode subsequently.			
8	Battery path Current Limiting Test			
8.1	Verify the battery path current limit (Charge current limit in controller) & reset it at 20 Amps through controller keypad note down the power plant O/P voltage.	Set value will be 10% of battery rating, shall not exceed the set		
8.2	Connect the external load (according to DCPS rated output capacity/module availability) on DCPS load terminals.			

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____ :

 (Manufacturer/Contractor)

Witnessed By _____ :

 (POWERGRID/Constituent)

Date _____ :

Date _____ :

SITE ACCEPTANCE TEST PROCEDURE FOR DCPS

Sl. No.	TEST & PROCEDURE	SPECIFICATI ON	OBSERVATI ON	REMARK S
8.3	Switch off DCPS INPUT Main MCB & Snitch on load MCB.			
8.4	Discharge DCPS batteries through External load for 30 minutes (discharge time may vary based on available load at site)			
8.5	Switch ON the DCPS Input Mains MCB & Measure the battery path current. Observe that power plant battery path current will be constant, Note current at this point.	Maximum current at battery path should not cross 20A (Set value)		
8.6	Restore the original battery path current limit through controller			
8.7	Disconnect external load from DCPS.			
9	Battery Charging & Full Load Current			
9.1	Put Maximum specified load current on the load terminal/bus bar			
9.2	Now slightly increase the battery path current so as the rectifier modules are on	System overload alarm shall		
9.3	Measure the battery path current & disconnect external load bank.			

Tested By _____
 (Manufacturer/Contractor)

Witnessed By _____
 (POWERGRID/Constituent)

Date _____

Date _____

SITE ACCEPTANCE TEST PROCEDURE FOR BATTERY

SAT conducted at : _____

The purpose of this document is to confirm the requirements of the supplied VRLA Battery for 48V DCPS/Charger at site in accordance to technical specifications & approved DRS/Drawings.

The following tests are carried out at site for the purpose of verifying the acceptability of the supplied VRLA batteries.

S.No	Test	Requirement
1	Visual Inspection	a) No damages, scratches on battery container and cover b) Terminals c) Presence of venting device
2	Verification of Marking	Following information shall be indelibly and durably marked on each Cell/Battery stack: a) Serial Number b) Ah capacity at 10-hour rate c) Manufacturer type and trade name d) Month and year of manufacture
3	Open Circuit Voltage & Polarity Marking Test	a) Open Circuit Voltage per cell shall be between 2.13–2.20 V/Cell b) Polarity indications: Red for Positive Terminal & Black for Negative Terminal
4	C10 Capacity Test	Discharge test (10 hour rate) the cell shall give minimum 100% rated capacity when discharged for 10 hours. After completion of installation activity, acceptance test shall be carried out before putting the battery into service to ensure the designed capacity of the battery. Following procedure shall be adopted to carry out the acceptance test: a) Battery should be ensured full state of charge before carrying out acceptance test. b) Resistive/coil load is to be used for conducting the discharge test at 10 hour rate @ 10% of AH capacity of the battery. c) Current should be maintained constant throughout the test. d) Measure and record the individual cell voltages on hourly basis. e) Test will be treated as passed when all the individual cell voltages of the battery bank are above 1.75 Volt. f) After completion of the discharge test, ensure full state of charge of battery before connecting the load on to the battery.

Check List:

S. No		Item/Description	Verification	Result
1.1		Cable	Check Neatness of Cable	Ok / Not Ok
1.2		Cable	Check Tightness of Cable	Ok / Not Ok
1.3		Cable	Check Continuity of Cable	Ok / Not Ok
2.1		Battery	Check Terminal Tightness	Ok / Not Ok
2.2		Battery	Check Battery Cells for cracks, damage and finish	Ok / Not Ok
2.3		Battery	Check Open Cell Voltage	Ok / Not Ok
2.4		Battery	Check Polarity of Cell	Ok / Not Ok
2.5		Battery	Check all cells physically installed and interconnected as per General Arrangement.	Ok / Not Ok
2.6		Battery	Check Covers installed properly	Ok / Not Ok
2.7		Battery	Check Marking of Cells	Ok / Not Ok

Equipment Under Test: _____

Test Date and Time: _____

Site Name: _____

Tested By _____
(Manufacturer/Contractor)

Witnessed By _____
(POWERGRID/Constituent)

Date _____

Date _____

Appendix F – Local Content Requirements (MoP Order Annexure-1 Items)

List of items, goods, services or works from Class-I Local supplier meeting the Minimum Local Content notified in Annexure-1 of Ministry of Power (MoP) order on ‘Public Procurement (Preference to Make In India) to provide for purchase preference (linked with local content) in respect of Power Sector‘ dated 16.11.2021

Appendix G – Table A, B & C of Department of Telecommunications (DoT) Order on Public Procurement (Preference to Make in India), 2017

TABLE A					
Sl. No.	Product Category	HSN code	Product Details	Minimum Local Content (MLC) (in %)	Ceiling of LC for Design out of total LC (in %)
1	Encryption/ UTM (Unified threat management) platforms (TDM and IP)	85176290	TDM (Time Division Multiplex)	65	55
			IP (Internet Protocol)	65	55
2	IP/ MPLS Core routers/ Edge/Aggregation/ Router	85176290	IP Edge, Aggregation & Core Routers (overall capacity ≤ 1 Tbps)	60	40
			Cell Site Router (CSR); (Overall capacity ≤ 1.2 Tbps) including virtual routers	60	40
			SD-WAN Routers (SDN Category) (Interface Capacity ≤ 10 Gbps)	60	40
3	Managed Leased Line Network Equipment, IP Based access systems-DSL	85176290, 85176990	Central Office Equipment and CPEs of DSL/HDSL/S-HDSL	60	40
4	Ethernet Switches (L2 and L3)	85176290	L2/L3 Ethernet Switches 1- 100 GbE interface Switches (stackable / standalone / modular switches), for Core / Distribution / Access Layers (including PoE/PoE+)	60	40
			Industrial Grade LAN 1, 10 GbE PoE/PoE+/Non-PoE Switches (Power over Ethernet)	60	40
5	IP based Soft Switches, IMS, Unified Communication Systems	85176290, 85176990	IP PBX / Unified Communication Systems (UCS)	60	40
			UCS (non-IMS based):	60	40

6	Wireline PABXs / IP PBX	85176290	Wireline PABXs / IP PBX	65	45
7	Media Gateways	85176290, 85176990	Media Gateways	65	45
8	Customer Premises Equipment (CPEs) (including Wi-Fi Access points, low-capacity Routers, Media Converters), CPE - NFV/ SDN/ Leased-line Modems	85176290, 85176990	CPE (including Wi-Fi Access points and Routers),	50	30
			Media convertor	50	30
			TDM over IP Converter	50	30
			CPE - NFV/ SDN (Virtualized CPE with cloud management)	50	30
			Leased-line Modems n* 2Mbps / IP	50	30
9	SDH/ NG-SDH	85176290	SDH/ NG-SDH (STM 1/4/16/64)	65	45
10	Ethernet/MPLS- TP/ Packet Optical Transport equipment/ PTN systems	85176290	MPLS- TP / Packet Optical Transport equipment/ PTN (with or without OTN interfaces) systems	65	45
11	CWDM systems	85176290	CWDM (Nx100G, Nx10G)	60	40
12	DWDM systems	85176290, 85176270	DWDM (upto 10G) with Mux/De MUX with Transponder / Muxponder; ROADM (Reconfigurable Optical Add Drop Multiplexer), Passive DWDM MUX/DeMUX	60	40
13	GPON/XGPON equipment (including ONT and OLT)	85176290, 85172990	GPON/ XGPON equipment (including ONT and OLT)	60	40
14	XGS-PON equipment (including ONT and OLT)	85176290, 85172990	XGS-PON (10G DS – 10G US) (including ONT and OLT)	60	40
15	SDH/ PDH Cross Connects	85176290	SDH/ PDH Cross Connects (STM: 1/4/16/64; E1/E3/DS3; Ethernet interfaces)	60	40
16	Small Size Radio Sub System	85176290	Micro 2G BTS	60	40

17	LTE/ LTE-R Based Mobile Systems, with its various derivatives	85176290, 85176990	Macro eNode B, as per TEC ENB GR (TDD/FDD)	60	40
			Micro eNodeB, as per TEC ENB GR (TDD/FDD)	60	40
			Pico eNodeB, as per TEC ENB GR (TDD/FDD)	60	40
			Home Base Station/ Femto	60	40
			EPC	60	40
			4G NIB Small cell	60	40
18	Wi-Fi based broadband wireless access systems - indoor	85176290, 85176990	Indoor AP (802.11 ax MIMO, 2.4 & 5 GHz bands)	55	35
			Indoor AP (802.11 ac MIMO, 2.4 & 5 GHz bands)	55	35
19	Wi-Fi based broadband wireless access systems - Outdoor	85176290, 85176990	Outdoor AP (802.11ac - MIMO 2.4 and 5 GHz bands) - IP67 Rated	55	35
			Outdoor AP (802.11ax MIMO, 2.4 & 5 GHz bands)	55	35
20	Wi-Fi Access Controller (with interoperability and multi-vendor AP support)	85176290	Type 1: <= 2000 AP support	55	35
			Type 2: upto 5000 AP support	55	35
21	Authentication, Authorization and Accounting (AAA) Server	85176290	AAA Block (Radius)	50	35
			AAA Block (Radius/ Diameter)	50	35
22	Radio systems (IP/ Hybrid)	85176290	Radio systems (IP/ Hybrid) (5 GHz band - License Exempt band)	55	35
23	Software Defined Radio, Cognitive Radio systems	85176290	Ruggedised handheld, Ruggedised or non-ruggedised vehicle mounts, P2P OR P2MP or Mobile adhoc topology, Unlicensed band operation	55	35
24	Repeaters (RF/RF-over-Optical), IBS and Distributed Antenna systems (indoor / outdoor)	85176290, 85177100	Repeaters (RF/RF-over- Optical), IBS and Distributed Antenna systems (indoor / outdoor) including Active & Passive Accessories	60	40
25	VSAT Terminal Subsystem – ODUs/	85176290, 85256091	Antenna	50	25
26		85256091	NMS H/W & S/W	50	25

	VSAT Hub Subsystems		Antenna ($\geq 7\text{m}$) and accessories etc.	50	25
27	Satellite Phones (S Bands)	85176990	Both Voice and Data (upto 9.6 Kbps)	50	25
28	Disaster communication Systems etc., including backpack satellite products (S Band)	85176990	Portable Terminals Voice and Data (2 Mbps UL)	50	25
29	Satellite based Systems, terminals including location, resources tracking (L, S and Ku, Ka bands)	85176990	Two way MSS Data Terminals (Satellite Receivers with location data) S - Band (Satellite IoT devices for various applications i.e. position tracking, messaging etc.)	50	25
			One Way Receivers MSS Data Terminals (Satellite Transmitters & Receivers - one way) S – Band (Simplex / Half-duplex, Mobile Satellite Service (MSS) terminal, Satellite IoT devices)	50	25
30	Telecom Network Management systems (NMS) with its various derivatives	85176290		65	50
31	Optical Fibre	9001000	Single Mode	50	0
32	Optical Fiber Cable	85447090	Optical Fiber Cable (UG & OH)	55	0
33	Telecom Power System (Including Solar Power)	85176990	UPS, Power Plant, Invertor (Including Solar Power) 0.5- 1500 KVA/Power Plant: 1-2000 KVA (Modular)	55	30
34	Telecom Batteries (Lead Acid)	85176990	Lead Acid up to 5000AH (Including VRLA)	55	30
35	IP Audio/ Video phones / Adaptor	85176990	IP Audio/ Video phones / Adaptor	50	15
36	IP/ Internet Set-top Box	85176990	IP/ Internet Set-top Box	55	35

TABLE B

Sl. No.	Main Inputs /stages for manufacture of telecom products *	Conditions to be met for the inputs to be qualified as Local Content
1	Design a) Hardware design b) Software Design & Development	The maximum Local Content (LC) percentage for Design which can be claimed by a Local manufacturer for the telecom products based on in-house/in country R&D costs incurred/amortized to create IPR in India are as per Table-A (last column) subject to additional conditions that: a) The Intellectual Property Right (IPR) reside in India for Hardware Design; and b) The Copyright is in India for the software Design & Development.
2	Components a) Integrated chips (ICs)- Processor, Memory etc. b) Active components – Transistors, Diodes etc. c) Passive Components – Resistors, Capacitors, Inductors etc.	Should be Manufactured in India
3	PCB Fabrication	Should be Manufactured in India
4	Cables/Chassis etc. a) Chassis b) Cables c) Racks d) Heat sinks e) Enclosures	Should be Manufactured in India
5	RF Components/Subsystem a) Duplexers/Filters b) Antenna	Should be Manufactured in India
6	Assembly/Integration/Testing#	The upper ceiling limit of Domestic Local Content (LC) for Assembly/ Integration/ Testing in respect of the telecom products listed in Table-A would be 10% of the total product Bill of Material
* The product may include some/all of the input/stage as mentioned above. While calculating the local content only those inputs/stages will be considered which are relevant in the manufacturing of the telecom product. # In case a system or subsystem is merely assembled / integrated / tested, then actual Local Content shall be taken as up to 10% of the cost of system / subsystem.		

Appendix H – Patch Management

The Contractor shall establish and maintain a secure patch management framework covering operating systems, applications, firmware, BIOS, databases, open-source components, and all cyber security devices supplied under the project. The framework shall support both online and offline patching and enable centralized patch management without requiring individual OT systems to connect directly to the Corporate-IT network.

The Owner shall provide a single controlled connection point to the Corporate-IT network at the Control Centre for downloading patches, firmware updates, antivirus/EDR signatures, and other security updates. No individual OT system shall be directly connected to the Corporate-IT network. Downloaded updates shall be transferred to the OT environment through designated patch management infrastructure and secure communication channels in accordance with the approved cyber security architecture.

Patch repositories and deployment servers shall be segregated in accordance with the approved cyber security architecture. All patches, signature updates, and firmware upgrades shall be obtained only from trusted OEM sources, verified for integrity, tested on a designated test environment, and deployed only after successful validation and approval.

The latest available patches shall be applied prior to Factory Acceptance Testing (FAT). Throughout the Maintenance period, the Contractor shall provide and manage security patches, firmware updates, antivirus/EDR definitions, and security signatures for all supplied systems and cyber security devices. Updates for cyber security systems shall be carried out through approved offline mechanisms.

The Contractor shall assess, mitigate, and remediate identified vulnerabilities throughout the project lifecycle. For vulnerabilities where patches are unavailable, OEM-recommended compensating controls and mitigation measures shall be implemented. A documented rollback mechanism and backup of at least the last two system configurations shall be maintained.

Patch deployment timelines shall be in accordance with the CEA (Cyber Security in Power Sector) Regulations, 2026, and applicable guidelines. Critical and zero-day vulnerabilities shall be addressed on priority following validation on the test environment, while vulnerability notifications and corrective actions shall be communicated to the Employer without delay.

Any modifications required to maintain system performance, reliability, or functionality following patch deployment or firmware upgrades shall be carried out by the Contractor at no additional cost to the Employer.

Appendix I – Cyber Security and System Hardening Policy

- No application software other than meant for/ required for OT system shall be installed without prior approval of employer/owner.
- Process controls systems shall be designed, configured, operated, and maintained to provide only required functions. Operating System services and components not required for safe and secure operation of Control System should be disabled / uninstalled. All unused default operating system users shall be disabled.
- All the Hardware, Operating Systems (OS) and application software shall be hardened based on industry standards and best practices. List of ports and services enabled in each hardware device must be shared after SAT. This list must be updated periodically if any new ports/services are allowed or blocked after prior approval of Owner.
- Whitelisting policy shall be deployed for all software, services, port configuration, network routing, data flow, access etc. and all these details shall be documented, and any changes shall be recorded and informed to owner during entire period of contract. List of ports and services enabled in each hardware and software must be updated periodically during Maintenance Period if any new ports/services are allowed or blocked after prior approval of Owner.
- Systems under operation shall not be run in administrator mode in normal operations. Administrator mode should only be used for specific administrative requirements.
- Usage of USB devices and Wi-Fi dongles is strictly prohibited. USB / Bluetooth Tethering shall be disabled in all servers and consoles.
- Transferring information from OT network is to be done only as per approved procedure for secure transfer of data.
- Anti-virus shall be installed in computers and laptops used in OT network. Laptops which are not registered and labelled shall not be connected to OT network.
- Any software/application/OS which is to be downloaded from OEM's website, its integrity check using hash SHA256 calculation should be done and verified by the contractor before installation.
- Remote Desktop Protocol and Network File Share on SMB protocol between devices shall be disabled.
- All default user id & passwords shall be changed. All default user id & passwords shall be changed periodically in coordination with employer as per their policy. Default user settings shall enforce password complexity and usage rules.
- Secure digital certificates shall be supported and configured
- Password Managers shall be used to store passwords in encrypted format and use it to perform any logins into the system.
- Any user created for system, or application shall not contain the word "admin" in it.
- Uniform IP address documents shall be maintained.
- Login banners with configurable warning text shall be provided for all operating systems.
- The Contractor shall configure each component of the procured product to operate using the principle of least privilege. This includes operating system permissions, file access, user accounts, application-to-application communications, and system services.
- Implement trusted, un-trusted and DMZ with clear perimeters.
- Spanning tree protocol shall be used in LAN devices to ensure stability in network when a device is removed or added.
- User authentication shall be done considering the best practices in cyber security.
- All Unused ports (physical and logical) of all devices such as on switches, routers, firewalls, consoles, servers etc. shall be disabled.

- All unused services shall be disabled by default. There shall be a provision to turn on all services on request.
- All the devices that connected to the system through LAN shall have mac-based binding. In routers & switches, only the specified/required IP addresses should be OPEN.
- Host-based firewalls shall be configured to only allow connections from specified nodes.
- All the communication should be done through secure protocols such as SFTP, HTTPS etc. All communication with system constituents shall be encrypted on application level, as applicable.
- Implement proper Access matrix (Access Control List-ACL) to prevent unauthorized access to resources / pages / forms in website.
- Do not reference components (such as javascripts, stylesheets etc.) directly from third-party sites.
- Store critical data such as secret keys, passwords, certificates etc. in encrypted form in the database.
- Prevent critical information from public access
- Hash the password before it is relayed over network, or is stored in database.
- Implement proper Session Timeout
- Assure admin/Super-Admin URL's is/are accessible from restricted IP's only.
- Assure third-Party links/page (partial/full) open in different tab, with a disclaimer.
- Disable directory listing.
- Implement Logout buttons in all authenticated pages
- Use the latest and non-vulnerable versions of Application Server (IIS/Apache etc.)
- Routers shall be configured with:
 - Deploy proper access management and avoid remote administration.
 - Enable secret password.
 - Change default SNMP community string.
 - ACLs (Access Control Lists) shall include
 - Apply egress/ingress filter
 - Filter all RFC 1918, 3330 address space and special/reserved address
 - Permit the required services for the required IP addresses only
 - Deny everything else.
 - Area segregation must be implemented (if OSPF is being used) between internal and external networks. Appropriate protocols must be enabled to prevent networks loops

Note: The applicability of the above requirements shall be based on project-specific operational needs and the Employer's policies. Compliance with the Employer's Cyber Security Policy and System Hardening Policy shall be included and ensured by contractor. The same shall be finalized during detail engineering.

Appendix J – Software Inventory

An inventory of all software including open-source components as per CERT-In guidelines and its license details shall be maintained by the Contractor. The Contractor shall submit the following inventory lists:

- preliminary inventory list at the time of the FDS approval,
- an updated inventory list immediately prior to the start of the FAT,
- and the final inventory list at the time of system commissioning.
- Checksum/Hash for all supplied Software for Software Integrity Check.
- Version Management

The inventory shall include the name of each program, a cross reference to pertinent Contractor documents, language and libraries used, and an indication of whether the program is to be standard, modified, or custom.

The Contractor shall also submit the inventory list in line with Technical Guidelines on SOFTWARE BILL OF MATERIALS (SBOM) as per CERT-In guideline (CERT-In Technical Guidelines on SBOM, QBOM & CBOM, AIBOM and HBOM Version 2.0) for approval and shall include the following minimum details:

S.No.	Data Field	Description
1	Component Name	The name of the software component or library included in the SBOM.
2	Component Version	The version number or identifier of the software component.
3	Component Description	A brief description or summary of the functionality and purpose.
4	Component Supplier	The entity or organization that supplied the software component.
5	Component License	The license under which the component is distributed, including terms.
6	Component Origin	The source or origin: proprietary, open-source, or third-party vendor.
7	Component Dependencies	Other components or libraries it depends on, including names and versions.
8	Vulnerabilities	Known security vulnerabilities, severity ratings, CVE references.
9	Patch Status	Indicates if patches or updates are available for known issues.
10	Release Date	The date when the component was released or made available.
11	End-of-Life (EOL) Date	The date when support or maintenance is scheduled to end.
12	Criticality	Importance to overall functionality or security: critical, high, medium, low.

S.No.	Data Field	Description
13	Usage Restrictions	Export control restrictions or intellectual property rights.
14	Checksums or Hashes	Cryptographic checksums or hashes to ensure integrity and authenticity.
15	Comments or Notes	Additional comments, notes, or annotations.
16	Author of SBOM Data	The entity that creates the SBOM data for this component.
17	Timestamp	Record of the date and time of the SBOM data assembly.

Note:

1. It is preferred that the above data fields be structured, maintained, and shared in SPDX format for compatibility and interoperability.

2. The above table is indicative only. The format and data fields shall be finalized during detailed engineering stage.

The inventory shall include the name of each program, a cross reference to pertinent Contractor documents, language and libraries used, and an indication of whether the program is to be standard, modified, or custom.

The SBOM and inventory shall be maintained by the contractor during entire contract period.

The Opensource components should be maintained with following Information:

Open-Source component	License	Baseline version	Git repository link	Deployed version	Latest version available	Checksum

Hardware Inventory

The contractor shall submit hardware inventory of all hardware supplied under this project as per CERT-In guidelines.

The Contractor shall also submit the inventory list in line with Technical Guidelines on Hardware BILL OF MATERIALS (HBOM) as per CERT-In guideline (CERT-In Technical Guidelines on SBOM, QBOM & CBOM, AIBOM and HBOM Version 2.0) for approval and shall include the following minimum details:

S.No.	Data Field	Description
1	Product Name	The common or marketing name of the hardware item.
2	Product Version	The specific iteration or release number of the product.
3	Product Details	Key specifications and features that describe the hardware.
4	Warranty/AMC	Information regarding the product's guarantee and any annual maintenance contract.
5	Manufacturer Name	The name of the company responsible for producing the hardware.
6	Manufacturer Location	The geographical address of the product's manufacturer.
7	Manufacturing Date	The specific date when the product was produced.
8	Supplier Information	Details about the company that provided or sold the product
9	Supplier Location	The geographical address of the product's supplier.
10	Model Number	A specific alphanumeric identifier for a particular product design.
11	Serial Number	A unique identifier assigned to each individual unit of a product for tracking.
12	Technical Specification	Detailed technical characteristics and performance parameters of the component (e.g., voltage, frequency, capacity).
13	Supplier Information	The name and contact details of the company that supplied the component to the manufacturer of the larger product.
14	Supplier Location	The geographic location (city, country) of the direct supplier of the component.
15	Technology Node	For integrated circuits, this refers to the semiconductor manufacturing process technology (e.g., 7nm, 14nm), indicating its feature size and generation.
16	Compliance	Declarations or certifications indicating adherence to relevant industry standards, regulations, or environmental directives (e.g., RoHS, CE).

S.No.	Data Field	Description
17	Power supply	Details about the component's power requirements, such as voltage, current, and wattage.
18	License Information	Any associated intellectual property licenses or usage terms, particularly relevant for firmware or embedded software within the component.
19	Subcomponent	This refers to the recursive nature of an HBOM; if a component itself contains further distinct hardware parts, those would also be listed with similar detailed attributes.

The above table is indicative only. The format and data fields shall be finalized during detailed engineering stage.

Appendix K – Declarations & Formats for Cyber Security

Index

- Declaration format for SBOM and HBOM
- Malicious Code declaration format during detail engineering
- NDA Format during commissioning/AMC
- Malicious Code declaration format before FAT
- End of Life declaration format from respective OEM
- End of Life declaration format from contractor
- MUTUAL CONFIDENTIALITY AGREEMENT

Declaration format for SBOM and HBOM

Name of OEM:

Date:

Project Name:

NOA Reference:

Subject: Declaration for Submission of SBOM and HBOM as per CERT-In guidelines

We, [OEM Name], hereby declare that all products, software, and hardware supplied to [Organization Name] comply with the requirements outlined in the **CERT-In Technical Guidelines on SBOM, QBOM & CBOM, AIBOM and HBOM Version 2.0**, issued by the Indian Computer Emergency Response Team (CERT-In), Ministry of Electronics and Information Technology, Government of India. We also confirm that , we will submit the SBOM and HBOM as per mentioned in CERT-In guidelines (TechnicalGuidelines-on-SBOM,QBOM&CBOM,AIBOM_and_HBOM_ver2.0.pdf) during detail engineering prior to design approval.

(Authorised Signatory)

Name/ Designation/ Address of the firm

Seal of the firm

Date:

Place:

Malicious Code declaration format during detail engineering

Name of OEM:

Date:

Project Name:

NOA Reference:

Subject:

1. This is to Certify that the Hardware and Software being offered as part of the contract does not contain embedded malicious code that would activate procedures to:
 - Inhibit the desired and designed function of the equipment.
 - Cause damage or corruption [includes physical / software / data] of or to the user or equipment by way of malicious exploit.
 - Tap information resident or transient in the equipment / networks.
2. The contractor will be considered to be in breach of the contract, in case physical damage, corruption or loss of software / data or infringements related to copyright and Intellectual Property Rights (IPRs) are caused due to activation of any such malicious code in embedded software.

(Authorised Signatory)

Name/ Designation/ Address of the firm

Seal of the firm

Date:

Place:

NDA Format during commissioning/AMC

--- TO BE FILLED BY Contractor REPRESENTATIVE AT SITE DURING COMMISSIONING / MAINTENANCE.---

DECLARATION OF CONFIDENTIALITY

I acknowledge that, in my capacity as a member (or staff, employee) of I will have access to certain Confidential Information (as defined in Agreement between Owner and M/S) of Owner, which may be in oral, written or any other form.

I understand that all _____ members must sign a Declaration of Nondisclosure when they commence their association with the _____. Under this declaration, members consent to keep all matters to which they are privy related to all projects being conducted at the _____ confidential.

I agree that during my association with the Project relating to Owner and after the competition/termination of Project, I shall not disclose to any other person, firm or corporation, any confidential information relating to Owner's Company.

I also understand that I am required to notify _____ of the _____ or his/her designate immediately of any breach of my obligations or conflict of interest under this agreement which comes to my attention.

By signing and returning a copy of this document, I confirm my understanding and acceptance of the above clause and will comply with these clauses. I also agree that my obligation to comply with the above will survive my termination of association with the M/S in future. _____

Contractor Representative Signed: _____

Contractor Representative Name (printed): _____

Sign and Name of Owner's Executive as Witness: _____

Seal of the firm

Date:

Place:

Malicious Code declaration format before FAT**Name of OEM:****Date:****Project Name:****NOA Reference:**

We hereby confirm that the any imported equipment/material/item/parts/component (comprising of embedded systems) to be supplied under the contract shall be tested in the certified laboratories to check for any kind of embedded malware/trojans/cyber threats and for adherence to Indian Standards as per the directions issued by Ministry of Power/Govt. of India from time to time.

In case of such import from specified “prior reference” countries, the requirement of prior permission from the Govt. of India including protocol for testing in certified and designated laboratories by Ministry of Power/Govt. of India shall also be complied.

We hereby confirm that the above test details & compliance shall be submitted prior to Factory Acceptance Test (FAT).

We also confirm that the list out the products and components producing Toxic e-waste under the contract and shall furnish to the Employer the procedure of safe disposal at the time of closing of the contract.

(Authorised Signatory)

Name/ Designation/ Address of the firm

Seal of the firm

Date:

Place:

End of Life declaration format from respective OEM**Name of OEM :.....****Date:****Project Name:****NOA Reference:**

We hereby confirm that we shall ensure that the **(Name of Equipment)** supplied to M/s contractor under “Project Name” is having support (including updates & patches) for a period of _____ years (as specified on the technical specification) from the **Operational Acceptance (OA)** as specified in technical specifications.

We also confirm that the **(Name of equipment)** is current industry standard model and the equipment has not established a date for termination of its production.

Details of Hardware

- **Complete Model No:**

The documentary evidence certified by us for the validity of End-of-Life/ End-of-Support is also attached.

(Authorised Signatory)

Name/ Designation/ Address of the firm

Seal of the firm

Date:

Place:

End of Life declaration format from contractor

Name of OEM:.....

Project Name:

NOA Reference:

We hereby confirm that the **(Type of Product)** supplied under “*Project Name*” **(hardware & applications)** are current industry standard models and the equipment manufacturer has not established a date for termination of its production and are available with more than one supplier locally.

The Obsolescence details of (hardware and applications) for patch/updates (Select one): **Declared/ Not Declared.** (Provide details if “Declared”).

We also hereby confirm that we ensure with OEM that the service & support (including updates & patches) for all software and hardware supplied under this project for a period of _____ years (as specified on the technical specification) from **Operational Acceptance (OA)**.

(Authorised Signatory)

Name/ Designation/ Address of the firm

Seal of the firm

Date:

Place:

Annexure-I**NON-DISCLOSURE AGREEMENT**

This Agreement made in duplicate and effective as of ____ of ____, 2024

BETWEEN

POWER GRID CORPORATION OF INDIA Ltd. (POWERGRID), India's largest power transmission corporation which is a Central Public Sector Undertaking of the Government of India established under Companies Act, 1956 and having registered Office at B-9, Qutab Institutional Area, Katwaria Sarai, New Delhi-110016 (INDIA) (hereinafter referred to as the 'FIRST PARTY' on the one-part, which term or expression shall include its administrators, successors and permitted assigns)

AND

....., a under the administrative control of the Department of XXXXXXXX, Government of India established under Companies Act, 1956 and having registered Office at.....(hereinafter referred to as the 'SECOND PARTY' on the other part, which term or expression shall include its administrators, successors and assigns) with either 'FIRST PARTY' or 'SECOND PARTY' being singularly referred to as a 'Party' and both the 'FIRST PARTY' and 'SECOND PARTY' being collectively referred to as the 'Parties';

WHEREAS:

The Parties intend to engage in discussions and negotiations concerning the establishment of a MoU between them. In the course of such discussions and negotiations, it is anticipated that both the parties may disclose or deliver to either of the Parties certain or some of its trade secrets or confidential or proprietary information, for the purpose of enabling the other party to evaluate the feasibility of such business relationship (hereinafter referred to as "the Purpose").

NOW, THEREFORE, THIS AGREEMENT WITNESSETH AND IT IS HEREBY AGREED BY AND BETWEEN THE PARTIES HERETO AS FOLLOWS:

- **Purpose.** The parties hereto wish to have for with mutual interest and in that either party may receive confidential information of the other party for the following purposes: "to build and operate.....at the 'FIRST PARTY'S' premise on the terms, conditions and stipulations contained herein, under 'Make-in-India' initiative of Government of India"
- 9. **Definition.** "Confidential Information" means any information, technical data, or know-how (including, but not limited to, information relating to research, products, software, services, development, inventions, processes, engineering, marketing, techniques, customers, pricing, internal procedures, business and marketing plans or strategies, finances, employees and business opportunities) disclosed by the Disclosing Party to Recipient either directly or indirectly in any form whatsoever including, but not limited to, in writing, in machine readable or other tangible form, orally or visually (subsequently reduced to writing) (1) that has been marked as

- confidential; (ii) whose confidential nature has been made known by Disclosing Party, orally or in writing, to Recipient; or (iii) that due to its character and nature, a reasonable person under like circumstances would treat as confidential.
10. **Exclusions.** Confidential Information does not include information, which: (i) is in Recipient's possession at the time of disclosure; (ii) before or after it has been disclosed to Recipient, becomes part of the public knowledge or literature, not as a result of any action or inaction of Recipient; (iii) is approved for release by written authorization of the Disclosing Party; (iv) is disclosed to Recipient by a third party not in violation of any obligation of confidentiality; or (v) is independently developed by Recipient without reference to Confidential Information of the Disclosing Party.
 11. **Use Limitations.** Recipient agrees not to use the Confidential Information for its own use or for any purposes except for the Purpose expressly set forth above. Recipient agrees not to copy, alter, modify, disassemble, reverse engineer or decompile any of the materials unless permitted in writing by the Disclosing Party.
 12. **Non-Disclosure.** Recipient agrees not to disclose the Confidential Information to any third parties or to any of its employees except those employees who have a need to know the Confidential Information for accomplishing the stated Purpose described herein and where such employees shall be made aware that the information is confidential and shall be under a written contractual restriction on non-disclosure and proper treatment of Confidential Information that is no less restrictive than the terms of this Agreement. Notwithstanding the foregoing, Recipient may disclose the Disclosing Party's Confidential Information to the extent required by a valid order by a court or other governmental body or by pursuant to an applicable law or regulation; provided, however, that Recipient will use all reasonable efforts to notify Disclosing Party of the obligation to make such disclosure in advance of the disclosure so that Disclosing Party will have a reasonable opportunity to object to such disclosure. Recipient agrees that it shall treat the Confidential Information with the same degree of care as it accords to its own confidential information of a similar nature; provided that in no event shall Recipient exercise less than reasonable care to protect the Confidential Information. Recipient agrees to advise the Disclosing Party in writing of any misappropriation or misuse by any person of such Confidential Information of which Recipient may become aware.
 13. **Third Party Information.** Neither party shall communicate any information to the other in violation of the proprietary rights of any third party.
 14. **Return of Materials.** Any materials or documents of Disclosing Party which are furnished to Recipient, and all copies thereof, at the earlier of Disclosing Party's request for return of the materials, or the termination of the business relationship between the Disclosing Party and Recipient, at the Disclosing Party's option, will either be: (i) promptly returned to the Disclosing Party; or (ii) destroyed by Recipient (with Recipient providing written certification of such destruction).
 15. **No License.** The Confidential Information shall remain the sole property of the Disclosing Party. No license is granted to Recipient under any patents, copyrights, mask work rights or other proprietary rights by the disclosure of any information hereunder, nor is any warranty made as to such information.
 16. **Remedies.** Recipient understands and agrees that the Disclosing Party is providing the Confidential Information to Recipient in reliance upon this Agreement, and

Recipient will be fully responsible to the Disclosing Party for any damages or harm caused to the Disclosing Party by a breach of this Agreement by Recipient or any of its officers, directors, employees or consultants. Recipient acknowledges and agrees that a breach of any of its promises or agreements contained herein will result in irreparable injury to the Disclosing Party for which there will be no adequate remedy at law, and the Disclosing Party shall be entitled to apply for equitable relief, including injunction and specific performance, in the event of any breach or threatened breach or intended breach of this Agreement by Recipient. Such remedies, however, shall not be deemed to be the exclusive remedies for any breach of the Agreement but shall be in addition to all other remedies available at law or in equity.

17. **Attorneys' Fees, Jurisdiction/Venue.** In the event of any litigation or other legal proceedings between the parties, the prevailing party shall be entitled to reasonable attorneys' fees and all costs of proceedings incurred in enforcing this Agreement. The Courts in Delhi, India shall have exclusive jurisdiction to try and dispose of any proceedings arising out of this Agreement.
18. **Termination & Survival.** This Agreement will become effective as of the date first mentioned herein above and will continue to be in force for a period of three years thereafter. Recipient's obligations under this Agreement with respect to Confidential Information it has received shall continue for a period of Nine (9) years after such disclosure.
19. **General.** This Agreement sets forth the entire understanding and agreement of the parties with respect to the subject matter hereof and supersedes all other oral or written representations and understandings. This Agreement may be amended or modified only in writing signed by authorized representatives of the parties hereto. If any provision of this Agreement is found by a proper authority to be unenforceable or invalid, such unenforceability or invalidity shall not affect the other provisions of this Agreement and the unenforceable or invalid provision shall be construed to be amended in order to avoid such unenforceability or invalidity while preserving as closely as possible the intent of the parties.
20. **Notices.** All notices or reports permitted or required under this Agreement shall be in writing and shall be by personal delivery, nationally recognized overnight courier service, facsimile transmission or by certified or registered mail, return receipt requested, and shall be deemed given upon the earlier of actual receipt or one (1) day after deposit with the courier service, receipt by sender of confirmation of electronic transmission or five (5) days after deposit in the mail.

IN WITNESS WHEREOF, the Parties hereto have executed these presents the day, month and year first hereinabove written.

For and on behalf of
M/S.....

Name of Authorized signatory:
Designation:

For and on behalf of
Power Grid Corporation of India Ltd

Name of Authorized signatory:
Designation:

Annexure-II**NON-DISCLOSURE AGREEMENT**

(For Third party/outsourced resources engaged by M/S..... for Project)

Date:

I, _____, S/D/o _____, representing M/s
_____ do hereby agree to abide by the below mentioned conditions:

- I am aware about the importance of the facilities and hence shall use the information related to.....and POWERGRID system, shared/gathered by me for this specific assignment only.

The information here means any technical data, drawings, schematics, vendor information, product information, Architecture, Network details, configuration files, software programs, logs, Operation procedures, maintenance procedures, location, processes, people, being used in and POWERGRID system.

- I agree not to **disclose** the information related to and POWERGRID systems to any persons/third party. The non-disclosure agreement shall even apply to persons in my organisation who are not related to the project.

Disclosure here means sharing of information in any communication method but not limited to, in writing, orally, messaging, email, electronic media etc.

- I agree not to take away any software media, database, crash dumps, logs, pictures, audio records, video records except with written permission of POWERGRID.
- Notwithstanding the foregoing, the undersigned may supply any information desired by the Court of Law or any Government body desirous of having the information under the rule of Law. I agree to inform such disclosure and its extent to POWERGRID.

PLACE:

DATE:

(SIGNATURE)

Enclose Copy:

- 1) Photo ID: PAN CARD/ DL/ VoterID/ Passport
- 2) Company ID _____

Verified by (on behalf of M/s):

Name: _____ **Desi**

HT/LT Meter Box

Appendix L – Standard Site Survey Format

1.General Information:

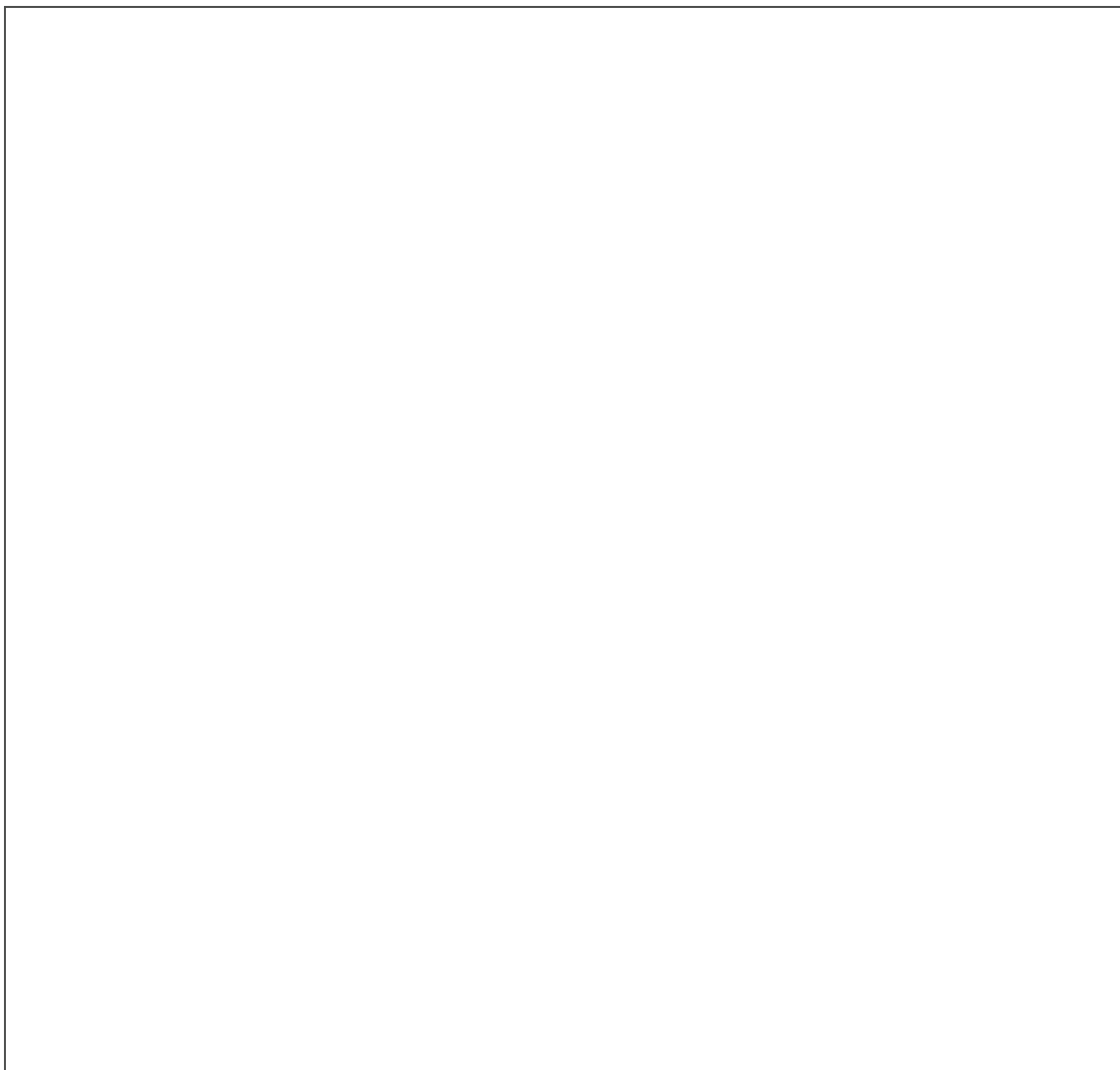
Site Survey format for SDH and NMS system

1.General Information:

PROJECT NAME:	
Contract / LOA No.	
Date of Survey	
Site Name	
Complete Address	
Telephone Number on Site	
Contact Person & Designation	
E-mail	
Nearest City and Distance	
Access Road Conditions	
Distance to Main Road	
Main Road Name/No.	

2. Detailed Layout of Site:

Make a sketch of the area Indicating the site positions. Indicate the access road and direction and distance to the nearest towns:

**3. Details of equipment to be installed under the present scope**

Item	Description	Quantity(Nos.)	Remarks

3.1 Details of existing equipment.

Item	Description	Details of the Existing Equipment	Remarks

4.Details of Infrastructure and Site Facility:

Access Time to Site	From:	To:
Access Pass Required	Yes / No	
Availability of Key at Site	Yes / No	
Access Permit arrangement (If required)	Yes / No	
Manned / Unmanned Site		
Special handling arrangements required for Material Transportation	Yes / No	
Building Work completed	Yes / No	
Availability of Ladder	Yes / No	
Availability of AC Supply	Yes / No	
Proper Lighting	Yes / No	
Availability of Stairs or Lift		
Expected Room Temperature	Min: °C	Max: °C
Noticeable dust	Yes / No	
Mobile Phone Coverage	Yes / No	

5. Details of Site Location for SDH Equipment and NMS System

No. of Racks to be Installed	
Type of Flooring	Anti- static / Raised
Type of Ceiling	
Availability of Air Conditioner	
Availability of Sufficient Work space in Equipment room	Yes/No
Location of equipment to be Installed (attach detailed room layout)	
Availability of -48 V DCPS	Yes/ No
Output Voltage	-----Volts
Capacity of existing -48V DCPS	-----kVA
Healthiness of Station Batteries	
Total no. of Battery strings / Batteries	
Capacity of Station Batteries	
Existing location -48V DCPS System	
Date of Commissioning of Charger and Battery System (if available)	
Location of -48V Distribution Panel (DCDP)	
Distance from DCDP to Equipment rack (Cable length)	
Availability of Space / MCB in existing DCDP	
Location of Station Earthbar	
Distance from Equipment rack to Station Earthbar (Earth bar cable length)	

Earth Resistance	
Availability of Cable Tray/Trench	
Details of the existing SDH equipment at site	
Location of the NMS system, availability of sufficient space in NMS room	
Distance of NMS from Equipment (Ethernet cable length)	
Length of Optical patch cord from ODF to SDH	
Healthiness of -48V DCPS System	
Healthiness of Station batteries	
Distance from wall (min1000mm front& back)	
Location of FODP (max.10m from equipment rack)	
Location from FODP to equipment rack (patch cord length)	

6. Room Layout for Telecom Equipment:



7.Details of Site Location for DCPS Equipments:

No. of cabinets to be installed	
Type of Flooring	
Type of Ceiling	
Availability of AirConditioners	
Room Ventilation	
Availability of sufficient works pace in Equipment room	
Location of equipment to be installed (attach detailed room layout)	
Availability of Station Earthing side the room	
Earth resistance as per available record	
Distance from Station earth to DCPS/Battery equipment (Earth cable length)	
Availability of main incomer AC Supply/ACDP	
Distance from DCPS system to Main incomer AC/ACDP (AC cable length)	
Distance from DCPS to Battery (DC cable length,max.20 mtrs)	
Availability of cable tray/Trench	
Any civil work is required to be done by PGCIL/Constituents (if yes, mention in	
Door aperture	
Distance from wall (min1000mmfrontandbac	

8. Room Layout for DCPS Equipment Room:

9. Comments

For Contractor	For Power Grid Corporation of India Limited
Signature:	Signature:
Name & Designation:	Name & Designation:
Mobile:	Mobile:
Landline:	Landline:
Email:	Email:

Site Survey Format For Repeater Shelter Location/Infrastructure

Site Details/Name: -----

1. **Purpose:** Purpose of this document is to provide the Format for site survey to be followed for Selection of location for Installation of Repeater shelter infrastructure on rental basis for Communication Fibre Optics Link.
Repeater Requirements General cases- For line lengths > 225km
2. **Objective:** The aim is to collect all the data mentioned below related to site as way of planning for location of Repeater with below attribute
3. Location to be near to midpoint of line between Two Substations. The midpoint requirement can be relaxed, if there is a suitable location and there is a provision for Amplifier card of longer length in the BOQ.
4. Location shall be suitable to optimize losses of the section.
5. Location should be chosen in a way so that it is approachable in all seasons and free from natural disaster like flood.
6. Location should be chosen in a way that Joint Box is available near to Tower so that the length of approach cable should be minimal and unnecessary joint can be avoided.
7. Location should be near to motorable road, petrol pump with no dispute in Landownership.
8. Location should be preferably near to human habitat/Village for safety, security and accessibility for maintenance perspective.
9. **Format:** The information is to be collected in the following formats (Annex-I to Annex-VI)

Annex-I

General Information	
Project Name	
Name of the TL I/C	
Name of The contractor	
Specification and LOI No:	
Date of Survey:	
Name of Transmission Line/Link/Section	
State	
S/S End 1	
S/S End 2	
Line Length	
Whether any other line exists between two S/S	
OPGW Fiber Pairs available/Planned	

Annex-II

	Requirement	Location Option1	Location Option2
(a) Tower details	Tower No./Type		
	Availability of Joint Box (JB) (Yes/No)		
	Latitude		
	Longitude		
	Distance S/S End 1		
	Distance S/S End 2		
	Remarks(if any)		
(b) Site details	Name(s) of Landowner(s) (Preferably Single owner)		
	Owner Residential Address		
	Area of proposed Site (Sq.ft) Preferably 10m X 10 m		
	Site/ Land is undisputable		
	Approx. Rent (Final rent will be finalized by the committee formed by POWERGRID)		
	Agreement Tenure (Yrs)		
(c) Other Details of site	Whether area is flood prone (Yes/No)(Level to be specified w.r.t nearby/adjacent land		
	If Yes, Any such incident in last 3 years (Yes/No)		
	Type of LAND (Soft Soil/ Stone)		

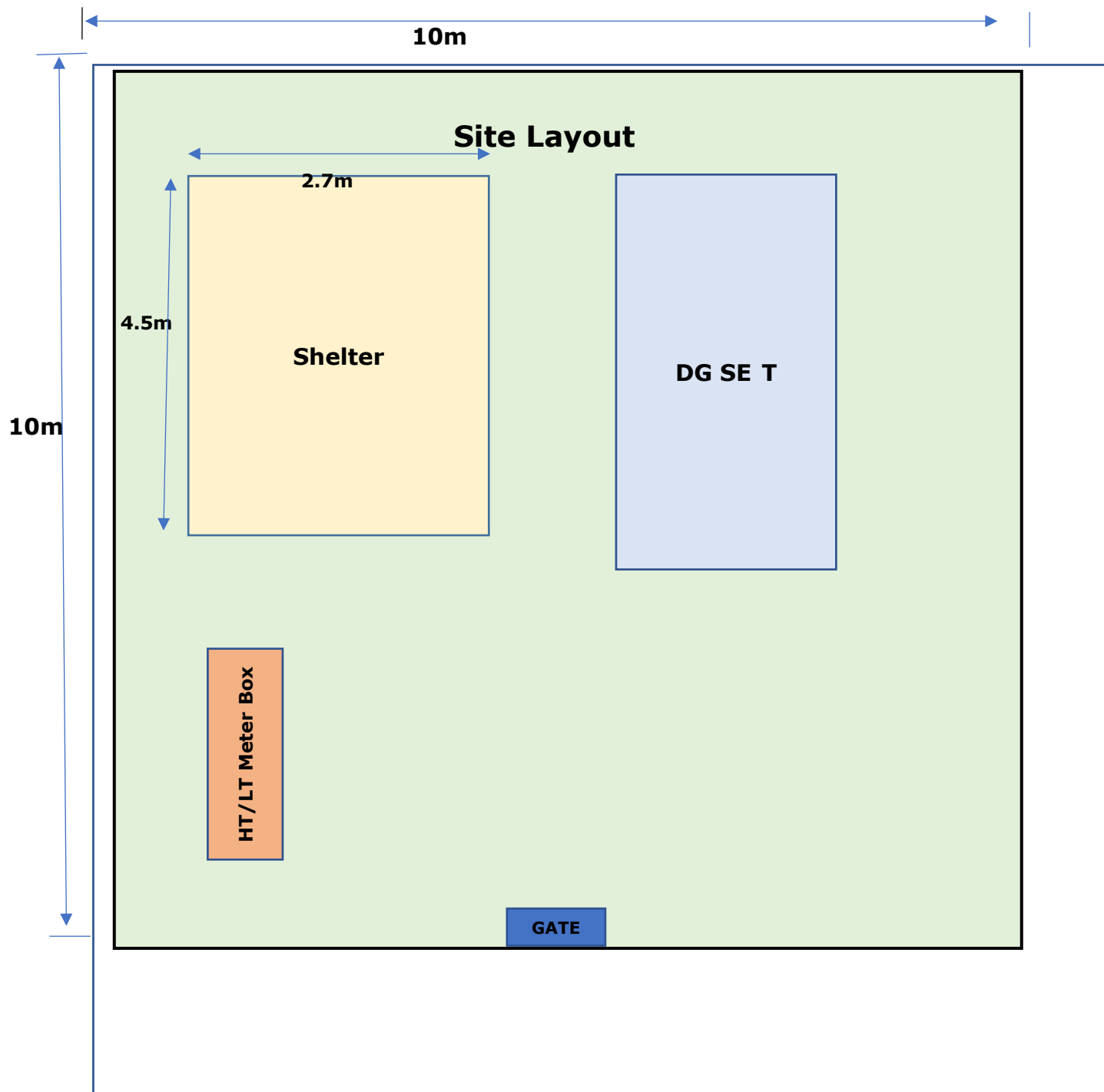
	Distance from POWERGRID nearest S/S / Repeater		
	Name of Nearest POWERGRID Substation/Repeater		
	Distance from Nearest Town/Village		
	Distance from Petrol Pump		
	Distance from Nearest Highway		
	Approach Cable distance from Tower via two diversified routes for main and protection path with route details to be shown in Annex-IV		
	Proposed Location is motorable or not		
(d) LT Supply details	Distance from Nearest LT Feeder		
	Type of SEB connection Availability (Agricultural/Commercial/Industrial)		
	If agriculture, distance of Commercial Feeder for Industrial use		
	SEB availability (Hrs/ Day)		

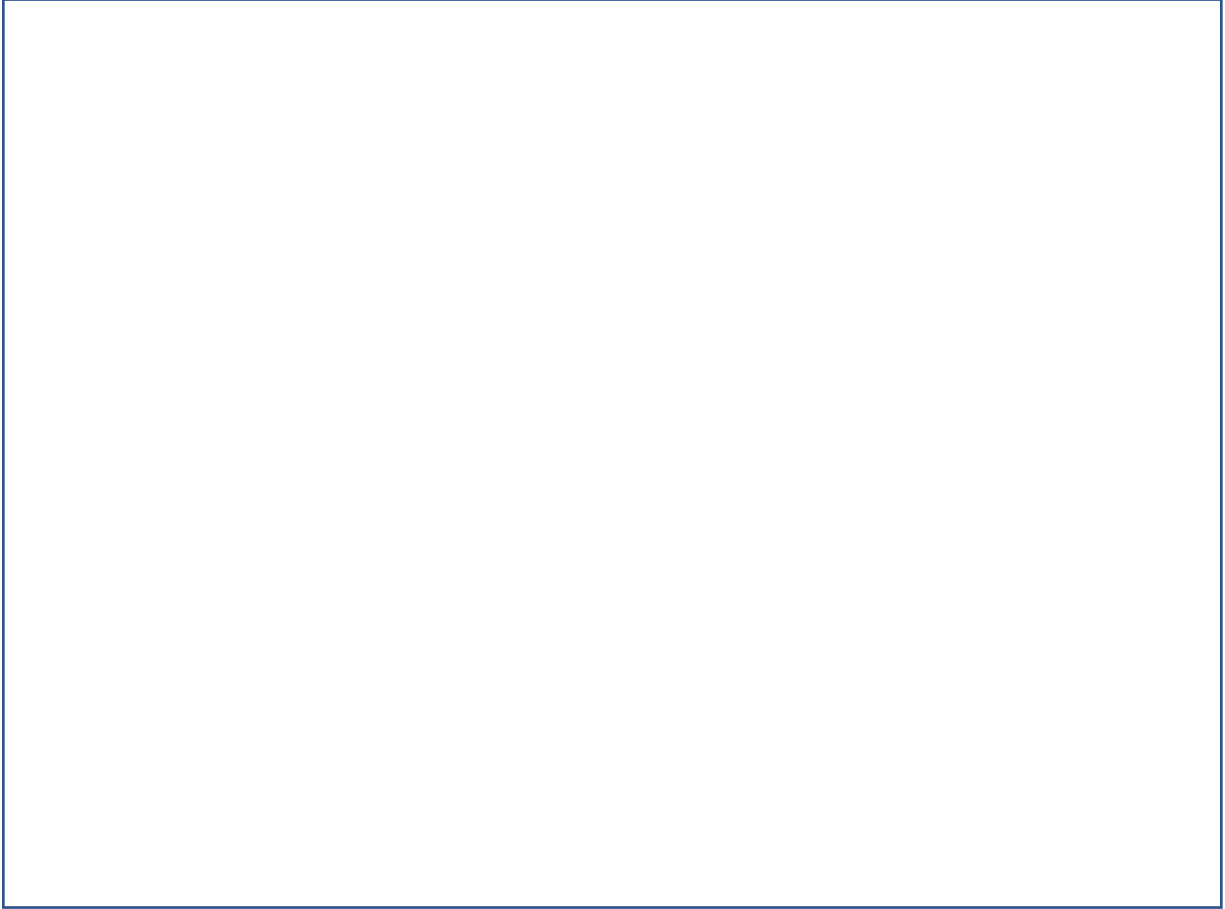
Note: Additional data may be added to record survey data, if required.

Annex-III**(Google Graphics Map of site option & site picture)**

Annex-IV

(Repeater Shelter site layout Specifying place for Shelter, DG Set, Outdoor ACDB)



Annex-V: External layout of Repeater Shelter

Annex-VI : Internal layout of Repeater Shelter (As per the technical requirement)

Representative’s Sign off:		
From: Contractor		From Power Grid
Name		Name
Date:		Date:
Contact No:		Contact No:

-----End of Appendix-L-----

Appendix A-1 – General Information & Implementation Schedule

Contents

General Information & Implementation Schedule For Package FOTE-09: Scheme for Installation of OPGW & associated communication systems on the existing lines of ISTS in NR region.

Table A-1 Implementation Schedule for below mentioned FOTE Locations
Execution Period: 30 Months from the Award

S. No	Region	FOTE Location	FOTE Requirement	FOTE Configuration
1	NWR	220kV BASSI	1	STM16
2	NR1	220kV MEERUT	1	STM16
3	NWR	220kV RAPPB- UDAIPUR	1	STM16
4	NWR	220kV UDAIPUR	1	STM16
5	NWR	REP RAPP-Udaipur	1	STM16
6	NWR	220kV SIKAR(RJ)	1	STM16
7	NR1	400kV BAGPAT	1	STM16
8	NR1	400kV DEHRADUN	1	STM16
9	NR1	400kV SAHARANPUR	1	STM16
10	NWR	400kV PHAGI (JAIPUR RRVPNL)	1	STM16
11	NR1	400kV HISAR	1	STM16
12	NR1	400kV KAITHAL	1	STM16
13	NR3	400kV BAREILLY	1	STM16
14	NR1	765kV AGRA	1	STM16
15	NR1	765kV JHATIKALA	1	STM16
16	NR1	Rep AGRA-JHATIKALA	1	STM16
17	NR1	765kV BHIWANI	1	STM16
18	NR1	REP BHIWANI-PHAGI	1	STM16
19	NR1	765kV MOGA	1	STM16
20	NR1	REP MOGA-BHIWANI	1	STM16
21	NR2	220kV Kishenpur	1	STM16
22	NR2	220kV Sarna	1	STM16
23	NR2	220kV Salal	1	STM16
24	NR2	220kV Kishanpur-III	1	STM16
25	NR2	220kV Dasuya	1	STM16
26	NR2	400 KV Rajpura (PSTCL)	1	STM16
27	NR2	400 KV Panchkula	1	STM16
28	NR2	400kV Ludhiana	1	STM16
29	NR2	400kV Patiala	1	STM16
30	NR2	400kV NALAGARH	1	STM16
31	NR2	400kV Uri 1	1	STM16
32	NR2	400kV Uri 2	1	STM16
33	NR3	220kV BHARATPUR(RRVPNL)	1	STM16
34	NR3	220kV SIKANDARA(UP)	1	STM16
35	NR3	220kV ALLD	1	STM16
36	NR3	220kV AUR	1	STM16
37	NR3	220kV KANPUR(PG)	1	STM16
38	NR3	220kV RANIYA(UP)-1	1	STM16
39	NR3	220kV MAINPURI	1	STM16
40	NR3	220kV NAUBASTA	1	STM16
41	NR3	220kV PANKI-II	1	STM16
42	NR3	220kV UNCHR-III	1	STM16
43	NR3	220kV RAIBRLY	1	STM16
44	NR3	220kV CG CITY(UP)	1	STM16
45	NR3	400kV BHIWADI	1	STM64
46	NR3	400kV BALIA	1	STM16
47	NR3	400kV MAU 400kV	1	STM16

48	NR3	400kV LUCKNOW	1	STM16
49	NR3	400kV UNNAO	1	STM16
50	NR3	400kV SINGRAULI	1	STM16
51	NR3	400kV FATEHPUR	1	STM16
52	NR3	REP SINGRAULI- FATEHPUR	1	STM16
53	NR3	765kV ALIGARH	1	STM16
54	NR3	765kV KANPUR(GIS)	1	STM16
55	NR3	REP KANPUR(GIS)- Aligarh	1	STM16
56	NR2	400kV BANALA-I	1	STM16
57	NR1	400kV Roorkee	1	STM16
58	NR1	400kV Malerkotla	1	STM16
59	NR1	400kV Amritsar	1	STM16
60	NR3	400kV Muzaffarpur	1	STM16
61	NR3	400kV Gorakhpur	1	STM16
62	NR3	REP Muzaffarpur- Gorakhpur	1	STM16
63	NR3	REP Lucknow-Gorakhpur	1	STM16
64	NR3	400 kVMandola	1	STM16
65	NR3	400 kV Allahabad	1	STM16
66	NR3	765kV Lucknow	1	STM16
67	NR3	REP Balia –Lucknow	1	STM16
68	NR3	400kV Rampur (PG)	1	STM16
Total FOTE Requirement			68	

Addition/deletion of Locations within the provisions of contractual quantity variation may be undertaken during detailed engineering, The location-wise schedule for installation and commissioning of communication equipment shall be finalized during the engineering phase and shall be aligned with the approved OPGW installation schedule.

Table A-2 Corresponding links are the following for above mentioned FOTE locations

S. No	Region	Voltage level(kV)	Name of the Line
1	NWR	220kV	BASSI-BAGRU
2	NWR	220kV	BASSI-IG NAGAR
3	NWR	220kV	HIRAPURA-IG NAGAR
4	NWR	220kV	HIRAPURA-SANGANER
5	NR1	220kV	MEERUT-NARA
6	NR1	220kV	MEERUT-SHTBDNGR
7	NR1	220kV	MEERUT-SIMBHOLO
8	NWR	220kV	RAPPB-UDAIPUR
9	NWR	220kV	SIKAR-RATANGARH
10	NWR	220kV	SIKAR-SIKAR(RJ)
11	NR1	400kV	BAGPAT-DEHRADUN
12	NR1	400kV	BAGPAT-SAHARANPUR
13	NWR	400kV	BASSI-PHAGI (JAIPUR RRVNPL)
14	NWR	400kV	BASSI-SIKAR
15	NR1	400kV	HISAR-KAITHAL
16	NR1	400kV	MEERUT-BAREILLY
17	NR1	765kV	AGRA-JHATIKALA
18	NR1	765kV	BHIWANI-PHAGI(JPR) CKT-I
19	NR1	765kV	BHIWANI-PHAGI(JPR) CKT-II (separate line)
20	NR1	765kV	MOGA-BHIWANI
21	NR1	220kV	Kishenpur-Sarna
22	NR1	220kV	Salal-Kishanpur-III
23	NR1	220kV	220kV Sarna-Dasuya
24	NR1	400kV	Dehar (BBMB) - Rajpura (PSTCL) (LILO Portion)
25	NR1	400kV	Bhiwani (BBMB) - Rajpura (PSTCL) (LILO Portion)
26	NR1	400kV	Dehar-Panchkula (LILO Portion)
27	NR2	400kV	Panipat-Panchkula (LILO Portion)
28	NR1/ NWR	400kV	Ludhiana - Patiala
29	NR2	400kV	NALAGARH-Patiala
30	NR2	400kV	Uri 1 - Uri 2
31	NR2	220kV	Salal-Jammu-I
32	NR2	220kV	AGRA(PG)- BHARATPUR(RRVNPL)
33	NR2	220kV	220kV AGRA(PG)- SIKANDARA(UP)
34	NR2	220kV	ALLD-JHUSI(UP)
35	NR2	220kV	AUR-SIKANDARA
36	NR2	220kV	JHUSI(UP)-PHULPUR(UP)
37	NR2	220kV	KANPUR(PG) - RANIYA(UP)-1
38	NR2	220kV	KNP-MAINPURI
39	NR2	220kV	KNP-NAUBASTA
40	NR2	220kV	KNP-PANKI-II
41	NR3	220kV	KNP-UNCHR-III
42	NR3	220kV	RAIBRLY-CG CITY(UP)
43	NR3	400kV	AGRA-BHIWADI
44	NR3	400kV	BALIA-MAU 400kV
45	NR3	400kV	LUCKNOW-UNNAO
46	NR3	400kV	SINGRAULI-FATEHPUR
47	NR3	765kV	ALIGARH-JHATIKARA
48	NR3	765kV	KANPUR(GIS)-ALIGARH
49	NR3	400kV	NALAGARH-BANALA-I
50	NR3	400kV	Muzaffarnagar-Roorkee
51	NR3	400kV	Roorkee -Rishikesh
52	NR3	400kV	Malerkotla-Amritsar
53	NR3	400kV	Muzaffarpur-Gorakhpur
54	NR3	400kV	Lucknow-Gorakhpur
55	NR3	400kV	Meerut -Mandola

56	NR3	220kV	Meerut-(Mataur PG)-Modipuram (UP)-ckt 1
57	NR3	220kV	Meerut-(Mataur PG)-Modipuram (UP)-ckt 2
58	NR3	400kV	Hisar-Bhiwadi (Ckt-2 & 3)
59	NR3	400kV	Hisar-Bhiwani (Ckt-2 & 3)
60	NR3	220kV	Jalandhar-Dasuya (PSTCL)
61	NR3	765kV	Balia-Lucknow
62	NR3	400kV	Allahabad-Kanpur 2
63	NR3	400kV	Fatehpur-Panki
64	NR3	400kV	Bareilly-Moradabad (UP)
65	NR3	400kV	Bareilly -Moradabad at Rampur (PG)
66	NR3	400kV	Singrauli (NTPC)-Allahabad-3

-----End of Appendix-A1-----

