BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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CUSTOMER	**APGENCO**
PROJECT	**400/220 kV Switchyard,RAYALSEEMA,1*600 MW, Stage-IV, Unit-6**

FIBRE OPTIC TELECOMMUNICATION EQUIPMENT

(complete with all associated equipments, hardware and accessories)

CONTENTS

Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS

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SECTION 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITES

1.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing, dispatch, supervision of erection and site testing of SDH equipment, termination equipment & Telecommunication Management Network (TMN) complete with accessories as listed under this specification.

This section covers the specific technical requirements of SDH equipment, termination equipment & Telecommunication Management Network (TMN). This constitutes minimum technical parameters for the above item as specified by the customer (APGENCO). The offered equipment shall also comply with the General Technical Requirements for the project as detailed under section-3 of this specification.

The specification comprise of following sections:
Section-1: Scope & Bill of Quantities
Section-2: Equipment Specification
Section-3: General Technical Requirements
Section-4: Data Requirement Sheet
Section-5: Enclosures

In case of any conflict between various sections, **order of precedence** shall be in the same order as listed above.

1.1 THE EQUIPMENT IS REQUIRED FOR THE FOLLOWING PROJECT

Name of the Customer: **APGENCO**

Name of the Project: **400/220 kV Switchyard, RAYALSEEMA,**
1X 600 MW Stage-IV, Unit-6

Refer Section -3 for Project Details and General Specifications

1.2 SPECIFIC TECHNICAL PARAMETERS

As per Technical specification given in Section- 2 of the document

1.3 BILL OF QUANTITIES:

S. No.	Description	Unit	Quantity
1	Two directional Managed Synchronous Digital Hierarchy (SDH) type, long haul that can drive up to 240 km, STM-4 upgradable to STM – 16 OLTE with Primary Multiplexer	Set	1
2	Digital Protection Signaling Equipment	Set	2
3	Fiber Distribution Panels for termination of Fibers of 48F capacity	Set	1
4	Fiber Approach Cable (DWSM) of 24 Fiber capacity with HDPE pipe	km	1
5	EPAX (16/16) with 2 EI cards wired for 128 ports	Nos.	1
6	EPB Telephones	Nos.	10
7	6 pair PVC Copper Telephone cable	km	0.2
8	Single pair PVC copper telephone cable	km	0.2
9	4 ½ digit true rms Digital multi-meter	Nos.	1
10	Laptop with NMS software (Network Management System) loaded in it.	Nos.	1
11	Medium size tool kit consisting of a) Screw driver set with detachable bits (Taparia) b) Spanner set c) Cutting Plier d) Nose Plier e) Wire Stripper f) 25 Watts Soldering Iron (Soldran) g) 50 Watts Soldering Iron (Soldran) h) Crimping Tool 4/6/8 pin i) 3 ½ Digit Digital Multi-meter along with brief case	Set	1
12	OFC tool kit consisting of Fiber stripping tool and tools for cutting and stripping of sheathing, jacket armouring of OFAC/ADSS/OPGW cables including two binoculars	Set	1
13	Mandatory spare set of long haul OLTE and MUX (1 set shall comprise of 1 nos. of card, module and accessories of each Type)	Set	1
14	Mandatory spare set for EPAX (1 set shall comprise of 1 nos. of card, module and accessories of each Type)	Set	1

15	Mandatory spare set for Protection Coupler (1 set shall comprise of 1 nos. of card, module and accessories of each Type)	Set	1
16	Site survey, Design engineering, Design integration & FAT of communication equipment	LOT	1
17	Supervision of Site installation, SAT (Site Acceptance Test), System Integration & commissioning of communication equipment	LOT	1
18	Training charges for providing training to end customer on OLTE and other associated equipment at manufacturer's work place/ Site/ APGENCO HQ.	Man-days	140

Note:

1) Bidder shall submit Power Budget Calculation along with the offer.

2) Any other item like rack mounted DCDB, hardware, communication cable, jumper cable, power cable, krone tool, pre-connectorized optics, fibre patch cord etc. which are required for completion of project is deemed to be included in the offer.

3) Any other commissioning/ technical support required for system commissioning to the satisfaction of APGENCO / APTRANSCO / BHEL is deemed to be included in the offered price. No price implication shall be entertained during execution and handing-over of the project.

4) Integration shall be complete in all respects. Any software/hardware/database updates required for complete integration shall be deemed to be included in the scope of bidder.

1.4 UNIT PRICE OF ALL THE FOTE PANEL FITMENTS

The addition/ deletion to the scope shall be as per the breakup unit rates for all the FOTE panel fitments furnished with the offer.

1.5 TYPE TESTS

All the equipments shall have valid type test certificates as per relevant IS/IEC from recognized and well –reputed test laboratory. The type test reports submitted shall be of tests conducted within last 5 years prior to the date of bid opening (date of bid opening is 10/02/2011). In case any of Type tests have not been conducted on the offered design or there has been a change in the design after the type tests the requisite tests shall be conducted by bidder on the offered design without any extra cost and delivery impact to BHEL.

1.6 DRAWINGS AND SCHEME

The documentation requirements detailed under Section-3 shall be submitted to BHEL at various stages of contract. Softcopy of the drawings and schemes are to be submitted at contract stage. Preparation of AS- BUILT drawings is also in the scope of the bidder.

1.7 DOCUMENTS REQUIRED WITH OFFER

a) Clause wise confirmation/ comments.
b) Bill of Material.
c) Un priced schedule of Unit Prices
d) Filled up Guaranteed Technical Particulars
e) Catalogue and Technical Leaflets for the offered Equipments

1.8 INSPECTION AND TESTING

Factory acceptance tests (FAT), Inspection, routine tests & Quality assurance shall be as per approved Quality Plan by APTRANSCO/APGENCO/ BHEL.

1.9 48V DC SYSTEM

BHEL shall provide the following as free issue item to the bidder.

2 Nos. 48V, 40A Battery Charger
2 Nos 48V, 200AH Battery
2 Nos. 48V DCDB

Bidder to check the adequacy of the same while submitting the offer.

Any additional item or hardware or software which is not explicitly mentioned here but required for the successful operation of the FOTE to meet the system requirements is deemed to be included in the offer.

SECTION 2

SPECIFICATIONS ENCLOSED HEREWITH

SECTION-2A: TECHNICAL SPECIFICATIONS FOR SDH OLTE WITH MUX

SECTION-2B: TECHNICAL SPECIFICATIONS FOR APPROACH CABLE

SECTION-2C: TECHNICAL SPECIFICATIONS FOR EPAX

SECTION-2D: TECHNICAL SPECIFICATIONS FOR TELEPHONE CABLE

SECTION-2E: TECHNICAL SPECIFICATIONS FOR DIGITAL MULTIMETER

SECTION-2F: TECHNICAL SPECIFICATIONS FOR CLEAVER, STRIPPER AND BINOCULAR

a) Technical specifications for SDH Type Optical Line Terminal Equipment (OLTE) with integrated Access Multiplexer equipment

1.0 Design, manufacture, factory testing before dispatch, packing, supply, installation, testing and commissioning of SDH type optical line terminal equipment (OLTE) with a capacity of STM4 upgradable to STM16 with 1+1 path protection at optical level in each direction for signal transmission on 1310 nm & 1550 nm with Primary Multiplexer, DACS , Tele-protection equipment and combined NMS for voice, data and protection signaling etc. on the following 220 KV,132kV EHT line sections.

1.1 The digital multiplex equipment shall be designed to operate in electrical high-voltage networks and shall be suitable for installations in substations with harsh environment and high electromagnetic interference. it shall be highly reliable and provide secure communications for real time signals such as VOICE, SCADA, TELEPROTECTION, DATA including IP/ETHERNET and status/control signals. the equipment offered shall already be working successfully in telecommunication networks operated by power utilities. it shall comply with the latest ITU-T recommendations and ETSI standards and be able to be interconnected with legacy multiplex and other telecommunication equipment.

1.2 It is not the intent of this specification to specify completely herein all details of the design and construction of the equipment or materials to be supplied or services to be rendered. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous operation as per latest international standards, in hostile electrical environments prevailing near extra high voltage grid substations, in absence of any air-conditioning environment. The purchaser will interpret the meanings of drawing, documents and specification and shall have the power to reject any work or material, which in his judgment is not in accordance therewith.

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

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

1.4 The equipment shall be in line with current practice as followed by Dept. of Telecommunication (Govt. of India) or by internationally accepted practices for communication system.

1.4.1 All the tools and testing equipment etc required for installation, testing and commissioning of the system shall be provided by the successful bidder and the same shall be treated to have been provided in the bid prices. no additional claim shall be entertained by the purchaser at any stage of the contract.

1.6 **Integration:** It is the total responsibility of the bidder to integrate the entire supplied equipment with the existing communication system (~~PLCC, OLTE, OFC, MUX, EPAX and~~ RTU etc.) For transmission of speech, real time data the necessary information for integration will be furnished during engineering stage. However the bidder should supply any necessary cables, connectors etc required for integration without any additional cost.

SAS

1.7 Training of Purchaser staff :

The supplier shall be required to provide facilities for imparting training at no extra cost to 4 x 5 = 20 Engineers to be nominated by the purchaser (APTRANSCO) for OLTE and associated equipment at the manufacture's works place for one week. An important objective of training is to increase the ability to control, supervise and carry out maintenance work on plant and equipment supplied and installed by the contractor. The supplier shall provide boarding, lodging and transportation to the training place as a part of the contract without any additional financial commitment to APTRANSCO.)

1.8 Cabling:

All signalling cables within the telecommunication system, and the power supply cables are part of contractor's delivery and installation. Signal cables and power supply cables shall be placed apart from each other (minimum distance 150 mm). Redundant cables and cables to redundant equipment shall be placed in separate cable routes. All Contractor supplied inside plant cables and cable assemblies shall be constructed from non-PVC, fire/smoke resistant materials.

Whether called for specifically or not, all accessories (attenuators, patch cards, test probes etc) required for normal and satisfactory operation (as deemed fit by the purchaser) shall be considered to be a part of the tenderers basic scope of supply and no claim for extra payment will be accepted on these grounds.

1.9 Equipment Shelf:

An equipment shelf be provided to hold all equipment modules and shall provide a backplane for system power and inter module communications. The shelf shall be capable of being mounted on a standard EIA 19 inch rack. If more than one shelf is required at any site, multiple shelves shall be combined and shall function as one integrated node.

2.0 General technical requirements of OLTE & hardware

2.1.1 The equipment shall be modular in design, compact and composite construction including power supply, switching and control units.

2.2 The equipment shall be fully solid state, field proven and adopt state-of-art technology.

2.3 The mechanical design and construction of each unit sub-assembly shall be inherently robust and rigid under all conditions of operation, adjustment, replacement, storage and transport.

2.4 The equipment shall have self cooling arrangement. No forced cooling using fans etc. Is envisaged.

2.5 The equipment shall operate from a nominal 48VDC or 60VDC battery, positive grounded. The equipment shall work satisfactorily over battery voltage variations of +20% / –15% (40.8vdc - 72vdc). Redundant Power-supply (1+1 protection) shall be supported. The equipment shall support dual power feed i.e. that two power sources can be connected directly to the equipment (two connection points).

2.6 The plug in units, whose removal or insertion, when in operation might endanger the reliability or performance of the units, shall have suitable protection.

2.7 All important switches/controls on front panel shall be provided with suitable safeguards such as interlock system to avoid accidental operation by the maintenance personnel.

2.8 The equipment shall be made vermin proof, protected against dust and insects. The indoor equipment shall conform to IP52 and outdoor equipment to IS-2147.

2.9 The equipment shall be able to work in saline atmosphere in coastal areas and should be painting of provided against corrosion.

2.10 All components shall be easily accessible for testing. Similarly all bays and bay panel wiring shall be easily accessible.

2.11 Special tools required for wiring are included within the scope of the specifications and shall be provided along with the equipment.

3.0 Operational requirement.

3.1 Each sub-assembly shall be clearly marked to show its function, schematic reference so that they are identifiable from the component layout diagram in the handbook.

3.2 Maintenance philosophy is to replace faulty units after quick analysis of monitoring and alarm indications and built-in test equipment. The actual repair will be undertaken at suitable centralized repair centre. The installation at site shall involve simply plug - in connection only.

3.3 Each station shall be provided with alarm interface card to take up to 8 external alarms (say air conditioned failure etc.)

3.4 The healthy, unhealthy and change of status condition of the units shall be displayed by LEDs and also should be seen from the Network Management System (NMS).

4.0 GENERAL

The fiber optic equipment supplied under this project shall be based on the Synchronous Digital Hierarchy (SDH) technology. The SDH system shall be designed for digital transmission using single mode fiber optics and shall comply with ITU-T G.707. The telecommunication network shall mainly use fiber optic system including optical SDH equipment and associated accessories.

The SDH equipment shall be an ultra-compact, carrier class, and cost effective bandwidth provisioning equipment designed to manage and deliver services from the optical core to the access.

The SDH equipment shall be configured as a Terminal Multiplexer (TMUX), Add-Drop Multiplexer (ADM), and In-Line Amplifier or as stand-alone Cross-Connect.

SDH equipment shall be a STM-4/16 platform, has been envisaged to address the growing demand for an ultra-compact STM-4/16 Add-drop Multiplexer (ADM) and provide Ethernet-over-SDH/SONET mapping functions, including Link Capacity Adjustment Scheme (LCAS) with Virtual Concatenation (VCAT).

The SDH equipment shall support the following interfaces—STM-1o/e, STM-4o, STM-16o, E1/DS1, E3/D3 and 10/100BaseT/x and GE Interfaces.

SDH equipment shall be configured in various topologies such as linear, ring and bus.

The multiplexing structure of the proposed SDH equipment shall permit the extraction of individual circuits from high capacity systems having a the whole STM-4 frame. 1+1 Cross Connect facility shall be provided to enable interconnection between different channels and network components. The SDH equipment shall consists of redundant cross connect card with STM-4 optical interfaces and interface slots for equipping E1 and Ethernet interface modules.

The SDH optical multiplexer equipment shall perform both multiplexing and optical line terminal functions. All features and functions of the SDH multiplexer equipment shall be readily software configurable to suit operational requirements of the fiber optic communication system.

All optical SDH ports shall support SFPS (small-factor pluggable unit) for short, medium, long and extra-long optical communication. ALS (automatic laser shut-down) shall be fully supported.

4.1 SDH EQUIPMENT:

The rack mountable STM-4 system shall be capable of offering both data and TDM and Ethernet services on a single platform.

STM-4 up-gradable to STM-16 equipment shall be provided with STM-4 optical interfaces, n x 63 E1s, n x 8 port 10/100 Mbit/s, L2 Ethernet interfaces and Gigabit Ethernet interface.

SDH STM-4/16 equipment should be equipped with 1+1 protection for cross connect & timing module. System should provide STM-4/16 interfaces on each of the cross connect cards configurable as 1+1 MSP and SNCP.

The SDH transmission equipment shall be a next generation optical system capable of transporting both circuit based TDM traffic as well as packet based data traffic and shall be capable of being configurable in linear, 1+1 linear and ring configuration

The SDH equipment shelf should provide spare slots for equipping STM-16 (electrical / optical) interfaces in future.

SDH STM-4 equipment shall be up-gradable to STM-16 by changing the optical interface (SFP) without replacing the common control cards.

The SDH equipment should be multi-service provisioning platform with add/drop, terminal and cross-connect functionality for universal installation at all network levels and shall be capable of supporting regeneration in the same platform.

The SDH equipment shall support GFP –F encapsulation for Ethernet data. It shall support Status Message Scheme(SSM) for SDH timing. Network protection timing shall be as per ETSI/ITU

4.2. Cross Connection Capability of the SDH Equipment

SDH equipment switching matrix shall be provided in 1+1 redundant configuration and shall support for fully non-blocking cross connections:-

a) Cross-connect capability with a granularity of VC-4, VC-3 and VC-12 bit rate

b) The cross-connects are non-blocking and can be created dynamically between STM rings terminating on the SDH network elements.

It should allow direct mapping of any 2 Mbps into any STM-4 aggregate.
The equipment shall be equipped with redundant, decentralized cross-connection functions. The cross-connect capacity shall be at least 40x 2Mbit/s (i.e. 1200x 64kbit/s) and non-blocking. For high-density applications the cross-connect capacity shall be upgradeable up to 128x 2Mbit/s with a granularity of 64kbit/s. Cross-connection shall be possible at line to line, line to tributary, tributary to line, tributary to tributary.

4.3 Optical Aggregate Interfaces

The multi-service SDH transport system shall support multiple optical interfaces in the same platform. The interface should be compliant with ITU-T G.957 SDH specifications.

It should support for 1+ 1 MSP on STM 4/16 level and SNCP on VC-12/VC-3/VC-4 level.

Access Interfaces

The offered SDH STM-4/16 equipment shall support following service interface modules:-

A) Cross-connect and timing and control system redundancy cards .
b) STM-4 Optical Interface card
c) 32x E1electrical interface card
d) 8 port FE Layer 2 Ethernet interface card

SDH 4 x E1 Interface Card (32xE1/DS1)

The E1 interface card shall provide line interfaces to 32 E1 channels respectively in both add and drop directions.

The E1 interface card shall have two Euro connectors at the front providing an interface for 32 and 31 E1/DS1 channels respectively. Status and Active LEDs are provided to indicate the power on and working status of the E1 interface card.
E1s shall be drawn from SDH eqpt. only and PDH eqpt. should not be used between SDH eqpt. and Primary MUX.

4.5 8xFE Switching Card (STM4 backhaul)

Ethernet interface module shall provide 8 LAN ports 10/100 Base-T (RJ-45) and two (2) SFP slots for GE interfaces.

Ethernet interface card shall be a tributary interface card, which provides line interface to 8x10/100 Mbps (FE) Ethernet ports. In addition to supporting EOS applications with an uplink bandwidth of STM-4, The Ethernet card shall capable of switching at L2 level and doing traffic classification from L2 to L7 level.

Status and Active LEDs shall indicate the power on and working status of the Ethernet interface card.
Ethernet L2 services EPL, EVPL, ELAN services with the following features shall be supported:

a) It shall support auto-negotiation feature.
b) At least eight 10/100 Mbps Tx/Fx Ethernet ports
c) IEEE 802.3 Flow Control
d) Support for dynamic provisioning using LCAS as per ITU-T G.7042.
e) VLAN tagging and priority as per 802.1 p/q
f) Advanced layer 2 protection
g) Spanning tree protocol as per 802.1d
h) Rapid spanning tree protocol as per 802.1 w
i) Multiple spanning tree as per 802.1s
j) VLAN, MAC learning and forwarding

4.6 SDH Capabilities

SDH equipment shall support 1+1 MSP function on STM-4 interface. SDH equipment shall provide bidirectional and unidirectional SNCP at VC-12/3/4 levels.

SDH equipment shall support GFP-F□ITU-T G.7041/Y.1303□encapsulation for Ethernet data.

SDH equipment shall support VC-12/3/4 - xv virtual concatenation (ITU-T G.707/Y.1322)

SDH equipment shall support LCAS (ITU-T G.7042) at VC12/3/4 -xv level, which shall provide dynamic bandwidth adjustment.

It should support the synchronous status message scheme (SSM) for SDH timing

SDH equipment shall support DCC transparency function. By using D1-D3 or D4-D12 channels, SDH equipment shall transparently pass through the management information of third party NEs.

The SDH equipment shall support EOW interface using E1, E2 channels.

To prevent personal injury form emerging laser light in the case of the fiber break, SDH equipment shall support Automatic Laser Shutdown (ALS) function according to ITU-T G.958 and ITU-T G.644.

E1 Interface Card (4/7 E1/DS1) Path protection

The equipment shall provide means to protect 64kbit/s channels. The protection shall be end to end from one interface (telephone, data, protection signaling) to the other. It shall switch automatically from the main channel to the standby channel. It shall be configurable whether the system switches back to the main channel (reversible switching) or not (non-reversible).

If a path has switched to its standby route because the main route is disturbed this shall be indicated with an alarm. the switching shall be done within the multiplexer without using the network management system.

4.8 1+1 section protection

The equipment shall provide means to protect STM-4 (MSP). It shall be possible to use two independent links: one as the main and the other as the standby. The system shall automatically switch to the standby connection and generate an alarm if the main connection is disturbed.
The switching shall be done within the multiplexer without using the network management system.

4.9 Synchronization and Timing

SDH equipment shall derive its clock from the following source:

Line-timed mode: In this mode, SDH equipment shall derive its clock from any one of the E1/DS1 tributaries or STM- 4/16 (OC-3/12) signals.

Externally timed mode: In this mode, an external 2048 KHz or 2.048 Mbps signal shall be used as the clock source.

Holdover mode: In this mode, SDH equipment shall use the stored timing data to control the output frequency for a short duration (of around 24 hrs). Beyond this it shall use its own internal oscillator in a free-running mode.

4.10 Protection

4.11 Equipment Protection Switching

Equipment protection switching shall accommodate various hardware failures while the transport facility is still functional. In an event of hardware failure, the hardware shall be substituted without affecting the traffic.

4.12 Cross-connect Card Redundancy

The SDH equipment shall facilitate the cross-connect redundancy by having main and standby cross-connect cards. Software on each cross-connect card decides which cross-connect card is the active controller. The active cross-connect card takes control of all the processor bus signals on the backplane. The processor bus is shared across all the tributary cards.

All the traffic related devices on each cross-connect card is always under the control of the active cross-connect card.

4.13 Power Supply Redundancy

The SDH equipment shall have two power supplies to facilitate power supply redundancy. The output of both the power supplies are shorted together on the backplane and then in turn given to all the cards.

SDH equipment shall be powered from DC power sources. The power supply card shall support -48 V (range –40.8 V to -72 V) DC power.

There shall be two power supply slots located on the chassis for equipping the power supply modules.

SDH equipment shall support multiple layer network protection functions and multiple layer protection escalation. The network protection functions supported shall be as follows:

a) MSP 1+1 protection at STM-4/16, Unidirectional or bi-directional, revertive or non-revertive modes, in compliance with ITU-T G.783/841
b) SNCP at VC-12, VC-3 and VC-4 levels, single ended, non-revertive and revertive in compliance with ITU-T G.783/841.
c) The switching time for above protections in case of failure shall be less than 50 milliseconds
d) LCAS protection
e) Rapid Spanning Tree Protocol (on cards incorporating layer 2 switching capabilities), in compliance with IEEE 802.1w, Spanning tree protocol shall prevent against loops at the Ethernet level of the network while providing L2 protection.

The optical line terminal equipment (OLTE) shall convert 'at the send end' STM-4 digital signals based on the 2048 kbps hierarchy, into optical signal for transmission over an optical fibre media and perform the reciprocal function on the receive side. Separate fibres shall be used for transmit and receive. Transmit/receive on single fibre is not acceptable.

4.15 OLTE shall comprise following modular units.

Transmit unit
- Code converter (transmit),
- Optical transmitter,

Receive unit
- Optical receiver,
- Code converter (receive),

Miscellaneous units
- Alarm control unit,
- Protection switching,
- Order wire unit/ service data interface unit
- Power supply unit.

4.16 Optical transmitter and receiver

The type of opto-electronic devices proposed shall be stated by the tenderer and shall be to the approval of the APTRANSCO. Data concerning the reliability of the opto-electronic devices, accelerated tests of device life time and mean time between failure (MTBF) calculations etc shall be submitted for approval.

Full automatic gain control (AGC) shall be provided for the optical receiver to cover a wide range of input levels, due to various cable lengths, and to provide temperature compensation of the detecting device.

The output power of the transmitter optical device and optical power at the receiver shall be designed such as to provide the same mean BER in each section as specified in this tender.

Bidder shall submit power budget calculation along with the offer.

4.17 Code converter (transmitter)

The code converter (transmitter) shall regenerate and equalise the ITU-T standard coded signal received from the digital multiplexer equipment and convert this to binary bit stream. Overhead bits for the service data channel shall be inserted into the aggregate data stream before conversion to the chosen optical signal code.

4.18 Code converter (receiver)

The code converter (receiver) shall convert the received optical signal to binary form and extract the overhead bits for the service data channel before further conversion to the ITU-T standard code used at the remote transmitter. The standard coded signal shall then be passed to the digital multiplexer equipment.

4.19 Alarm control unit

The operating conditions at each terminal and at each repeater shall be monitored by an alarm control unit associated with that equipment. This information shall be transmitted to each terminal equipment for processing via the service data channel. It shall ascertain alarm conditions to be detected and a command shall be given to the protection switching to changeover to the stand-by system. The following system faults shall cause line switching to occur:

- Loss of optical input signal,
- Loss of optical output signal,
- Loss of synchronisation,
- Excessive bit error rate.

4.20 Protection switching

The OLTE shall be equipped with two optical transmitter/receiver pairs (one used as normal system, the other as stand-by system) connected to two different fibres on the transmission side, and to another two on the reception side.

On receipt of a command from the alarm control unit, the protection switching shall automatically transfer all traffic from the normal to the stand-by system. Traffic shall resume on the normal transmission system when the fault detected by the alarm control unit has been cleared. Provision shall however be made to permit traffic to stay on the stand-by system until a fault occurs on the stand-by system, even if the normal system is restored to a healthy condition.

Provision shall also be made for traffic to be forced switched by bypassing the control circuit with a manually operated switch. Switch over shall also be possible by a remote command issued from a centralised fault supervision system.

Equipment entering the redundant state shall initiate alarm indications and shall also initiate the changeover signal. The switching criteria in the automatic mode shall be based on the following fault conditions being detected within the system:

- An alarm initiation signal (AIS),
- Loss of incoming signal (LIS),
- Bit error rate (BER) > 5×10^{-4}

Both AIS and LIS shall be considered as major fault conditions. The status of all signal path switches shall be indicated on the equipment. Switching shall be completed within 50 ms from time of detection of fault condition that initiates the protection switch to time of changeover of signal path.

4.21 Engineer order wire telephone

In order to facilitate maintenance of the fibre optic communication system, an order wire telephone channel shall be provided. Selective calling, using dual tone multi-frequency (DTMF) signalling, shall be provided.

The engineer order wire telephone signal shall be PCM to produce digital signals at 64 kbits/s. These signals shall be presented to the service data interface for inclusion in a composite signal to be processed by the code converters for transmission in the service data channel.

This 64 kbps channel shall be over and above 8MBPS transmission capacity of the equipment.

4.16 Code converter (receiver)

4.22 Clock signal:

The system shall have its own internal clock for synchronisation purpose. Also it shall have the capability to regenerate clock signal from the 2 Mb stream received from nearby station. The system shall also accept external clock signal to be given from any reference station.
The priority of working of the clock signals is as below:

1. External clock from reference station.
2. Clock regenerated from 2 Mb stream
3. Internal clock

5.0 DIGITAL DISTRIBUTION FRAME.

Digital distribution Frame with a capacity of 63 E1s shall be provided. Initially, DDF is terminated with 32 E1s (E1 Tributary capacity) with all necessary cables and connectors both for transmitter and receiver. Interfacing cables for 32 E1s shall be provided with connectors for SDH equipment side to interface with the Multiplexes or existing fibre optic equipment in APTRANSCO.
All suitable Connectors for both ends along with 100 metres cable and 2 Nos. Crimping tool shall be supplied as mandatory spare to terminate spare E1s in future.

6.0 SNMP COMPATIBILITY:

The offered equipment under the present project(OLTE, MUX and Digital Tele-protection eqpt.) shall be compatible to SNMP (Simple Network Management Protocol). It shall be able to integrate to the third party Network Management system. The supplier shall handover the MIB (Management Information Base) file of the offered equipment to APTRANSCO and shall extend his cooperation for integration of the equipment to the 3rd party Network Management system during the execution of the project or after. The supplier shall show demonstration on how he is going to integrate his equipment to the one of the existing NMS available with APTRANSCO. The bidder can view the existing NMS at APTRANSCO with a prior intimation and approval before bidding.

7.0 Technical specifications for multiplexer (MUX) equipment

The telecommunication system to be offered shall comprise of optical fibre system which is intended to be used for:

- Voice communication.
- Tele-protection signalling.
- Data transmission.
- Facsimile communication.
- Video conferences

7.1 Multiplex equipment (MUX) PCM:

- The equipment shall be designed and tested in accordance with ITU-T G.742 and G.823 recommendations. Shall be provided with optical interfaces for distance and differential protection (IEEEC37.94)

The 2 MBPS multiplexer shall be standard PCM multiplexer, providing 30 digital and/or analogue channels with associated signalling, in accordance with ITU-T G.711, G.712, and G.732 recommendations. The equipment shall be provided with redundant power supply module. At each station the PCM MUX shall be provided suitable for 120 channels so that in future the channel capacity can be increased by just inserting the interface modules.

PCM multiplexer should take one clock input of 2 MHz for synchronization and shall able to give at least one-clock outputs for synchronization of other equipment in a station.

The equipment shall serve as the basic system for the higher digital hierarchy levels in accordance with ITU-T G.702 recommendation. Digital interfaces at 64 kbits/s and 2,048 kbits/s shall be provided in accordance with ITU-T G.703 recommendation.

PCM transmission shall be based on a sampling rate of 8,000 samples/s of each incoming VF element. The encoding law used shall be a-law using 8 binary digits per sample, thus generating a 64 kbits/s signal in accordance with ITU-T g.711 recommendation.

32 channels of 64 kbits/s each, transmitted in 32 time slots of 8 bits per frame, shall build up to a digital bit stream of 2,048 kbits/s. 30 channels, corresponding to 30 time slots, shall be for speech/ data channels. Time slot # 0 shall be used for frame alignment and remote supervision whilst the remaining timeslot (timeslot #16) shall be used for channel associated telephone signalling.

Signalling units shall be provided at both subscriber and exchange ends of the system for PCM line working. The type of signalling unit shall be as stated in the technical specifications.

The rated supply voltage shall be 48 to 60V DC, however the equipment shall be able to work in the range of 48 V (-15%. To +20%)

The multiplex and signalling equipment shall be equipped with circuits to detect at least the following:

- Loss of incoming signal (2,048 kbit/s),
- Loss of frame alignment,
- Bit error rate (BER) greater than 10^{-3},
- Alarm indication signal (AIS) detection,
- Failure of 64 kbits/s interface (signalling only),
- Failure of power supply.

The speech companding law employed in encoding and decoding shall follow the logarithmic A-law with the value of A=87.6 and approximated by 13 segments. Single channel code structure is preferred. The MTBF shall be $\leq 10^5$ hours at operating temperature conditions. The tenderer shall indicate the MTBF at standard temperature conditions.

The PCM multiplexers shall be installed in same distribution rack as that for OLTE.

Digital interfaces at 2,048 kbits/s shall be provided in accordance with ITU-T G.703 recommendation.

Signal bit rates shall be 2,048 kbits/s +/ - 50ppm and signal code format shall be HDB3. The impedance shall be 75 ohm unbalanced.

Loss of frame alignment shall be considered to have occurred when 4 consecutive frame alignment signals are incorrectly received in their predicted positions. When 3 successive frame alignment signals are correctly detected, the system may be deemed to have regained frame alignment.

In a given frame, the status of the cyclic bit contained in the justifiable digit time slot associated with a particular tributary shall be indicated by means of 3 relevant justification control bits, in accordance with table 1 of ITU-T G.742 recommendation. Positive justification shall be indicated by the signal 111; and no justification by the signal 000.

The maximum permissible limits of jitters at the 2,048 kbits/s interfaces shall be in accordance with table 1 of ITU-T G.823 recommendation.

With the following input signals encoded in hdb3 format, at a bit rate of 2,048 kbits/s ± 50ppm, connected to any 2,048 kbits/s input port, the error rate introduced at the corresponding 2,048k bits/s output port, shall be less 5.10^{-11} :

- a rated aggregate signal
- a repetitive signal having a block length of 8 bits,
- an all binary zeros signal,
- an all binary ones signal.

This requirement shall be met for all signal conditions on the remaining 2,048 kbits/s input ports. The output tributary bit rates of all tributary outputs shall remain within 2,048 kbits/s ± 50 ppm when any 2,048 kbits/s input tributary signal is lost.

With the following conditions at one or more input ports, the remaining tributaries shall continue to function within their specified limits:

- no input signal,
- input signal outside the limits of this specification,
- removal or insertion of any of the tributary cards other than those cards appropriate to the tributary under test.

The following fault conditions shall be detected and alarm indications provided, in accordance with clause 10 of ITU-T G.742 recommendation:

- failure of power supply,
- loss of incoming, 2,048 kbits/s tributary system at input port,
- loss of frame alignment, alarm indication signal (AIS) from remote multiplex equipment.
- bit error rate (BER) greater than 10^{-3},
- failure of multiplex-demultiplex timing,
- failure of 2,048 kbits/s AIS clock,

All the E1s shall be derived from the SDH frame only and no PDH shall be used. E1 Tributary card shall be an integral part of the SDH eqpt
All equipment shall be of modular construction and installed in the same distribution rack as of the OLTE. They shall be wired for their maximum capacity at 64 kbps & 2 Mbps level; future extension shall be possible by simple field installation of the appropriate modules.
For testing purpose remote/local loop back at 64 kbps as well as at 2 Mbps shall be possible by using software. Bidder shall explain how the testing will be carried out by using these loops.

The rated supply voltage shall be 48 to 60 V DC, however the equipment shall be able to work in the range of (-48 -15% to +20%) V DC. Redundant power supply shall be provided.

The equipment shall be compatible to the existing one in order to cater for any upgrading without limitation. at present 2 mbps system is envisaged. Synchronisation at 2 Mbps level with external signalling received from the existing OLTEs shall be possible.

Equipment at each end station shall be capable of providing 60 channels so that number of drop/insert channels can be increased in future by just inserting the interfacing modules.

Bidder shall provide the full capacity termination for unused 2 Mbps signals at each station which shall provide transparent 2 MBPS interfaces for transmission of 2 Mbps signal from these stations to other directions.

Configuration of MUX equipment shall include the following interface cards at each station:

1. Voice frequency modules suitable for 2 hot lines.
2. Voice frequency 4W E&M modules suitable for min 16 ports
3 .G.703 data interface modules suitable for min 4 ports
4. V.35 data interface modules suitable for min 4 ports of n x 64 kbps
5. V.24 / V.28 data interface module suitable for min 4 ports.
6. V.11 data interface module suitable for min 4 ports
7.External Alarm interfacing for 8nos.

7.2 MAIN DISTRIBUTION FRAME

Main Distribution Frame with a capacity of 100 krones for termination of voice and data circuits shall be provided. Subscriber lines and Trunk lines are to be terminated on the MDF on one side of the terminal-block with the legend of the terminal connections clearly indicated in alphanumeric. The MDF shall be provided with individual surge protection.

Krone tag blocks are preferred to be used for the MDF. The supply of relevant wire terminating tool (Krone tool) shall be supplied.

All the subscriber lines and the trunk lines shall be provided with surge protection. Invariably suitable surge protectors in the form of Gas discharge tubes and fuses are to be provided to protect electronic circuitry of the MUX equipment from the damages due to external surges /spikes. Minimum maintenance and free workability on the equipment is to be ensured.

8.0 Network Management System

The Network Management System shall be common for primary OLTE, multiplexer and Digital Tele-protection equipment. The hardware platform shall be PC based. The man machine interface shall use mouse and window technique. The software of MIB file of OLTEs, MUX and Digital Tele-protection equipment should be provided to interface with existing NMS of APTRANSCO.

The network manager shall be able to address any of the primary multiplexer and second order multiplexer. The network manager shall have four levels of interaction with password protection limiting the access to the users. From the software it shall be possible to program the multiplexers, do the level settings etc without any necessity of hardware settings. It shall be possible to do the monitoring and configuration of remote network element from NMS station. The necessary embedded operation channel for the NMS shall be provided by the bidder. This embedded operation channel shall be in addition to the engineer order wire mentioned elsewhere in the specification. It shall be possible to remotely configure the system from the master station upto 64 kbps level thus obviating the need for any handheld terminals at other stations.

The NMS program shall be based on windows with its well known mouse operated "pull down menu and interactive communication box technology. By using embedded data channel it shall be possible to configure all network elements remotely from NMS.

The main objectives of the NMS software are:

- Checking the user authorization and allow/deny access to the user
- Display of the SW version
- To be used as a tool to write and store the configuration files
- Control the interactions between pc and communication equipment
- Identification of particular communication equipment
- Loading the configuration data to the database of the communication equipment
- Copying the database of the equipment and convert/store it as a configuration file
- Allow temporary changes of the configuration for test purposes
- Setting individual parameters
- Printing reports
- It must support to integrate with existing NMS.

CONFIGURATION FOR LAPTOP PC

Laptop PCs to be supplied under this specification shall meet the following requirements:
Make: IBM / HP / DELL or equivalent
Processor: Intel core-II Duo E8400 (3.00 GHz 6 M cache)
RAM : 4 GB DDR SDRAM
HDD :500GB
Graphics :512MB
DVCD/RW combo, Built in webcam
Serial ports: 2 Nos.
USB ports: 2nos.
Built-in modem,
Intel 10/100 MBPS Ethernet
Ultra NAV (touch pad + track point)
Intel pro/ wireless network connection 802.11b/g
Monitor: wide Screen (15")

Power adaptor: suitable to operate on 230 V AC and with battery backup for four hours.
Carrying case: Good leather carrying case with safety belts.
Thumb memory: 32 GB

Software: Windows XP professional, driver software, anti virus s/w.
Laptop PCs shall be loaded with OLTE / MUX equipment software and tested for monitoring of the equipment. Necessary interfacing cables and connectors shall also be supplied along with the equipment. However the bidder shall choose the relevant operating system software suitable for running the equipment software for monitoring the OLTE / MUX equipment.

10.1 Installation of OFAC:
Installation in cable trenches and on cable trays.
Each OFAC shall be pulled in HDPE pipe of 40 mm diameter and required thickness (mm) placed in cable trench (separate trays for OFAC's). There shall be spare HDPE pipes for the OFAC's to be decided by the Purchaser. The pulling instructions and minimum-bending radius shall be indicated by the bidder. The route for laying the OFAC shall be decided by the contractor in consultation with the Purchaser. Contractor shall terminate the fibres in Fibre Distribution Panel and OFAC shall be spliced with OPGW at the gantry.

10.2 Burial.
In the case of direct burial the OFAC shall be installed in HDPE pipe of 75 mm diameter and required thickness (mm) to a depth of 1.0 m . The pipe shall be embedded in M 15 concrete with cover of 37.5 mm (150 mm overall) and the trench filled with excavated material and hand compacted. The route for laying the OFAC shall be decided by the contractor in consultation with the Purchaser. The supply and burial of the pipe is the responsibility of the contractor.

11. PIGTAIL CORDS.
The pigtail cords will be used for the interconnections of the approach cables with the respective optical terminal equipment. The optical fibres of the pigtail cords and approach cable shall be fusion spliced and protected in an approved type terminal box.

On the optical equipment side, FC-PC type optical connectors shall be used. Insertion loss shall not exceed 0.5 d B and return loss shall not be less than 35 dB. **The pigtail cords with optical connectors, terminal boxes and flexible corrugated tubes are an integral part of the scope of supply of the UG OFC/OFAC manufacturer.** The technical specifications of the pigtail cord with a connector, terminal box and of the tubing offered shall be provided with the bid.

TECHNICAL SPECIFICATION

DIGITAL TELEPROTECTION EQUIPMENT

11.0 Protection signalling equipment (compatible to fibre optic equipment)

The protection signalling equipment is intended for providing (i) intertripping (ii) direct tripping (iii) blocking commands OF HV lines.

Digital protection signalling equipment shall be provided which shall be suitable for communicating through fibre optic equipment.

Digital Tele-protection coupler equipment shall be an integral part of offered OLTE & MUX equipment for the links as specified in item no.1 of schedule of requirement. Digital Tele-protection equipment shall be provided with visual trip counters event registers to register events which can be down loaded in to pc or laptop.

The protection signaling equipment shall have digital electrical output preferably V.11 or V.35 interface. Bidder shall quote for protection signaling equipment suitable for 8 commands with trip counters event registers in each equipment and suitable for transmission on V.11 or V.35 electrical interface .

High security and dependability shall be ensured by the contractor. probability of false tripping and failure to trip shall be minimum. curves / figures indicating above-mentioned measures shall be submitted with the tender proposal.

if not otherwise stated routine and type tests of the protection signalling equipment shall consider the IEC recommendations and suggestions of the latest revision.

11.1 Principle of operation during normal operation protection signaling equipment shall transmit a secured guard code. in case protection signaling equipment receives one or more command it should interrupts the guard code and shall transmit the command code in sequence. the receiver recognizes the command code and absence of the guard code and generates the command.

All signal processing i.e. the generation of tripping signal and the evaluation of the signals being received shall be performed completely digitally by using dsp. the digital techniques thus employed obviate any need for calibration.

11.2 Loop testing an automatic loop testing routine shall cyclically checks the Tele-protection channel. the test signal shall be transmitted in the same way as the genuine tripping signal shall be recognized by the receiver and shall be reflected back to the transmitter. in case test signal does not reach the transmitter the test should be repeated automatically for atleast 5 trials and alarm should be given in case the test still fails.

It shall also be possible to initiate a loop test manually at any station by pressing a button on the front of the equipment.

Internal test routine shall continuously monitor the availability of the protection signaling equipment.
Proper tripping signal shall always take the priority over the test procedure.

The high speed digital protection signaling equipment shall be designed and provided with following features.

- shall employ latest digital signal processing technology.
- shall be able to monitor through same NMS of OLTE & MUX equipment. i.e. Digital Tele-protection equipment shall be an integral part of OLTE & MUX eqpt. for the offered OLTE & MUX equipment if required digital protection coupler shall also be interface with optical interface to the MUX equipment.
- shall be provided with redundant power supply unit
- Shall be provided with optical interfaces for distance and differential protection (IEEEC37.94)
- shall work in conjunction with PCM multiplexer
- it shall communicate on 64kbps channel preferably on V.11 or G.703.
- all I/Os electrically isolated
- full duplex operation
- permissive tripping
- direct tripping
- blocking, unblocking
- auto loop test facility shall be provided
- should meet IEC 834-1 standard
- shall provide an interface facility to connect handheld terminal or pc for indicating status, alarm messages, and transmission time etc.
- shall have the addressing facility
- shall able to transmit upto 8 commands in one 64 kbps channel
- transmission time shall be < 7ms.
- the tele protection eqpt. shall be able to programmed through handheld terminal / pc.
- the Teleprotection equipment shall have a visual contains.
- Visible counters for each command (Input/Output should be provided.

12.0) Protection signaling equipment design

The Tele-protection equipment shall be of modular construction and shall be an integral part of the optical terminal multiplexer eqpt and shall be completely solid state using semiconductors, micro-processors and self-supervision, providing alarms in the case of equipment failure (TX / RX), absence of the guard frequency signal, power supply failure, etc.

The input/output interface to the protection equipment shall be by means of relays and the input/output rack wiring shall be carefully segregated from other shelf/cubicle wiring.

The isolation requirements of the protection interface shall be for 2 kv rms.

12.1 each tele-protection equipment shall be supplied with redundant power supply unit.
all command channels are operationally independent from each other and they meet the following performance characteristics:

- ❖ equipment operating time < 6 ms (8 channels)
- ❖ probability of missing command p_{mc} (at ber < 10^{-3}) <10^{-9}
- ❖ mean time between unwanted commands
  (at t_{ses} < 0.005 % and t_{es} < 0.1 %) 100000 a

The error control procedure in the 64 kbit/s channel is based on the use of a block code specifically developed to be used for tele-protection signaling via telecommunication networks based on the ITU-T recommendations. the error control procedure includes a means to identify the origin of the incoming 64 kbits / s.

command-type Tele-protection applications are normally placed in three categories according to the nature of the information conveyed by the Tele-protection commands: permissive, blocking and inter-tripping schemes.

The Tele-protection signaling equipment shall be managed from network management system of primary multiplexer.

The Tele-protection equipment shall be provided with trip counters for both TX and RXcommands in the form of event register.

Main characteristics:

64 kbit/s interface :

The 64 kbit/s interface meets the requirements of the ITU-T recommendation G.703. both timing modes, co-directional and contra-directional, are provided.

Command interfaces:

Command inputs:

The command inputs should be galvanically isolated inputs, which generate internally the operating voltage for the input circuit.

a) potential free contacts (via internal dc-dc converter with nominal operating voltage 24 VDC)
b) operating current 10 ma
c) wetting current 15 ma

Command outputs :

The command outputs should be galvanically isolated outputs. each output has one MOS-FET changeover contact.

a) nominal operating voltage 250 VDC or AC
b) maximum switching power 100 VA
c) maximum switching current 1 A

12.0 Protection signal Unequipped System Command interface-related requirements:

All interfaces with the protection relay logic comply with the following requirements of IEC 255 / IEC 834-1.

Command inputs:

Insulation resistance >100 mohm (measured at the voltage of 500 VDC)

A) isolation voltage test voltage 1 kv AC / 1 minute
B) impulse test voltage 1.2/50 ms 2 kv (differential and common mode)
C) high frequency disturbance test 1.0 kv (differential mode)
D) high frequency disturbance test 2.5 kv (common mode)

Command outputs:

A) insulation resistance >100 mohm (measured at the voltage of 500 VDC)
B) isolation voltage test voltage 2 kv AC / 1 minute
C) impulse test voltage 1.2/50 ms 2 kv (common mode)
D) high frequency disturbance test 2.5 kv (common mode)

Operating voltages: -20 to –70 VDC

13.0 TYPE TESTING

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

A) All cable & equipment being supplied shall conform to type tests as per technical specification.
B) The test reports submitted shall be of the tests conducted within last five (5) years for telecom equipment prior to the date of bid opening. In case the test reports are older than five years (5) for telecom equipment on the date of bid opening, the contractor shall repeat these tests at no extra to the purchaser.
C) The contractor shall submit, within 30 days of contract award, copies of test reports for all of the type tests that are specified in the specifications and that have previously (before contract award) been performed. These reports may be accepted by the employer only if they apply to materials and equipment that are essentially identical to those due to be delivered under the contract and only if test procedures and parameter values are identical to those specified in this specifications carried out at accredited labs and witnessed by third party / customer's representatives.

   In the event of any discrepancy in the test reports or any type tests not carried out, same shall be carried out by contractor without any additional cost implication to the employer.
D) Type tests shall be certified or performed by reputed laboratories using material and equipment data sheets and test procedures that have been approved by the employer. The test procedures shall be formatted as defined in the technical specifications and shall include a complete list of the applicable reference standards and submitted for employer approval at least four (4) weeks before commencement of test(s). The contractor shall provide the employer at least 30 days written notice of the planned commencement of each type test.
E) The contractor shall provide a detailed schedule for performing all specified type tests. These tests shall be performed in the presence of a representative of the employer if required.
F) The contractor shall ensure that all type tests can be completed within the time schedule offered in his technical proposal.
G) 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.

13 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 / item / cable drum except fo cable installation hardware & fittings shall be offered for selection. For FO cable installation hardware & fittings at least ten (10) samples shall be offered for selection.

13.2 List of type tests

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

(A) SDH equipment with all types of cards (optical card, tributary card or any other equipment as part of repeater less links)

(B) Drop – insert multiplexer with subscriber interface card

(C) DACS

(D) Approach cable

13.3 List of type test to be conducted on telecom equipment

The type tests for SDH equipment with all types of cards, primary multiplexer & drop insert MUX with subscriber interface card and DACS are described below:

13.3.1 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 13.3.1: operation to specification range.

3) **Acceptance criteria**: no degradation of performance during and after the test.

Table 13.3.1

Environmental Operating Limits

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

(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 specification.

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

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

(f) **Temperature Variation Test**

Temperature variation testing shall be as per IEC publication 60068-2-14 (gradual variations, method NB). The equipment shall be powered on and various parameters shall be monitored continuously during the test period.

1) Number of cycles required is five (5)

2) The degree of severity: temperature TL: 0°c, TH: as per 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.

14.0 **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 14.0:

TABLE 1.3: RECOMMENDED IMMUNITY TESTS

SL.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.	100/1300 µS Surges	YES	YES	N/A	N/A	Table 12 of IEC 60870-2-1: 1995
4.	1.2/50 – 8/20 µS Surges	YES	YES	YES	N/A	Table 12 of IEC 60870-2-1: 1995 – LEVEL : 4
5.	Fast Transient Bursts	YES	YES	YES	YES	
6.	Damped Oscillatory Waves	YES	YES	YES	YES	
7.	10/700 µS Surges	N/A	N/A	N/A	YES	
8.	Electrostatic Discharge	YES				Table 13 of IEC 60870-2-1: 1995 – Level : 4
9.	Power frequency magnetic field	YES				Table 14 of IEC 60870-2-1: 1995 – Level : 4
10	Damped oscillatory magnetic field	YES				
11	Radiated electromagnetic field	YES				TABLE 15 OF IEC 60870-2-1: 1995 – LEVEL : 4
12	Power frequency voltage on control and signal lines	N/A	N/A	YES	YES	IEC 61000-4-16: 2002-07 – LEVEL : 4

13	DC voltage on control and signal lines	N/A	N/A	YES	N/A	IEC 61000-4-16: 2002-07 – LEVEL : 4

- END OF TABLE -

(B) **EMISSION TESTS**

The list of Emission tests are specified below in Table 14.1

TABLE 14.1:

RECOMMENDED EMISSION TESTS

SL. NO.	Emission Test	AC Power Supply	DC Power Supply	Control & Signal	Telecom line	Para Metres
1.	LF disturbance voltage CCITT recommendation P.53	N/A	YES	N/A	N/A	Table 17 of IEC 60870-2-1: 1995 – Class : B
2.	Transient disturbance voltages	YES	YES	N/A	N/A	
3.	RF disturbance voltages CISPR 22	YES	YES	N/A	N/A	
4.	RF disturbance currents CISPR 22	N/A	N/A	N/A	YES	
5.	RF radiated fields CISPR 22	YES				

- END OF TABLE -

(C) **Insulation withstand Voltages**

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

14.2 **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 tests conditions are selected according to the vibration withstand requirements.

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

(b) **Shock test**

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

The recommended severity shall be a = 294 m/s2, d = 18 ms. three shocks per axis per direction shall be applied to the equipment packed according to the contractor's specifications.

OR FREE FALL TEST

This test could be performed as an alternative to the shock or bump test. The procedure is defined in IEC publication 60068-2-32. The equipment shall be packed according to the contractor's specifications. The drop height shall be defined in accordance with IEC 68-2-32. The surface of the packing case which comes into contract 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.

14.3 TYPE TESTS FOR FIBRE OPTIC APPROACH CABLE

The type tests to be conducted on the fibre optic approach cable are listed in table 6-8: type tests for fibre optic approach cable. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05db/km.

TABLE 14.3

TYPE TESTS FIBRE OPTIC APPROACH CABLE

S.NO.	TEST NAME	TEST PROCEDURE
1	Water ingress test	(IEC 60794-1-F5/EIA 455-82B) Test duration:24 HOURS
2	Seepage of filling compound	(EIA 455-81A) Preconditioning: 72 Hours, Test duration: 24 Hours
3	Crush test	(IEC 60794-1-E3/EIA 455-41)
4	Impact test	(IEC 60794-1-E4/EIA 455-25A)
5	Stress strain test	(EIA 455-33A)
6	Cable cut-off wavelength test	(EIA 455-170)
7	Temperature cycling test	(IEC 60794-1-F1/EIA-455-3A)-2 CYCLES
- END OF TABLE -		

14.4 IMPACT TEST

The impact test shall be carried out in accordance with IEC: 60794-1-e4. Five separate impacts of 2.0 kg shall be applied at different locations. The radius of the intermediate piece shall be the reel drum radius ± 10%. A permanent or temporary increase in optical attenuation value greater than o.o5 db/km shall constitute failure.

14.5 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 approach cable and associated hardware fitting, FODP, SDH equipments, associated line & tributary cards, termination equipments (drop/insert multiplexer, DACS, associated subscriber line interface cards etc), network management system. 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 material inspection & clearance certificate (MICC). Successful completion of the factory tests and the employer approval to ship shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the employer's authorized representatives unless waiver for witnessing by employer's representatives is intimated to the contractor.

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

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

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

14.6 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.

The sampling rate for the factory acceptance tests shall be 10% of the batch size (minimum2) for FO cable drums, FODPS joint box and other similar items.

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.

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

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.

14.7 FAT OF COMMUNICATION EQUIPMENTS

TABLE 14.7

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 lightwave 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 test 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
10	Simulation of failure conditions and failover of each redundant unit
11	VLAN (layer-2 switching) feature testing with atleast three equipments configuration
12	Protection scheme for ethernet traffic (erps)
13	Test of spare card slots
14	Checks of power supply/converter voltage margins
15	Random inspections to verify the accuracy of documentation
16	Test of spare parts/modules/cards as per applicable tests

TABLE 14.8

FACTORY ACCEPTANCE TESTING REQUIREMENTS FOR TERMINATION EQUIPMENT (MUX & DACS)

ITEM	DESCRIPTION
1	Physical inspection for conformance to DRS, BOQ, drawings and appearance of equipment
2	Performance of supervision, alarm, control and switching systems, diagnostics, loopbacks, craftsperson interface etc.
3	Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for the channel banks/low – level multiplexers

4	Framing, signaling, and operational and maintenance test consistent with applicable itu-t requirements
5	Simulation of failure conditions and failover of each redundant unit
6	Test of spare card slots and test of spare parts/modules/cards as per applicable
7	Checks of power supply/converter voltage margins and short circuit and overvoltage protection
8	Random inspections to verify the accuracy of documentation

TABLE 14.9

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.

15.0 FACTORY ACCEPTANCE TEST ON APPROACH CABLE

The factory acceptance tests for approach cable specified below in table 15.0

TABLE 15.0

FACTORY ACCEPTANCE TESTS ON APPROACH CABLE

S.NO.	FACTORY ACCEPTANCE TEST
1	Attenuation co-efficient at 1310 nm and 1550 nm
2	Point discontinuities of attenuation
3	Visual material verification and dimensional checks as per approved drs/drawings

15.1 FACTORY ACCEPTANCE TEST ON SPLICE ENCLOSURE (JOINT BOX)/FODP

The factory acceptance tests for Splice Enclosures/FODP as specified below in Table:

TABLE 15.1

FACTORY ACCEPTANCE TESTS ON SPLICE ENCLOSURES (JOINT BOX)/FODP

SL.NO.	FACTORY ACCEPTANCE TESTS
1.	Visual check of quantities and specific component number for each component of splice enclosure/FODP and dimensional checks against the approved drawings

15.2 FACTORY ACCEPTANCE TESTS ON TEST EQUIPMENT, PIGTAIL & OTHER ITEMS

As per technical specification and approved DRS/documents.

15.3 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 FO cable, 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 FO & telecom equipment installation

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

15.4 **MINIMUM SITE ACCEPTANCE TESTING REQUIREMENT FOR FO CABLING**

Prior to installation, every spooled fibre optic cable segment shall be tested for compliance with the pre-shipment data previously received from the manufacturer. This requirement will preclude the installation of out of specification cable segments that may have been damaged during shipment.

15.5 **PHASE OF SITE ACCEPTANCE TESTING**

Sat shall be carried out link from FODP to FODP. Sat may be performed in parts in case of long links.

The tests, checks, adjustments etc conducted by the contractor prior to offering the equipment for sat shall be called pre-sat activities. The pre-sat activities shall be described in the installation manuals and field quality plan documents.

15.6 PHASES FOR SITE ACCEPTANCE TESTING FOR COMMUNICATION EQUIPMENTS

The sat shall be completed in following phases:

15.7 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 provide in respective tables in this section.

16.0 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 requirement 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.

16.1 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

4) End-to-end testing of all individual data circuits originating from PLCC, RTU and SCADA front ends and to establish proper interfacing with PLCC/RTU/FRONT end and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of monitoring of BER/packet loss.

5) Testing of NMS to demonstrate proper operation of all functions: configuration management, performance management, fault, management and security management. All the standard features of the NMS shall be demonstrated for proper functioning.

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

TABLE 16.1

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 signaling earthing system and resistance to ground to be checked.
10	Simulation of failure conditions and failover of protected components

TABLE 16.2

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 signaling earthing system
9	Simulation of failure conditions and failover of protected components

TABLE 16.3

NMS INSTALLATION TESTING

ITEM	DESCRIPTION
1	Physical inspection for conformance to drawings, rack elevations and appearance of equipment and cabling
2	Work station hardware inventory, configuration and characteristics
3	Demonstration of proper operation of all hardware, including workstations peripherals

GUARANTEED TECHNICAL PARTICULARS FOR DIGITAL TELEPROTECTION COUPLER (DTPC) EQUIPMENT:

1. Make &Model :
2. Commands capacity :
3. Compatible to Optical Equipment : Yes / No
4. Type of Command Input Interfacing :
5. Type of Command output Interfacing:
6. No. of commands capability :
7. Type of Trip counters (event registers) :
8. Power Supply redundancy : Yes / No
9. Operating time for Protection couplers:
10. Interfacing through Potential free contacts: Yes / No
11. Monitoring through MUX NMS for the DTPCs offered.
12. Whether the offered DTPCs are an integral part of OLTE/MUX eqpt.
13. Visible counters for each command (Input/Output) provided : Yes/No.

SIGNATURE OF THE TENDERER

GUARANTEED TECHNICAL PARTICULARS for OPTICAL LINE TERMINATION EQUIPMENT (OLTE) SDH STM-4			
Manufacturer: **Model :**			
S.No	**Technical parameter**	**Unit**	**Particulars**
1.	Capacity Aggregate Bit-rate: CEPT E-1 Ports:	Mbps nxE1 nx10/100 Ethernet ports	
2.	Cross connect redundancy	Yes / No	
3	Control unit redundancy	Yes / No	
4.	Protection OLTE = 1:1 APS E-1 Ports = 1:1 APS	Yes / No	
5.	Unprotected System Gain for BER 10^{-3} : BER 10^{-6}:	DBm	
6.	1 + 1 APS System Gain for BER 10^{-3}: BER 10^{-6}:	DBm	
7.	MTBF Unprotected: 1+1APS Protected:	Hours	
8.	Code Format:		
9.	List Optical Coupling options:		
OPTICAL TRANSMITTER:			
10.	Source (LED or Laser)		
11.	Source wavelength:	Nm	
12.	Source spectral width:	Nm	
13.	Mean launched power Maximum: Nominal:	dBm	
14.	Launch power during safety Power-down due to fibre break:	dBm	
15.	Stability (nominal power variation due to temperature and/or biasing):	%	
16.	Source rise time:		
17.	Source estimated life span:	Hours	
18.	Source extinction ratio:		
19.	Low power alarm Threshold: field adjustable		

GUARANTEED TECHNICAL PARTICULARS for OPTICAL LINE TERMINATION EQUIPMENT (OLTE) Optical receiver:

20.	Nominal receive signal strength:	dBm	
21	Receiver Threshold BER 10-6: BER 10-9:	dBm	
22	Receiver overload limit:	dBm	
23	Spectral Bandwidth (3 Db point):	Nm	
24	Digital Bandwidth:	mbps	
25	Signal-to-noise @ center wavelength: @ 3 dB points:		
26	AGC range:		
SERVICE CHANNELS AND ORDER WIRE UNIT Engineering Orderwire			
27	Omnibus calling available Describe:	Yes/No	
28	Selected station calling available? Describe:	Yes/No	
29	Signalling scheme Describe:		
30	Tx/Rx level	DBm	
31	Speech coding method & bit rate	Kbit/s	
31	Distortion: Noise performance:	S/N	

Date: Signature:

Place: Name:

Seal: Designation:

GUARANTEED TECHNICAL PARTICULARS for Multiplexer

S.No	Technical parameter	Unit	Particulars
Voice Channels			
1	Are Service channel requirements specified met?	Yes/No	
2	No. of VF Channels:	Ea	
3	Pass band:	KHz	
4	Subscriber side interface:		
5	Input & Output level	dBm	
6	Idle channel noise	DBmOp	
7	Distortion:		

	Data and Supervisory Channel		
8	No of data channels:	Ea	
9	Interfaces/Connectors:		
10	Data rates:	Kbps	
	ELECTRICAL INPUT/OUTPUT INTERFACES		
11	List ITU-T Standards in compliance With:		
12	Tributary bit rate (nominal):	Mbit/s	
13	Tolerance in bit rate:	Ppm	
14	Line code:		
15	No. of ports:		
16	Impedance of coax cable used for Input/Output port:	ohms	
17	Type of Connector		
18	Input jitter acceptance 100 Hz to 10 KHz: 10 KHz to 800 KHz:	UI (p-p)	
19	Maximum output jitter in the absence of i/p jitter 100 Hz to 10 KHz: 10KHz to 800 KHz: UI (p-p)	UI (p-p)	
20	Jitter transfer characteristic:		
	OUTPUT PORT		
21	Line impedance Balanced: Unbalanced:	□	
22	Test load impedance (Unbalanced):	□	
23	Peak pulse amplitude (nominal + tolerance):	V dc	
24	Pulse width (nominal + tolerance):	Ns	
25	Ratio of +ve & -ve pulses at the center of a pulse interval		
26	Ratio of width of +ive & -ive pulses at nominal half Amplitude		
27	Maximum insertion loss	dB	

	Supervisory Channel **INPUT PORT**		
28	Attenuation Char. of inter-connecting cable for digital signal presented at input port		
29	Return loss (at 1.024 MHz)	dB	
30	Admissible i/p signal attenuation	dB	
31	Cable loss Equalization Range	dB	
32	Maximum insertion loss	dB	

Date: Signature:

Place: Name :

Seal: Designation:

GUARANTEED TECHNICAL PARTICULARS for OPTICAL LINE TERMINATION EQUIPMENT (OLTE) SDH STM-4			
PROTECTION SWITCHING Manufacturer: Model name :			
S.No	**Technical parameter**	**Unit**	**Particulars**
1	Switching modes available Auto? Manual? Remote/network management?	Yes/No	
2	Switching priority:		
3	Tx switchover & switchback criteria:		
4	Rx switchover & switchback criteria:		
5	Inbuilt Mux (if applicable) switchover & switchback criteria:		
6	Switch option mode & status indicators:		
MECHANICAL AND ENVIRONMENTAL PARAMETERS			
7	Number of chassis (including. DC/DC converters, O/W muldem etc.,) required for Unprotected Terminal: I: 1 Protected Terminal		
8	Chassis Dimensions (L *W*H):	cm	
9	Chassis Weight:	Kg	

10	Chassis mounting options:		
11	Chassis clearance requirements Top * Bottom * Sides: Front Access: Rear Access:	m	
12	Chassis colour and finish		
S.No	**Technical parameter**	**Unit**	**Particulars**
13	Rack options available 19" ETSI? Slim rack? Others (specify)?	 Yes/No Yes/No Yes/No	
14	Protection Class (IP Class):		
15	Rack Colour and Finish:		
16	Temperature range Guaranteed performance: Operation without damage: Storage/ transport:	□C	
17	Relative humidity Minimum: Maximum:	%	
18	Altitude Installed: Transport/storage:	M	
19	Describe Ventilation requirements:		
20	Describe dust proofing provisions:		
21	Electromagnetic compatibility (List standards & severity levels)		

Date: Signature:

Place: Name:

Seal: Designation:

Chassis mounting options

GUARANTEED TECHNICAL PARTICULARS for OPTICAL LINE TERMINATION EQUIPMENT (OLTE) SDH STM-4			
POWER supply unit (dc/dc converter) Manufacturer: Model name :			
S.No	**Technical parameter**	**Unit**	**Particulars**
1.	Nominal supply voltage:	Vdc	
2.	Power supply variation Guaranteed performance: Operation without damage:	Vdc	
3.	Polarity:	+/-	
4.	POWER Supply redundancy	YES/NO	
5.	List derived DC voltages:	Vdc	
	Total power consumption (Fully equipped incl. Service channels) Unprotected terminal: 1+1 Protected terminal:	Watt	
6.	1+1 APS protection provided?	Yes/No	
7.	MTBF of Power supply unit:	Hours	
8.	Ultimate Power delivery capacity	Watt	
9.	Ultimate Power delivery capacity	Watt	
10.	Are the following protections Provided Over voltage? Under voltage? Overload? Reverse polarity? Other(specify)?	Yes	

Date: Signature:

Place: Name:

Seal: Designation:

GUARANTEED TECHNICAL PARTICULARS for OPTICAL LINE TERMINATION EQUIPMENT (OLTE) SDH STM-4

Main Distribution Frames

Manufacturer:
Model name :

S.No	Technical parameter	Unit	Particulars
1.	Dimensions Height: Width: Depth:	 Cm cm cm	
2.	Weight;	Kg	
3.	Colour and Finish:		
4.	Method(s) of Mounting		
5.	Clearances required for Installation: Ceiling: From: Rear:	 mtr. mtr. mtr.	
6.	Cable entry(s):		
7.	Cable Glanding:		
8.	Frame material & Guage:		
9.	Locking Arrangement		
10.	Frame capacity: Number of Horizontal Rows: Number of Vertical Rows: Number of Terminal Blocks per Row:	Each	

11. Provide details on installation, cabling, cross connections and patching facilities (if any)

Date: Signature:

Place: Name:

Seal: Designation:

GUARANTEED TECHNICAL PARTICULARS for OPTICAL LINE TERMINATION EQUIPMENT (OLTE) SDH STM-4

Digital Distribution Frames

Manufacturer:
Model name :

S.No	Technical parameter	Unit	Particulars
1.	Dimensions Height: Width: Depth:	 cm cm cm	
2.	Weight;	Kg	
3.	Colour and Finish:		
4.	Method(s) of Mounting		
5.	Clearances required for Installation: Ceiling: From: Rear:	 mtr. mtr. mtr.	
6.	Cable entry(s):		
7.	Cable Glanding:		
8.	Frame material & Guage:		
9.	Locking Arrangement		
10.	Frame capacity: (No. of co-axial panels)	Each	
11.	Co-axial panel capacity: (Number of PCM Systems)	Each	
12	No. of E1s termination capacity		
13.	Co-axial connectors: Type: Characteristic impedance: Return loss (up to 90 MHz): Transfer impedance: Test voltage (1 Minute): Maximum current rating:	 ❑ dB ❑ V A	

13.

Provide details on installation, cabling, cross connections and patching facilities (if any).

Date: Signature:

Place: Name:

Seal: Designation:

GUARANTEED TECHNICAL PARTICULARS for OPTICAL

TERMINATION WISE BILL OF MATERIAL FOR IMPORTANT CARDS

SL.NO.	DESCRIPTION		
1	STM-4 OPTICAL LINE CARDS FOR 1+1		
2	CONTROL UNIT CARDS		
3	CROSS CONNECT CARDS		
4	POWER SUPPLY CARDS		
5	32 x E1 Trib. cards		
6	8 x 10/100 Mbps ETH cards		
7	4W E&M cards		
8	HOT LINE CARDs		
9	V.24 I/F cards		
10	V.11 I/F cards		
11	G.703 I/F cards		
12	V.35 I/F cards		
13	Channel i/f card for DTPCs		
14	Ext. Alarm i/f cards		
15	Any other cards needed to meet spec. requirement.		

Date: Signature:

Place: Name:

Seal: Designation:

List of mandatory spares for OLTE / MUX

SL.NO.	DESCRIPTION	Quantity
1	STM-4 OPTICAL LINE CARDS FOR 1+1	
2	CONTROL UNIT CARDS	
3	CROSS CONNECT CARDS	
4	POWER SUPPLY CARDS	
5	32 x E1 Trib. cards	
6	8 x 10/100 Mbps ETH cards	
7	4W E&M cards	
8	Any other cards needed to meet spec. requirement as a mandatory spare	

Date: Signature:

Place: Name:

Seal: Designation:

List of mandatory spares for Digital Teleprotection equipment

SL.NO.	DESCRIPTION	Quantity
1.	CONTROL UNIT CARDS	
2.	POWER SUPPLY CARDS	
3.	Channel Interface card.	
4	Any other cards needed to meet spec. requirement as a mandatory spare	

Date: Signature:

Place: Name:

Seal: Designation:

1.1.2.7.4 Operating conditions

The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.

(d) Structure Attachment Clamp Assemblies: Clamp assemblies used to attach the OPGW to the structures, shall have two parallel grooves for the OPGW, one on either side of the connecting bolt. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. The tower attachment plates shall locate the OPGW on the inside of the tower and shall be attached directly to the tower legs/cross – members without drilling or any other structural modifications.

(e) Vibration Dampers: Vibration dampers type 4R Stockbridge or equivalent, having four (4) different frequencies spread within the Aeolian frequency bandwidth, shall be used for suspension and tension points in each span. The Contractor shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis as specified in technical specifications. Vibration damper clamps shall be made of aluminium or aluminium alloy, shall support the dampers during installation and shall maintain the dampers in position without damage to the OPGW and without causing fatigue. Armour or patch rods made of aluminium or aluminium alloy shall be provided as required to reduce clamping stress on the OPGW. The vibration damper body shall be hot-dip galvanized mild steel/cast iron or shall be permanent mould cast zinc alloy.

1.1.3 Fibre Optic Splice Enclosures (Joint Box)

All splices shall be encased in Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. Splice enclosures shall comply to ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of required number of optical fibre splices and equipped with sufficient number of splice trays for splice trays for splicing all fibres in the cable. No more than 6 fibres shall be terminated in a single splice tray. They shall be filled with suitable encapsulate that is easily removable should re-entry be required into the enclosures.
Splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on transmission line towers above anti-climb guard levels at about 10 metres from top of the tower and shall accommodate pass-through splicing. The actual mounting height and location shall be finalized after Survey. Contractor shall be responsible for splicing of fibres and installation of splice enclosures.

1.1.3.1 Optical Fibre Splices

Splicing of the optical fibre cabling shall be minimized through careful contractor planning. There shall be no mid-span splices allowed. All required splices shall be planned to occur on tower structures. All optical fibre splicing shall comply with the following:

(a) All fibre splices shall be accomplished through fusion splicing.
(b) Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.
(c) All splices and bare fibre shall be neatly installed in covered splice trays. No more than six (6) fibres shall be installed in each splice tray.
(d) For each link, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05 dB and no single splice loss shall exceed 0.1 dB when measured at 1550 nm.
(e) For splicing, fibre optic cable service loops of adequate length shall be provided so that all splices occurring at tower structures can be performed at ground level.

1.1.4 Fibre Optic Approach Cables (IN BHEL SCOPE)

For purposes of this specification, a fibre optic approach cable is defined as the Armoured underground fibre optic cable required to connect Overhead Fibre Optic Cable (OPGW) between the final in line splice enclosure on the gantry / tower forming the termination of the fibre cable on the power line and the Fibre Optic Distribution Panel (FODP) installed within the building. The estimated fibre optic approach cabling length requirements are indicated in the appendices. However, the Contractor shall supply & install the optical fibre approach cable as required based

on detailed site survey to be carried out by the Contractor during the project execution and the Contract price shall be adjusted accordingly.

1.1.4.1 Basic Construction

The cable shall be suitable for direct burial, laying in trenches & PVC/Hume ducts, laying under false flooring and on indoor or outdoor cable raceways.

1.1.4.2 Jacket Construction & Material

The approach cable shall be a UV resistant, rodent proof, armoured cable with metallic type of armoring. The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall confirm to ASTM D1248 for density.

1.1.4.3 Optical, Electrical and Mechanical Requirements

Approach cable shall contain fibres with identical optical/physical characteristics a those in the OPGW cables. The cable core shall comprise of tensile strength member(s), fibre support/bedding structure, core wrap/bedding, and an overall impervious jacket.

1.1.5 Installation of Approach cable

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 provided after Employer approval. However, the approach cable shall be laid in the HDPE pipe in all condition.

Suitable provisions shall be made by the contractor to ensure adequate safety earthing and insulated protection for the approach cable.

All required fittings, supports, accessories, ducts, inner ducts, conduits, risers and any item not specially mentioned but required for laying and installtion of approach cables shall be supplied and installed by the Contractor.

1.1.6 Optical Fibre Termination and Splicing

Optical fibre terminations shall be installed in Fibre Optical Distribution Panels (FODP) designed to provide protection for fibre splicing of preconnectorized pigtails and to accommodate connectorized termination and coupling of the fibre cables. The contractor shall provide rack/wall mounted fibre optic distribution panels (FODPs) sized as indicated in the appendices and shall terminate the fibre optic cabling up to the FODPs. The location of FODP rack shall be fixed by the Contractor, with the Employer's approval.

1.1.6.1 Fibre Optic Distribution Panel

At each location requiring the termination of at least one fibre within a cable, all fibres within that cable shall be connectorized and terminated in Fibre Optic Distribution Panels in a manner consistent with the following:

a) All fibre optic terminations shall be housed using FODPs provisioned with splice organizers and splice trays. All fibres within a cable shall be fusion spliced to preconnectorized pigtails and fitted to the "Back – side" of the provided fibre optic couplings.

b) FODPs shall be suitable for use with each of the cable types provided as part of this contract. FODPs shall accommodate pass-through splicing and fibre terminations.

c) FODPs for indoor use shall be supplied in suitable cabinets/racks with locking arrangement.

d) ALL FODPs shall be of corrosion resistant, robust construction and shall allow both top or bottom entry for access to the splice trays, Ground lugs shall be provided on all FODPs and the Contractor shall ensure that all FODPs are properly grounded. The FODP shall meet or exceed ingress protection class IP55 specifications.

e) Flexible protection shall be provided to the patch cord bunches going out from FODP to other equipment.

1.1.6.2 Optical Fibre Connectors

Optical fibres shall be connectorised with FC-PC type connectors preferably. Alternatively connector with matching patch cord shall also be acceptable. Fibre optic couplings supplied with FODPs shall be appropriate for the fibre connectors to be supported. There shall be no adapters.

1.1.7 Service Loops

For purposes of this specification, cable and fibre service loops are defined as slack (extra) cable and fibre provided for facilitating the installation, maintenance and repair of the optical fibre cable plant.

(a) Outdoor Cable Service Loops: In – line splice enclosures installed outdoors and mounted on the utility towers, shall be installed with sufficient fibre optic cable service loops such that the recommended minimum bend radius is maintained while allowing for installation or maintenance of the cable to be performed in a controlled environment at ground level.

(b) Indoor Cable Service Loops: FODPs shall provide at least three (3) metres of cable service loop. Service loops shall be neatly secured and stored, coiled such that the minimum recommended bend radius' are maintained.

(c) Fibre Units Service Loops: For all fibre optic cable splicing, the cable shall be stripped back a sufficient length such that the fan-out of fibre units shall provide for at least one (1) metre of fibre unit service loop between the stripped cable and the bare fibre fan-out.

(d) Pigtail Service Loops: Connectorised pigtails spliced to bare fibres shall provide at least 1 metre of service loop installed in the FODP fibre organizer and at least one (1) metre of service loop to the couplings neatly stored behind the FODP coupling panels.

(e) Fibre Service Loops: At least 0.5 metre of bare fibre service loop shall be provided on each side of all fibre splices. The bare fibre service loops shall be neatly and safely installed inside covered splice trays.

1.1.8 Methodology for Installation and Termination

All optical fibre cable termination, installation, stringing and handling plans, guides and procedures, and engineering analysis (e.g. tension, sag, vibration etc.) shall be submitted to the Employer for review and approval in the engineering/design phase of the project, prior to establishing the final cable lengths for manufacture. Installation procedures including details of personnel and time required shall be documented in detail and submitted to Employer for approval. All installation practices shall be field proven and ISO accredited.

All cable segments shall include service loops as specified in this specification. The maximum allowable stringing tension, maximum allowable torsional shear stress, crush strength and other physical parameters of the cable shall not be exceeded. The preventative measures to be taken shall be documented in details and submitted to Employer in advance of installation.

Optical fibre attenuation shall be measured after installation and before splicing. Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable segment failure. In the event of cable damage or any fibre damage, the complete section (tension location to tension location) shall be replaced as mid-span joints are not acceptable.

3 of 3

TECHNICAL SPECIFICATION FOR EPAX & ELECTRONIC PUSH BUTTON TELEPHONES :

1. **SCOPE:**
This specification covers design, manufacture, testing, packing, forwarding and delivery FOR destination of Electronic Private Automatic Exchanges and Electronic push button telephones.

1.1. **The EPAX shall support a capacity of 128 universal ports, which can be programmed to the 4W &2W E&M trunks (both conventional & PLCC version), 2W Loop interrupt trunks and 2W subscribers. The EPAXs shall be supplied fully wired and equipped for all 128 universal ports as follows:**

E&M trunks (PLCC version)	**:**	**16**
Subscriber lines	**:**	**16**

1.2 The E&M trunk requires 2 wires for signaling E & M and 4 wires for Tx/Rx speech. The subscriber line supports 2-wire loop signaling.

1.3 The EPAX should support both pulse and DTMF signaling and compatible with the existing switching equipment in the system.

1.4 The CPU card and PSU cards shall be duplicated for redundancy with hot switchover.
In the event of the failure of one or both of the cards, the stand-by card shall take over the functioning of the EPAX with out any interruption.

1.5 The EPAX should support 3 Nos E1 channel cards.

1.6 The Electronic Push Button Telephones are intended to be connected to the EPAX for providing speech on dialing network in the PLCC system provided on the 400 kV, 220 kV and 132 kV transmission lines.

1.7 The telephones shall support dialing on 2-wire loop mode.

2. **STANDARDS:**

2.1. As there are no known IS standards, the EPAX and telephones proposed for purchase as per clause 7.1.0 shall conform to the relevant CCITT recommendation and ITDs TEC specification including latest revisions, amendments / changes adopted and published as detailed below:

The EPAX and Telephones shall however be tested thoroughly for the EMC/EMI compatibility as per the IS standards mentioned below:

Standards	Title
	EPAX
TEC Specn.G/PBX -01/01/May'90.	TEC specification approved by DoT
	Electronic Push Button Telephones
TEC Specn.G/TEL-01-02/June'96	TEC Specification approved by DoT
IS 6873 Series	Methods of measurement of Electromagnetic interference from various electrical disturbance
IEC 60255-21-1-1988	Vibration tests (sinusoidal)
IEC 255-21-2-1988	Shock and bump tests.
IEC 60255-22-1-1988	1 MHz burst disturbance test.
IEC 60255-22-2-1996	Electrostatic discharge tests
IEC 60255-22-3-2000	Radiated electromagentic field disturbance tests.

EN 55022 Radiated emission & conducted emission

CISPR Publication 22 (class A)

2.2 Equipment meeting with the requirement of other authoritative standards, including IS, which ensure equal or better performance than the standards mentioned above, shall also be considered. When the equipment offered by the bidder conforms to other standards, salient points of difference between standards adopted and the standards specified in this specification shall be clearly brought out in the relevant schedule. Four copies of such standards with authentic translation in English shall be furnished along with the offer.

3. CLIMATIC CONDITIONS:

The EPAX & Push Button Telephones called in this specification are required to operate satisfactorily under climatic conditions given in the Specifications.

4. PRINCIPAL PARAMETERS

4.1 Digital EPAX System:

S. No.	Parameter	Description
1	Technology (Type)	PCM / TDM with 32 bit microprocessor based digital technology Electronic Private Automatic Telephone Exchange (EPAX) on E & M signaling and DC loop signaling to work with PLC Communication System.
2	Control	Stored Programme Control (SPC)
3	Back-Up Memory	Flash ROM Based
4	System Capacity Required capacity of E & M Trunks / Subscribers	128 Universal Ports Programmable to E & M, Loop Interrupt Trunks and Subscribers. E & M Trunks : 16 Subscriber Lines : 16
5	Configuration	Universal Slots for Extension / Trunk Interface
6	Priority Facility	Shall be provided as per Clause 7.5.1.9
7	Communication Links	100 % Non-Blocking
8	Architectural Design	Distributed Design
9	System Modularity	Easy expansion by adding Modules
10	Approvals Required	TEC with ISDN, BRI and PRI
11	Trunk Interface	4W / 2W E & M Interface with LED indication with DP / DTMF E1 / R2 (2Mbps Digital Link) with BNC connector VoIP Interface CO Trunk Lines ISDN BRI & PRI Trunk Lines
12	Alarm On Indication	Self-diagnostics with alarm on fault condition shall be provided.
13	Protection	All the Trunk Lines and Subscriber lines shall be provided with Surge Arresters on the MDF
14	Extension Interface	Station Interface for normal analog PBT Digital Extension Interface for Key Phones Hybrid Station Interface for PBT / Key Phones
15	Redundancy	System should have redundancy for PSU & CPU.
16	System Voltage	-48V DC (positive ground) + 15%, -10% with MCB protection
17	Power Consumption	Less than 300W
18	EMI / EMC	As per IEC 17025: 2000 Standard
19	Programming	Programming of the EPAX should be done using **Console/Laptop** that should be part of the exchange at no extra cost .

The microprocessor based EPAX should directly interface with communication transmission systems like Power Line Carrier Communication, Optical fiber, Satellite and Microwave radio communication links. The subscribers must be able to communicate with local subscribers and far end subscribers through trunk lines. The EPAX should form a part of Communication system and should be capable of switching speech paths on trunk routes.

The exchange should be compatible with the existing switching systems for its operation in conjunction with electronic four wire group selectors and EPAXs of any other make at far end stations. It would be the sole responsibility of the successful bidder to guarantee the compatibility of the EPAX with the existing switching systems.

4.3 The exchanges shall be manufactured to the state of art technology and employ the stored program technique by utilizing the principles of TDM/PCM. The system software shall be posted in flash memory as per the international standards. The equipment should be reliable and capable of giving service in adverse tropical temperature climatic condition. The equipment should work in non air-conditioned environment at EHT sub-stations.

4.4 Exchanges are to be self contained and provided with conventional facilities like dial tone, busy tone, ringing tone, ring back tone etc. The dialing pulse rate of subscriber for make and break ratio 1:2 (33.3msec. / 66.66msec.) and for trunk dialing 1:1 (50 m sec./ 50 m sec). The EPAX should be capable of working to single, two digit and three digit numbering schemes. The existing two digit numbering scheme as adopted in APTRANSCO network is however to be programmed in the EPAX initially.

4.5 Main Distribution Frame shall be provided. Subscriber lines and junction lines are to be terminated on the MDF on one side of the terminal-block with the legend of the terminal connections clearly indicated in alphanumeric. The MDF shall be provided with individual surge protection.

4.6. Krone tag blocks are preferred to be used for the MDF. The supply of relevant wire terminating tool for the type of tag block quoted towards MDF is covered in the scope of this specification.

4.7. All the subscriber lines and the PLCC junction lines shall be provided with surge protection. Invariably suitable surge protectors in the form of Gas discharge tubes and fuses are to be provided to protect electronic circuitry of the exchange from the damages due to external surges /spikes. Minimum maintenance and free workability on the equipment is to be ensured.

4.8. The EPAX should be provided with self-checking diagnostic facility to monitor the exchange continuously through software controlled program. The status of the call being established is to be visually displayed suitably as the call is progressing and faults by audible and visual indications. Reliability, security and quality of service must be the main features of the EPAX. The EPAX shall have the priority feature for a particular subscriber.

The following state of art facilities are also to be provided.

i. Priority cut-in into an engaged extension/tie line.
ii. Automatic cut off on forced release condition.
iii. Barred access to tie lines
iv. Call transfer
v. Call consult
vi. Call forward etc.

4.9. The priority cut in facility shall be provided in three hierarchies as stated below.

i. Priority cut in into two busy local extensions.
ii. Priority cut in into one busy local extension and one local E&M tie trunk.
iii. Priority cut in into two busy E&M trunks in the same EPAX on transit call.

Subscriber access to the E&M Trunks shall be controlled through barred access facility.

4.10. **SPECIFIC TRUNK ACCESS:** If more than one route is available from the same EPAX to an out station EPAX and in case the main route is busy, the selection of alternate route shall be made available on Automatic selection of at least two alternative routes apart from the main trunk route. Specific trunk access shall also have to be provided. The subscriber shall be able to access a specific trunk route by dialing a special access code followed by the trunk route number.

The EPAX shall support exclusive Load Dispatch Express type communication network with all to one and one to all type of trunk access. This feature shall be in addition to the normal All to All type.

4.11. The equipment should be housed in a standard steel cabinet with proper ventilation, and it should be dust and vermin proof housing. It should be painted as per relevant IS and must have provision for access to the circuitry from both the front and rear sides. The ventilation fan shall work on 48V DC only.

4.12 The EPAXs shall be got wired for a minimum capacity of 128 universal ports. Required number of junction cards and line cards may be provided as per the schedule of materials.

4.13. Programming the required facilities on the EPAX with an ordinary telephone through the service line is preferred. For EPAXs, which cannot be programmed with an ordinary telephone, the Bidder shall include the supply of the required programmer (Example: EPROM programmer or console) within the scope of supply with a detailed write-up of the programming schedule through the operator console/ programmer.

4.14 The Bidders are requested to quote as mandatory for one set of spare PCB modules as stated below:

i. Power supply unit
ii. Central processing unit
iii. Line interface card
iv. E&M trunk interface card
v. Switching matrix card

5. ELECTRONIC PUSH BUTTON TELEPHONES:

The Electronic Push button telephones (Desk top type) shall have the approval of Telecom Engineering Centre of DoT and suitable to work with PLCC system.

5.1.	a)	Type	:	Electronic Push button Telephones (Decadic) supporting both pulse and DTMF signaling and ring LED.
	b)	Dial speed	:	10 PPS $\pm$ 5%
	c)	Break make Ratio	:	2:1
	d)	Inter digit pause	:	800 ms.
	f)	Reliability	:	The performance of the instrument should be very reliable and accurate with large MTBF as per TEC requirements.

5.2 The Telephones shall be provided with the following features:

i. Decadic / DTMF dialing
ii. Last number redial
iii. Redial capacity up to 32 digits
iv. Ringer with volume control
v. Interchangeable Transducers of electrodynamic type
vi. Electronic speech circuitry with regulated speech levels
vii. Speaker phone

6.0. TESTS

6.1. Type/acceptance and routine tests shall be carried out on the EPAX and Electronic Push Button Telephones proposed for purchase under this package in accordance with TEC specification applicable as per clause 7.2.1.

6.2 **EMI/EMC Test**

The EPAX is required to perform in a working environment of high voltage power system with high level of Electromagnetic interference and calls for high degree of Electromagnetic computability for achieving maximum throughout of traffic. The working environment is riddled with fast transients, currents, high voltage lightning & switching surges and severe short circuit current faults. The EPAX is therefore required to be tested thoroughly for its functional performance as per the EMI/EMC standards mentioned in clause No 7.2.1. Bids of bidders who do not enclose copy of authenticated certificate by a reputed laboratory either in India or Abroad of testing the performance of the offered EPAXs under severe Electromagnetic interference conditions will be rejected.

7 **Type Tests:**

The following type tests shall be conducted on a selected sample of EPAX

7.1 EPAX

i. Power supply test
ii. Protection test
iii. Engage pulse timing test
iv. Priority timing test
v. Digital pulse timing test
vi. Interdigit pulse timing test
vii. Releasing pulse timing test
viii. Test calls - Subscriber to Subscriber
Subscriber to Trunk
Trunk to Trunk

7.2 Telephones

i. Climatic test
ii. Vibration test
iii. Bump/Fall/Topple test
iv. Corrosion test
v. Protection test

8 **Acceptance/Routine Tests**

8.1 EPAX

i. Power supply test
ii. Pulses timing test
iii. Test calls - Subscriber to Subscriber
Subscriber to Trunk
Trunk to Trunk

8.2. Telephones

i. Climatic test
ii. Vibration test
iii. Corrosion test
iv. Protection test

9 **Testing Expenses**

9.1 The bidder shall furnish charges for conducting specified type tests as per Price schedule.

9.2 In case of failure in any of the type tests, the Supplier is required to modify the design of the material and the material shall be type tested successfully for the modified design.

9.3 Bidders shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedul

SECTION - 29.4

Entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price of EPAX and Electronic Push Button Telephones.

10. Additional Tests:

The Purchaser reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Bidder's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests, to satisfy himself that the material comply with the specifications.

11. Test Reports:

a. i. Copies of the type tests shall be enclosed with the bid

ii. Before dispatch of the equipment at least six (6) copies along with one original shall be submitted. One copy shall be returned duly certified by the Purchaser only after which the material will be dispatched.

b. Record of routine test reports shall be maintained by the Bidder at his works for periodic inspection or as and when desired by the Purchaser's representative.

c. Test Certificates of tests conducted during manufacture shall be maintained by the Bidder. These shall be produced for verification as and when desired by the Purchaser.

ANNEXURE I

GUARANTEED TECHNICAL PARTICULARS FOR EPAX

(To be filled by the Bidder)

S. No.	Parameters	Description
1	Technology (Type)	
2	Control	
3	Back-Up Memory	
4	System Capacity Full capacity of trunks Initially required capacity Required Capacity of E & M Trunks / Subscribers	
5	Configuration	
6	Priority Facility	
7	Communication Links	
8	Architectural Design	
9	System Modularity	
10	Approvals Required	
11	Trunk Interface with LED indication for all trunks	
12	E1 Interface	
13	Alarm On Indication	
14	Protection	
15	Extension Interface	
16	Redundancy	
17	System Voltage	
18	Power Consumption	
19	EMI / EMC	

	The EPAX shall be compatible for the following codes for pulses in various signaling circuits.	
	(i) Engage pulse	
	(ii) Priority pulse	
	(iii) Digit pulse	
	(iv) Inter digit pulse	
	(v) Release pulse	

Date :
Place :

Signature of Manufacturer / Supplier Signature of the Bidder

Name & Address

Name:

Whether Authorised Attorney of the tendering Company

Name of the tendering Company with Seal

ANNEXURE II

GUARANTEED TECHNICAL PARTICULARS FOR PUSH BUTTON TELEPHONES

(To be filled by the Bidder)

Item No.	Description	Data
(a)	Manufacturer's Name & Address / Supplier's Name & Address	
(b)	Governing Standards	
(c)	Type	
(d)	Dial speed	
(e)	Break-make ratio (PPs with +/-)	
(f)	Inter digit pause (msec.)	
(g)	Reliability	
(h)	Ringing voltage (V DC)	
(i)	Hook-switch endurance (No. of operations)	
(j)	Operating temperature (deg. C)	
(k)	Tone/Pulse switchable	
(l)	Last no. redial facility	
(m)	Ringer OFF-LOW-HI facility	
(n)	Hold on music	
(o)	Pause facility	
(p)	Ring LED (Yes/No)	
(q)	Display	

Date :
Place :

Signature of Manufacturer/Supplier Signature of the Bidder

Name & Address

Name :

Whether Authorised Attorney of the tendering Company

Name of the tendering Company with Seal

SECTION - 2D

TECHNICAL SPECIFICATION FOR 6 Pair &1 Pair Telephone Cables

1.0 SCOPE:

1.1. The scope of the specification covers design, manufacture, testing, packing, forwarding and delivery on FADS basis of cables as detailed below:-

i. 0.63mm 6 pair un-armoured telephone cable
ii 0.63mm single pair un-armoured telephone cable.

1.3. Six pair and single pair telephone cables are intended to interconnect the switching equipment to Power Line Carrier Communication terminal and interconnecting the switching equipment to telephone instruments. The telephone cables will carry voice and data signals with frequencies below 4 kHz. The cables are intended for indoor use only.

2.0 **STANDARDS:**

(i). The cables proposed for purchase shall conform to the following I.S. Standards which shall mean latest revisions, amendments/changes adopted and published unless otherwise specified herein after.

Standards	Title
Telephone cables	
IS10579/	Polythene Insulation and sheath of
IS5831/84	PVC Insulation and sheath of Electrical cables

Equipment meeting with the requirement of other authoritative standards, including IS which ensure equal or better performance than the standards mentioned above, shall also be considered. When the equipment offered by the bidder conforms to other standards, salient points of difference between standards adopted and the standards specified in this specification shall be clearly brought out in the relevant schedule. Four copies of such standards with authentic translation in English shall be furnished along with the offer.

3.0 **CLIMATIC CONDITION :**

2.0. The Cables called in this specification are required to operate satisfactorily as per the service conditions setout in the clause No.23 of Section-III of this specification.

4.0. **PRINCIPAL PARAMETERS:**

4.2. Six pair/Single pair cable

4.2.1.	Type of cable	:	telephone cable
4.2.2.	Voltage grade	:	300V
4.2.3	Conductor material	:	Annealed tin copper
4.2.4.	Conductor size	:	0.63mm +/- 0.1mm
4.2.5.	Conductor resistance	:	57 Ohms/Km
4.2.6.	Conductor elongation (%)	:	20.0 (Min)
4.2.7.	Insulation material	:	Solid medium density polythene
4.2.8.	Insulation thickness	:	0.25 mm Nominal
4.2.9.	Max. dia of insulation core:		1.2 mm
4.2.10.	Overall sheath material	:	Extruded PVC ST-1 IS:5831/84
4.2.11.	High voltage	:	2 kV rms for 1 minute

4.2.12.	Capacitance Unbalanced	:	250 pf (Max)
4.2.13.	Packing length / coil	:	100 m +/- 5% coil
4.2.14.	Overall sheath thickness :		
	5 Pair	:	1.4mm Nominal
	Single pair	:	1.0 mm Nominal
4.2.15.	Overall dia. of cable		
	6 pair	:	8.0 mm
	Single pair	:	5.5 mm
	Insulation material		: PVC type A of IS:5831/84
4.3.5.	Thickness of Insulation		: 1.2mm Nominal
4.3.6.	Approx. cable outer dia		: 9.5 mm Nominal
4.3.7.	Max. CR at 20 deg.C.		: 0.95 Ohms/km
4.3.8.	Volume resistivity		: 1 X 10^{12} ohms/cms at 20 deg.C
4.3.9.	High voltage test		:3.0 kV for 5 minutes between conductor and ground
3.2.9	RLS type		Category C1
3.2.9.0.	Oxygen Index		:As per ASTMD 2963
3.2.9.0.	Temperature Index		:not less than 25^0C

5.2. **<u>6 Pair & Single Pair Telephone cables</u>**

4.1.0 The telephone cables shall be made up of 0.63 mm diameter annealed, high conductivity copper conductor, polythene insulated, 2 cores twisted to form pairs all pairs bundled and wrapped together with Teflon paper. Overall PVC sheathed unarmourmed telephone cable generally conforming to IS:1554-part-I.

4.1.0 Cable shall be designed and manufactured so that damage will not result from transportation, installation and operation under any/or all the climatic and operating conditions to which they may be subjected. The conductor in every single core of the cable shall withstand an external voltage of 300V.

6.0. **TESTS**

6.1. The type tests carried out on the offered cables should be in accordance with IS:5026-1969, IS:11967(part.2/sec.2)/89,

6.1.1. The bidder along with his bid shall furnish type test certificates for the tests specified in clause No.10.6.2.0 below for the equipment offered by him. The type tests should have been conducted on particular type & model of the equipment i.e., offered by the bidder against this specification by a reputed independent laboratory and the satisfactory performance of the said equipment should have been certified by the laboratory.

The bids of bidders not accompanied by the type test certificates as stated above will be treated as incomplete and termed as non-responsive and liable to be rejected.

Type tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this specification.

6.2.0. <u>Type Tests</u>

6.2.2. 6 Pair and 1 Pair cables

i) resistivity of conductor
ii) dielectric strength of insulator
iii) insulation resistance
iv) spark test
v) high voltage test
vi) hot deformation
vii) elongation test
viii) tensile strength test

6.3.2. Telephone cables
i) dimensions
ii) insulation resistance
iii) elongation test
iv) tensile test
v) high voltage test
vi) conductivity test / shrinkage
vii) thermal stability test

6.4. **Routine Tests**

6.4.2. Telephone cables
i) dimensions
ii) insulation resistance
iii) elongation test
iv) tensile test
v) high voltage test
vi) conductivity test/ shrinkage

6.5. Testing Expenses

The entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price of cables.

6.6. Additional Tests:

The Purchaser reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Bidder's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests, to satisfy himself that the material comply with the specifications.

6.7. Test Reports:

6.7.1. Copies of test reports shall be furnished in at least six (6) copies along with one original. One copy shall be returned duly certified by the Purchaser only after which the material will be dispatched.

6.7.2. Record of routine test reports shall be maintained by the Bidder at his works for periodic inspection or as and when desired by the Purchaser's representative.

6.7.3. Test Certificates of tests conducted during manufacture shall be maintained by the Bidder. They shall be produced for verification as and when desired by the Purchaser.

6.8. **TEST FACILITIES**

6.8.1. The following additional test facilities shall be available at Bidder's works:

a) Various testing and measuring equipment shall be provided.

b) Standard resistance for calibration of resistance bridges.

GUARANTEED TECHNICAL PARTICULARS
for Telephone Cables

		6Pair/1Pair
1)	Manufacturer Name & Address:	
2)	Suppliers Name & Address :	
3)	Governing Standards :	
4)	Voltage grade :	
5)	No. of pairs :	

SECTION - 2D

6.	Conductor	
	a) material	:
	b) size	:
	c) resistance	:
	d) elongation	:
7.	Insulation	
	a) material	:
	b) thickness	:
	c) Max.dia of core	:
	d) resistance	:
	e) colour code	:
8.	Pair lay length	:
9.	Core wrapping	:
10.	Moisture barrier	:
11.	Overall sheath	
	a) material	:
	b) thickness	:
	c) colour	:
12.	Overall dia of cable	:
13.	High voltage	:
14.	Packing length	:
15.	Rip cord	
16.	Capacitance unbalanced	:
17.	Type test certificates enclosed (Yes/No) :	

Date :
Place :

Signature of Manufacturer/Supplier
Name & Address

Signature of the Bidder
Name :
Whether Authorised Attorney
of the tendering Company

Name of the tendering Company
with Seal

ANNEXURE – I

CLIMATIC CONDITIONS

I.	MAXIMUM AMBIENT TEMPERATURE (DEGREE C)	45
II.	MINIMUM AMBIENT AIR TEMPERATURE (DEGREE C)	5
III.	DAILY AVERAGE AMBIENT TEMPERATURE (DEGREE C)	32
IV.	MAX.RELATIVE HUMIDITY	74%
V.	ANNUAL RAIN FALL (MAX) MM	1500
VI.	RAINY DAYS IN A YEAR (DAYS)	JUNE TO OCTOBER – 120 DAYS
VII.	BASIC WIND SPEED M/SEC	44
VIII.	MAXIMUM ALTITUDE ABOVE MEAN SEA LEVEL (METERS)	1000
IX.	SEISMIC LEVEL	
	(HORIZONTAL ACCELERATION)	0.03
	(VERTICAL ACCELERATION)	0.015
X.	AVERAGE NUMBER OF THUNDER STORM DAYS PER YEAR	

Technical Specification

4-1/2 DIGIT HANDHELD Digital MULTIMETER

10.4.3.1	Scale	:	4 1/2 Digit
10.4.3.2.	Count djsplay	:	80000 counts LCD display
10.4.3.3.	DC voltage accuracy	:	± (0.05% +10) to ± (0.05% +40)
10.4.3.4.	AC voltage accuracy	:	± (0.8% +20) to ± (1.5% +60)
10.4.3.5.	Ohm accuracy	:	± (0.3% +60) to ± (0.5% +20)
10.4.3.6.	Frequency response	:	100 kHz
10.4.3.7.	Ranges		
	i. DC voltage	:	80 mV to 1000V
	ii. AC voltage	:	800 mV to 1000V True (rms)
	iii. AC & DC current	:	80 mA to 10A
	iv. Resistance	:	800 Ohms to 80M Ohms
	v. Capacitance	:	1nF to 100 µF
	vi. Frequency	:	50 Hz to 10 KHz

10.4.3.8. Operating Voltage : On a built-in 9V rechargeable battery

10.5.3.0. 4 1/2 Digital Handheld Digital Multimeter

10.5.3.1 The 4 1/2 digit handheld digital multimeter to be supplied under this specification must have overload protection.

10.5.3.2 The 4 1/2 digit handheld multimeter should be compact in construction and light weight and rugged shock absorbent case.

10.5.3.3 The 4 1/2 digit handheld multimeter should have the following indications.

- Automatic Polarity
- Low battery indication.

10.5.3.4 The 4 1/2 digit multimeter should be suitable for carrier signal measurement in dBs on PLC, VHF and UHF Communication system and should be capable of diode testing.

10.5.3.5. Accessories along with each meter.

Fuses	2 of each type
Testing probes	2 pairs
User manual	1
Batteries installed	1set

ANNEXURE –

GUARANTEED TECHNICAL PARTICULARS FOR 4 1/2 DIGIT HANDHELD MULTIMETER (TO BE FILLED BY BIDDER)

Sl. No.	Description	Data
1.	Manufacturer Name & Address	
2.	Suppliers Name & Address	
3.	Make & Type	
4.	Scale	
5.	Count display	
6.	DC voltage accuracy	
7.	AC voltage accuracy	
8.	Ohm accuracy	
9.	Frequency response	
10.	Ranges	
	i. DC voltage :	
	ii. AC voltage :	
	iii. AC & DC current :	
	iv. Resistance :	
	v. Capacitance :	
	Weight	
	Dimensions	
11.	Whether over load protection provided	Yes/No
12.	Whether capable of indicating automatic Polarity and Low battery	Yes/No
13.	Whether accessories provided	Yes/No

Signature of the bidder.

Technical specification for Cleaver, Stripper, Binoculars

I. HIGH PRECISION CLEAVER;

High precision cleaver should have flexible design which permits it to meet variety of cleaving requirements. This cleaver will be used for fusion splicing. Hence the cleaving mechanism should give a splice loss less than 0.02 d B. It should also have the provision to accept fiber holders to support multi-fiber cleaving operations.

II. STRIPPER:

Stripper shall be designed in such a way that all sizes of fibers to remove without scratching or marring the fiber. It is of hardened, precision formed, ground cutting surfaces and having a 0.005" precision laser drilled hole.

TOOLS FOR CUTTING ,STRIPPING,SHEAQTHING, JACKET ARMOURING STRENGTH MEMBERS OF OFAC/ADSS

Each set SHOULD consists of THE FOLLOWING TOOLS housed in a standard quality suitcase:

1.Jacket Stripper
2.Universal continuity Tester
3.Buffer Tube stripper
4.Round cable slitter
5.Round cable cutter
6.Kevlar scissors
7.FIS Connector Cleaner
8.Foam Swabs
9.Matching gel
10.KM Wipes
11.Utility knife
12.Tweezers
3.Needle nose splier
14.Plano wire
15.4 bit screw driver
16.Black marker
17.safety glasses
18.D-GEL wipes
19.Black work mat
20.Fibre Disposable Unit
21.Wire marker dispenser
22.Ruler
23.Fabric tape measure
24.1/2" Nut driver
25.Economy tie labels
26.Fusion splice sleeves(100nos.)
27. 4gm blue Dye epoxy
28.1mtr. ,3mm furcation
29.1mtr.,900um furcation
30. PVC Electrical Tape
31. 4OZ Alcohol Bottle
32. Rugged carry case 33. Safety belts 34.Binoculars (2nos.)

TOOLS FOR CUTTING ,STRIPPING,SHEAQTHING, JACKET ARMOURING STRENGTH MEMBERS OF OFAC/ADSS

III. BINOCULARS

Binoculars are required for Monitoring of EHT line Towers and its members and position of Fibre Optic Cable and its accessories fixed to the Tower Members.

Binoculars should able to be provide clear picture / image over a minimum distance of 1000 mts. It should also meet the following parameters.

i) Magnification : 10 x or better
ii) Diameter of the front lens : 50 MM or more

iii) Complete water proof proteciton
iv) Dry Nitrogen – purged and sealed to prevent frogging, clouding and moisture damage.
v) Fully multi – coated optics which maximizes light transmission for superior brightness and clarity.
vi) BAK-4 prisms for crisp and clear images.
vii) Extreme close focus distance.
viii) Wide field of view
ix) Optimum long eye relief with twist-up eye-cups.
x) Large Knurled center focus knob for precise focusing.
xi) Textured and rugged shock-absorbing rubber armor
xii) Non-slip and ergonomic rubber design for a secure grip.
xiii) Solid and sturdy construction.
xiv) Deluxe carrying case and neck strap.

ANNEXURE
GTP FOR BINOCULARS

S.No.	Description	
1.	Make & Model	:
2.	Magnification	:
3.	Diameter of the Front lens	:
4.	Water proof protection	:
5.	Focus distance	:
6.	Clear view Distance(kms)	:
7.	Maximum Viewing distance.	:
8.	Shock abscorbing Mechanism	:
8.	Prisms design	:
9.	Carrying case	:

Signature of the bidder
with official seal

iv) Dry Nitrogen – purged and sealed to prevent fogging, clouding and moisture damage.

SECTION – 3
PROJECT DETAILS AND GENERAL SPECIFICATIONS

SL.NO.	DESCRIPTION	
1.	**PROJECT INFORMATION**	
	a) Customer	APGENCO, Hyderabad
	b) Consultant	Desein Consulting Engineers, New Delhi
	b) Projects	1x600MW RayalseemaTPP, Stage-IV, Unit#6-400/220kV Switchyard
	c) Project locations	The project site is located in VV Reddy nagar, Post- Karamala Distt Kadapa (Formarely Cuddapah) about 30KM west-south of Proddatur & 20KM from Yerraguntla. Approx. 7 km north of Chillamkur Village. Nearest Rail head is Muddanur, which is approx. 10 kM from Site. Site is approximately 480KM from Hyderabad and 350KM from Chennai.

Equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions:

2.	**SITE CONDITIONS**	
i.	Maximum Ambient air temp. (max.)	40.3 °C
ii.	Minimum Ambient air temp. (max.) °C	19.1 °C
iii.	**Design ambient temperature**	**50 °C**
iv.	Altitude above MSL	190m
v.	Basic wind speed	39m/s at 10m above retarding surface
vi.	Seismic acceleration	Zone-III As per IS-1893
vii.	Terrain Classification	Category-2
viii.	Average Rainfall	742.8 mm Average
ix.	Humidity	Max: 49-74% (June to Oct) Min: 35-60% (march to June)

3. Auxiliary Supply

Normal Voltage	Variation in Voltage	Frequency in Hz	Phase/Wire	Neutral Connection
415 Volts	± 10%	50 ± 5%	3 phsae/4 wire	Solidly earthed
240 Volts	± 10%	50 ± 5%	1 phase/2 wire	Solidly earthed
220 Volts	190V to 240V	DC	---	Isolated 2 wire system (ungrounded)

Combined variation of voltage and frequency shall be limited to ± 10%.

5. DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

1) Drawings.
2) Guaranteed Technical Particulars
3) Type Test Reports
4) Manufacturing Quality Plan

6. DOCUMENTATION SCHEDULE AT CONTRACT STAGE

A : For & After Approval	Soft copies as per clause no. 5 in 1 set
B : For Approval	Hard copies as per clause no. 5 in 12 sets
B : After Approval	Bound sets of Approved Hard copies and Installation, Operation & Maintenance manual and all as built drawings in 20 sets
	3 Set of Computer CD-ROMs (with unbreakable CD Covers) containing all as-built drawings in Auto-Cad version 2006 or later with 2D and 3D drawings, Instruction Manual and GTP.

7. **Title block:** Title block shall be forwarded to successful bidder after placement of order.

8. All outdoor enclosures shall provide a degree of protection of not less than IP 55 as per IS-13947 & colour shade of RAL 7032 and one enclosures of each type shall be tested for the same or evidence of testing shall be furnished in lieu of type testing.

9. CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

All types of boxes, cabinets, etc. shall generally conform to & be tested in accordance with IS-5039/ IS 8623, IEC: 439, as applicable, and the clauses given below:

Control cabinets, junction boxes, Marshalling boxes and terminal boxes shall be made of sheet steel or aluminium enclosure and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled. The thickness of aluminium sheet shall be minimum 3mm. However the junction boxes & switch boxes shall be hot dip galvanized.

Protection Class shall be as follows:

i)	INDOOR Air conditioned area-	IP 31
ii)	Indoor Non AC Areas-	IP 54
iii)	Outdoor Areas-	IP 55
iv)	Motors-	
	a) Indoor-	IP 54
	b) Outdoor-	IP 55

Cabinet/boxes shall be free-standing, floor-mounting type, wall mounting type or pedestal mounting type as per requirements. A canopy and sealing arrangement for operating rods shall be provided in Marshalling boxes/Control cabinet to prevent ingress of rain water.

10. Quality plan:

BHEL or APGENCO approved QP shall be followed.

11. Type Test reports:

Bidder shall submit valid type test reports (as per relevant IEC/IS Standard) of the tests carried out within last five years from the date of bid opening.. The report should have been conducted on identical or similar equipment/ components to those offered. In case type test reports are more than 5 years old OR the reports of type tests are found to be technically unacceptable, the type test shall be conducted without cost and delivery implication to BHEL/APGENCO.

12. INSPECTION, TESTING AND INSPECTION CERTIFICATE

Inspection testing shall be done as per customer specification and inspection plan.

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