

ATTACHEMENT 07

SECTION 14**FIBRE OPTIC MULTIPLEXER EQUIPMENT FOR
COMMUNICATION AND PROTECTION****14 Fibre-Optic Multiplexer Equipment for Communication and Protection****Contents**

14	FIBRE-OPTIC MULTIPLEXER EQUIPMENT FOR COMMUNICATION AND PROTECTION	1
14.1	SUMMARY OF STANDARDS	4
14.1.1	PDH INTERFACES	4
14.1.2	ARCHITECTURE OF OPTICAL SDH INTERFACES	5
14.1.3	SYNCHRONISATION AND TIMING OF OPTICAL SDH INTERFACES	6
14.2	Abbreviations	7
14.3	General Requirements	8
14.4	General Conditions	9
14.4.1	Channel Capacity: Digital Cross Connection	9
14.4.2	Redundant Centralised Functions	10
14.4.3	Power Supply	10
14.4.4	ITU Compliance	10
14.4.5	Electromagnetic Compatibility and Safety Regulations	10
14.4.6	Ambient Conditions	10
14.4.7	Mechanical Construction	10
14.4.8	Network Management System	11
14.4.9	1+1 Path Protection	11
14.4.10	1+1 Section Protection	11
14.4.11	Network Topology	11
14.4.12	Synchronisation	12
14.4.13	Alarms	12
14.4.14	Test Loops	12
14.4.15	Maintenance Facilities	12
14.5	Requirements for Transport Level	12
14.5.1	SDH Aggregate Units	12
14.5.2	HDSL Aggregate Units	13

14.6	Tributary Units	15
14.6.1	4-Wire Interface (VF Interface)	15
14.6.2	Analogue Subscriber Interface	15
14.6.3	Exchange Interface	16
14.6.4	Party Line Telephone System (Engineering Order Wire)	17
14.6.5	V. 24N.28 RS232 Interface	17
14.6.6	V.11/X.24 Interface	17
14.6.7	V.35 Interface	17
14.6.8	V.36 / RS 485 Interface	18
14.6.9	64 kbit/s Co-directional Interface	18
14.6.10	Ethernet Interface	18
14.6.11	Alarm Interface	19
14.6.12	Teleprotection Interface	19
14.6.13	Optical Protection Relays Interface	20
14.6.14	Binary Contact Interface	20
14.6.15	2Mbit/s G.703 / G.704 Interface	21
14.7	Telephone System	21
14.8	Communications DC Power Supply Equipment	22
14.8.1	General	22
14.8.2	Configuration	22
14.8.3	Charger	23
14.8.4	Battery	25
14.8.5	D.C. Distribution and Instrumentation	27
14.8.6	Housing	28
A14.1	NI-CAD BATTERY	ERROR! BOOKMARK NOT DEFINED.
A14.2	48 V BATTERY CHARGER	ERROR! BOOKMARK NOT DEFINED.
A14.3	FIBRE OPTIC MULTIPLEXER EQUIPMENT	ERROR! BOOKMARK NOT DEFINED.
A14.4	OPERATIONAL TELEPHONE SYSTEM (PABX)	ERROR! BOOKMARK NOT DEFINED.

SECTION 14

FIBRE OPTIC MULTIPLEXER AND POWER LINE CARRIER EQUIPMENT FOR COMMUNICATION AND PROTECTION

This specification describes the communication requirements for the transport of voice, data and protection signals between the new substations existing substations and the National Load Dispatching Centre (NLDC & BNLDC) in Rampura and Siddirganj, including engineering, configuration, testing, installation, commissioning and training.

The scope of work is to connect the Substation Automation System to the existing communication system to be installed under this contract for securing the transport of voice, data and protection signals, complete system for new substations and extension and integration into the existing system for existing substations.

The scope of work is to connect REMOTE END substations, too. All necessary equipment, material and services shall be included in the contract price.

OPGW with 48 cores of optical fibre in 400kV, 230kV & 132kV Overhead Line will be installed by the transmission Line Contractor, but this optical fibre will be used for optical connection for Fiber Optic Multiplexer Equipment and Line/Current Differential Protection of the 400 kV, 230 kV & 132 kV line.

All materials and equipment offered shall be brand new, from the Manufacturer's normal and standard construction, designed and manufactured according the latest technological methods.

For the purpose of standardisation of operating performance and facilities offered equipment shall be compatible with the existing ones.

For standardization of operation performance, facilities and spare requirements, the fibre optic multiplexer equipment for communication and protection to be supplied under this project shall consist of equipment which can totally be integrated into the existing telecommunication system in PGCB's network, including the telecommunication network management system. The fibre optic multiplexers presently used in PGCB's network are:

- Hitachi FOX 515/615, and
- GE MSE 5001, MSE 5010
- Huawei OSN 1800V, E6616

The Manufacturer of Telecommunication system – Fibre optic multiplexer equipment for communication and protection shall be: Hitachi Energy (Switzerland)(Former ABB), , GE (Former Alstom/Areva), ZTE/HUAWEI (China).

Any other Manufacturer of Telecommunication system shall have to fulfil the Qualification Criteria required in sub-clause 2.6. of Section 3 of Volume 1 of Tender documents

14.1 Summary of Standards

The Equipment shall comply with the latest ITU-T recommendations for the Plesiochronuous, synchronous hierarchies & multiprotocol label switching-transport -profile.

The equipment shall be KEMA type tested.

14.1.1 PDH Interfaces

The PDH interfaces shall conform to the following recommendations:

ITU

ITU-T G.702	General aspects of digital transmission systems - Terminal equipment Digital hierarchy bit rates
ITU-T G.703	Digital transmission systems - Terminal equipment - General Physical/electrical characteristics of hierarchical digital interfaces
ITU-T G.704	Digital transmission systems - Terminal equipment - General Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels
ITU-T G.706	General aspects of digital transmission systems - Terminal equipment- Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in recommendation G.704
ITU-T G.71 1	Pulse code modulation (PCM) of voice frequencies
ITU-T G.712	Transmission performance characteristics of pulse code modulation channels
ITU-T G.732	General aspects of digital transmission systems - Terminal equipment - Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s
ITU-T G.735	Characteristics of primary multiplex equipment operating at 2048 kbit/s and offering synchronous digital access at 384 kbit/s and/or 64 kbit/s
ITU-T G.736	General aspects of digital transmission - Characteristics of a synchronous digital multiplex equipment operating at 2048 kbit/s

ITU-T G.737	Characteristics of external access equipment operating at 2048 kbit/s and offering synchronous digital access at 384 kbit/s and/or 64 kbit/s
ITU-T G-823	The control of jitter and wander within digital networks, which are based on the 2048 kbit/s hierarchy
ITU-T G.826	Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate

14.1.2 Architecture of Optical SDH Interfaces

The architecture of optical SDH interfaces shall conform to the following recommendations:

ETS/EN

ETS 300 147:	Synchronous digital hierarchy multiplexing structure
ETS 300 417:	Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment
ETS 300 417-1-1 / EN 300 417-1-1 V 1. 1.2:	Generic Processes and Performance
ETS 300 417-2-1 / EN 300 417-2-1 V1.1.2:	SDH and PDH Physical Section Layer Functions
ETS 300 417-3-1 / EN 300 417-3-1 V 1. 1.2:	STM-N Regenerator & Multiplex Section Layer Functions
ETS 300 417-4-1 / EN 300 417-4-1 V 1. 1.2:	SDH Path Layer Functions

ITU

ITU-T G.707	Network node interface for the synchronous digital hierarchy
ITU-T G.783	Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks
ITU-T G.803	Architecture of transport networks based on the synchronous digital hierarchy (SDH)
ITU-T G.805	Generic functional architecture of transport networks
ITU-T G.826	Error performance parameters and objectives for international, constant bit rate digital

	paths at or above the primary rate
ITU-T G.841	Types and characteristics of synchronous digital hierarchy (SDH) network protection architectures
ITU-T G.957	Optical interfaces for equipment and systems relating to the synchronous digital hierarchy
ITU-T G.958	Digital line systems based on the synchronous digital hierarchy for use on optical fibre cables
ITU-T M.2101.1	Performance limits for bringing into service and maintenance of international SDH paths and multiplex section
ITU-T T.50	International Reference Alphabet (IRA) - Information technology 7 bit coded character set for information interchange

14.1.3 Synchronisation and Timing of Optical SDH Interfaces

The synchronisation and timing of optical SDH interfaces shall conform to the following recommendations:

ETS/EN

ETS 300 417-6-1 / EN 300 417-6-1 V 1. 1. 2	Synchronisation Layer Functions
ETS 300 462-1 / EN 300 462-1-1 V 1. 1. 1	Transmission and Multiplexing (TM); Generic requirements for synchronisation networks; Part 1: Definitions and terminology for synchronisation networks.
EN 300 462-4-1 V1.1.1	Transmission and Multiplexing (TM); Generic requirements for synchronisation networks; Part 4-1: Timing characteristics of slave clocks suitable for synchronisation supply to Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) equipment
ETS 300 462-5 / EN 300 462-5-1 V1.1.2	Transmission and Multiplexing (TM); Generic requirements for synchronisation networks; Part 5: Timing characteristics of slave clocks suitable for operation in Synchronous Digital Hierarchy (SDH) equipment

ITU

ITU-T G.813:	Timing characteristics of synchronous digital hierarchy (SDH) equipment slave clocks (SEC)
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14.1.1 Architecture of MPLS-TP Interfaces

The architecture of MPLS-TP interfaces shall conform to the following recommendations

ITU

ITU-T G.8112/Y.1371 MPLS-TP Interface

ITU-T G.8113: Operations, administration and maintenance mechanisms for MPLS-TP in packet transport networks.

14.2 Abbreviations

ADM	Add-drop multiplexed
ALS	Automatic Laser Shutdown
BIP	Bit Interleaved Parity
CAP	Carrier-less Amplitude and Phase
CAS	Channel Associated Signalling
CRC	Cyclic Redundancy Check
DTMF	Dual Tone Multi-Frequency
EN	European Norm
EOW	Engineering Order Wire
ETS	European Telecommunications Standards
GPS	Global Positioning System
HDSL	High Density Subscriber Line
IEC	International Electrical Commission
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ITU	International Telecommunication Union
LAN	Local Area Network
MCMI	Multi Coded Mark Inversion
MS	Multiplex Section
NE	Network Element
NMS	Network Management System
OS	Optical Section
OSPF	Open Shortest Path First
PDH	Plesiochronous Digital Hierarchy

PPP	Point-to-Point Protocol
RS	Regenerator Section
SDH	Synchronous Digital Hierarchy
SNMP	Simple Network Management Protocol
SOH	Section Overhead
STM	Synchronous Transport Module
TCP	Transmission Control Protocol
TTI	Trail Trace Identifier
VC	Virtual Container
MPLS-TP	Multiprotocol Label Switching- Transport Profile
VF	Voice Frequency

14.3 General Requirements

The digital multiplex equipment shall be universal, software-controlled, and provide various interface cards to connect tributary interfaces signals such as voice, teleprotection and data to aggregate interfaces. On aggregate level 2Mbit/s and 8Mbit/s electrical interfaces complying with ITU-T recommendations G.703 / G.704, G.8112/Y.1371 and 2Mbit/s HDSL interfaces shall be available. In addition, optical STM-1/STM-4/STM-16 and/or Ethernet 1GE/10GE aggregate interfaces on 155Mbit/s shall be available. All modules shall form an integrated part of a shelf.

The multiplexer shall provide means to drop and insert individual 64 kbit/s signals and allocate them to determined time slots in the 2Mbit/s streams. Path protection on 64 kbit/s and 2Mbit/s shall be supported.

It shall be suitable for operation in substation with harsh environment with high electromagnetic interference, be highly reliable and provide secure communication for real time signals such as voice, SCADA, teleprotection and status/control signals.

The equipment offered shall already be working successfully in telecommunication networks operated by power utilities. It shall comply to the latest ITU-T standards and be able to be interconnected with telecommunication equipment.

Any equipment in the network shall be manageable from a control centre and there shall be means to supervise external/existing equipment as well.

As a minimum modules for the following user signals shall be available as plug-in units for the digital multiplexer:

- Analogue subscriber interface: subscriber and exchange side
- G.703, 64kbit/s data Interface
- ~~X.24/V.11 (RS-422), Nx 64kbit/s data interface~~
- ~~V.24/V.28 (RS-232), data interface~~
- ~~RS 232/485/422 data interface~~
- Alarm collection interface
- Teleprotection command interface
- Binary signal (status and control) interface
- 2Mbit/s electrical interface for unframed signals acc. to ITU-T G.703 and framed signals acc. to G.703 and G.704.

Additionally, the equipment shall provide the following aggregate interfaces:

- STM-4 (622 Mbit/s) optical 1+1 interface for medium and long distances, with automatic laser shut down.
- STM-1 (155 Mbit/s) / STM-4 (622 Mbit/s) optical add-drop interface for medium and long distances, with automatic laser shut down
- 2 Mbit/s electrical interface /
- ~~2 Mbit/s HDSD interface~~

The equipment may provide 1GE/10 GE Ethernet interface

The equipment shall be equipped with a ringing generator for analogue subscriber interfaces.

14.4 General Conditions

The same equipment shall be used as a terminal, for through connections (transit, repeater) and as add-drop multiplexer (ADM) with integrated optical line modules.

- First order multiplexing (2048 Kbit/s), second order multiplexing (8448 Kbit/s/s) and STM-1/STM-4 or STM-16 & 1Gbps/10 Gbps multiplexer shall be integrated.

Conference for voice channels and point-multipoint function for data signals shall be possible.

The equipment shall be of fully modular design, based on a single cubicle.

14.4.1 Channel Capacity: Digital Cross Connection

The equipment shall be equipped with a redundant cross connection function with decentralised cross connection functions on each board.

The cross connect capacity shall be minimum 40x 2Mbit/s, or 200x 64kbit/s non-blocking.

14.4.2 Redundant Centralised Functions

The equipment shall be equipped with redundant circuits for all centralised functions.

14.4.3 Power Supply

The multiplex equipment shall operate at 48VDC +/- 15%. Redundant power-supply shall be supported.

14.4.4 ITU Compliance

The Equipment shall comply to the latest ITU-T recommendations for the plesiochronuous, synchronous hierarchies & multiprotocol label switching-transport -profile such as:

G.702-704, G.706, G.711-714, G.732, G.735-737, G.742, G.826, G.823, G.8112/Y.1371, Q-552

14.4.5 Electromagnetic Compatibility and Safety Regulations

The equipment shall comply with the EN50022, EN50082, IEC 801-2, IEC 801-6 and shall be conformant with CE.

14.4.6 Ambient Conditions

Storage and transport: -40... +70°C; 98% (no condensation)

Operation: -5... +45°C, humidity of max. 95% (no condensation)

14.4.7 Mechanical Construction

The equipment shall be of robust design. All tributary and aggregate units shall be integrated in the same shelf.

All connectors shall be accessible from the front.

14.4.8 Network Management System

The equipment shall be software programmable, by both a local craft terminal - preferably notebook and a centralised Network Management System (NMS).

Traffic through the multiplexer shall under no circumstances depend on Network Management System; i.e. the multiplexer has to operate without being connected to any management system.

The Network Management System shall be used to supervise & configure the tele-protection, PDH/SDH/MPLS-TP equipment.

14.4.9 1+1 Path Protection

The equipment shall protect communication channels. The protection shall be end to end from one interface (telephone or data) 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.

14.4.10 1+1 Section Protection

The equipment shall provide multiplexing section protection. 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.

14.4.11 Network Topology

It shall be possible to build point to point, linear, ring, T, and meshed networks.

14.4.12 Synchronisation

The equipment shall be synchronisable with an external centralised clock, with connected 2.048 Mbit/s signals and/ or with internal oscillator. The synchronisation shall be configurable and it shall be possible to distribute the synchronisation to other equipment as well.

The system shall have means to switch to select the synchronisation source as well as means to prevent the system from switching synchronisation loops. The equipment shall be capable select the synchronisation source by means of the SSM (Synchronisation Status Messaging) feature according to ITU-T G.704 or priority based.

14.4.13 Alarms

Each module shall supervise its functions and shall have an alarm-indication LED on its front. All alarms shall be collected by the NMS.

Each node shall be capable to collect up to 50 external alarms.

14.4.14 Test Loops

The equipment shall provide means to loop signals on 64kBit/s level as well as on 2Mbit/s level. It shall indicate an alarm if a loop is activated. It shall have the possibility to determine the time after which an activated loop is switched back.

14.4.15 Maintenance Facilities

Every Network Element shall have a built-in Signal Generator and Analyser to analyse communication paths. It must be possible to cross connect the Generator and Analyser to transmission channels and terminate the signal in other Network Elements. The configuration must be possible locally with the craft access terminal and remotely with the NMS or the craft access terminal.

It must be possible to loop-back signals locally and remotely using the craft access terminal or the NMS.

14.5 Requirements for Transport Level

14.5.1 SDH Aggregate Units

The interface shall be designed for use on single mode fibre at 1310nm and 1550nm

The following main functions shall be supported:

- Termination of the OS-, RS-, MS- and VC-4 layer
- Extraction and insertion of the SOH communications information through connections of VC-12 and VC-3

The following maintenance functions shall be supported:

- Status indications
- Loops
- Restart after ALS
- TTI monitoring
- BIP Error Insertion

The following SDH interfaces shall be available:

- STM-1/4 for 132kV & lower voltage level
- STM-4/16 for 230kV voltage level
- STM-16 for 400kV voltage level
- The number of optical port shall be as per field requirement

This interface shall provide Multiplex Section Protection (MSP): 1+1 Section Protection

- 2Mbit/s & 64kbit/s electrical interface
- The number of port shall be as per field requirement

14.5.2 HDSL Aggregate Units

2Mbit/s HDSL interface

The HDSL interface shall provide means to interconnect the multiplexer over two pairs of copper wire up to 12km using CAP modulation (Carrier-less Amplitude and Phase). It shall communicate either with another interface of the same type or with a remote desktop terminal.

2Mbit/s HDSL Desktop Terminal

This Terminal shall provide a HDSL interface to transmit 2Mbit/s over two pairs of copper over a distance up to 12 km. It shall be housed in a metallic indoor case. The following interfaces shall be available:

- ~~G.703, 2Mbit/s, 75 ohm~~
- ~~G.703, 2Mbit/s, 120 ohm~~
- ~~X.21/V.11, Nx 64kbit/s (N = 1 .. 32)~~
- ~~V.35, Nx 64kBit/s (N = 1.. 32)~~
- ~~V.36 / RS485, Nx 64kbit/s (N = 1.. 32)~~

LAN Connection:

~~I/O base ethernet connection for e.g. router supporting LAN protocols: IP, IPX; routing protocols: RIP; WAN protocols: HDLC, PPP, frame relay (including RFC 1490). It shall inter-operate with Cisco, Wellfleet, 3Com etc. and be manageable locally, remotely, and with Telnet and SNMP. Two such desktop terminals shall be connectable to provide a 2Mbit/s link over two pairs of copper.~~

HDSL Repeater:

~~An HDSL repeater solution for distances longer than 12km shall be offered including a remote powering solution.~~

HDSL Line Protection:

~~The HDSL equipment shall (where necessary) be protected against influences of induced voltages up to 10 kV.~~

14.1.4 MPLS-TP Aggregate Units

The interface shall be designed for use on single mode fibre at 1310nm and 1550nm

The following main functions may be also supported:

- MPLS forwarding
- Pseudo-wire (PWE3)
- Bi-directional LSPs
- Static Provisioning

The following maintenance functions shall be supported:

- Continuity Check (CC)
- Connectivity Verification (CV)
- Loopback (LB)
- Remote Defect Indication (RDI)
- Loss Management (LM)
- Delay Measurement (DM)

The following MPLS-TP interfaces shall be available:

- 1/10 Gbps
- The number of optical ports shall be as per field requirement

14.6 Tributary Units

14.6.1 4-Wire Interface (VF Interface)

This interface shall provide 8 voice channels with a bandwidth of 300 Hz to 3.4 kHz and 2 signalling channels ($M \Rightarrow E$, $M' \Rightarrow E'$) per voice channel.

Each interface shall be configurable to operate with or without CAS. With CAS it shall use the a and b bits for the two signalling channels.

The level shall be software adjustable within the following range:

- Input: +7.5 to -16 dBr
- Output: +7.0 to -16 dBr

Modules where each interface can be individually configured with 1+1 path protection shall be available.

14.6.2 Analogue Subscriber Interface

An interface with at least 10 subscribers as well as high-density analogue subscriber card with 60 subscribers shall be available. The ringing generator shall be integrated in the subscriber module interface. The ringer frequency shall be adjustable for 20Hz, 25Hz, and 50Hz.

The following main functions shall be supported:

Downstream signalling:

- Ringing
- Metering
- Polarity reversal

- Reduced battery
- No battery

Upstream signalling:

- On/off-hook
- Pulse and DTMF dialling
- Flash impulse
- Earth key

General:

- Constant current line feeding
- Line test
- Permanent line checks
- CLIP (On-hook VF transmission)
- Metering after on-hook

14.6.3 Exchange Interface

This interface shall provide 12 interfaces to connect remotely connected analogue subscribers to an exchange. It shall provide the following functions:

- pulse dialling
- tone dialling (DTMF)
- earth key function
- metering function(12 kHz or 16 kHz)
- flash impulse
- polarity reversal
- indication of busy lines

The following parameters shall be configurable by software:

- input voice level -5 to +4 dBr
- output voice level -7.5 to -1 dBr
- metering pulse enable/disable
- signalling bit definition
- loop back of voice to the telephone

~~14.6.4 Party Line Telephone System (Engineering Order Wire)~~

~~An engineering order wire (EOW) facility shall be provided at each multiplexer. The EOW shall be configured as a party line and use in band DTMF signalling to call another EOW Terminal. The terminal shall have an integrated DTMF decoder allowing to program a subscriber call number (LA digits), and two group call numbers (LA digits each).~~

~~14.6.5 V. 24N.28 RS232 Interface~~

~~It shall support the following bit rates:~~

- ~~• 0... 0.3 kbit/s transp. (V. 110)~~
- ~~• 0.6... 38.4kbit/s synchronous / asynchronous (V. 110).~~

~~Modules where each interface can be individually configured with 1+1 path protection shall be available.~~

~~14.6.6 V.11/X.24 Interface~~

~~This interface shall comply to the ITU T X.24 recommendation for signal definition and to V. 11 for electrical characteristics.~~

~~It shall support the following bit rates:~~

- ~~• 48, 56, Nx 64 kbit/s (N = 1... 30) synchronous~~
- ~~• 0.6... 38.4kbit/s synchronous / asynchronous (X.30)~~

~~Modules where each interface can be individually configured with 1+1 path protection shall be available.~~

~~14.6.7 V.35 Interface~~

~~This interface shall comply with the ITU T V.35 and V. 110 recommendations. It shall support the following bitrates:~~

- ~~48, 56, Nx 64kbit/s (Nx = 1... 30) synchronous~~
- ~~0.6... 38.4kbit/s synchronous / asynchronous~~

~~Modules where each interface can be individually configured with 1+1 path protection shall be available.~~

~~14.6.8 V.36 / RS 485 Interface~~

~~This interface shall comply with the ITU-T V.36 and V. 110 recommendations. It shall support the following bit rates:~~

- ~~48, 56, Nx 64kbit/s (N = 1... 30) synchronous~~
- ~~0.6... 38.4kbit/s synchronous / asynchronous~~

~~Modules where each interface can be individually configured with 1+1 path protection shall be available.~~

14.6.9 64 kbit/s Co-directional Interface

This interface shall comply with the ITU-T G.703 part 1.2.1 for co-directional data transfer. A module shall have at least 8 interfaces.

Modules where each interface can be individually configured with 1+1 path protection shall be available.

14.6.10 Ethernet Interface

There shall be a 10BaseT interface available with Router Bridge and FRAD Function available. The following specification shall be covered:

Ethernet connection: 10baseT
LAN protocols: IP, IPX
Routing protocols: static IP route, OSPF2 V2
WAN protocols: PPP, Frame Relay (including RFC 1490)

The interface shall be manageable locally, remotely, with the management system of the platform. The LAN interface shall support linear-, ring- and star-configurations. The WAN side shall support link capacities n*64kBit/s and 2Mbit/s.

14.6.11 Alarm Interface

This interface shall provide means to collect various alarms, which will be displayed, on the network management system. It shall be used to manage non-PDH equipment with the PDH network management system.

It shall have at least 24 binary inputs and at least 4 outputs, which can be switched by the network management system.

It shall be possible to connect an input to an output so that if an alarm occurs, the output contact will be switched.

It shall be possible to label an alarm. The label-text shall be read from the interface module so that it can be indicated on the network management system as well as on the local craft terminal.

14.6.12 Teleprotection Interface

The protection of the overhead lines shall be arranged as detailed in Section 5. Teleprotection equipment shall be provided for permissive tripping and direct tripping on the lines. The permissive tripping signals are required to operate circuit breaker trip relays in conjunction with the distance protection and directional earth fault relays. The direct tripping signals are required to operate remote circuit breaker tripping relays.

Technical Requirements

This interface shall provide means to transmit four bi-directional command channels. The signals shall be adjustable from 24 to 250VDC by means of software.

All inputs and outputs shall be isolated and with EMC immunity for harsh environment.

Security, dependability and transmission speed shall be selectable and programmable.

It shall be able to drop and insert commands, transfer commands as a transit station, it shall be possible to have AND- and OR-connections between commands.

The interface shall support T-nodes.

The teleprotection interface shall provide an integrated non-volatile event-recorder which shall be synchronisable either internally or by GPS or a command counter which counts trip commands.

The teleprotection interface shall provide means for signal delay measurement.

1+1 protection must be available; the switching shall be done within less than 10ms. The interface shall do automatic loop test every 60s.

Under no circumstances shall the interface cause trip-commands in case of power supply failure or when put in or out of service.

It shall be possible to synchronise all teleprotection interfaces with one GPS in one station. The GPS time shall be distributed over the teleprotection channel.

An 8-bit command addressing shall be used to prevent tripping if the signal is inadvertently re-routed through the telecommunication network.

14.6.13 Optical Protection Relays Interface

This interface shall have an optical port to connect protection relays for teleprotection to the multiplexer. It shall operate on 1300nm use MCMI line coding and be suitable for teleprotection relays. Optical Interface of Fiber Optic Multiplexer must comply with IEEE C37.94 protocol for differential protection.

14.6.14 Binary Contact Interface

- This interface shall provide means to transmit binary signals.
- The inputs and outputs shall be isolated.
- The inputs shall be suitable for 24VDC to 60VDC.
- Outputs shall be solid state relays.
- The interface shall provide a 24VDC short circuit proofed auxiliary power supply.

- It shall be able to drop and insert commands, transfer commands as a transit station, it shall be possible to have AND- and OR-connections between commands.
- The teleprotection interface shall provide an integrated event recorder, which shall be synchronisable either internally or by GPS.

14.6.15 2Mbit/s G.703 / G.704 Interface

- This interface shall comply with the ITU-T G.703 and G.704 recommendations.
- The interface module shall have at least four interfaces to be activated individually. It shall be possible to have 128 interface modules a multiplexer.
- In order to connect different equipment, the interfaces shall be available with the impedance of 120 ohms and 75 ohms.
- The interface shall support CRC-4 multi-frame according to ITU-T G.704 (enabled and disabled by software).
- The CAS signalling according to ITU-T G.704 table 9 shall be activated optionally.
- The interface shall be able to extract the 2.048 MHz clock, which can be used to synchronise the multiplex equipment.
- The interface module shall support 2Mbit/s loop-back of the incoming signal as well as the loop-back of the internal signals.

14.7 Telephone System

An IP phone facility shall be provided at each new substation. The IP phone shall be incorporated by IP connection from upstream substation through IP network in the operational telephone system which is controlled from the existing call manager at NLDC Dhaka. At least three IP telephone sets proper to above mentioned administrative telephone system shall be provided at each new substation.

New substations will become remote subscribers in the administrative telephone system. Facility for minimum 10 x 2W remote subscribers shall be provided and installed at the substation and the remote subscribers shall be connect with the nearest existing exchange of the existing telephone network.

Necessary cards required at the nearest exchange and its associated multiplexer shall be included in the contract price. At least three telephone sets proper to the above mentioned administrative telephone system shall be provide at each new substation

The trunk numbering plan shall be compatible with the present scheme in service in Bangladesh.

The telephone signalling (dialling) system shall be compatible with the present system.

An alarm system shall be provided to indicate traffic failure including blown fuses, loss of power supply, etc. In addition, contacts shall be provided to facilitate extension of the alarms to the telecontrol equipment.

14.8 Communications DC Power Supply Equipment

14.8.1 General

14.8.1.1 Basis of Design

The equipment shall comply with IEC 60146 and 60478.

The charger shall be of either the Thyristor-controlled type or of the SMPS type. The battery shall be nickel cadmium type - as detailed in a separate section of this Specification.

The design and selection of equipment and components shall be based on achieving a minimum lifetime of 20 years, when operating under the specified service conditions.

14.8.1.2 Operating Principle

The output of the charger shall, during normal operation, continuously supply the power requirements of the load whilst simultaneously maintaining the battery charge in the float charge mode. In the event of an interruption in the a.c. mains supply to the charger, the battery shall supply the load requirements for not less than the specified standby time - whilst maintaining the output voltage within permissible limits.

Upon restoration of the a.c. mains supply, the rectifier shall automatically resume supply of the load requirements whilst simultaneously recharging the battery at the float voltage.

14.8.2 Configuration

The power supply installation shall comprise two batteries and two charging sources. each charger shall be able to float charge both batteries as well as supplying the total load.

The total battery capacity shall be able to supply the total load (comprising the delivered load together with 25% spare for future use) for at least 5 hours in the event of failure of the a.c. mains supply.

The d.c. power supply equipment is required to limit the output voltage to the load within plus 15% and minus 15% of the nominal value, provided these values do not exceed the voltage guarantee of the load equipment. The power supply output positive shall be earthed.

14.8.3 Charger

14.8.3.1 General

The charger shall operate according to the constant voltage current limiting principle and shall incorporate a soft start feature to gradually accept load on initial energising.

The charger shall restart automatically upon restoration of the a.c. mains supply following a mains supply interruption, and recharge the battery at the float voltage.

Internal cooling shall be by natural ventilation. Forced cooling is not acceptable.

The charger shall be suitable for operation in parallel with one or more chargers, and shall include a current sharing facility.

The charger shall be of sufficient output capacity for the application, parallel operation of chargers (where required) is for the purpose of redundancy and not to satisfy the output current requirements.

14.8.3.2 Charger Output

The output characteristic shall provide an output voltage regulation of $\pm 1\%$, over the specified a.c. mains voltage and frequency range and for load changes 0-100%. The output voltage regulator shall be adjustable within limits approved by the Engineer and shall be so designed that special tools are not required for such adjustment. Compensation for battery temperature shall be provided.

The charger shall have protection against overloads or short circuits and shall limit the output current.

Recovery to a constant voltage characteristic shall occur automatically at the end of the overcurrent/short circuit.

14.8.3.3 Boost Charging

Both Auto & Manual boost charging shall be provided. A boost timer shall be included to prevent overcharging.

Operation of boost charging shall not disconnect the charger and battery from the load. The load shall be connected to DC charger during boost charging. However, provision may be applied so that, it shall not be possible for both chargers to be selected to boost charging at the same time, or for the load to become disconnected from both batteries and chargers simultaneously.

If the a.c. mains supply fails during boost conditions the two batteries shall be automatically connected in parallel by "no volt" contactors to the load.

It shall not be possible to connect a "boosted" battery to the load until its terminal voltage has fallen below the load equipment upper voltage limit.

14.8.3.4 Noise and Interference

To avoid unacceptable levels of electrical noise in the load equipment smoothing of the d.c. output is required. This shall achieve a psophometric noise level at the output, for loads between 0 and 100%, not exceeding the equivalent of 2 rnV at a frequency of 800 Hz after weighting as specified by ITU-T (CCITT).

The relative harmonic content of the input current shall comply with the European Directive for EMC, the EN 60555-2 standard. In the case of SMPS chargers active power factor correction (i.e. boost for step up converter) shall be provided to control the power factor.

The production of radio frequency interference voltages shall not exceed the values of suppression grade "N", as defined in EN 55014/55015 - for Thyristor-controlled type chargers, and suppression grade "B" as defined in EN 55022 for SMPS type chargers.

The performance of the d.c. power supply equipment unit shall not be affected, or in any way degraded, by the use of the following when the severity of the electromagnetic radiation environment corresponds to Class 3, in accordance with IEC 801-3:

- private mobile radio operating in designated or planned radio frequency bands
- current cellular radio equipment
- future cellular equipment
- mobile data equipment.

It is the Contractor's responsibility to determine the radio frequency bands applicable in the locality.

14.8.3.5 Efficiency/Rating

The charger efficiency shall not be less than 85%.

All chargers supplied shall preferably have the same rating, or be in fixed multiples, to limit the number of different charger ratings.

14.8.3.6 Instruments, Controls and Alarms

The charger shall be equipped with the following:

- a.c. mains input circuit breaker
- d.c. output circuit breaker
- charger output current meter
- charger output voltage meter
- alarms for charge fail, d.c. volts high etc.

Each alarm shall be provided with local annunciation and two sets of potential free contacts, for connection to external alarm monitoring systems.

14.8.4 Battery

14.8.4.1 Type

Nickel cadmium cells shall be of the pocket plate type in accordance with IEC 60623.

Cell containers shall be of the moulded plastic type, non-flame propagating and mechanically shock resistant. They shall provide for the electrolyte level to be viewed through the container material.

Cells shall be permanently marked with the following information:

- Manufacturer's reference number and code
- year and month of manufacture
- voltage and nominal capacity at C5 rate
- cell number.
- Cell Class-L

14.8.4.2 Mounting

The batteries shall be mounted on metal stands, or racks, in a manner such that all the plates of each cell are visible for inspection, test and maintenance purposes. Stands or racks shall have a maximum of two tiers. In all cases adequate space must be left between the tiers for maintenance purposes and to permit the topping up of electrolyte. Stands or racks shall have a protective finish of not less than two coats of electrolyte resisting enamel or gloss paint. Alternatively, an epoxy resin sintered finish may be used.

At locations where the battery is not housed in a separate battery room the battery stand/rack shall be fitted with cladding. The cladding shall permit the free flow of air to the battery, and shall be removable for maintenance purposes.

Cell containers shall be accurately set up in alignment on the stand or rack with lead and/or rubber discs under the feet moulded on each container. Cell lids shall be so positioned that at least one topping up aperture is on the access gangway side of the cell and not obstructed by any inter-cell connecting arrangements.

14.8.4.3 Battery Main Fuses

Bolted cartridge fuses shall be provided in both positive and negative leads and positioned as close to the battery as possible and shall be rated at five times the charger float output rated current. A cartridge fuse shall be provided in the charger input lead to the negative pole of the battery and rated at twice the charger float output rated current. These fuses shall be mounted preferably on the end of the battery stand or rack. These fuse links shall comply with BS 88.

Class DC 40 or equivalent and shall be mounted in fuse carriers with an insulated barrier between the poles.

The cable or busbar to the battery shall be firmly supported at a point near the cell terminal pillar. Where two cables are used they shall be terminated one to either side of the terminal pillar. These cables shall be arranged as to allow some flexibility and to avoid any forces being applied to the cell terminal pillar.

14.8.4.4 Connections

The positive pole of each battery shall be connected to station earth via a single bolted link at the distribution cubicle. Low resistance inter-cell connectors shall be used. Connections between tiers of cells and between end cells and fuses shall be made with insulated copper rod which shall be of equivalent cross-section to the distribution busbars.

Connections from the battery fuses to the chargers and distribution cubicles shall be made with insulated cable of equivalent cross-section to the distribution busbars. The positive and negative terminals of each cell shall be clearly indicated. The positive and negative terminals of the complete battery shall be indicated by red and black marking respectively.

14.8.4.5 Capacity

The battery capacities shall be 250 ampere hours at C5 rate.

14.8.5 D.C. Distribution and Instrumentation

14.8.5.1 General

The distribution section shall be designed for incoming and outgoing d.c. supplies as follows:

- Two independent supplies (including one for future use) incoming from the batteries and associated chargers. The battery negatives shall be connected to the distributed busbar through a single pole switch. The 48V battery positive shall be directly connected to the positive busbar.
- Each load equipment shall be connected to a distribution outlet. The use of teed supplies to more than one load equipment will not be permitted.
- Double pole miniature or moulded case circuit breakers to IEC 157 shall be supplied, fitted with auxiliary contacts which operate when the circuit breaker trips.

The MCBs shall be rated to meet the load requirements and shall be labelled with the destination of the load. Outgoing connections shall be brought to terminals, mounted in the cubicle, provided with strip connectors and cable lugs. The number of outlets shall cater for the quantity of load equipment items plus 50%, with a minimum of 10 outlets being provided, Space shall also be available for the installation of 10 extra outlets for future use.

14.8.5.2 Instruments and Alarms

Instrumentation shall comprise:

- battery ammeter (charge and discharge)
- battery voltage
- load current ammeter
- busbar voltage

An alarm indication shall be provided if the busbar voltage falls outside set limits.

The MCB auxiliary contacts and the high/low voltage alarm shall each provide local annunciation and two sets of potential free contacts, for connection to external alarm monitoring systems.

14.8.6 Housing

The above covers the mounting/housing for batteries.

A modular construction is preferred for the battery charger and d.c. distribution/instrumentation, with each unit comprising a single 19" or ETSI standard rack configuration, all mounted in a single cubicle.

The modular construction shall provide:

- simple plug in units for easy assembly and servicing
- individual battery charger unit removal in safety, without loss of output power to the load.
- expansion of capacity at a later date

In the case of Contractors who do not offer a modular construction, separate cubicles are required for each charger and the d.c. distribution/instrumentation.