

ODISHA POWER TRANSMISSION CORPORATION LIMITED



VOLUME-II

Technical Specification for Fiber Optic Terminal Equipment

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1. FIBER OPTIC TERMINAL EQUIPMENT (FOTE)

1.1 SCOPE

This Specification defines the requirements for the design of a high bandwidth digital fibre optic communication (FOC) system and associated works.

This Specification includes for all design and engineering, installation of SDH and primary access multiplexing equipment, digital cross connection units including necessary optical line terminal equipment, optical repeaters if required, optical fibre distribution frames and patch panels, Fiber Optic Approach cable from Gantry tower to communication room, equipment cubicles and enclosures, all associated connectors, interconnecting cables including pigtails and patch cords, power supplies, and all necessary ancillary equipment including installation materials to complete the system.

The digital fibre optic communication backbone shall be based on the SDH technology and network architecture. The proposed FOTE system shall be capable of supporting both SDH, PDH & Teleprotection (Distance & Differential Protection) interfaces required for the project.

The FOC system shall be designed for digital transmission using single mode optical fibres and shall conform to the ITU-T recommendations G.703, G.704, G.707, G.783 and G.957.

The multiplexing structure of the proposed FOC system shall allow existing PDH signals to be carried over the synchronous network and shall permit the extraction of individual circuits from high capacity systems without having to demultiplex the whole system. Cross connect facilities shall be provided to enable interconnections between different channels and network components i.e. the same cross-connect card shall be able to manage both SDH & PDH traffic with redundancy.

The proposed fibre optic communication network consists shall support the voice, Teleprotection (both distance protection commands operation & line differential protection) & data communication requirements of RTUs and the SCADA/EMS system. The communication system shall provide data & voice connectivity across the various locations or connectivity of RTUs with Sub-LDC/SLDC. The RTUs located at various locations will report to Control Center using IEC 870-5-101 or IEC 870-5-104 Protocol. The proposed communication system shall also support Ethernet interface for RTUs over TCP/IP protocol and serial interface.

The fibre optic network shall be based on the lowest bit rate of the Synchronous Digital Hierarchy (SDH) i.e. STM-1. However, the offered equipment can be upgraded to STM-4 by changing the optical SFP only without upgrading the hardware. The Contractor can propose a system based on higher bit rate systems, if required, so as to meet the link budget requirements or any other specification requirement.

1.2 GENERAL REQUIREMENT

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.

On TRANSPORT LEVEL interfaces for optical transmission on PDH 8Mbit/s (Optical), STM-1 155Mbit/s and STM-4 622Mbit/s shall be available. Additionally 2Mbit/s x DSL (HDSL or SDHSL) interfaces shall be available for connection to copper cables. For connection to higher order transport equipment also N x 2Mbit/s and STM-1 electrical interfaces shall be available. Equipment shall support 8 Mbps optical link with MSP protection with remote substation to transport voice, Data, Teleprotection & Current Differential protection signalling minimum upto 80 km.

The equipment shall be software controlled, of modular design and all modules shall form an integrated part of a 19" shelf. The expandability for requirement to be supported by offered equipment shall be obtained by just inserting the cards in access multiplexer.

The platform shall have means to cross-connect, drop and insert individual channels (64kbit/s time slots), 2Mbit/s framed (G.704) and unframed (G.703) signals. It shall also support termination and cross connection of VC 12, VC-3 and VC-4.

Equipment protection and various protection schemes (SNCP & MSP) shall be supported.

For stations with teleprotection and telecommunication requirements an integrated teleprotection function (distance and differential protection) has to be provided and for special cases (Critical Lines) in hybrid network the same teleprotection module should be capable to provide redundant communication over PLCC also. The interface for command (4 independent commands per interface for sending/receiving signals with operation of distance protection scheme of transmission line) transmission & reception shall be supported by offered system. The Telerotection module should also capable to provide redundant communication over SDH and on Dark Fibers directly as well without repeater/multiplexer upto 225 km.

Modules for direct connection to following USER SIGNALS shall be available as plug-in modules for the equipment:

Analogue subscriber interface: subscriber and exchange side

- 4-wire E&M voice interface Module with atleast 8 channels
- G.703, 64kbit/s data Interface Module with atleast 8 channels
- X.24/V.11
- V.24/V.28 (RS-232) data interface Module with atleast 8 channels
- V.35/V.36, N x 64kbit/s data interface Module with atleast 6 channels
- Alarm collection interface

- Teleprotection command interface for Distance Protection Commands Signaling
- Optical protection relay interface C37.94
- Binary signal (status and control) interface module with Minimum 8 NO/NC Contacts
- 2Mbit/s electrical interface for unframed signals acc. to ITU-T G.703 and framed signals acc. to G.703 and G.704.
- LAN interface 10/100BaseT electrical interface RJ45 supporting Layer-3 Protocol (Routing, WAN) with atleast 8 ports per module.
- LAN Interface for 100BaseT supporting EoS Layer-2 switching with atleast 8 FE Ports.

On TRANSPORT LEVEL the equipment shall support the following connection ports:

- Up to 5 x STM-4 SDH optical ports
- Up to 10 x STM-1 SDH optical ports for medium and long distances, with automatic laser shut down programmable on each interface.
- Up to 14 x 8Mbit/s optical ports
- Up to 12 x 2Mbit/s HDSL ports
- STM-1/4 Interfaces shall support Bidirectional SFP for single Fibre operation.

All optical 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.

1.3 FUNCTIONAL REQUIREMENT

The primary function of the communication network is to provide a highly reliable voice, teleprotection and data communication system in support of the SCADA/EMS. The communications support requirement for SCADA/EMS system is for low & high speed data, express voice circuits and administrative voice circuits.

1.3.1 Equipped Minimum Configuration

Each FOTE Equipment shall consist of below interfaces at minimum:

- a) Redundant Power supply units
- b) Redundant Cross Connect Units
- c) Nos. STM-1 ports which can also be used for STM-4 also. (Type of SFPs and quantity to be proposed by the bidder avoiding the requirement of repeaters)
- d) E1 Card- Minimum 16 E1s.
- e) Ethernet Ineterface Card with Layer-2 Switching Capability with minimum 8 FE ports
- f) 4-wires E & M channel interface Card with minimum 8 channels
- g) Low speed RS232 data Channels(600 -1200 bps)- minimum 8 channel
- h) 2-Wire FXO Card- minimum 12 channels to interface with Exchange
- i) 2-Wire FXS Card- minimum 6 channels to interface with Remote Subscriber

Note:

Bidder has to provide the optimized network solution specifying the required modules/ cards & optical interfaces based upon information provided in the tender document. Optical interfaces (SFPs) has to be proposed by the bidder meeting link budget calculation according to section lenth/s/distances provided.

1.3.2 Other interfaces supported by the equipment

Each FOTE equipment shall also support below interfaces which may be required by the employer. (Also refer BOQ and Section Project if these interfaces/ modules are required in the project):

- a) IEEE C37.94 Interface Card – Minimum 4 ports for Differential Protection and direct connectivity with Current Differential Relays.
- b) Teleprotection Module with minimum 4 Input /Output Commands and same shall be upgradeable to 8 Input/Output Commands.
- c) Router Card with minimum 8 FE ports with Layer-3 features and supporting WAN protocols i.e. Static, RIP-I, RIP-II and OSPF routing protocols.
- d) 2 Wire Hotline Interface Card- Minimum 4 Channels
- e) SDH Tributary/Branching Card with minimum 2 x STM-1 Interfaces

1.3.3 Teleprotection Module

The Teleprotection and communication system has to ensure the easy and secure function of the teleprotection. Therefore following features have to be provided:

- At least an 8 bit command addressing for teleprotection signal shall be provided to prevent tripping if the signal is inadvertently re-routed through the telecommunication network.
- An automatic and periodic loop test (<100s) has to be provided for a signal delay measurement.
- A switch-over of the teleprotection command in less than 10 ms has to be guaranteed.
- The configuration of the teleprotection has to be integrated into the communication configuration tool in order to ensure an easy maintenance.

More details on the requirement of the teleprotection features are defined under the Teleprotection Equipment.

1.4 **GENERAL EQUIPMENT CHARACTERISTICS**

All equipment shall be new and of the finest production quality. The Employer will not accept modules or printed-circuit boards that are modified by appending wires or components. All applicable requirements stated in this section shall equally apply to the NMS equipment as specified in this Section.

1.4.1 Salient Features to be supported by the FOTE System

- Modular, open and technology-independent system structure supporting SDH (STM-1, STM-4), PDH (DSO, E1, E2) and C.37.94 Interfaces in single subrack.
- Communication Interfacing Cards suitable for interconnecting with existing PLCC &

Teleprotection panels for transit connection over 4 Wire E & M channels and dialing/express tie line connectivity of Electronic speech exchanges over 4 wire E&M channel at substations between which FOTE shall be installed. It also support interfacing card for existing Data communication (600 baud) connectivity through RS 232 and also over 4 wire in VF band.

- Communication Interfacing Cards suitable for communication with existing VFT equipment and digital and analog speech subscribers.
- Communication Network Management system for Online parameter modification without interruption of function.
- LED's/LCD Display for indications of all operating conditions
- High EMC (electromagnetic compatibility)
- Increased electric strength
- Signal interfacing Module for distance teleprotection as well as line differential protection (Optical protection relay interface C37.94) fully manageable under the same NMS shall be provided for interconnecting with relays of DPS scheme at existing /newly planned substations.
- The offered FOTE shall provide one single platform for whole range of application from 64kbits/sec to STM-4.
- The FOTE (SDH STM-1 ADM) shall provide platform to deploy SDH and the latest Ethernet over SDH technology and thus will provide both IP & teleprotection in the same fibre.
- The FOTE (SDH STM-1 ADM) should be ready for IEC 61850.
- The SDH STM-1 ADM should be capable of handling SCADA RTU's operating on IEC-870-5-101 as well as IEC-870-5-104 and both shall be supported in single subrack.
- The reliability of each board of SDH STM-1 ADM shall be more than 20 years. Calculative evidence to be submitted for availability.
- The STM-1 ADM with SDH should be backward compatible with PDH installations providing the desired bandwidth for new Ethernet based services like IEC 60870-5-104 SCADA and VoIP without the need for PDH equipment operating on 64 Kbps levels.

1.4.2 General Equipment Characteristics

The equipment shall be capable of functioning as a terminal, in 'through connection' (transit, repeater) mode and as add-drop multiplex. First order multiplexing (2Mbps), second order multiplexing (8Mbps) and STM-1 multiplexing shall be integrated. Conference for voice channels and data multiplexing shall be possible. The equipment shall be of fully modular design.

a Channel capacity: Digital Cross Connection

The equipment shall be equipped with redundant, decentralized cross-connection

functions. The cross-connect capacity that the equipment will offer shall be non-blocking. For high-density applications the cross-connect capacity shall be upgradeable. It shall cross-connect 64kBit/s as well as 2Mbit/s (G.703 unframed and G.704 framed) and VC12. The cross-connect shall be capable of cross-connecting the SDH overhead with any 64kBit/s timeslot on the system. On addition the equipment shall offer an SDH cross-connect capacity of at least 4xVC-4 in the same equipment.

b. Redundant centralized functions

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

c. Power Supply

The multiplex equipment shall operate from a nominal 48Volt DC battery with positive ground. The equipment shall work satisfactorily over battery voltage variations of + / – 15% (40.8 volts through 55.2 volts). Redundant power-supply (1+1 hot-standby) 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).

d. Safety

The equipment shall be safe to use and shall comply with EN / IEC 60950-I.

e. Electromagnetic compatibility and safety regulations

The equipment shall comply with IEC TS 61000-6-5: "Immunity for power station and substation environments"

EN55022 Class A, EN50024/EN300386, FCC Part 15 Class A

f. Ambient Conditions

Storage and transport:

Temperature range: - 25°C ... +70°C

Humidity: max. 98% (no condensation)

Operation:

Temperature range: - 5°C ... +55°C

Humidity: max. 95% (no condensation)

g. Mechanical construction

The equipment shall be available as a 19" shelf to be mounted in a 19" rack or 19" cabinet. It shall be of robust design. All modules shall be integrated in the same shelf. All connectors shall be accessible from the front and comply with international specifications. The minimum cabinet depth required shall be stated.

h. Network configuration/management system

The network management system (NMS) shall have facilities to supervise, monitor, control and configure each equipment and the whole network. It shall have capabilities of fault, configuration, performance and security management. It shall provide various graphical views to the network such as geographical overview, logical network structure, and hierarchical view. The network management system shall allow to define different user profiles.

A comprehensive alarm management shall show current alarms such, that icons of the network elements change their colours according to the alarm level. The alarms shall be categorized as critical, major, minor alarms and of the warnings and a summary shall indicate the total number of them in the entire network. An alarm list shall list all alarms of the entire network according to the time of their occurrence. It shall be possible to filter alarms with various filter criteria. Operators shall be able to add comments to the alarms.

The DCN (Data Communication Network) to access all Network Elements shall be based on TCP-IP. -The management system shall offer an SNMP interface for alarm integration into higher order networks.

i. Local User Terminal

It shall be possible to connect the craft terminal to any Network Element in the network

using the TCP-IP protocol. The craft terminal shall support configuration, maintenance, and status information.

j. Network protection

The equipment shall provide means to protect the network by SNCP and 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.

k. Network Topology

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

l. Synchronization

It shall be possible to synchronize the equipment using an external clock source, derived from a network or with an internal oscillator. The synchronization shall be configurable and it shall be possible to distribute the synchronization to other equipment as well. The system shall have the means of switching to select the synchronization source as well as a means of preventing the system from creating synchronization loops. The equipment shall be capable of selecting the source of synchronization by means of SSM (Synchronization Status Messaging) on 2Mbit/s PDH or SDH port or by means of a priority-based sequence. For teleprotection event recording it shall be possible to synchronize all the Teleprotection modules with one GPS at central location station over SNTP protocol.

n. 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 of collecting up to 50 external alarms.

o. 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.

p. Maintenance facilities

Every Network Element shall have a built-in Signal Generator and Analyzer to analyze communication paths. It must be possible to connect the Generator and Analyzer to the communication channels and terminate the signal on other Network Elements. It shall be possible to configure circuits locally with the craft terminal and remotely from the NMS or the craft terminal. It shall be possible to loop-back signals locally and remotely using the craft terminal or the NMS.

1.5 TRANSMISSION INTERFACES

a SDH Modules

The interface shall be designed for use on single mode fibre (conforming to ITU-T G.652 or G.655). The interface card shall be based on SFP technology with LC/PC connectors.

The following main functions shall be supported:

- Prepared for SFP's (small-factor pluggable units) for short, medium, long and extra-long optical communications (1310nm and 1550nm)
 - Termination of the OS-, RS-, MS- and VC-4 layer
 - Extraction and insertion of the SOH communications information
 - Through connections of VC-12, VC-3 and VC-4
 - Support MSP (Multiplex Section Protection)

The following Optical interfaces shall be available:

- STM-1 (155Mbit/s) optical port interface

- STM-4: (622Mbit/s) optical port interface

b. PDH Modules

An 8Mbit/s module for optical communication on 1310nm or on 1550nm shall be available. Each module shall provide at least 4x 2Mbit/s (G.703) electrical ports and have an integrated switch matrix to convert the incoming optical signal directly into electrical G.703 signals.

c. DSL Trunk Modules

The 2Mbit/s DSL interface shall provide means to interconnect the multiplexer over one or two pairs of copper wire up to 10km using G.SHDSL modulations. It shall communicate either with another interface of the same type or with a remote desktop terminal.

1.6 USER SIGNAL INTERFACES

a. 4-Wire Interface (VF interface)

This module shall provide connections for voice channels with a bandwidth of 300 Hz – 3.4 kHz and 2 signaling channels ($M \Rightarrow E$, $M' \Rightarrow E'$) per voice channel. Each voice channel shall be configurable to operate with or without CAS. With CAS it shall use the “a” and “b” bits for the two signaling channels.

The level shall be software adjustable within the following range:

- Input: +7.5 to -16dBr and Output: +7.0 to -16dBr Modules where each voice channel can be individually configured with 1+1 path protection shall be available. This interface should support two main applications
- Inter-exchange connectivity to support E&M interface types I to V.
- Terminal equipment connections -For Party line subscriber set, - For modems for data over voice transmission

b. Analogue Subscriber Interface (FXS)

The multiplexer shall support analogue Subscriber interface module for at least 12 subscribers. The same module can also be used to make hotline circuits. The ringing generator shall be integrated on the subscriber module. The ringing frequency shall be adjustable.

The following main functions shall be supported: Downstream signaling

- Ringing, Metering, Polarity reversal, Reduced battery, No battery Upstream signaling
- On/off-hook, Pulse and DTMF dialing, Flash impulse, Earth key General:
- Constant current line feeding, Line test, Permanent line checks, CLIP (On-hook VF transmission), Metering after on-hook

c. Exchange Interface (FXO)

This module shall provide at least 10 ports for connection to the ports for remote analogue subscribers of a telephone exchange (PAX, PABX). It shall provide the following functions:

- pulse dialing, tone dialing (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.. +4dBr, output voice level -7.5... -1dBr
- metering pulse enable/disable, signaling bit definition,
- loop back of voice to the telephone

d. Engineering Order Wire

An engineering order wire (EOW) facility shall be provided at each multiplexer. Following options shall be available:

- The EOW shall be configured as a party line and use in band DTMF signaling to call another EOW-Terminal. The Terminal shall have an integrated DTMF decoder allowing to program a subscriber call number (1..4 digits).
- EOW based on Voice over IP (VoIP).

e. Data Interfaces

Following interfaces shall be available for both Synchronous and asynchronous data transmission:

- V.24/V.28, V.11/X.24, V.35 and shall support following bit rates :
- Synchronous and asynchronous: 0.6 ... 38.4kbit/s
- Synchronous: 48, 56, N x 64kbit/s (n = 1 ... 31) Following options shall be available:

f. 64kbit/s Co-directional Interface

This module shall comply with the ITU-T G.703 part 1.2.1 for co-directional data transfer. Each module shall support atleast 8 independent channels.

g. IP/Ethernet Interface

Ethernet module shall comply with the following specification:

- Ethernet electrical connection: 10/100BaseT
- Ethernet electrical connection: 1000BaseT
- Switching: bypass mode for IEEE Std 802.3 frame or based on port or VLAN tag ID
- This module shall provide WAN connectivity of VC-12 or VC-3 and also support configuration of Logical WAN port.
 - Framing: According General Framing Procedure (GFP) ITU-T G.7041
 - Capacity: Virtual Concatenation (VCAT) acc. ITU-T G.707
- Protection: Link Capacity Adjustment Scheme (LCAS) acc. ITU-T G.7042

Additionally a module with an integrated Ethernet Router shall be available with following function:

- Ethernet connection: Minimum 8 nos. 100BaseT
- Routing Protocols: Static IP route, OSPF2 V2
- WAN protocols: PPP
- WAN capacity: N x 64kbit/s (n=1 to31)
- WAN-ports: > 30

h. Alarm Interface

This module shall provide means to collect minimum 4 external alarms, which shall be displayed on the Network Management System. It shall be used to supervise external equipment by the Network Management System. Minimum 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.

I Teleprotection Signalling Equipment (For distance protection scheme)

This module shall support the following features related to the protection commands:

Transmit 4 protection commands bi-directionally (i.e. Transmit/receive independently).

All 4 commands Transmit/receive independently such that in case of all four commands if transmitted from one end then all four will be received to opposite end.

Accept protection command signals in the range of 24VDC- 250VDC

All inputs and outputs shall be isolated and with EMC immunity for harsh environment. Security and Dependability shall be selectable and programmable.

The teleprotection module shall provide an integrated non-volatile event-recorder, which shall be synchronized either internally or by Global Positioning System (GPS IRIG-B) or SNTP.

A command counters which counts trip Send/Receive commands with circuitry to store the counts for history recording.

Teleprotection Module should be operable at 48V, 110V & 220VDC voltages and if required can be installed near protection relay panel in the protection room and can communicate with remote teleprotection Module directly without using the SDH or PDH Backbone

The teleprotection interface (comply with IEC 60834-1) shall allow the protection scheme i.e. permissive tripping, Direct tripping, blocking/Unblocking etc. The teleprotection module shall further support:

1+1 protection, switching shall be done within less than 4ms (typical value)
Periodically automatically initiated loop-tests (e.g. every 60s).

Command addressing: This function shall be used to prevent tripping if the signal is inadvertently re-routed through the telecommunication network

Under no circumstances will the module cause trip-commands in case of power supply failure or when equipment is put into or taken out of service.

j Module to interface directly with Protection Relays (Optical interface)

This module shall have optical ports each of them allowing direct connection to protection relays with interfaces complying with ANSI/IEEE C37.94. Each interface shall support all 12 time slots (12x 64kbit/s) in accordance with ANSI/IEEE C37.94.

K. Module for transmission of Binary Signals

This interface shall provide means to transmit binary signals and support the following features:

- Isolated inputs and outputs (I/O)
- Accepting I/O for 24 ... 60VDC.
- Outputs shall be solid-state relays.

1.7 NETWORK MANAGEMENT SYSTEM (NMS)

The Bidder shall provide a Network Management System (NMS) for operational support to the typical utility telecom network elements like SDH/PDH, Teleprotection and PLCC. This NMS shall provide the capability to monitor, reconfigure, and control elements of the telecommunications network from a centralized location (RLDC) as well as at remote operation location (SLDCs) and at each node of the network (through craft terminal) where equipment is located.

Network management is crucial for the overall performance and availability of the communication network. The task of the network management system (NMS) is to provide complete and efficient supervision of the alarm state of the network (fault management), to facilitate the adaptation of the configuration to changing needs (configuration management) and to strictly control the access to the various NMS features (security management).

The NMS design concept, functional and informational architecture and physical architecture, shall be in compliance with ITU-T Recommendation M.3010. For ease of management and monitoring by the System shall be able to manage all the offered communication equipment SDH/PDH, Differential Protection Interface and Teleprotection equipment from a single software and hardware.

a) Supported Network Elements

FOTE (SDH/PDH/Teleprotection) Equipment

PLCC Terminal Equipment

b) Graphical User Interface

The Graphical User Interface should have definable network displays (maps). Icons symbolizing sub-networks, equipment and links are to be placed on an optional background image and can be opened to display greater details down to equipment port level. Context sensitive menus and online help should be available. It should be possible to create any number of network maps to create different views of the network, e.g. geographical, schematic, sub-network, etc.

The Bidder shall submit for the NMS architecture for employer's approval describing the following subsystems/features in details:

- I. Database used in NMS
- II. Master Processor, server/workstation, LAN, Peripherals and hardware
- III. Software and operating system
- IV. Local Consoles/remote consoles
- V. Craft Terminals
- VI. Data communication between NEs, Remote/Local Consoles and TMN Processor(s)
- VII. Routers/Bridges
- VIII. Expansion Capabilities

c) Configuration Management

Configuration management is concerned with management, display, and control of the network configuration. Minimum specific requirements that shall be satisfied include the following:

- I. Provide tools to establish and maintain the backbone topology and configuration information and provide graphical maps depicting the configurations.
- II. Gather descriptive information about the current configuration of the equipment, provide operator displays, and prepare reports.
- III. Provide tools for planning, establishing, and changing the static equipment configuration. Provide for changes to the equipment configuration in response to equipment failures, planned upgrades, and operator requests to take equipment offline for testing.
- IV. Provide verification testing to support new equipment installation.

d) NMS Configuration

A graphical User Interface should exist to create network Domains, the NEs to be managed by the system and NE supervision processes. (Domains are used to structure the network in areas of responsibilities and are used in the definition of access right. The supervision processes allow grouping the NEs for supervision and enabling the supervision of a group of NEs to be turned to ON or OFF.)

Once an NE is discovered by the NMS its configuration shall be automatically uploaded and stored on the NMS hard disk. It shall be possible to configure the NMS to automatically keep a definable number of the most recent NE configurations accessible for inspection and/or download. All NE configuration changes should be done from the NMS using easy to use graphical windows accessible via drop down menus starting from the NE symbol on the graphical network view. The NMS shall fully support the administration of the NE configuration data (upload, download, backup, copy) and the NE embedded software (upgrade).

e) Hardware Requirement

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

- I. The server shall have minimum configuration of 3 GHz , 2 GB RAM, , 2 X 80 GB SAS Hard Disk Drive, RAID, integrated Gigabit Ethernet network interface (2 NICs), DVD+/- RW drive, Redundant Power Supply, 101-Enhanced style keyboards, Optical Scroll mouse, parallel, serial, USB(2.0) ports and hot swap redundant power supply. VDUs shall be 20" TFT active matrix colour LCD with a minimum resolution of 1024 X 768. Appropriate network drive card shall also be provided wherever required. However, the internal hard disk drive for the server shall be redundant and all the data shall be mirrored. Further, the NMS software shall support data mirroring on redundant disk drives.
- II. The workstation shall have minimum configuration of 2.4GHz, 1GB RAM, DVD+/-RW drive, 160 GB Hard Disk Drive, 101-Enhanced style keyboards, mouse, parallel, serial and USB (2.0) ports. VDUs shall be 19" TFT active

matrix colour LCD with a minimum resolution of 1024 X 768. Appropriate network drive card shall also be provided wherever required.

- III. The craft terminal shall have minimum configuration of 2.4 GHz, 2 GB RAM, 256 MB VRAM, DVD RW drive, 160 GB Hard Disk Drive, integrated Gigabit Ethernet network interface, keyboard, mouse/trackball etc., parallel, serial/USB (2.0) ports to accommodate printers, RS 232 serial port and Internal/external Data/Fax modem and a battery back-up of at least 60 minutes. VDUs shall be 15" TFT active matrix colour LCD with a minimum resolution of 1024 X 768.
- IV. NMS system shall be provided with laser printers. The laser printers shall have a minimum print speed of 17 pages per minute and a minimum resolution of 1200 x 1200 dpi. The laser printer shall have parallel and LAN ports for connecting to NMS system. All laser printers under this specification shall be black & white and include print enhanced buffering to prevent loss of print data in the event of a print failure.

1.8 OPTICAL LINK BUDGET CALCULATION

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

- 1) Fibre attenuation: The fibre attenuation shall be taken to be the guaranteed maximum fibre attenuation i.e. 0.21 dB/Km @1550nm and 0.35 dB/km @1310nm.
- 2) Splice loss: Minimum 0.05 dB per splice. One splice shall be considered for every 3 kms.
- 3) Connector losses: Losses due to connectors shall be considered to be minimum 1.0 dB per link.
- 4) Equipment Parameters: The equipment parameters to be considered for link budget calculations shall be the guaranteed "End of Life (EOL)" parameters. In case, the End of Life parameters are not specified for the SDH equipment, an End of Life Margin of at least 2 dB shall be considered and a similar margin shall be considered for optical amplifiers.
- 5) Optical path Penalty: An optical path penalty of at least 1 dB shall be considered to account for total degradations due to reflections, inter symbol interference, mode partition noise and laser chirp.
- 6) Maintenance Margin: A maintenance margin of at least 2.5 dB/100Km shall be kept towards cabling, repair splicing, cable ageing and temperature variations etc.
- 7) Other losses: Other losses, if any required specifically for system to be supplied shall also be suitably considered.
- 8) Dispersion: The fibre dispersion shall be taken to be the guaranteed maximum dispersion i.e. 18 ps/nm.Km @1550 nm & 6 ps/nm.km @ 1310 nm for DWDM fibres.
- 9) Bit Error Rate: The link budget calculations shall be done for a BER of 10^{-10} .

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

For finalising the FOTE system design & BOQ, above methodology shall be adopted taking into account fibre attenuation, dispersion and splice loss determined during the detailed engineering. Accordingly, additions and deletions from the contract shall be carried out based on unit rates indicated in the contract.

1.8.1 OPTICAL FIBER SPECIFICATION

The fiber optic route lengths are specified in the specification. The lengths specified in appendices are the transmission line route lengths; however the actual fiber cable length shall exceed the route lengths on account of extra cable requirement due to sag, jointing & splicing, approach cabling etc. For bidding purposes the Contractor may assume an additional cable length of 5% of given route length + 1Km towards approach cable for calculating the link length.

The exact cable lengths shall be determined by the Fibre Optic cable package Contractor during the survey. The same shall be forwarded to this package Contractor for final link design during the detailed engineering of the project. In case of change in the specified BOQ, the contract price shall be adjusted accordingly.

Fibre rings shall be implemented wherever the network permits (Network diagram enclosed). On linear sections of the network, protected links using 4 fibres shall be implemented.

DWSM Optical Fibre Characteristics

Fibre Description:	Dual-Window Single-Mode
Mode Field Diameter:	8.6 to 9.5 μm ($\pm 0.6\mu\text{m}$)
Cladding Diameter:	125.0 $\mu\text{m} \pm 1 \mu\text{m}$
Core- Clad concentricity error	$\leq 1.0\mu\text{m}$
Mode field concentricity error	$\leq 0.6\mu\text{m}$
Cladding non-circularity	$\leq 1\%$
Cable Cut-off Wavelength λ_{cc}	$\leq 1260 \text{ nm}$
1550 nm loss performance	As per G.652 D
Proof Test Level	$\geq 0.69 \text{ GPa}$
Attenuation Coefficient:	@1310nm $\leq 0.35 \text{ dB/Km}$ @1550nm $\leq 0.21 \text{ dB/Km}$
Chromatic Dispersion; Maximum:	18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm
Zero Dispersion Wavelength:	1300 to 1324nm
Zero Dispersion Slope:	0.092 ps/(nm ² xkm) maximum
Polarization mode dispersion coefficient	$\leq 0.2 \text{ ps/km}^{1/2}$
Temperature Dependence:	Induced attenuation $\leq 0.05 \text{ dB}$ (-60 deg C - +85 deg C)
Bend Performance:	@ 1310 nm (75 \pm 2 mm dia Mandrel), 100 turns; Attenuation Rise $\leq 0.05 \text{ dB}$ @ 1550 nm (30 \pm 1 mm radius, Mandrel), 100 turns; attenuation Rise $\leq 0.05 \text{ dB}$ @1550 nm(32 \pm 0.5 mm dia Mandrel, 1 turn; Attenuation Rise $\leq 0.50 \text{ dB}$

1.9 SUMMARY OF STANDARDS

The Equipment shall comply with the latest ITU - T Recommendations for the plesiochronous and synchronous hierarchies. The Equipment shall be KEMA/Equivalent Lab Type Tested.

ETSI

- ETSI EN 300 386 V1.3.2 (2003 - 05):
 - Electromagnetic Compatibility and Radio Spectrum Matters (ERM)
 - Telecommunication Network Equipment; Electromagnetic Compatibility (EMC) Requirements
 - 7.2.1 Equipment Operating in Telecommunication Centres.
 - 7.2.2 Equipment Operating in Locations other than Telecommunication Centres.

IEC

- IEC 61000 – 6 - 2 (1999 - 01):
 - Electromagnetic Compatibility (EMC) - Part 6 - 2: Generic Standards - Immunity for Industrial Environments
- IEC 61000 – 6 - 5 (2001 - 07):
 - Electromagnetic Compatibility (EMC) - Part 6 - 5: Generic Standards - Immunity for Power Station and Sub Station Environments - Test: 1.2, 1.3, 2.3 and 2.5

IEEE

- IEEE C37.1 (1994):
Definition, Specification and Analysis of Systems Used for Supervisory Control, Data Acquisition, and Automatic Control
 - 6.6 Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC)
- IEEE C37.90.2 (1995): Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
- IEEE C37.94: IEEE Standard for N x 64 kbps Optical Fibre Interfaces Between Line Differential Relay and Multiplexer Equipment

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 kbps 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.711: 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 kbps
- ITU - T G.735: Characteristics of Primary Multiplex Equipment operating at 2048 kbps and offering Synchronous Digital Access at 384 kbps and / or 64 kbps
- ITU - T G.736: General Aspects of Digital Transmission - Characteristics of a Synchronous Digital Multiplex Equipment operating at 2048 kbps
- ITU - T G.737: Characteristics of External Access Equipment operating at 2048 kbps and offering Synchronous Digital Access at 384 kbps and / or 64 kbps
- ITU - T G.823: The Control of Jitter and Wander within Digital Networks, which are based on the 2048 kbps Hierarchy
- ITU - T G.826: Error Performance Parameters and objectives for International, Constant Bit Rate Digital Paths at or above the Primary Rate

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 V1.1.2: 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 V1.1.2: STM - N Regenerator & Multiplex Section

Layer Functions

- ETS 300 417 – 4 - 1 / EN 300 417 – 4 - 1 V1.1.2: 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

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 V1.1.2: Synchronisation Layer Functions
- ETS 300 462 - 1 / EN 300 462 – 1 - 1 V1.1.1: Transmission and Multiplexing (TM); Generic Requirements for Synchronization Networks; Part 1: Definitions and Terminology for Synchronization Networks
- EN 300 462 – 4 - 1 V1.1.1: Transmission and Multiplexing (TM); Generic Requirements for Synchronization Networks; Part 4 - 1: Timing Characteristics of Slave Clocks suitable for Synchronization 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 Synchronization 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)

ABBREVIATIONS

AAL	ATM Adaptation Layer
ADM	Add Drop Multiplexed
ATM	Asynchronous Transfer Mode
ALS	Automatic Laser Shutdown
BIP	(Bit Interleaved Parity)
CAS	Channel Associated Signalling
CAP	Carrier - Less Amplitude and Phase
CRC	

	Cyclic Redundancy Check
DTMF	Dual Tone Multi - Frequency
EN	European Norm
EOW	Engineering Order Wire
ETS	European Telecommunications Standards
GPS	Global
HDSL	High Density Subscriber Line
IEC	International Electrical Commission
ITU	International Telecommunication Union
IP	Internet Protocol
ISDN	Integrated Services Digital Network
MCMI	Multi Coded Mark Inversion
MS	Multiplex Section
NE	Network Element
NMS	Network Management System
LAN	Local Area Network
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
VF	Voice Frequency

1.10 TABLE OF COMPLIANCE

Equipment supplied for the system shall be sized and equipped with sufficient capacity to support BOQ and shall require to support the capacity as specified here under. The system supplied shall be sized (to be equipped as specified) to support full system expansion.

Data about offered Equipment is to be filled in by the Bidder. The offered equipment shall be complied fully in Toto for system capacity to be supported as specify in below table. The bidder shall have to submit undertaking regarding conformity for System capacity in accordance with table and deviation if any found against your confirmatory document submitted with tender bid, the offer shall be liable to be rejected.

NAME OF MANUFACTURER:

MODEL:

TYPE:

		REQUIRED	OFFERED
GENERAL:			
Type of Multiplexer		SDH cum PDH: ADM	
Complying to ITU-T rec.		Yes	
Transmission Capacity	Ports	8Mbps (O): 14 nos.	

		STM-1: 10 nos. STM-4: 5 nos.	
Access Capacity on 64 kbps	Channels	Minimum 72	
Access Capacity on 2 Mbps	Channels	Minimum 63	
Redundant Central Processor		Shall be available	
Digital Cross Connect Function		Fully Non Blocking	
PDH Cross Connect Capacity		Minimum 21 x 2 Mbps	
SDH Cross Connect Capacity, High Order		Minimum 4 x VC4	
Equipment Used in Sub Station Environment		List of 10 reference Sub Station Projects	
The Equipment is KEMA/ Equivalent Type Tested		YES	
TELE PROTECTION INTERFACE:			
Distance Tele Protection Interface		YES	
Integrated Optical Tele Protection Interface (IEEE C37.94)		YES	
Addressing of Protection Commands		YES	
Loop Test for measuring Delay Time		YES	
TRANSPORT LEVEL: INTERFACES:			
SDH based on SFP Technology		YES	
Electrical SDH Interface		YES	
Optical 8 Mbps Interface		YES	
HDB3, 2 Mbps Interfaces per Module	No.		
Complying to ITU-T rec.		G.703, Transparent G.704, Selectable	
USER INTERFACES			
VOICE INTERFACES FOR TRUNK LINES:			
1 + 1 Com Path Protection, Individually Programmable		YES	
Analogue, 4 wire with E & M: Input Level	dBr	+7.5 to -16	
Output level		+7.0 to -16.5	
Analogue, 2 wire with E & M: Input Level	dBr	+6.5 to -12.5	
Output Level		-1.0 to -20	
Digital, 2 Mbps CAS or PRI		YES	
VOICE INTERFACES FOR REMOTE SUBSCRIBER:			
2 Wire, Subscriber Side	dBr	-5 ... +4 / -7.5 ... -1	
Minimal Number of Subscriber	No.	10	
2 Wire, PABX Side	dBr	-5 ... +4 / -7.5 ... -3	
Minimal Number of PABX	No.	1	
INTEGRATED TELE PROTECTION:			
Interface for Commands:			
Number of Independent Commands	No.	4	
Transmission Time Max.	ms	6	

Signal voltage	V_{peak}	250	
1 + 1 Com Path Protection		YES	
DATA: INTERFACES PER MODULE			
V.24 / V.28 (RS232), V.11 / X.24 (RS422), V.35	number	4	
Integrated LAN Port available on DATA Interface		YES	
Software Programmable Board available		YES	
Functions available for Individual Configuration:			
- 1 + 1 Path Protection			
- Point Multipoint			
- Performance Monitoring		YES	
- Sub Rate Multiplexing available for all Data Interface		YES	
ETHERNET INTERFACE:			
Ethernet A:			
10 / 100 Base T	Ports	8 x RJ45 Electrical	
1000 Base LX / SX		2 x Optical	
L2 Switching Function		YES	
WAN Capacity Logical	Mbps	63 x VC12 or 3 x VC3	
WAN Ports	Ports	Minimum 8	
GFP (acc. ITU-T G.7041)		YES	
VCAT (acc. ITU-T G.707)		On VC - 12 and VC - 3	
LCAS (acc. ITU-T G.7042)		YES	
CONFIGURATION MANAGEMENT:			
Type / Name of Configuration Tool			
For Local / Remote Operation		YES / YES	
Data Communication Network (DCN)		Ethernet / IP	
Integrated Management System for SDH, PDH, PLCC, Tele Protection & Differential Protection		YES	
AMBIENT CONDITIONS:			
Storage: ETS 300 019 – 1 - 1, Class 1.2	°C / % hum	- 25 ... + 70 °C / 98 %	
Transport: ETS 300 019 – 1 - 2, Class 2.2	°C / % hum	- 25 ... + 70 °C / 98 %	
Operation: ETS 300 019 – 1 - 3, Class 3.1E	°C / % hum	- 5 ... +55 °C / 95 %	
For x DSL, ISDN and IP / Ethernet Modules	°C / % hum	- 5 ... +45 °C / 95 %	
POWER SUPPLY			
Operation	VDC	48 (-15 / +20 %)	
Fully Redundant Power Supply		YES	
Dual Power Feeding		YES	

EMISSION OF THE EQUIPMENT (SUBSTATION ENVIRONMENT)

No.	TEST NAME	DESCRIPTION	BASIC STANDARD	CLASS	COMPLY
1.1	Radiated Radio Frequency Interference	30 MHz to 1 GHz	EN 55022	A	
1.2	Conducted Radio Frequency interference AC / DC Power Supply	150 kHz to 30 MHz	EN 55022	A	

IMMUNITY OF THE EQUIPMENT (SUBSTATION ENVIRONMENT)

No.	TEST NAME	DESCRIPTION	BASIC STANDARD	LEVEL	COMPLY
2.1	ESD Test	Contact / Air Discharge	IEC 61000 - 4 - 2	6 / 8 kV	
2.2	Radiated Electromagnetic Field	80 to 1000 MHz, 80 % AM, 1 kHz Modulated	IEC 61000 - 4 - 3	10 V / m	
2.3	Radiated Electromagnetic Field	1.0 to 2.5 GHz, 80 % AM, 1 kHz Modulated	IEC 61000 - 4 - 3	10 V / m	
2.4	Fast Transient Test	AC / DC Power Supply: All Other Ports:	IEC 61000 - 4 - 4	4 kV 2kV	
2.5	Surge Test (1.2 / 50 J. s)	AC / DC Power Supply:	IEC 61000 - 4 - 5		
		Common Mode		2.0 kV	
		Differential Mode		1.0 kV	
		DC Power Supply 48 V:			
		Common Mode		0.5 kV	
		Differential Mode		0.5 kV	
		Signal Terminals:			
		Common Mode		2.0 kV	
		Differential Mode		1.0 kV	
		Telecommunication Ports:			
		Common Mode		1.5 kV	
2.6	Conducted Radio Frequency Interference	0.15 to 80 MHz, 80 % AM, 1 kHz Modulated	IEC 61000 - 4 - 6	10 V / m (emf)	
2.7	Power Frequency Magnetic Field	Continuous Short (1 to 3 s)	IEC 61000 - 4 - 8	30 A / m 300 A / m	
2.8	Damped Oscillatory Waves	AC / DC Power Supply:	IEC 61000 - 4 - 12		
		Common Mode		2.5 kV	
		Differential Mode		1.25 kV	

		Signal Terminals:			
		Common Mode		2.5 kV	
		Telecommunica tion Ports:			
		Common Mode		2.5 kV	
		1 MHz, 400 Hz repetition rate, 2 s burst duration			
2.9	Conducted Common Mode Disturbance	Frequency 50 Hz, Continuous Mode	IEC 61000 – 4 - 16	10 / 30 V _{rms}	

QUALIFICATION REQUIREMENTS FOR FOTE SYSTEM

Qualification of bidder will be based on meeting the minimum pass/fail criteria specified in Part-A below regarding the Bidder's technical experience as demonstrated by the Bidder's responses in the corresponding Bid Schedules. The Bidder shall also be required to furnish the information specified in Part-B in their Bid. Subcontractors' technical experience and financial resources shall not be taken into account in determining the Bidder's compliance with the qualifying criteria.

[PART-A] Technical requirement:

- a) The bidder or its parent company has its own product of FOTE (SDH/PDH) with integrated Access Multiplexer, Teleprotection and PLCC equipment. The offered equipments should have been designed, manufactured, tested & comply with relevant Standards.
- b) The bidder or its parent company as a Prime Contractor must have supplied, installed, tested & commissioned at least 100 no. SDH, PDH and Teleprotection equipments each in substations (132 kV and above) in last Six (6) years. One of such certificate should be from National or State Transmission/Power Utilities/IPPs/CPPs. The certificates being attached for experience proof along with the bid shall be certified by Chartered Accountant.
- c) The bidder or its parent company as a prime contractor shall have executed at least One Turnkey contract of value not less than 10 Crore in last Six (6) years involving Supply, Installation, Testing and Commissioning of similar equipments.
- d) At least one of the above projects shall be in successful operation for at least two (02) years as on scheduled date of Bid Opening with followings:
 - Shall be involving 35 Nos. of substations (132kv and above)
 - Shall be involving 50 no. of SDH and PDH equipments
 - Shall be involving 50 nos. of Teleprotection equipments
- e) The bidder or its parent company must possess valid ISO 9001:2008 certification.

[PART-B] Financial Requirement

1. Minimum Annual Turnover (MAT) for best three individual years out of last five financial years shall not be less than the estimated cost. (For Individual Bidders)
Copies of original documents defining the constitution or legal status, place of registration and principal place of business of the company shall also be submitted along with the bid.

Additional Documents:

Apart From various documents to be furnished along with the Bid as required in the GCC and ECC, the following documents/details are to be furnished by the Bidder:

1. Service Tax Registration No. date/ issuing authority.
2. Details of Partners/Directors of the Firm/Company.
3. Experience Record and details of orders pending / executed for Various Utilities
4. Solvency certificate from Bank (up to 20 % of Bid value).