



# BHARAT HEAVY ELECTRICALS LIMITED

## TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

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				GROUP	TBEM	W.O. No	85003
CUSTOMER	Power Grid Corporation of India Ltd.						
PROJECTS	765kV Banaskantha & 400kV Sankhari Extn Substation , <b>Project code : 384</b>						

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**SECTION 1**  
**SCOPE AND QUANTITIES**

**1.0 GENERAL SCOPE**

This technical specification covers the requirements of Survey , planning, design, manufacture, testing at works, packing, dispatch, supervision of erection and site testing and commissioning of the Telecommunication equipments/items, complete in all respect for 765/400/220kV Banaskantha and 400kV Sankhari (GETCO) substations . The detailed technical specification is enclosed under Section II of this specification.

Bidder is responsible for the designing, engineering, testing and supply including transportation & insurance, at site of mandatory spares and testing instruments for telecommunication equipments.

This section covers the specific technical requirements of Telecommunication Equipment System. This constitutes minimum technical parameters for the telecommunication system as specified by the customer (POWERGRID). The offered equipment shall also comply with the General Technical Requirements for the project as detailed under section-3 of this specification.

The specification comprise of following sections:

Section-1: Scope & Bill of Quantities

Section-2: Equipment Specification

Section-3: General Technical Requirements

Section-4: Enclosures to Specifications

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

**1.1 A) THE EQUIPMENT IS REQUIRED FOR THE FOLLOWING PROJECT**

The equipment is required for the following Projects.

**Name of Customer** : Power Grid Corporation of India Ltd.

**Name of the Project** : 765kV Banaskantha & 400kV Sankhari(GETCO)S/s

Refer Section - 3 for Project Details and General Specifications

**1.1 B) SCOPE**

Telecommunication equipments (SDH & PDH) for 765/400/220kV Banaskantha and 400kV Sankhari ( GETCO) Substations are covered under present scope.

However OPGW Links for these stations are being laid under separate package.

Communication equipments shall be placed in the control room/ Switchyard panel room.

No dismantling of any communication equipment is required.

24 Fibre OPGW shall be provided. However number of fibres required to be utilized by the bidder shall be finalized during detailed engineering.

The auxiliary power supply to PSU of FOTE shall be 48V DC.

## 1.2 BILL OF QUANTITIES

Telecommunication equipment for 765/400/220kV Banaskantha and 400kV Sankhari (GETCO) substations .

The BOQ mentioned below is tentative and is liable to change based on the link budget calculations submitted by bidder during detail engineering.

SN	DESCRIPTION	UNIT	QTY
1.	BANASKANTHA S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :- Base Equipment (Common cards, Cross-connect/control cards, Optical base cards, Power supply cards, power cabling, other hardware & accessories including sub-racks patch cords, DDF etc. fully equipped excluding optical interface /SFP and Tributary Cards below)	No.	1
2.	BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM-16 MADM, up to 3 MSP protected directions) :- # Optical Interface/SFP for S16.1	No.	1
3.	BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM-16 MADM, up to 3 MSP protected directions) :- # Optical Interface/SFP for L16.1	No.	1
4.	BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM-16 MADM, up to 3 MSP protected directions) :- # Optical Interface/SFP for L16.2	No.	1
5.	BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM-16 MADM, up to 3 MSP protected directions) :- # Optical Interface/SFP for Optical Line Interface card (to support minimum 150 km) for STM-16 **	No.	1
6.	BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM-16 MADM, up to 3 MSP protected directions) :- # Optical Interface/SFP for Optical Line Interface card (to support minimum 225 km) for STM-16 : ** To support minimum 175km	No.	1
7.	BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM-16 MADM, up to 3 MSP protected directions) :- # Optical Interface/SFP for Optical Line Interface card (to support minimum 225 km) for STM-16 : ** To support minimum 200km	No.	1

8.	BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM-16 MADM, up to 3 MSP protected directions) :- # Optical Interface/SFP for Optical Line Interface card (to support minimum 225 km) for STM-16 : ** To support minimum 225km	No.	1
9.	BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM-16 MADM, up to 3 MSP protected directions) :- Tributary Cards : E1 Interface card ( Minimum 16 interfaces per card)	No.	2
10.	BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM-16 MADM, up to 3 MSP protected directions) :- Tributary Cards : Ethernet interfaces 10/100Mbps with layer-2 switching ( Minimum 4 interfaces per card)	No.	2
11.	BANASKANTHA S/s : Termination Equipment : Drop & Insert Multiplexer- Base Equipment (Common cards, Power supply cards, power cabling, other hardware & accessories including sub-racks, etc. fully equipped excluding subscriber line interface cards)	No.	2
12.	BANASKANTHA S/s : Termination Equipment : Subscriber line interface cards : 2 wire (sub/sub) voice channel cards (min 8 channels per card)	No.	2
13.	BANASKANTHA S/s : Termination Equipment : Subscriber line interface cards : 2 wire (sub/Exchange) voice channel cards (min 8 channels per card)	No.	1
14.	BANASKANTHA S/s : Termination Equipment : Subscriber line interface cards : 4 wire (E&M) voice channel cards (min 8 channels per card)	No.	2
15.	BANASKANTHA S/s : Termination Equipment : Subscriber line interface cards : Asynchronous Sub Channels data cards (V.24/V.28) , minimum 4 channels per card	No.	2
16.	BANASKANTHA S/s : Equipment Cabinets (2200mmx400mmx400mm) : For SDH Equipment, Primary Multiplexer, Drop/Insert and DACS	No.	2
17.	BANASKANTHA S/s : TMN : Craft Terminal : Hardware  Note : 1 Set shall include all required hardware /software for complete TMN/Craft terminal system as specified in the technical specification. NMS facilities for SDH equipment shall include monitoring of Ethernet ports also.	Set	1
18.	BANASKANTHA S/s : TMN : Craft Terminal : Software  Note : 1 Set shall include all required hardware /software for complete TMN/Craft terminal system as specified in the technical specification. NMS facilities for SDH equipment shall include monitoring of Ethernet ports also.	Set	1
19.	BANASKANTHA S/s : Main Distribution Frame ( Minimum 200Pairs)	No.	2
20.	BANASKANTHA S/s : 2 Wire Hand Set	No.	3
21.	BANASKANTHA S/s : Synchronization Equipment : GPS Clock including all hardware & accessories	Set	1

22.	BANASKANTHA S/s : 4 Port VOIP gateway for remote locations (RTU Locations)	No.	2
23.	BANASKANTHA S/s : Testing Equipment for Telecom Equipment : SDH Analyser ( Upto STM-16) with Jitter and wander option.  <b>Note: The testing capacity of SDH analyser shall be provided according to that offered up to maximum bit rate of SDH equipment.</b>	No.	1
24.	BANASKANTHA S/s : Testing Equipment for Telecom Equipment : Handheld 2Mbps BER Tester	No.	1
25.	BANASKANTHA S/s : Testing Equipment for Telecom Equipment : Digital Multimeter	No.	1
26.	BANASKANTHA S/s : Testing Equipment for Telecom Equipment : Ethernet Tester ( with dual port ,10/100ports Mbps Ethernet Option , Layer-1 & layer-2 functionality)	No.	1
27.	Mandatory Spares : BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Common cards, Cross-connect/control cards, Optical base cards, Power supply cards, Power cabling , other hardware & accessories( each)  { 1 Set means one of each type of module / unit card etc }	Set	1
28.	Mandatory Spares : BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical cards/SFP For : S16.1  Note : Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare.	No.	1
29.	Mandatory Spares : BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical cards/SFP For : L16.1  Note : Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare.	No.	1
30.	Mandatory Spares : BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical cards/SFP For : L16.2  Note : Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare.	No.	1
31.	Mandatory Spares : BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical cards/SFP For :  Optical Line Interface card ( to support minimum 150km) for STM-16 **	No.	1
32.	Mandatory Spares : BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical cards/SFP For :  Optical Line Interface card ( to support minimum 225km) for STM-16 ** To support minimum 175km	No.	1

33.	Mandatory Spares : BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical cards/SFP For :  Optical Line Interface card ( to support minimum 225km) for STM-16** – To support minimum 200km	No.	1
34.	Mandatory Spares : BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical cards/SFP For :  Optical Line Interface card ( to support minimum 225km) for STM-16** – To support minimum 225km	No.	1
35.	Mandatory Spares : BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Tributary cards – E1 Interface card( Minimum 16 interfaces per card)	No.	1
36.	Mandatory Spares : BANASKANTHA S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Tributary cards – Ethernet interfaces 10/100Mbps with layer-2 switching (Minimum 4 interfaces per card)	No.	1
37.	Mandatory Spares : BANASKANTHA S/s : Termination Equipment – Drop & Insert Multiplexer : Base equipment ( Common cards, Power supply cards , power cabling , other hardware & accessories including sub-racks etc. fully equipped excluding subscriber line interface cards)  { 1 Set means one of each type of module / unit card etc }	Set	1
38.	Mandatory Spares : BANASKANTHA S/s : Termination Equipment – Subscriber Line Interface Cards : 2 Wire (Sub/sub) voice channel cards( min. 8 channels per card)	No.	1
39.	Mandatory Spares : BANASKANTHA S/s : Termination Equipment – Subscriber Line Interface Cards : 4 Wire (E&M) voice channel cards( min. 8 channels per card)	No.	1
40.	Mandatory Spares : BANASKANTHA S/s : Pre-connectorized Optical Fiber patch cords (10 metres) – Pack of Six Patch cords	Set	3
41.	Mandatory Spares : BANASKANTHA S/s : 4 Port VOIP gateway for remote locations ( RTU Locations)	No.	1
42.	SANKHARI S/s : Transmission Equipment : SDH Equipment (STM- 16 MADM, up to 3 MSP protected directions) :- Base Equipment (Common cards, Cross-connect/control cards, Optical base cards, Power supply cards, power cabling, other hardware & accessories including sub-racks patch cords, DDF etc. fully equipped excluding optical interface /SFP and Tributary Cards below)	No.	1
43.	SANKHARI S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :-	No.	1

	Optical Interface/SFP # for S16.1		
44.	SANKHARI S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical Interface/SFP # for L16.1	No.	1
45.	SANKHARI S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical Interface/SFP # for L16.2	No.	1
46.	SANKHARI S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical Interface/SFP # for Optical Line Interface card (to support minimum 150 km) for STM-16 **	No.	1
47.	SANKHARI S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical Interface/SFP # for Optical Line Interface card (to support minimum 225 km) for STM-16 : ** To support minimum 175km	No.	1
48.	SANKHARI S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical Interface/SFP # for Optical Line Interface card (to support minimum 225 km) for STM-16 : ** To support minimum 200km	No.	1
49.	SANKHARI S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Optical Interface/SFP # for Optical Line Interface card (to support minimum 225 km) for STM-16 : ** To support minimum 225km	No.	1
50.	SANKHARI S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Tributary Cards : E1 Interface card ( Minimum 16 interfaces per card)	No.	2
51.	SANKHARI S/s : Transmission Equipment : SDH Equipment ( STM- 16 MADM, up to 3 MSP protected directions) :- Tributary Cards : Ethernet interfaces 10/100Mbps with layer-2 switching ( Minimum 4 interfaces per card)	No.	2
52.	SANKHARI S/s : Termination Equipment : Drop & Insert Multiplexer- Base Equipment (Common cards, Power supply cards, power cabling, other hardware & accessories including sub-racks, etc. fully equipped excluding subscriber line interface cards)	No.	2
53.	SANKHARI S/s :: Termination Equipment : Subscriber line interface cards : 2 wire (sub/sub) voice channel cards (min 8 channels per card)	No.	2

54.	SANKHARI S/s : Termination Equipment : Subscriber line interface cards : 4 wire (E&M) voice channel cards (min 8 channels per card)	No.	2
55.	SANKHARI S/s : Termination Equipment : Subscriber line interface cards : Asynchronous Sub Channels data cards (V.24/V.28) , minimum 4 channels per card	No.	2
56.	SANKHARI S/s : Equipment Cabinets (2200mmx400mmx400mm) : For SDH Equipment, Primary Multiplexer, Drop/Insert and DACS	No.	2
57.	SANKHARI S/s : Main Distribution Frame ( Minimum 200Pairs)	No.	1
58.	SANKHARI S/s : 2 Wire Hand Set	No.	3
59.	SANKHARI S/s : 4 Port VOIP gateway for remote locations (RTU Locations)	No.	1
60.	Banaskantha S/s : Training to employer's personnel at Substation site in field of erection, testing ,operation and maintenance of SDH equipment, Mux Equipment , DACS & NMS as per TS for two(2) days.	Lot	1
61.	Banaskantha S/s : Maintenance Charges for Communication System for One (1) year during Warranty period as per TS	Lot	1
62.	Banaskantha S/s : Site survey, design engineering, integration & FAT of communication equipment	Lot	1
63.	Banaskantha S/s : Site installation, SAT & commissioning of communication equipment (station-wise)	Lot	2

**NOTE:**

#

Optical Interface/SFP can be provided with optical base card or control card with the condition that control card shall not be equipped with more than one Optical interface / SFP and optical card with not more than two optical interface /SFP . However main and protection channel shall be terminated on separate cards.

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Suitable optical interface card(s) or any other solution such as SDH equipment with optical amplifier , wavelength translator or higher aggregate bit rate SDH equipment may be offered to meet the link budget requirements without repeater.

**1.3 TRAINING :**

- a. The supplier shall also impart training to Employer's personnel at substation site in the field of Erection, Testing, operation and maintenance of Telecommunication equipments including SDH Equipment , Mux Equipment , DACS & NMS for two (2) days.
- b. However, the travel lodging, & boarding expenses of employers personnel, if any shall be done by Employer.

**Note: Charges for Tutorials & other training materials for the trainees shall also be included in the price quoted by the bidder.**

#### 1.4 APPROVAL CRITERION

- (a) The contract drawings shall preferably be POWERGRID standard approved drawings or shall be approved by POWERGRID in some of their previous project. The approval extension of standard drawings for this project or obtaining fresh approval from POWERGRID Engg shall be the sole responsibility of the bidder without any price and delivery implications to BHEL.
- (b) The items offered shall be of approved make and model from POWERGRID and is working satisfactorily in their projects.
- (c) In case, the offered item is not POWERGRID approved then it is the sole responsibility of the bidder to get it approved without any price & time implication to BHEL.

#### 1.5 TYPE TEST REQUIRMENTS

As per Technical Specification Section -2.

#### 1.6 INSPECTION, TESTING AND ACCEPTANCE

Bidder has to follow Technical specification and POWERGRID approved Manufacturing Quality Plan of Power Grid Corporation of India Ltd.

#### 1.7 DEVIATION

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date.

#### 1.8 DOCUMENTATION

Final Documentation (after approval) shall be separate for each Substation. List of documents to be submitted is mentioned in section-2 of specification.

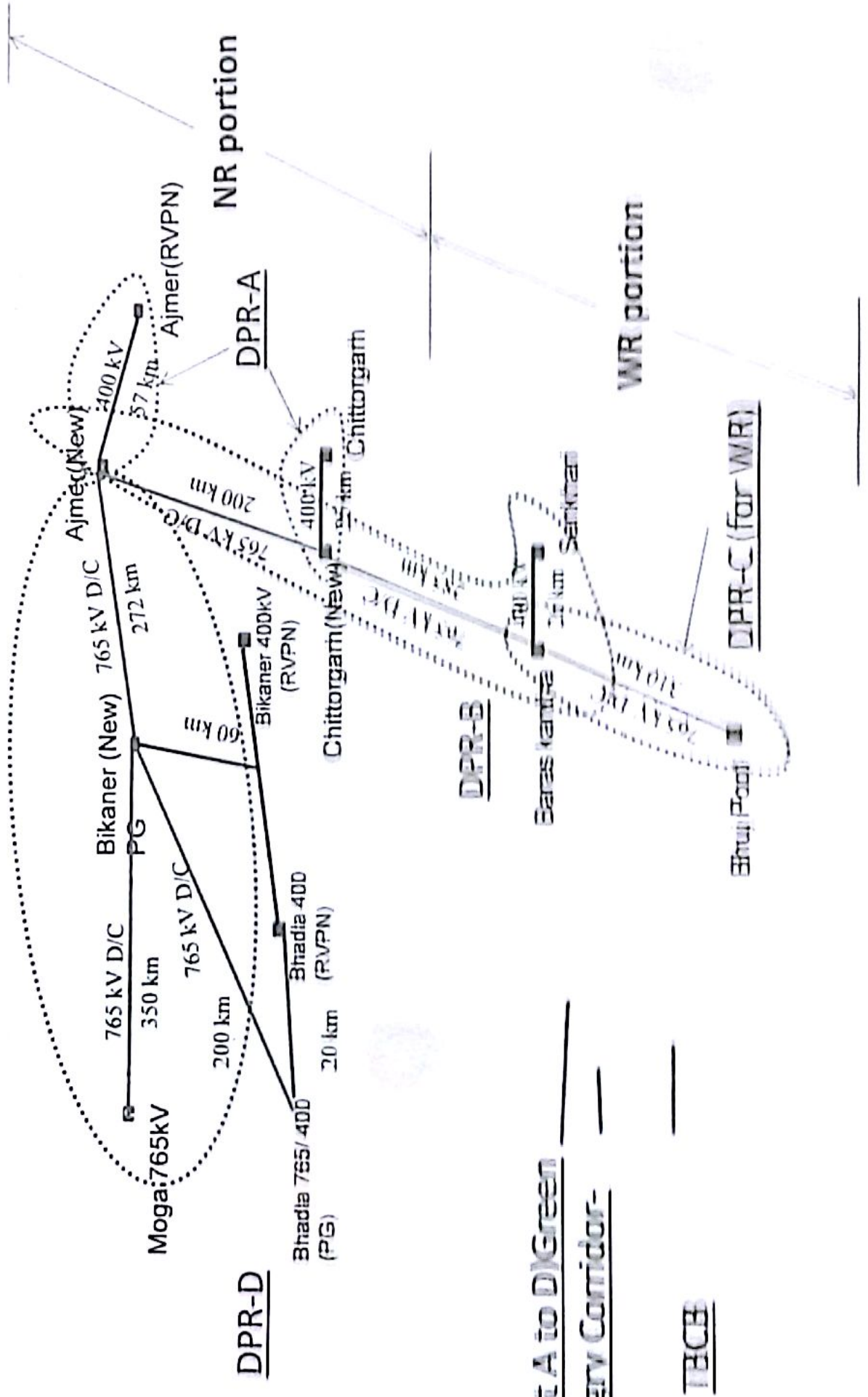
#### 1.9 DOCUMENTS REQUIRED DURING TENDER STAGE

Following documents are required during tender stage:

- a) Clause wise compliance to the specification
- b) Available catalogs of offered items
- c) Filled checklist
- d) Un-priced Bill of Quantity

**Note:** It may be noted that word “contractor “wherever is referred in section-2 &4 shall be read as bidder and word “employer “wherever is referred in section – 2 & 4 shall be read as “Powergrid”.

# Proposed Fibre Optic Communication network under Green Energy Corridor Project (Revision-B)



(Part A to D) Green Energy Corridor-

TECE

## Section- 1

### Introduction, General Information & General Requirement

#### 1.1 Introduction

This specification describes the Fiber Optic communication network configuration and the equipment characteristics for communication system to be supplied under the contract. The Contractor shall offer type tested equipment as per requirement of technical specifications. All offered equipment shall also meet the technical requirement in the technical specification.

#### 1.2 Scope

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

- (i) SDH Equipment along with suitable interfaces & line cards etc.
- (ii) Associated Termination equipment system including E-1 channel banks & drop-insert multiplexer & subscriber line interfacing card.
- (iii) All cabling, wiring, Digital Distribution Frame patch facilities, equipment MDF's and interconnections to the supplied equipment at the defined interfaces
- (iv) All cabling, wiring, Digital Distribution Frame patch facilities and interconnections to the supplied equipment at the defined interfaces.
- (v) MDF & DDF cross connects required to route and activate circuits.
- (vi) System integration of the supplied subsystems and also integration with existing communication equipment such as SDH, MUX etc.
- (vii) Integration of supplied system with RTUs/SAS, SCADA system, PLCC equipment, EPABX etc.
- (viii) Reconfiguration of communication channel in existing communication equipment.
- (ix) Maintenance of the supplied system

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

#### 1.3 General Technical Requirements:

- (i) Communication Equipments (SDH) manufacturer: The SDH equipment shall be offered from a manufacturer(s) who has been manufacturing SDH equipment for the last three (3) years. SDH equipment manufactured by such manufacture(s) shall have been in satisfactory operation in 110 kV or higher voltage Power substations for at least two (2) years as on the date of bid opening.



- (ii) Communication Equipments (Primary multiplexer) manufacturer: The Primary multiplexer shall be offered from a manufacturer(s) who has been manufacturing Primary multiplexer for the last three (3) years. Primary multiplexer manufactured by such manufacture(s) shall have been in satisfactory operation in 110 kV or higher voltage Power substations for at least one (1) year as on the date of bid opening.
- (iii) The installation of communication equipment shall be done by a firm who has previous experience of installation, testing and commissioning of at least 20 nodes of Fibre Optic Transmission System based on SDH technology and at least 5 no. of these nodes must be in satisfactory operation for at least two (2) years as on date of opening of bids

### **General Requirements**

The Contractor is encouraged to offer standard products and designs. However, the Contractor must conform to the requirements and provide any special equipment necessary to meet the requirements stated herein.

It should be noted that preliminary design information and bill of quantity (BoQ) specified in this specifications are indicative only. The Contractor shall verify the design data during the site surveys & detail engineering and finalise the BoQ as required for ultimate design & system performance. However, Location of execution of works under this package shall not be limited only to the links and locations indicated in the appendices. The Employer reserves the right of execution of works within the stipulated quantity variation provision at places (anywhere inside the respective Region) other than those indicated in the appendices at the same rates, terms and conditions.

An analysis of the functional and performance requirements of this specification and/or site surveys, design, and engineering may lead the Contractor to conclude that additional items are required that are not specifically mentioned in this specification. The Contractor shall be responsible for providing at no added cost to the Employer, all such additional items and services such that a viable and fully functional communication equipment system is implemented that meets or exceeds the capacity, and performance requirements specified. Such materials and services shall be considered to be within the scope of the contract. To the extent possible, the Bidders shall identify and include all such additional items and services in their proposal.

The communication equipments shall be designed and provisioned for expansions and reconfigurations without impairing normal operation, including adding and removing circuits. The offered items shall be designed to operate in varying environments. Adequate measures shall be taken to provide protection against rodents, contaminants, pollutants, water & moisture, lightning & short circuit, vibration and electro-magnetic interference etc.

The Contractor shall demonstrate a specified level of performance of the offered items during well structured factory and field tests.

The site visits after contract award shall include all necessary surveys to allow the contractor to perform the design and implementation functions. The Contractor shall inform their site survey schedule to the Employer well in advance. The site survey schedule shall be finalised in



consultation with the Employer. The Employer may be associated with the Contractor during their site survey activities.

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

- (a) Proposed layout of Equipment in the existing rooms and buildings.
- (b) Proposed routing of power, earthing, signal cables and patch cords etc.
- (c) Confirmation of adequacy of Space and AC/DC Power supply requirements
- (d) Proposals for new rooms/buildings if required
- (e) Identification of facility modifications if required
- (f) Identification all additional items required for integration for each site/location.

#### **1.4 General Responsibilities and Obligations**

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

##### **1.4.1 Contractor's Responsibilities and Obligations**

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

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

- (1) Provide a working system that meets the functional and performance requirements of this specification.
- (2) Site visits, and surveys, necessary to identify and provide all equipment needed to implement the network.
- (3) Equipment Engineering and design specific to each location including review of, and conformance with local environmental and earthing considerations.
- (4) Overall integration of communication equipments/subsystem procured in present and existing network.
- (5) Connectivity between the FODP and SDH equipment.
- (6) Installation and integration of network management software, hardware and firmware.
- (7) Planning & Implementation for a smooth transition from existing operations to new



upgraded network operations including all new equipment.

- (8) Project management, project scheduling, including periodic project reports documenting progress, review meeting during the contract period.
- (9) Engineering and technical assistance during the contract and warranty period.
- (10) Provide all additional Equipment necessary to ensure compatibility between new and existing equipment.
- (11) Implement all minor civil works and identify any major civil works i.e. expansion or construction of rooms, trenches necessary for installation of proposed equipment and provide the details of such work to the Employer.
- (12) Define source power requirements for each cabinet/ rack of equipment provided at each location.
- (13) All hardware, software, and firmware required to satisfy the requirements of this Specification.
- (14) Factory and site testing of all hardware, software, and firmware provided.
- (15) Provide documented evidence of satisfactory Type Test performance to the Employer and if required by The Employer, conduct type test.
- (16) Provide a Quality Assurance Plan, ensuring the Employer access to the manufacturing process.
- (17) Shipment of all equipment and documentation to the Employer designated locations and/or staging areas.
- (18) Staging, maintenance of staging area and security including full responsibility for protection from theft and fire.
- (19) All documentation and drawings as specified.
- (20) All required spare parts, maintenance aids, and test equipment.
- (21) Training of the Employer personnel.
- (22) An availability analysis showing MTBF (mean-time-between-failure) and MTTR (mean-time-to-repair) figures for all system components.
- (23) Availability of service, spare and expansion parts for the supplied items for the designed life of the equipment or seven (7) years after the declaration of withdrawal of equipment from production, whichever is earlier. However, the termination of production shall not occur prior to Operational Acceptance of the system by the Employer.



- (24) Notification services for field updates to the hardware, software, and firmware for ensuring the availability of the supplied hardware & software including NMS for the entire lifespan.
- (25) The contractor shall appoint key personnel for the project such as Project Manager, Site Manager, Design Engineer, Installation Engineer and Commissioning Engineer only after approval of the experience data by the Employer. Approval of the Employer shall be obtained, whenever the Contractor wants to change key personnel.

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

#### **1.4.2 The Employer Responsibilities and Obligations**

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

- (1) Overall project management of the project
- (2) Review and approval of the Contractor's designs, drawings, and recommendations.
- (3) Communication network configuration data, including:
  - (a) Channel assignments for voice and data
  - (b) Interconnection drawings for existing equipment, including MDFs.
- (4) Review and approval of test procedures.
- (5) Participation in and approval of "Type", factory and site acceptance tests.
- (6) Review and approval of training plans.
- (7) Providing support and access to facilities at the sites.
- (8) Implement the major civil works such as expansions or construction of rooms, trenches etc. as required for the equipment to be provided by the Contractor.
- (9) Coordination of the Contractor's activities with the Employer's and constituents' concerned departments.
- (10) Provide to the extent possible drawings for existing sites and facilities for which equipment installations are planned.
- (11) Approval of the key personnel for the project

#### **1.5 Organization of the Technical Specification Document**

The following is a list of sections which provides the Communication Equipment Package requirement of the fibre optic communications system to be provided.

- Section 2 Contains Network Configurations and Characteristics for the Telecom Equipment  
Section 3 Contains the requirement for Environment, EMI, Supply, Cabling and Earthing  
Section 4 Contains the requirement for Inspection & Testing  
Section 5 Contains the requirement for Training and Support Services



Section 6 Contains the documentation and deliverables requirements

### **1.6 Applicable Standards**

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

- (i) IEEE 802.3
- (ii) ITU-T/CCITT Recommendations, G.652, G.701, G.702, G.703, G.711/ 12/ 14/ 35/ 36, G.721, G.742, G.811 and G.823
- (iii) ITU-T/CCITT Recommendations, G.801, G.821, G.822, G.823, G.826.
- (iv) ITU-T/CCITT Recommendations of the V Series
- (v) ITU-T/CCITT Recommendations R35, R37, and R38A (or R38B)
- (vi) ITU-T/CCITT Recommendations M3010, G771
- (vii) Internet Activities Board, RFC-1157 (SNMP)
- (viii) International Electrotechnical Commission standards, IEC 60801-2/3/4/5, IEC-60255-4, IEC 60255-5, IEC 60870-2-1, IEC 60721-3-3, IEC 60529.
- (ix) International Electrotechnical Commission standards, IEC 61000-4-xx series.
- (x) IEC publication 60068, 60068-2-2, 60068-2-3, 60068-2-14, 60068-2-27, 60068-2-32.
- (xi) ITU-T/CCITT Recommendations K.11, K.17, K.20.
- (xii) International CISPR standards

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

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

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



## Section 2

### Network Configuration and Equipment Characteristics

#### 2.1 Introduction

This section describes the Fibre Optic Communication network configuration and the equipment characteristics for communication system to be installed under the project. The sub-systems addressed within this section are:

- (1) Fibre Optic Transmission System (FOTS)
- (2) Termination Equipment Subsystems
- (3) Network Management System (NMS)
- (4) MDF, DDF and Cabling

The requirements described herein are applicable to and in support of network requirements. The equipment supplied shall support existing regional network for Power system operational requirements. TMN and NMS have been interchangeably used in this specification.

The security related requirements of the equipment shall be as per DoT (Department of Telecommunication) guidelines and all similar security requirements as amended by DoT on time to time basis shall be followed/complied by the vendor.

The manufacturer shall allow the Employer and/or its designated agencies to inspect the hardware, software, design, development, manufacturing, facility and supply chain and subject all software to a security /threat check any time during the supplies of equipment

The contractor shall ensure that the supplied equipments have been got tested as per relevant contemporary Indian or International Security Standards e.g. IT and IT related elements against ISO/IEC 15408 standards, for Information Security Management System against ISO 27000 series Standards, Telecom and Telecom related elements against 3GPP security standards, 3GPP2 security standards etc. from any international agency/ labs of the standards e.g. Common Criteria Labs in case of ISO/IEC 15408 standards until 31<sup>st</sup> March 2013. From 1<sup>st</sup> April, 2013, the certification shall be got done from authorized and certified agency/lab in India.

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

The contractor shall get the Employer's equipment audited from security point of view once a year from a network audit and certification agency as identified by DoT. The audit of the equipment shall be carried once in a financial year till the maintenance service contract in the bid.

In case of any deliberate attempt for a security breach at the time of procurement or at a

later stage after deployment/installation of the equipment or during maintenance, liability and criminal proceedings can be initiated against the Contractor as per guidelines of DoT and any other Government department.

## **2.2 General Network Characteristics**

### **2.2.1 Description**

The fibre optic network shall be based on the Synchronous Digital Hierarchy (SDH) having bit rate of STM-16 as indentified in the BoQ. The network shall consist of overhead fibre optic links with a minimum bit rate of Synchronous Transport Module-16 (STM-16). The Contractor can propose a system based on higher bit rate systems, if required, so as to meet the link budget requirements or any other specification requirement. The detailed BOQ is described in appendices.

### **Functional Requirement**

The primary function of the communication network is to provide a highly reliable voice and data communication system for grid operation in support of the SCADA/EMS/RTUs/PMUs. The communications support requirement for SCADA/EMS/RTUs/PMUs system is for low & high speed data, express voice circuits and administrative voice circuits as defined in appendices. A brief summary of the communication system requirements is as follows:

- (a) High speed E1 channel support
- (b) 64kbps & nx64kbps data channel support
- (c) Low speed (300 -1200 bps) data channel support
- (d) Voice (2 wires, 4 wires) channel support.
- (e) Data transport supporting Network Management channels
- (f) The connectivity envisaged between RTUs and Control Centre over TCP-IP using Ethernet interface or over serial interface.

### **2.2.2 General Systems Requirements**

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

#### **2.2.2.1 System Synchronization**

The Contractor shall synchronize the existing equipments and all the new equipments under the contract using existing Master clock. However, if there is a requirement of new clock under any circumstances such as capacity exhaustion of existing clock, no fiber connectivity with existing clock etc, Contractor shall provide additional GPS clock for

synchronization of the new SDH Equipment under the set of clock as specified in BoQ of Communication Equipment. The contractor shall submit the synchronisation plan as per standard ITU-T G.811. All sync equipments proposed under this contract should meet ITU-T G.811 criterion. The holdover quality of PRC clock shall meet ITU-T G.811 and slave clock, if any, shall meet ITU-T G.812 standard requirements.

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

#### **2.2.2.2 System Maintainability**

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

#### **2.2.2.3 System Upgradeability and Expandability**

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

#### **2.2.2.4 Equipment Availability**

The calculated availability of each fibre optic link (E1 to E1) shall be at least 99.999%. The calculated availability is defined as the theoretical availability determined by a statistical calculation based on the mean-time-between-failure (MTBF) and the mean-time-to-repair (MTTR) of the components and subsystems comprising the FOTS. For this analysis, an MTTR of at least 4 hours shall be assumed. The down time of the fibre optic cable shall not be considered in the aforesaid availability calculations. The calculated failure rates of the units and the calculated availabilities of the equipment being offered shall be provided by the Contractor during detailed engineering.

#### **2.2.2.5 Revision Levels and Modifications**

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

#### **2.2.2.6 Equipment Capacities**



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

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

### 2.2.2.7 Redundancy Requirements and Protection Schemes

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

**Table 2-1  
Equipment Redundancy Requirements Summary**

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

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

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

### 2.2.2.8 Lost Signal Recovery

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

### 2.2.2.9 Software Upgrades

The Contractor shall provide antivirus software along with all the computer hardware/software which shall be upgraded periodically till the maintenance services contract in the bid. Further, to meet all the specifications requirements during implementation and maintenance, if upgrade in the hardware/software of supplied item is required, the same shall be done by the contractor without any additional cost to the Employer.

### 2.2.2.10 General Site Considerations

All fiber optic links up to 150kms/175kms/200kms/225kms transmission line length (as applicable with respect to BoQ) shall be implemented by the Contractor without repeaters. In order to meet the link budget requirement, the Contractor shall provide all the necessary equipments only in the end stations. The contractor may provide the optical amplifier, wave length translator, optical cards or high capacity SDH equipment with suitable rack/sub rack to meet the maximum distance limit. All the provided equipments shall be monitored by centralized NMS. The contractor will have to integrate the new equipments with the existing NMS.

### 2.2.2.11 Proposed Optical Fibre Characteristics

The link budget calculations and equipment design shall be based on the specified fibre parameters. The optical cables shall have Dual Window Single Mode (DWSM) fibres conforming to ITU-T Recommendations G.652D and the major parameters of these optical fibre(s) are defined in Table-2-2:

<b>Table-2-2 Optical Fibre Characteristics</b>	
<b>Fibre Description:</b>	Dual-Window Single-Mode (DWSM)
<b>Mode Field Diameter:</b>	8.6 to 9.5 $\mu\text{m}$ ( $\pm 0.6 \mu\text{m}$ )
<b>Cladding Diameter:</b>	125.0 $\mu\text{m} \pm 1 \mu\text{m}$
<b>Mode field Concentricity Error:</b>	$\leq 0.6 \mu\text{m}$
<b>Core-Clad concentricity error:</b>	$\leq 1.0 \mu\text{m}$
<b>Cladding non-circularity</b>	$\leq 1\%$
<b>Cable Cut off Wavelength:</b>	$\leq 1260 \text{ nm}$
<b>1550 loss performance</b>	As per G.652D

**Table-2-2**  
**Optical Fibre Characteristics**

<b>Proof Test Level</b>	≥ 0.69 Gpa
<b>Attenuation coefficient</b>	@1310nm ≤ 0.35 dB/Km @1550nm ≤ 0.21 dB/Km
<b>Attenuation variation with wavelength</b> 1285 nm - 1330 nm 1525 nm – 1575 nm	Attenuation coefficient @1310 ± 0.05 dB Attenuation coefficient @1550 ± 0.05 dB
<b>Point discontinuities</b>	≤ 0.1dB
<b>Chromatic Dispersion; Max.:</b>  <b>Zero Dispersion Wavelength:</b> <b>Zero Dispersion Slope:</b>	18.0 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) @ 1288-1339nm 5.3 ps/(nm x km) @ 1271-1360nm  1300 to 1324nm 0.092 ps/(nm <sup>2</sup> xkm) maximum
<b>Polarization mode dispersion coefficient</b>	≤ 0.2 ps/km <sup>1/2</sup>
<b>Temperature Dependence:</b>	Induced attenuation ≤ 0.05 dB (-60 deg C - +85 deg C)
<b>Bend performance:</b>	@1310nm (75±2 mm dia Mandrel), 100 turns; Attenuation rise ≤ 0.05 dB @1550nm (30±1 mm dia Mandrel), 100 turns; Attenuation rise ≤ 0.10 dB @1550nm (32±0.5 mm dia Mandrel), 1 turn; Attenuation rise ≤ 0.50 dB

### 2.2.2.12 Fibre Optic Link Lengths

The fiber optic lengths specified for optical interfaces in BoQ 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 & optical budget. The exact cable lengths shall be determined by the Contractor during the survey. The same shall be used by the Contractor for final link design during the detailed engineering of the project.

## 2.3 Fibre Optic Transmission System

The Fibre Optic Transmission System (FOTS) is defined herein to include ETSI digital optical line termination equipment. The FOTS shall be based on SDH technology. Minimum aggregate bit rate shall be STM-16 and equipped with 2 nos. of minimum 16 port E1 interface(G.703) card, two nos. of minimum 4 port Ethernet interface (IEEE 802.3/IEEE 802.3u) card supporting layer 2 switching as tributaries. The Ethernet interfaces shall support VLAN (IEEE 802.1P/Q), spanning tree (IEEE 802.1D) quality of service. Protection scheme for Ethernet traffic should be ERPS based (Ethernet ring protection scheme) as per ITU-T G.8032.

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

### **2.3.1 SDH Equipment**

#### **2.3.1.1 Functional Requirement**

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

If bidder is offering equipment with multifunction cards such as cross-connect or control card with optical interface/SFP or tributary interface, such type of multifunction card shall be considered as Common control card and shall be the part of base equipment. In case optical interface/SFP is embedded with control card, the adequate number of optical interface/SFPs shall be offered to meet the redundancy requirements of the specifications. Further, control card and optical base card shall not be equipped with more than two optical interface/SFP.

#### **SDH MADM**

The aggregate interfaces at present shall be STM-16 towards at least three MSP protected directions (as per BoQ requirement). At present the equipment shall be equipped with a 2 nos., min.16 E-1 port electrical tributary cards & two no., min.4 port Ethernet interface card as tributaries. Cross connection capability of offered SDH equipment shall be 256 STM-1 at VC-4 level and 128 STM-1 at VC-12 level. For Redundancy and protection, Two fiber rings shall be implemented wherever the network permits. On linear sections of the network, protected links using 4 fibres shall be implemented.

#### **2.3.1.2 Service Channel**

Service channels shall be provided as a function of the SDH equipment and shall be equipped with Service Channel Muldem's that shall provide at a minimum: One voice channel (order wire) with analog interface (0.3 to 3.4 kHz) and one data channel. Both omnibus and selective calling facilities shall be provided. There shall be a facility to extend the line system order-wire to any other system or exchange lines on 2W/4W basis.

### 2.3.1.3 Supervision and Alarms

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

The Equipment shall support collection of at least four (4) external alarms for monitoring and control of station associated devices by the TMN.

### 2.3.1.4 Synchronisation

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

### 2.3.1.5 Electrical and Optical I/O Characteristics and General Parameters

Table 2-3 provides the electrical and optical characteristics as well as other general parameters for SDH equipment.

<b>Table 2-3</b> <b>Electrical and Optical I/O Characteristics and General Parameters</b>	
<b>Optical Wavelength</b> <sup>NOTE (1)</sup>	1310/1550nm
<b>Optical Source</b> <sup>NOTE (2)</sup>	Laser
<b>Optical Source Lifespan</b>	Better than 5 X10 <sup>5</sup> hours
<b>Optical Fibre Type</b>	G.652 D
<b>Optical Connectors</b>	Type FC-PC
<b>Transmission Quality</b>	Per ITU-T G.821, G.823, G.826
<b>Source Primary Power</b>	-48 Vdc
<b>Equipment Specifications</b>	Per ITU-T G.783
<b>Tributary, Electrical Interface</b>	Per ITU-T G.703, 75 Ω
<b>Ethernet Interface</b>	10/100 Mbps
<b>SDH Bit Rates</b>	Per ITU-T G.703
<b>Optical Interfaces</b>	Per ITU-T G.957, G.958
<b>Frame and Multiplexing Structure for SDH</b>	Per ITU-T G.707



<b>Synchronization</b>	Per ITU-T G.813
<b>Management Functions</b>	Per ITU-T G.774, G.784
<b>Protection Architectures</b>	Per ITU-T G.841
<b>Built In Testing and Alarms</b>	Per ITU-T G.774, G.783, G.784

**NOTE (1)** Optical wavelength shall be selected considering the characteristics of the optical fibre and the link budget.

**NOTE (2)** **Eye Safety for Laser Equipment:** To avoid eye damage, when a receiver detects a line interruption, it is required that the optical power of the laser shall be reduced to safe limits on the transmitter in the opposite direction as per ITU-T G.958.

**NOTE (3)** In case other than FC-PC connector is provided in the equipment, suitable patch cord with matching connector are to be provided to connect with FODP.

### 2.3.2 Optical Link Performance Requirements

The optical fibre link performance requirements are specified as follows:

#### 2.3.2.1 Link Budget Calculations

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

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

(2) Splice loss: Minimum 0.05 dB per splice. One splice shall be considered for every 3 kms.

(3) Connector losses: Losses due to connectors shall be considered to be minimum 1.0 dB per link.

(4) Equipment Parameters: The equipment parameters to be considered for link budget calculations shall be the guaranteed “End of Life (EOL)” parameters. In case, the End of Life parameters are not specified for the SDH equipment, an End of Life Margin of at least 2 dB shall be considered and a similar margin shall be considered for optical amplifiers.

(5) Optical path Penalty: An optical path penalty of at least 1 dB shall be considered to account for total degradations due to reflections, inter symbol interference, mode partition noise and laser chirp.

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



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

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

(9) Bit Error Rate: The link budget calculations shall be done for a BER of  $10^{-10}$  or better.

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

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

### **2.3.2.2 Link Performance**

The Link performance for ES, SES and BER for the fibre optic links shall correspond to National Network as defined in ITU-T G.826.

### **2.3.2.3 FODP to SDH Equipment**

The Contractor shall be responsible for connectivity between the FODP and the SDH equipment. The Contractor shall provide FC PC coupled patch cords. The patch-cord length between the FODP & equipment rack shall be suitably protected from rodents, abrasion, crush or mechanical damage.

## **2.4 Digital Distribution Frame Functional Requirements**

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

- (i) "Normally thru" circuit routing
- (ii) Circuit rerouting via patch cord assemblies
- (iii) Circuit disconnect and termination

All DDFs shall be sized and equipped to support the offered configuration of the provided equipment. Independent Transmit and Receive patch jack assemblies (line and equipment) shall provide for separate transmit and receive single-plug patching. Transmit and receive patch jack assemblies shall be located side-by-side such that dual-plug patch cord assemblies may be used to route both transmit and receive for the same circuit.



### **2.4.1 Main Distribution Frames**

The Contractor shall make provision for cross connection of subscriber services to the subscribers utilizing Krone type or equivalent and shall provide full connectivity up to and terminated on the equipment side of the appropriate DDFs and line side of MDFs. The Contractor shall terminate on the equipment side of patching facilities provided by other contracts and shall provide DSX type patching facilities supporting aggregate bit streams (i.e. dataplexers and E-1 Channel Banks). Separate Patch panels or MDFs shall be provided for Data and Voice. All cross connects shall be accomplished utilizing one, two or three pair patch cords. Patch plugs are permissible for direct one-to-one circuit "cut-thru".

### **2.5 Termination Equipment Subsystem**

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

#### **2.5.1 Functional Description**

The transmission network node provides subscriber interface to the transmission network and/or switching/routing. For clarity, the basic functions accomplished at the network nodal points, are described briefly as follows:

Multiplexer shall be used to accomplish subscriber connectivity to the Digital Communication Network. Subscriber Line Units shall provide analog to digital and direct digital conversion to 64 Kbps digital channel. In the CEPT standard hierarchy, thirty (30) such 64 Kbps digital channels shall be Time Division Multiplexed (TDM) resulting in a single 2.048 Mbps (E-1) digital bit stream.

Digital Drop-Insert and Branching Equipment shall be used to digitally interface a small number of channels at spur locations without requiring successive D/A and A/D conversions of the throughput channels.

Digital Cross connect Equipment (DACS) shall be used to provide software controlled dynamic routing/rerouting of the primary (E-1) bit stream as well as the 30 channels of the E1 bit stream.

The equipment shall also have an interface for external 2048 kHz synchronisation signal according to ITU-T Recommendation G.703.

#### **2.5.2 First Order Multiplexing**

The Contractor shall be required to provide E-1 Drop & Insert Multiplexer and E-1 Channel Bank primary multiplexing in compliance with the electrical input-output characteristics provided in Table 2-3.



### 2.5.2.1 Drop & Insert Multiplexing

Drop & Insert multiplexing in conformance with CEPT E-1 characteristics shall be required at locations where the subscriber requirement is minimal. The drop and insertion of up to thirty 64 Kbps channels supporting subscriber line units (SLU) shall be required at intermediate locations. The Drop & Insert Muxes supplied shall be performance and card compatible with the Channel Bank Equipment provided so that all Subscriber Line Interface cards are interchangeable.

**Table 2-3**  
**CEPT E-1 Standard First Order Multiplexing**

#### Electrical Input/Output Characteristics

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

### 2.5.2.2 Channel Banks (Mux, Drop/Insert)

User voice and data equipment interfacing requirements are defined at the subscriber line level. Primary multiplexing in conformance with CEPT E-1 characteristics shall be used to provide first order multiplexing of up to thirty 64 Kbps channels supporting Subscriber Line Units (SLUs).

### 2.5.2.3 Subscriber Line Units\Subscriber Line Interface Cards

The terms Subscriber Line Interface Cards and Subscriber Line Units have been used interchangeably throughout the specification. Multiple configurations of SLUs shall be required to provide subscriber to primary multiplexer Bank interfacing for a variety of voice and data communications. In case there are changes in number or type of cards because of changes in channel requirements, the contract price shall be adjusted accordingly.



The SLU interface requirements are discussed in the following subparagraphs:

**(A) Voice Channels**

The voice channel requirement is for (I) 4-Wire E&M trunking in support of PABX trunks & PLC VF and (II) 2-Wire telephonic interfaces. 2 wire SLUs shall be DTMF/TP optioned for 2-wire loop start or 2-wire GND start. The voice cards shall utilize ITU.T A - law companded PCM G.711, 64 kbits/s encoding. The voice card requirements are indicated in the BoQ in appendices.

**(B) Sub-Channel Data Multiplexing**

For this Project, the RTU data interface to the wideband telecommunications network node shall be defined at the DTE level at low-speed rates of 300, 600 and 1200 baud. The port shall be compatible with RS232C interface. The Contractor shall be required to furnish 64 Kbps SLU asynchronous dataplexing for at least 4 selectable low speed DTE interfaces whenever multiple asynchronous data circuits are required.

**2.6. Patch Cords**

The Contractor has to supply FC PC coupled Patch cords as described in BOQ. The Patch cord return loss shall be equal to or better than 40 dB and insertion loss equal to or less than 0.5 dB.

**2.7 Craft Terminal**

Each equipment (SDH, Drop/Insert Mux etc.) on the fibre optic communication network shall include provision for connecting a portable personal computer (PC) to be known as craft terminal to support local commissioning and maintenance activities. Through the use of this PC and local displays/controls, the operator shall be able to:

- a. Change the configuration of the station & the connected NEs.
- b. Perform tests
- c. Get detailed fault information

The craft terminal shall be connected to the interface available in the communication equipment. Portable (laptop) computers (Craft terminals), each complete with necessary system and application software to support the functions listed above, shall be supplied to the employer as per BOQ given in the appendices.

**2.8 Hardware Requirements for Craft Terminal**

The craft terminal shall be laptop and shall have minimum configuration of 2.4 GHz, 2 GB RAM, 256 MB Video Graphics Memory, DVD RW drive, 160 GB Hard Disk Drive, keyboard, mouse/trackball etc., serial/USB (2.0) ports to accommodate printers, and Internal/external Data/Fax modem and a battery back-up of at least 3 hours. VDUs shall be 15" TFT active matrix



color LCD with a minimum resolution of 1024 X 768.

## **2.9 General Software/Firmware Requirements**

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

### **2.9.1 Operating System Software**

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

### **2.9.2 Applications Software**

All applications software shall be written in a high-level programming language unless developed using industry proven application programs and development tools provided with the system. The contractor shall make no modifications to the applications program except as provided as USER development tools.

### **2.9.3 Software Utilities**

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

### **2.9.4 Revisions, Upgrades, Maintainability**

All firmware and software delivered under this specification shall be the latest field proven version available at the time of contract approval. Installed demonstration for acceptance shall be required. All firmware provided shall support its fully equipped intended functional requirements without additional rewrite or programming.

All software shall be easily user expandable to accommodate the anticipated system growth, as defined in this specification. Reassembly recompilation or revision upgrades of the software or components of the software, shall not be necessary to accommodate full system expansion.

Software provided shall be compliant with national and international industry standards.

### **2.9.5 Database(s)**

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



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

### **2.9.6 Help**

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

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

## Section - 3

### Environment, EMI, Power Supply, Cabling and Earthing

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

#### 3.1 Environmental Requirements

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

##### 3.1.1 Temperature and Humidity

Most of the equipment will not be installed in environmentally controlled shelters. Therefore, equipment shall operate in accordance with the limits shown in Table 4-1.

Table 4-1  
Environmental Operating Limits

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

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

##### 3.1.2 EMI and Electrostatic Interference

At each location, the Contractor shall assess the need for shielding against radiated emissions and shall provide recommended solutions for any EMI problem found at each location. Specifications provides the type of immunity tests for which the equipment shall be required to pass without



failure. For the individual tests to be carried out at the different interfaces, references are made to the relevant IEC and ITU-T recommendations.

### **3.1.3 Vibration and Shock Resistance**

As per testing requirements indicated in this specification.

### **3.1.4 Tropicalization**

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

### **3.1.5 Contaminants**

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

## **3.2 Primary Source AC/DC Power Requirements**

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

### **3.2.1 Primary Source AC Power**

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

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

The Contractor shall provide in their Bid as well as in the survey report to the Employer the projected 240 VAC Primary Power load requirement per equipment and totals, by location, for equipment provided under this specification. The Contractor shall provide suitable UPS for communication equipment/module etc. requiring AC power supply at locations other than control centre.

### **3.2.2 -48V DC Power**

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



### **3.2.3 Power Distribution and Protection**

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

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

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

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

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

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

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

### **3.3 Equipment Construction, Assembly and Installation**

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

#### **3.3.1 Identification**

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

##### **3.3.1.1 Equipment**

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



Where custom components and parts are provided, each component/part shall be marked to specifically identify that component/part. Printed circuit card cages are defined as an equipment component and as such, shall be clearly identified as stated within this specification.

Equipment chassis and printed circuit card cages having wired backplanes, shall be clearly marked with the manufacturer's part number, serial number, month/year of manufacture, revision level and an additional identifier corresponding directly to the applicable backplane wiring diagram/list.

### **3.3.1.2 Power Distribution**

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

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

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

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

### **3.3.1.3 Signal Cabling**

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

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

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

### **3.3.1.4 Equipment Racks and Enclosures**

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

## **3.3.2 Installation Hardware**



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

### **3.3.2.1 Equipment Sub-Racks and Cabinets (Enclosures)**

All equipment provided under this specification, shall be physically mounted in sub-racks and cabinets (enclosures). The Contractor shall determine and propose for the Employer approval, the type, weight and manner of installation for each location. The size of the cabinet (enclosure) shall be minimum 2200mmx600mmx600mm(HxWxD).

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

#### **(A) Equipment Sub-Rack Construction**

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

- (1) Equipment Sub Racks shall be steel/aluminium fabricated and finished on all surfaces. All metal and welds shall be thoroughly cleaned and sanded to obtain a smooth finish. All surfaces shall be treated for rust and primed to form a bond between metal and the finish coats of paint.
- (2) Equipment covers shall be provided for exposed components mounted in equipment sub Racks.
- (3) Dust and moisture protection shall meet or exceed IP20 standards.

#### **(B) Equipment Cabinet (Enclosure) Construction**

- (1) Equipment cabinets (enclosures) shall be steel/ steel & Aluminium extrusion fabricated and finished on all surfaces. All metal and welds shall be thoroughly cleaned and sanded to obtain a smooth finish. All surfaces shall be treated for rust and primed to form a bond between metal and the finish coats of paint. Height of Equipment Cabinet shall be minimum 2200 mm.
- (2) Equipment cabinets (enclosures) shall be designed free-standing but shall be mounted to the floor. Cabinets (enclosures) shall have secure fitting, lockable, full-length front doors for access to hardware and wiring. Equipment covers for exposed components mounted inside cabinets are not required unless specifically recommended.
- (3) All doors and removable panels shall be fitted with long life rubber beading. All panels shall be fabricated from minimum 2.0mm thickness steel sheet. However, for racks with load bearing Aluminium extrusion frame, door panels and side panels may be fabricated from minimum 1.6mm thickness steel sheet and the top

& bottom panels shall be fabricated from minimum 2.0mm thickness steel sheet.

- (4) Equipment cabinets (enclosures) shall be dust and moisture-proof as per IP41 specification, or better (supporting test certificates/documents for meeting IP41 protection class of offered cabinets shall be submitted during detailed engineering).

### **3.3.2.2 Cable Raceways**

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

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

### **3.3.3 Signaling Distribution**

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

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

### **3.3.4 Lightning and Transient Voltage Protection**

The Contractor shall be required to provide protection from lightning and transient voltages for



all wideband communications equipment, in accordance with the following:

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

### **3.3.5 Station Safety Earthing and Signal Grounding**

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

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

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

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

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



or make new earthing as per requirement.

### **3.3.6 Interconnections**

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

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

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

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

### **3.3.7 Finish Colors**

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

## **3.4 Location of Equipment, Cable Routes and Associated Civil Works**

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

### **3.4.1 Locations for Supplied Equipment**

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

### **3.4.2 Associated Civil Works**

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

- (1) All wall and floor penetrations necessary for the installation of all cabling to be performed in accordance with the requirements of this specification.



- (2) Installation of racks, cabinets, cable raceways, and cabling supplied as part of this contract.

### 3.4.3 Cable Trenches

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

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

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

----- **End of this Section -3** -----



## **Section - 04**

### **Inspection, Test and Availability**

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

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

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

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

All tests shall be witnessed by the Employer and/or its authorized representative (hereinafter referred to as the Employer) unless the Employer authorizes testing to proceed without witness. The Employer representative shall sign the test form indicating approval of successful tests.

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

The Employer reserves the right to require the Contractor to perform, at the Employer's expense, any other reasonable test(s) at the Contractor's premises, on site, or elsewhere in addition to the specified Type, Acceptance, Routine, or Manufacturing tests to assure the Employer of specification compliance.

All security related features shall be demonstrated during FAT/SAT as required by the Employer.

#### **4.1 Inspection**

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



following:

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

#### **4.2 Test Plans and Procedures**

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

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

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



writing, that said modifications are unnecessary for contract compliance.

#### 4.2.1 Factory and Site Test Plans

A test plan for factory and site acceptance tests shall be submitted for approval, at least four (4) weeks before the start of testing. The test plan shall be a single overview document that defines the overall schedule and individual responsibilities associated with conducting the tests, documenting the test results, and successfully completing the test criteria. Test Plans shall include, at a minimum, the information contained in Table 4-1.

**Table 4-1**  
**Factory & field Test Plan Requirements**

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

#### 4.2.2 Test Procedures

Test procedures for factory and site testing shall be submitted for the Employer approval at least four (4) weeks before each individual test. Fully approved test procedures shall be submitted to the Employer at least four weeks prior to the commencement of testing. Testing shall not commence without approved test procedures. At a minimum, test procedures shall include the items listed in Table 4-2.

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

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

**Table 4-2**  
**Test Procedure Requirements**

<b>Item:</b>	<b>Description:</b>
--------------	---------------------

**Table 4-2**  
**Test Procedure Requirements**

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

#### 4.2.3 Test Records

Complete and indexed records of all factory and site acceptance tests results shall be maintained and provided to the Employer by the Contractor in hardcopy. The records shall be keyed to the steps enumerated in the test procedures. The minimal items required in test records are described in Table 4-3.

**Table 4-3**  
**Test Record Requirements**

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



All principle test records, test certificates and performance curves shall be supplied for all tests carried out as proof of compliance with the specifications and/or each and every specified test. These test certificates, records and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Employer within the specified duration after the completion of test. Information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificates refer, and shall also bear the Contractor's reference and heading.

#### **4.2.4 Rejection of Elements**

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

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

#### **4.2.5 Test Periods Defined**

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

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

Operational Acceptance - Successful completion of SAT

### **4.3 Type Testing**

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

- (a) All equipment being supplied shall conform to type tests as per technical specification.
- (b) The test reports submitted shall be of the tests conducted within last five (5) years prior to the date of bid opening. In case the test reports are older than five years (5) ago on the date of bid opening, the Contractor shall repeat these tests at no extra cost to the purchaser.
- (c) The Contractor shall submit, within 30 days of Contract Award, copies of test reports for all of the Type Tests that are specified in the specifications and that have previously (before Contract award) been performed. These reports may be accepted



by the Employer only if they apply to materials and equipment that are essentially identical to those due to be delivered under the Contract and only if test procedures and parameter values are identical to those specified in this specifications carried out at accredited labs and witnessed by third party / customer's representatives.

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

- (d) Type Tests shall be certified or performed by reputed laboratories using material and equipment data sheets and test procedures that have been approved by the Employer. The test procedures shall be formatted as defined in the technical specifications and shall include a complete list of the applicable reference standards and submitted for Employer approval at least four (4) weeks before commencement of test(s). The Contractor shall provide the Employer at least 30 days written notice of the planned commencement of each type test.
- (e) The Contractor shall provide a detailed schedule for performing all specified type tests. These tests shall be performed in the presence of a representative of the Employer.
- (f) The Contractor shall ensure that all type tests can be completed within the time schedule offered in his Technical Proposal.
- (h) In case of failure during any type test, the Supplier is either required to manufacture a fresh sample lot and repeat all type tests successfully or repeat that particular type test(s) at least three times successfully on the samples selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

#### **4.3.1 Type Test Samples**

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

#### **4.3.2 List of Type Tests**

The type testing shall be conducted on the following equipment

- (a) SDH Equipment with all types of cards (optical card, Tributary card or any other equipment/ devices as part of repeater less links for the maximum fibre lengths)

(b) Drop & Insert Multiplexer with subscriber interface card

#### 4.3.2.1 List of type test to be conducted on Telecom equipment

The type tests for SDH Equipment with all types of cards, Drop & Insert Multiplexer with subscriber interface card and DACS are described below:

##### 4.3.2.1.1 Temperature and Humidity Tests

The tests listed below are defined in IEC Publication 60068.

##### (a) Low Temperature Test: Operation to Specifications

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

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for sixteen (16) hours. Its performance is checked during the test.
- (2) Degree of Severity: Test shall be done at 0°C
- (3) Acceptance Criteria: No degradation of performance during and after the test.

##### (b) Low Temperature Test : Operation without Damage

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

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 72 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (*Post-test*).
- (2) Degree of Severity: Test shall be done at -10° C
- (3) Acceptance Criteria: Degradation of performance is allowable during the test, however there shall be no degradation of performance in the *post-test*.

##### (c) Dry Heat Test: Operation to Specifications



Dry heat test shall be done as defined in IEC Publication 60068-2-2, test method Bd, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test.
- (2) Degree of Severity: As per table 4-1: operation to specification range.
- (3) Acceptance Criteria: No degradation of performance during and after the test.

**(d) Dry Heat Test: Operation without Damage**

Dry heat tests shall be done as defined in IEC Publication 60068-2-2, test method Bd, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (*Post-test*).
- (2) Degree of Severity: Test shall be done at 55°C.
- (3) Acceptance Criteria: Degradation of performance is allowable during the test, however there shall be no degradation of performance in the *post-test*.

**(e) Damp Heat Test**

Damp heat testing reveals aging with respect to the humidity level and applies basically to electronic equipment. This test shall be done as defined in IEC Publication 60068-2-3 with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 10 days. Its performance is checked during the test.
- (2) Degree of Severity: Test shall be done at  $(40 \pm 2) ^\circ\text{C}$  &  $(93 \pm 3) \% \text{RH}$
- (3) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

**(f) Temperature Variation Test**



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

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

#### 4.3.2.1.2 Power Supply and EMI/EMC tests

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

##### (a) Immunity Tests

The list of Immunity tests are specified below in Table 5-4:

**Table 4-4: Recommended Immunity Tests**

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

**Table 4-4: Recommended Immunity Tests**

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

**(b) Emission Tests**

The list of Emission tests are specified below in Table 5-5

**Table 4-5:  
Recommended Emission Tests**

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

**Table 4-5:  
Recommended Emission Tests**

S. NO.	Emission test	AC Power Supply	DC Power Supply	Control & Signal	Telecom Line	Parameters
3	RF disturbance currents CISPR 22	N/A	N/A	N/A	Yes	2-1: 1995 - Class : B
4	RF radiated fields CISPR 22	Yes				
<b>-End Of Table-</b>						

**(c) Insulation Withstand Voltages**

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

**4.3.2.1.3 Mechanical Tests**

**(a) Mechanical Vibration Test**

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

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

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

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

**(b) Shock Test**

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

The recommended severity shall be  $A = 294 \text{ m/s}^2$ ,  $D = 18 \text{ ms}$ . Three shocks per axis per direction



shall be applied to the equipment packed according to the Contractor's specifications.

**(c) Free Fall Test**

This test could be performed as an alternative to the shock or Bump test. The procedure is defined in IEC publication 60068-2-32. The equipment shall be packed according to the Contractor's specifications. The drop height shall be defined in accordance with IEC 68-2-32. The surface of the packing case which comes into contact with the ground is the surface on which the packing case normally rests; if the packing does not have any features (inscription, special shape, etc.) identifying this surface, the test is carried out successively on all the surfaces of the packing.

**(d) Bump Test**

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

#### **4.4 Factory Acceptance Tests**

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

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

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

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

alarms and diagnostics etc.

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

#### 4.4.1 Sampling for FAT

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

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

#### 4.4.2 Production Testing

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

**Table 4-6:**  
**Factory Acceptance Testing for Fibre Optic Transmission System**

<b>Item:</b>	<b>Description:</b>
1.	Physical inspection for conformance to DRS, BOQ, drawings and appearance of equipment
2.	Optical output power
3.	Transmitter lightwave spectral analysis
4.	Low receive level threshold
5.	Generation of bit error rate curve

**Table 4-6:  
Factory Acceptance Testing for Fibre Optic Transmission System**

6.	Measurement of analog and digital service channel parameters as well as service channel functionality
7.	Performance of supervision, alarm, Craftsperson interface, diagnostics, loop backs etc.
8.	Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for multiplexers
9.	At a minimum tests on Ethernet interface shall include demonstration of ping test, throughput test, Latency test, Packet Loss test as per RFC 2544
11.	Simulation of failure conditions and failover of each redundant unit.
12.	VLAN (Layer-2 switching) feature testing with atleast three equipments configuration
13.	Protection scheme for Ethernet Traffic (ERPS)
14.	Test of spare card slots
15.	Checks of power supply/converter voltage margins
16.	Random inspections to verify the accuracy of documentation
17.	Test of spare parts/modules/cards as per applicable tests

#### 4.5 Site Acceptance Tests

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

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. At a minimum Site Acceptance Testing requirement for Telecom equipments etc. is outlined in following section. This testing shall be supplemented by the Contractor's standard installation testing program, which shall be in accordance with his quality plan(s) for Telecom equipment installation.

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

##### 4.5.1 Phases for Site Acceptance Testing:

The SAT shall be completed in following phases:



#### **4.5.1.1 Installation Testing**

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

In the installation test report, the Contractor shall include a list of all hardware or components replaced or changed between the completion of factory tests and the start of field tests and show that documentation and spare parts have been updated.

The minimal installation testing requirements for fiber optic transmission subsystem, Termination equipment sub-system are provided in respective Tables in this section.

#### **4.5.1.2 Link Commissioning Tests**

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

For Ethernet interface: At a minimum the following test requirements shall be demonstrated as per RFC 2544:

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

VLAN (Layer-2 switching) feature testing with equipments as per network configuration shall be demonstrated.

10% of the total communication links (Chosen by the Employer, generally to cover links from all configurations used) shall be tested for a duration of 12 Hours.

Rest of the links shall be tested for 1 Hour. In case a link does not meet the performance requirements during 1 hour, then the duration of the test shall be increased to 12 hours.

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

This phase of testing shall be conducted by the Contractor and witnessed by the Employer. Field adjustments shall be made to meet established standard, however if the field adjustments fail to correct the defects the equipments may be returned to the Contractor for replacement at his own

expense. In case any adjustments are required to be made during the interval of the test then the test shall be repeated.

#### 4.5.1.3 Integrated Testing

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

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

- (1) Equipment configuration shall be checked to establish that it supports the channel routing.
- (2) End to end testing of all individual voice circuits originating from PLCC, PABX or Phones and to establish proper interfacing with PLCC\PABX\Phones and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of quality of voice, call initiation and call termination processes. The requirements for integrated testing for PABX system is described separately below.
- (3) End-to-end testing of all individual Data Circuits originating from PLCC, RTU and SCADA Front Ends and to establish proper interfacing with PLCC\RTU\Front End and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of monitoring of BER/packet loss.
- (4) Demonstration of Protection switching and synchronization of equipment as per synchronization plan.

**Table 4-9**  
**Fibre Optic Transmission system Installation Testing**

Item:	Description:
1.	Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling
2.	Station power supply input and equipment power supply (DC-DC converter) output voltage measurements
3.	Terminal transceiver performance testing (Tx power, Tx spectrum, receive signal



	strength, connector losses etc.)
4.	Service channel performance
5.	Craftsperson interface, alarm and control functional performance
6.	Rack and local alarms: No alarms shall be present and all alarms shall be demonstrated to be functional
7.	Network management interface and supervision performance
8.	Correct configuration, level setting & adjustments and termination of Input/ output interfaces
9.	Proper establishment of Safety and signalling earthing system and resistance to ground to be checked.
10.	Simulation of failure conditions and failover of protected components.

**Table 4-10**  
**Termination Equipment Sub-system Installation Testing**

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



## **Section -5 Training and Support Services**

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

### **5.1 Training (if applicable)**

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

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

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

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

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

#### **5.1.1 System Design & Overview Training**

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

The training shall be oriented to a user's point of view. The Employer/Owner users will include managers, design & planning personnel, communication support staff and maintenance person-



nel. As part of the proposal, the Contractor shall identify the number of days deemed appropriate for this training.

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

### **5.1.2 Installation & Maintenance Training**

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

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

### **5.1.3 Network Management Training**

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

The Network Management training course shall provide the course participants with hands-on experience using the actual system being supplied. Table 5-1 summarizes the minimal Network Management training requirements.

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



**Table 5-1:  
Network Management System Training on Craft Terminal**

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

#### **5.1.4 Training Course Requirements**

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

##### **5.1.4.1 Class Size**

The Employer plans to send a number of participants to the training courses for a specified duration as described in Appendices.

##### **5.1.4.2 Training Schedule**

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

The training courses shall be offered in one cycle, such that none of the courses within the cycle overlap.

The Contractor shall take the above requirements into account in developing the preliminary training schedule. Contractor shall develop a final training schedule in consultation with the Employer after contract award.

##### **5.1.4.3 Manuals and Equipment**

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

Each course participant shall receive individual copies of training manuals and other



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

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

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

## **5.2 Support Services**

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

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

After final acceptance of the communications equipment, the Contractor shall offer continuing technical support and spare parts for the designed life of the equipment or 7 years after the declaration of withdrawal of equipment from production whichever is earlier. However the termination of production shall not occur prior to Operational Acceptance of the system by the Employer. Some locations have existing SDH & MUX equipment. The traffic may be switched over to new fibre optic communication equipment in phase manner. The Contractor shall review the Employer existing equipment make, integration & switch over recommendation and prepare a detailed field implementation plan.

### **5.2.1 Technical Support**

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

### **5.2.2 Contractor's Future Hardware/Software Changes**

The Employer shall be informed of all alterations or improvements to the hardware supplied under this Specification. The Employer shall be placed on the Contractor's mailing list to receive announcements of the discovery, documentation, and solution of hardware/software problems as well as other improvements that could be made to supply equipment. The service



shall begin at the time of contract award, and shall continue for 10 years. The Contractor shall also include a subscription to the hardware subcontractors' change notification service from the time of contract award through the warranty period, with a Employer renewable option for extended periods.

### **5.3 Spare Parts and Test Equipment**

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

#### **5.3.1 Mandatory Spare Parts**

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

#### **5.3.2 Recommended Spare Parts List**

In addition to the Mandatory Spares the bidder shall provide a list of “Recommended Spare Parts”, which may be required over and above the spares listed in Mandatory Spare parts list (Vol II, appendices), to support system availabilities specified in specifications during a one year period. This list of spares shall be called the "Recommended Spare Parts List". The Recommended spare parts list shall not be considered for evaluation and may be included in the final scope of supply. The Bid shall include the following minimum information for the recommended spare parts:

- a. Original manufacturer and part number
- b. Name and Description
- c. Either theoretical or empirical MTBF of the unit
- d. Number of units in each set
- e. Total number of sets to be provided

The unit as well as set prices shall be provided for each subsystem set item of the spare parts list in the appropriate Bid Price Schedule.

### **5.4 System Maintenance**

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

#### **5.4.1 Warranty Period**

The one year period commencing immediately after the operational acceptance is called the Warranty Period/Defect liability Period.



## 5.5 Miscellaneous Supplies

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

## **Section -6 Documentation and Deliverables**

This section describes the documentation requirements and provides a list of deliverable that the Contractor shall provide to the Employer. Complete documentation necessary for the operation and maintenance of the communication system is required. All the documentation shall be provided in hard copy and also on CD-ROMs in full compliance with the specification. Conditions pertaining to Document Review and Approval Rights and Document Submission Scheduling are specified in this specification. All documents shall be supplied in English.

As detailed in subsequent sections the documentation shall include the following:

- (a) Detailed list of the deliverables
- (b) Description of the products
- (c) Technical particulars
- (d) Installation manuals
- (e) Maintenance manuals
- (f) Quality assurance manuals, Manufacturing Quality Plan (MQP) & Field Quality Plan (FQP)
- (g) Tests (type test, production, FAT, SAT) documentation

### **6.1 System Functional Description Document**

The document shall include an overview of the system configuration. This document shall be designed to serve as a complete introduction to the supplied system and to the more specific documents that are defined in technical specifications. The document shall be oriented to the Employer user's point of view and be subject to the Employer's review and approval. Users will include POWERGRID operating personnel communication support staff and maintenance personnel.

### **6.2 System Documentation**

A detailed documentation plan and document submission schedule shall be prepared and submitted for approval. The guidelines specified in table 6-1 and 6-2 shall be followed.

### **6.3 Supplementary Documentation**

If during the training courses or while performing maintenance on such equipment during the warranty period, the Employer determines that additional information is required to perform the maintenance function, the Contractor and/or its subcontractors shall provide the specific supplemental information necessary to perform the maintenance function. This information shall be documented in a form suitable for incorporation into the appropriate maintenance document.

### **6.4 Test Documentation**

The Contractor shall provide documentation for all factory and field tests.

The test documentation shall include the following:

- (a) Test Procedure Document
- (b) Type test documents
- (c) Factory Acceptance Test Documents
- (d) Site Acceptance Test Documents

## 6.5 Drawings

All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component, break-up for packing and shipment, shipping arrangement required, the dimensions required for installation and any other information specifically requested in the Specifications.

Each drawing submitted by the Contractor shall be clearly marked with the Employer name, the unit designation, the specification title, the specification number and the name of the Project. All titles, notes, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in metric units. The drawing revision level/ issue no, issue date shall be marked on each drawing and the drawing shall carry issue history information and appropriate signatures (eg: originator, checker and approving authority).

## 6.6 Drawing and Document Approval Procedure

The drawings/documents submitted by the Contractor shall be reviewed by the Employer as far as practicable within stipulated duration and shall be modified by the Contractor if any modifications and/or corrections are required by the Employer in compliance with the Specifications. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval. Any delays arising out of failure by the Contractor to rectify the drawings in good time shall not alter the contract completion date.

The drawings/documents submitted for approval to the Employer shall be in triplicate. One print of such drawings shall be returned to the Contractor by the Employer marked with one of the categories as listed below:-

Category	Inference
Cat I	Approved/Released for implementation.
Cat II	Approved/Released for implementation subject to incorporation of comments. Revised drawing required.
Cat III	To be resubmitted for approval after incorporating comments.
Cat IV	For information and record.



The approval of the drawing/document conveyed vide above marked copy shall neither relieve the Contractor of its contractual obligations and its responsibilities towards weights, qualities, design details, assembly fits, performance particulars and conformity of supplies with the Indian Statutory Laws as may be applicable, nor shall it limit Employer's right under the contract.

Depending upon the category of approval the Contractor shall resubmit the drawings/documents for review by Employer after incorporating all corrections.

Further work by the Contractor shall be strictly in accordance with the Cat-I, Cat-II or Cat-IV approved drawings and no deviation shall be permitted without the written approval of the Employer.

All manufacturing and fabrication work in connection with the equipment/material prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment/material conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the Contractor of any of his responsibilities and liabilities under the Contract.

## 6.7 Final Documentation

Final documentation shall consist of the documents approved in Cat I and Cat IV listed in table 7-1. The documents will be used by the Employer personnel for operating and maintaining the equipment after acceptance.

Until acceptance of the equipment by the Employer, the Contractor shall be responsible for supplying documentation revisions or changes necessitated by inaccuracies, installation requirements, omissions determined by usage, and design or production alterations to the equipment. All changes shall be issued in the form of replacements for the affected drawings, diagrams, charts, graphs, tables, lists, and pages in the various documentation such that all documentation describes the equipment "as delivered".

For all CAT-I & CAT-IV approved documents listed in table (except Type, FAT & SAT related), Five (5) sets of the final approved documentation shall be provided to the Employer in CD-ROM and two sets in hardcopy.

All final Contractor-supplied documentation shall be easily reproducible by the Employer.

<b>S. No</b>	<b>Document</b>	<b>Applicable Equipments / Item</b>	<b>Brief Description</b>	<b>Category of Approval</b>
1.	Documentation plan & schedule		This document shall contain the list of all documents to be	I



**Table 6-1**  
**Documentation Plan for Communication Equipment Package**

S. No	Document	Applicable Equipments / Item	Brief Description	Category of Approval
			submitted for approval and their submission/approval schedule.	
2.	Survey guidelines		As per Technical Specifications	I
3.	Data Requirement Sheets (DRS) and Guaranteed Technical Parameters & Drawings	For each and every item to be supplied including SDH, PDH equipment, power and signal cables, earthing cables, patch cords etc	These document(s) shall describe all the technical parameters of the equipment being offered.	Cat-I (for DRS) & Cat-IV (for brochure)
4.	Mechanical drawings	As applicable	This document shall fully describe the equipment racks/enclosures, MDF, peripherals and related hardware with particular reference to mechanical construction, materials and dimensions, appearance, mounting methods, earthing clearances required from walls/roof/other panels, cable entry details, dust and moisture ingress protection provisions etc.	I
5.	Equipment Manuals & Standard Documents	For all items	Complete set of all equipment manuals (Construction, Installation, Maintenance, Reference etc) for that product. A set of product brochures, photographs etc.	IV
6.	Previous type test reports	For all items for which type testing is envisaged.	Shall be complete in all respect including all test graphs, curves, calculations, photographs etc.	Acceptance
7.	Type test procedures	For all items for which type testing is required.	Shall be formatted as per the technical specifications	I
8.	Manufacturing	For all items to be supplied		I



**Table 6-1**  
**Documentation Plan for Communication Equipment Package**

S. No	Document	Applicable Equipments / Item	Brief Description	Category of Approval
	Quality Plan			
9.	Type test schedule	For all items for which type testing is required.	Shall indicate the start & finish data for each test & sequence of tests if applicable, test labs.	I
10.	Type test report	For all items for which type testing is required.		I
11.	Link and site survey reports & engineering analysis	For each Fibre Optic link and site	Link wise survey reports as per specifications, link budget calculations etc.	I
12.	Bill of Quantity	For each items and each line		I
13.	Numbering, Marking, labeling Document	As applicable.	Must include numbering, marking, labelling and naming conventions for channels, cables, connectors, subracks, cubicles etc	I
14.	Physical planning/site preparation manuals	As applicable.	Must contain data gathered during the site survey, including test results, if any. The document shall also contain floor plan, cable trenching/raceway drawings, station block diagrams, rack/cabinet elevation drawings, air-conditioning and power supply requirements, and power supply distribution and earthing system details.	I
15.	Channel Routing	Whole Network	E1 level Plan, subscriber voice and data channels plan for whole network.	I
16.	Synchronisation Plan	With Existing Network	Locations of clocks, depiction of all interfaces, flow of synchronising signal.	I
17.	Configuration Diagrams	Whole Network	Network configuration, Linkwise and site wise equipment configuration,.	I
18.	Factory Acceptance	For all items to be supplied	This document shall include the list of Site acceptance tests,	I



**Table 6-1**  
**Documentation Plan for Communication Equipment Package**

<b>S. No</b>	<b>Document</b>	<b>Applicable Equipments / Item</b>	<b>Brief Description</b>	<b>Category of Approval</b>
	tests: test plan, procedures and report format		the administrative & functional test plans, test procedures and formats for recording & reporting factory acceptance test results.	
19.	Factory acceptance test report	For all Factory acceptance tests		Acceptance letter by Employer
20.	Transportation & Handling Procedures	For all equipments	This document shall describe the procedures & precautions to be observed during overseas & inland transportation, equipment handling during transport, storage & pre-installation. It shall also include packing details and package labelling details.	IV
21.	Equipment Installation manual	For all equipment such as SDH equipment, etc	The expected content of this document are presented in table below.	IV
22.	Site Drawings	Site wise complete documentation	This document must include, general details of equipments, cubicles, cables, connectors, MDFs, DDFs, network diagram, earthing connections, power supply connections and specific details i.e. site layout, floor plans, cubicle layout, subrack layout, channel routing, signal connections, cable routing, MDF and DDF cross connections etc	I
23.	Site Acceptance tests (SAT) test plan, procedures and report format	System document	This document shall include the list of Site acceptance tests, the administrative & functional test plans, test procedures and formats for recording & reporting site acceptance test results. This document shall be restricted to describing the	I



**Table 6-1**  
**Documentation Plan for Communication Equipment Package**

<b>S. No</b>	<b>Document</b>	<b>Applicable Equipments / Item</b>	<b>Brief Description</b>	<b>Category of Approval</b>
			acceptance tests listed in this technical specification, and other similar tests which shall be conducted in Employer presence for Site acceptance.	
24.	Field Quality Plan	One Document with multiple subdocuments if required	Field Quality Plan shall describe the quality control to be exercised during the field activities. This document can include the following information: (a.) The list of performance & safety checks applied to installation equipment, tools & tackles, checks, check on physical health & training records of installation crew etc. (b.) The list of Site Acceptance tests (including statement of acceptance criteria). The inclusion of list of site acceptance tests in FQP is analogous to the inclusion of list of FAT in the MQP. The formats for recording & reporting Site acceptance tests can also be reproduced	I
25.	Training Manuals	System document	An advance copy of all training material.	IV
26.	Maintenance Philosophy & Procedures	System document	Shall cover breakdown maintenance procedures, preventive maintenance schedules and procedures	IV
27.	SAT reports	Per Link and per location		*

Note\*: To be reviewed & approved by site.

**Table 6-2(a)**  
**Expected Contents & Structure of Equipment Installation Manual**

1.	Installation procedure	<u>Description of activities of installation gangs</u> : Preparation & Setting up, Precautions for preventing damage etc shall be highlighted.
2.	Safety Instructions	<u>Instructions &amp; procedures related to ensuring installation crew safety</u> : personnel grounding & safety, installation equipment safety, Safety for power system & environment
3.	Description of Installation Equipment	Sketches, drawings, photographs, safe working ratings of installation equipment, tools & tackles etc., handling instructions & precautions.
4.	Cable routing	<u>Illustrations</u> of the various possible cable routing (Intra cabinet and inter cabinet, within the same room and located in different rooms/buildings etc.) methods.
5.	References	References to other related documents covering the installation, jointing & testing, such as <ul style="list-style-type: none"> <li>. SAT administrative &amp; functional test plans &amp; test procedures</li> <li>. Field Quality Plan &amp; Field Quality Audit</li> <li>. Storage &amp; Handling Instructions</li> <li>. Drawings, technical parameters, DRS etc</li> <li>. Employer &amp; Statutory safety rules, safety manuals, standards, codes of practices etc.</li> </ul>

----- **End of this Chapter – 6** -----



## SECTION-3

## PROJECT DETAILS &amp; GENERAL SPECIFICATION

## SITE INFORMATION

	Particular	Details
a)	Owner	POWERGRID
b)	Customer	POWERGRID
c)	Project Title	765kV/400Kv/220kV Banaskantha (New) Substation and Extn. of 400kV Sankhari (GETCO) Substation
d)	Location	Banaskantha, Gujrat Sankhari , Gujrat
e)	Transport Facilities	RAOD/TRAIN, For both Site Nearest Rail Head: Palanpur
<b>SITE CONDITIONS</b>		
a)	Max. ambient air temp.	50°C
b)	Min. ambient air temp.	0°C
c)	Max. design ambient temp.	50°C
d)	Design reference temp.	50°C
e)	Average Humidity	Max. 100%
f)	Special corrosion conditions	No
g)	Solar Radiation	1.2kW/sqmtr
h)	Atmospheric UV radiation	High
i)	Altitude above sea level	Less than 1000meter
j)	Pollution Severity	High Polution (25mm/kV)
k)	Seismic Zone	As per the seismic zone defined in the relevant BIS but not less than 0.3g horrrizontal
<b>WIND DATA</b>		
	Wind velocity	As per IS
	Average No. of thunderstorm days per annum	As per IS

<b>Main Electrical Parameters:</b>		
<b>Fault Levels:</b>	<b>For Banaskantha</b> <b>765kV: 50kA for 1 sec</b> <b>400kV: 63kA for 1 sec</b> <b>220kV: 40kA for 1 sec</b>  <b>For Sankhari</b>  <b>400kV: 40kA for 3 sec</b>	
<b>Creepage Distance</b>	<b>25mm/kV</b>	

## 1.0 GENERAL

This Chapter covers Technical Requirements and requirements of auxiliary items.

- a) Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes unless included in the list of exclusions.
- b) Material and components not specifically stated in this specification but which are necessary for satisfactory operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded and shall be supplied at no extra cost.
- c) Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition.
- d) In case any Deviation Schedule, Bid Proposal Sheet, Schedule of Data Requirements (DRS), test reports or any other document/information are not furnished along-with the bid, the bid is liable to be rejected. Unless brought out clearly, the Bid will be deemed to conform to the specification scrupulously. All deviations from the specification shall be clearly brought out in the respective deviation schedule.

Auxiliary supplies as described below would be available at site.

Normal	Variation	Frequency	Phase	Neutral
Voltage	in voltage	(Hz)		connection
(Volts)				

415	+ 10 %	50 + 5 %	3 Ph- 4wire	Solidly earthed
240	+ 10 %	50 + 5 %	1 Ph-2wire	Solidly earthed
220	+ 10 %	DC		Isolated(2 wire system)
48		DC		Isolated(2 wire system) (+ Earthed)

- 
- f) The Bidder shall clearly indicate in the bid, the specific standards in accordance with which the works will be carried out.
- g) The equipment must be new, of highest grade, the best quality of their kind, to best engineering practice and latest state of art, and in accordance with purpose for which they are intended and ensure satisfactory performance throughout the service life.
- h) All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same materials and workmanship as the corresponding parts of the equipment. Where feasible, common components, units shall be employed in different pieces of equipment in order to optimize the spare part stock-up and utilization.
- i) The requirement regarding external RIV as specified for equipment shall include the terminal fittings and the equipment shall have been tested preferably with fittings, if any.

## **2.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED**

- a) The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc.
- b) The equipment shall be able to withstand forces due to wind load, short circuit, system over voltages, fluctuations, frequency variations etc., all forces considered together.

## **3.0 SUPPORT STRUCTURES (If in the scope of Bidder)**

- a) The support structures should be hot dip galvanised with minimum 610 gram/m<sup>2</sup> net of zinc.
- b) The design calculations taking into account the environmental conditions of the substations shall be furnished for sizing of the structures.

## **4.0 STANDARDS**

- a) The equipment to be furnished under this specification shall conform to latest issue with all amendments of standard specified under respective Chapters of this Specification. The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other. The bidder shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC. When the

specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

- b) Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards referred shall also be accepted.
- c) In case governing standards for the equipment is different from IS or IEC, the salient points of difference shall be clearly brought out in additional information schedule alongwith English language version of standard or relevant extract of the same. The equipment conforming to standards other than IS/IEC shall be subject to POWERGRID's approval.

## 5.0 ENGINEERING DATA AND DRAWINGS

5.1 The list of drawings/documents which are to be submitted to the Purchaser shall be discussed and finalised by the Purchaser at the time of award. The supplier shall necessarily submit all the drawings/ documents unless anything is waived.

5.2 The Contractor shall submit 4 (four) sets of drawings/ design documents /data / detailed bill of quantity and 1 (one) set of test reports for the approval of the Purchaser. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.

### 5.3 Drawings

5.3.1 All drawings submitted by the Contractor shall **be in sufficient** detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, **dimensions**, internal & the external connections, fixing arrangement required **and any** other information specifically requested in the specifications.

5.3.2 Drawings submitted by the Contractor shall **be clearly** marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. POWERGRID **has** standardized a large number of drawings/documents of various make including **type test** reports which can be used for all projects having similar requirements and **in such cases** no project specific approval (except for list of applicable drawings alongwith **type test** reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per provision of the contract. All titles, noting, markings and writings **on the** drawing shall be in English. All the dimensions should be in SI units.

5.3.3 The review of these data by the Purchaser will **cover** only general conformance of the data to the specifications and documents, interfaces **with the** equipment provided under the specifications, external connections and of **the** dimensions which might affect substation layout. This review by the Purchaser may not indicate a thorough review of all dimensions, quantities and details **of** the equipment, materials, any devices or items indicated or the accuracy of **the** information submitted. This review and/or approval by the Purchaser shall not be **considered** by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

5.4 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the

provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

5.5 All engineering data submitted by the Contractor after final process including review and approval by the Purchaser shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Purchaser in Writing.

#### 5.7 Approval Procedure

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Purchaser would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

- |  |   |
|--|---|
| i) Approval/comments/<br>Purchaser on initial  | As per agreed by<br>schedule submission               |
| ii) Resubmission<br>(whenever<br>required)   | Within 3 (three) weeks<br>from date of comments       |
| iii) Approval or comments  | Within 3 (three) weeks of<br>receipt of resubmission. |
| iv) Furnishing of distribution<br>copies (5 hard copies per<br>substation and one scanned<br>copy (pdf format) for Corporate<br>Centre)          | 2 weeks from the date<br>of approval                  |
| v) Furnishing of distribution copies of test reports   |   |
| (a) Type test reports<br>(one scanned softcopy in<br>pdf format per substation plus one for corporate centre<br>& one hardcopy per substation)   | 2 weeks from the date<br>of final approval            |
| (b) Routine Test Reports<br>(one copy for each substation)   | -do-  |
| vi) Furnishing of instruction/<br>manuals (2 copies<br>per substation and one softcopy<br>(pdf format) for corporate centre<br>& per substation) | As per agreed schedule operation                      |
| (vii) As built drawings (two sets of<br>hardcopy per substation & one<br>softcopy (pdf format) for<br>corporate centre & per substation)         | On completion of entire works                         |

#### NOTE :

- (1) The supplier may please note that all resubmissions must incorporate all comments given in the earlier submission by BHEL/POWERGRID or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

- (2) All drawings should be submitted in softcopy form, however substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.
- (3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.
- (4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the supplier to BHEL/POWERGRID.
- (5) The manufacturer shall furnish to the Purchaser catalogues of spare parts.
- (6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

## **6.0 MATERIAL WORKMANSHIP**

### **6.1 General Requirement**

- 6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.
- 6.1.2 In case where the equipment, materials or components are indicated in the specification as "similar" to any special standard, the Purchaser shall decide upon the question of similarity. When required by the specification or when required by the Purchaser the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the supplier.
- 6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the BHEL/POWERGRID.
- 6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

- 6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer's limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.
- 6.1.6 The supplier shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The supplier shall apply all operational lubricants to the equipment installed by him.
- 6.1.7 All oil, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. In such is the case he shall declare in the proposal, where such oil or grease is available. He shall help POWERGRID in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.
- 6.1.8 Corona and radio interference voltage test and seismic withstand test (for 132kV and above voltage level) procedures for equipments shall be in line with the procedure given at Annexure-A and B respectively.

## **6.2 Provisions For Exposure to Hot and Humid climate**

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipments located in non-air conditioned areas shall also be of same type.

### **6.2.1 Space Heaters**

- 6.2.1.1 The heaters shall be suitable for continuous operation at 240V as supply voltage. On-off switch and fuse shall be provided.
- 6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.
- 6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

### **6.2.2 FUNGI STATIC VARNISH**

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of

the equipment. Such surfaces or parts shall be protected against the application of the varnish.

### **6.2.3 Ventilation opening**

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

### **6.2.4 Degree of Protection**

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

- a) Installed out door: IP- 55
- b) Installed indoor in air conditioned area: IP-31
- c) Installed in covered area: IP-52
- d) Installed indoor in non air conditioned area where possibility of entry of water is limited: IP-41.
- e) For LT Switchgear (AC & DC distribution Boards) : IP-52

The degree of protection shall be in accordance with IS:13947 (Part-I) / IEC-60947(Part-I) / IS 12063 / IEC-60529. Type test report for degree of protection **test**, shall be submitted for approval.

## **6.3 RATING PLATES, NAME PLATES AND LABELS**

Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Purchaser. The rating plate of each equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

## **6.4 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS**

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into successful Operation, shall be furnished by the supplier unless specifically excluded under the exclusions in these specifications and documents.

## **7.0 DESIGN IMPROVEMENTS / COORDINATION**

- 7.1 The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Purchaser or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Purchaser & contractor agree upon any such changes, the specification shall be modified accordingly.

- 7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.
- 7.3 The supplier shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.
- 7.4 The supplier has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Purchaser. The names of agencies shall be intimated to the successful bidders.
- 7.5 The supplier will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Purchaser (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at POWERGRID Corporate Centre, Gurgaon (Haryana) or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

## **8.0 QUALITY ASSURANCE PROGRAMME**

- 8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the supplier's Works or at his Sub-contractor's premises or at the Purchaser's site or at any other place of Work are in accordance with the specifications, the supplier shall adopt suitable quality assurance programme to control such activities at all points necessary. The detailed programme shall be submitted by the contractor after the award for reference. A quality assurance programme of the supplier shall generally cover the following:
- (a) His organisation structure for the management and implementation of the proposed quality assurance programme;
  - (b) Documentation control system;
  - (c) Qualification data for bidder's key personnel;
  - (d) The procedure for purchases of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
  - (e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
  - (f) Control of non-conforming items and system for corrective actions;
  - (g) Inspection and test procedure both for manufacture and field activities.
  - (h) Control of calibration and testing of measuring instruments and field activities;
  - (i) System for indication and appraisal of inspection status;
  - (j) System for quality audits;
  - (k) System for authorising release of manufactured product to the Purchaser.

- (l) System for maintenance of records;
- (m) System for handling storage and delivery; and
- (n) A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

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

## **8.2 Quality Assurance Documents**

The supplier would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of POWERGRID/BHEL inspection of equipment/material

## **9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE**

- 9.1 All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections.
- 9.2 The reports for all type tests as per technical specification shall be furnished by the supplier alongwith equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall be applicable for all project with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by POWERGRID or representative authorized by POWERGRID or Utility or representative of accredited test lab or reputed consultant.

The test reports submitted shall be of the tests conducted within last 10 (ten) years prior to the date of bid opening i.e. 24.02.15. In case the test reports are of the test conducted earlier than 10 (ten) years prior to the date of bid opening, the contractor shall repeat these test(s) at no extra cost to BHEL.

However, in case of instrument transformers, the following type tests should have been conducted within 5 (five) years prior to the date of bid opening.

- i) Lightning Impulse Test
- ii) Switching Impulse Test
- iii) Multiple Chopped Impulse Test (For CT)
- iv) Chopped Impulse Test (For CVT )

In case the test reports are of these tests (for instrument transformers) as mentioned above are conducted earlier than 5 (five) years prior to the date of bid opening i.e. 24.02.15, the contractor shall repeat these test(s) at no extra cost to the purchaser.

Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out

without any additional cost implication to the Purchaser.

The supplier shall intimate the BHEL/POWERGRID the detailed program about the tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

Further, in case type tests are required to be conducted/repeated and the deputation of Inspector/Purchaser's representative is required, then all the expenses shall be borne by the supplier.

- 9.3 The Purchaser intends to repeat the type tests on Power Transformer and Shunt Reactor except Dynamic short circuit tests on transformers, for which test charges shall be payable as per provision of contract. The price of conducting type tests shall be included in Bid price and break up of these shall be given in the relevant schedule of Bid Proposal Sheets. These Type test charges would be considered in bid evaluation. In case Bidder does not indicate charges for any of the type tests or does not mention the name of any test in the price schedules, it will be presumed that the particular test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected. BHEL/POWERGRID reserves the right to witness any or all the type tests. The BHEL/POWERGRID also reserves the right to waive the repeating of type tests partly or fully and in case of waiver, test charges for the same shall not be payable.

The Purchaser shall bear all expenses for deputation of purchaser's representative(s) for witnessing the type tests under this clause except in the case of re-deputation if any, necessitated due to no fault of the purchaser.

For outdoor receptacles, trefoil clamps, diesel engine, alternator, motors, cable glands, lighting fixtures, ACSR/AAC conductor, IPS aluminum tube and junction boxes, type test reports are not required to be submitted for the makes indicated at Annexure-E /POWERGRID approved list of subvendors. For the new makes(other than those indicated at Annexure-E / POWERGRID approved list of subvendors), type test reports as per relevant standard shall be submitted for POWERGRID's approval.

- 9.4 The Purchaser, his duly authorised representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractor's/sub-vendors premises or Works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, despatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.
- 9.5 The supplier shall give the Purchaser /Inspector fifteen (15) days written notice for on-shore and six (6) weeks notice for off-shore material being ready for joint testing including contractor and POWERGRID. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Purchaser/inspector, unless witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to

have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

9.6 The Purchaser or Inspector shall, within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Purchaser /Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

9.7 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Purchaser/inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Purchaser /Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/Inspector. Failure of the Purchaser /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of CIP by the Purchaser.

9.8 In all cases where the Contract provides for tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Purchaser /Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Purchaser /Inspector or to his authorised representative to accomplish testing.

9.9 The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

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

9.11 The Purchaser reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Purchaser.

## **10.0 TESTS**

### **10.1 Pre-commissioning Tests**

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Purchaser and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in respective chapters and shall be included

in the Contractor's quality assurance programme.

## **10.2 Commissioning Tests**

- 10.2.1 The available instrumentation and control equipment will to be used during such tests and the Purchaser will calibrate, all such measuring equipment and devices as far as practicable.
- 10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
- 10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.
- 10.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed by POWERGRID on production of requisite documents.

## **11.0 PACKAGING & PROTECTION**

- 11.1 All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Purchaser, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Purchaser takes no responsibility of the availability of the wagons.
- 11.2 All coated surfaces shall be protected against abrasion, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

## **12.0 FINISHING OF METAL SURFACES**

- 12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to IS:2629.

### **12.2 HOT DIP GALVANISING**

- 12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq. m minimum.
- 12.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots,

unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

12.2.3 After galvanizing, no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

12.2.4 The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.

12.2.5 Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

12.2.6 Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

### **12.3 PAINTING**

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

12.3.2 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

12.3.3 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

12.3.4 The exterior and interior colour of the paint in case of new substations shall preferably be RAL 7032 for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. Glossy white colour inside the equipments /boards/panels/junction boxes is also acceptable. The exterior colour for panels shall bemarking with the existing panels in case of extension of a substation. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching

up required at site after installation of the equipments.

12.3.5 In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted alongwith the Bids for Purchaser's review & approval.

12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air Conditioning systems

S.No.	PIPE LINE	Base colour	Band colour
<b>Fire Protection System</b>			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line – water	FIRE RED	Sea Green
3	Emulsifier system detection line – Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
<b>Air Conditioning System</b>			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
6	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red
7	Refrigerant liquid pipeline	Dark Admiralty Green	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

12.3.7 For aluminium casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium enclosures the surface shall be coated with powder (coating thickness of 60 microns) after surface preparation for painting.

### 13.0 HANDLING, STORING AND INSTALLATION

13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

13.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

13.3 The contractor shall have to ensure that the hard and flat indoor and outdoor storage areas are in place prior to commencement of delivery of material at site. Contractor shall also ensure availability of proper unloading and material handling equipment like cranes etc. and polyester/nylon ropes of suitable capacity to avoid

damage during unloading and handling of material at site. All indoor equipments shall be stored indoors. Outdoor equipment may be stored outdoors but on a hard and flat raised area properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress. However, all associated control panels, marshalling boxes operating boxes etc. of outdoor equipments are to be stored indoors only. Storage of equipment on top of another one is not permitted if the wooden packing is used. Material opened for joint inspection shall be repacked properly as per manufacturer's recommendations. During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.

- 13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.
- 13.5 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- 13.6 Supplier shall be responsible for examining all the shipment and notify the Purchaser immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. The Contractor shall submit to the Purchaser every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- 13.7 The supplier shall be fully responsible for the equipment/material until the same is handed over to the Purchaser in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Purchaser, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- 13.8 Where material / equipment is unloaded by Purchaser before the Contractor arrives at site or even when he is at site, Purchaser by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.
- 13.9 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.
- 13.10 The words 'erection' and 'installation' used in the specification are synonymous.
- 13.11 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- 13.12 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

#### 14.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

#### 15.0 AUXILIARY SUPPLY

- 15.1 The sub-station auxiliary supply is normally met through a system indicated under section "Electrical & Mechanical Auxiliaries" having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform the parameters as indicated in the following.

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase/Wire	Neutral connection
415V	± 10%	50 ± 5%	3/4 Wire	Solidly Earthed.
240V	± 10%	50 ± 5%	1/2 Wire	Solidly Earthed.
220V	190V to 240V	DC	-	Isolated 2 wire System
48V	-	DC	-	2 wire system (+) earthed

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

#### 16.0 SUPPORT STRUCTURE (If in the scope of supplier)

- 16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 14.0 meter, 8.0 meter and 5.9 meter from plinth level for 765 kV, 420 kV and 245 kV substations respectively. All equipment support structures shall be supplied alongwith brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.

- 16.2 Support structure shall meet the following mandatory requirements:

- 16.2.1 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.

#### 17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

- 17.1 All power clamps and connectors shall conform to IS:5561 & NEMA CC1 and shall be made of materials listed below :

- |    |  |   |
|----|--|---|
| a) | For connecting ACSR conductors             | Aluminum alloy casting, conforming to designation A6 of IS:617 and all test shall conform to IS:617 |
| b) | For connecting equipment terminals made of | Bimetallic connectors made from aluminum alloy casting, conforming to designation A6                |

- |    |   |  |
|----|---|--|
|    | copper with<br>ACSR conductors            | of IS:617 with 2mm thick<br>bimetallic liner and all test<br>shall conform to IS:617                   |
| c) | For connecting G.I                        | Galvanised mild steel shield wire  |
| d) | i) Bolts, nuts &<br>Plain, washers        | i) Electrogalvanised for sizes<br>below M12, for others hot dip<br>galvanised.                         |
|    | ii) Spring washers<br>items<br>'a' to 'c' | ii) Electro-galvanised mild for<br>steel suitable for atleast<br>service condition-3 as per<br>IS:1573 |
- 17.2 Necessary clamps and connectors shall be supplied for all equipment and connections. The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.
- 17.3 Where copper to aluminum connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress.
- 17.4 Low voltage connectors, grounding connectors and accessories for grounding allequipment as specified in each particular case, are also included in the scope of Work.
- 17.5 No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminum body or 2 mm thick bi-metallic strips shall be provided for Bi-metallic clamps.
- 17.6 All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- 17.7 Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of 4" IPS AL. tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.
- 17.8 Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.
- 17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 17.10 Clamps and connectors shall be designed to be corona controlled.
- 17.11 Tests**
- 17.11.1 Clamps and connectors should be type tested as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports shall be submitted for approval as per clause 9.2 above except for sl. no.(ii) & (iii) for which type test once conducted shall be applicable (i.e. the requirement of test conducted within last ten years shall not be applicable).

- i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)
- ii) Short time current test
- iii) Corona (dry) and RIV (dry) test (for 220 KV and above voltage level clamps)
- iv) Resistance test and tensile test

## **18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT**

- 18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039/IS-8623, IEC-60439, as applicable, and the clauses given below:
- 18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.
- 18.3 A canopy and sealing arrangements for operating rods shall be provided inmarshalling boxes / Control cabinets to prevent ingress of rain water.
- 18.4 Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.
- 18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene gaskets. The gasket shall be tested in accordance with approved quality plan, IS:11149 and IS:3400. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.
- 18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by meanof weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet.  
Suitable cable gland plate above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.
- 18.7 A 240V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.
- 18.8 For illumination, a fluorescent tube or CFL of approximately 9 to 15 watts shall be provided. The switching of the fittings shall be controlled by the door switch. .  
For junction boxes of smaller sizes such as lighting junction box, manual operated earth

switch mechanism box etc., plug socket, heater and illumination is not required to be provided.

- 18.9 All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.
- 18.10 Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.
- 18.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.
- 18.12 a) The following routine tests alongwith the routine tests as per IS:5039 shall also be conducted:
- i) Check for wiring
  - ii) Visual and dimension check
- b) The enclosure of bay marshalling kiosk, junction box, terminal box shall conform to IP-55 as per IS:13947 including application of, 2.5 KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.
- 19.0 Deleted.

**20.0 TERMINAL BLOCKS AND WIRING**

- 20.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All interphase and external connections to equipment or to control cubicles will be made through terminal blocks.
- 20.2 Terminal blocks shall be 650V grade and have continuous rating to carry the maximum expected current on the terminals and non breakable type. These shall be of moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type of Elmex or Phoenix or Wago or equivalent make.
- 20.3 Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.
- 20.4 The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.
- 20.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.
- 20.6 The terminal blocks shall be of extensible design.
- 20.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.
- 20.8 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.
- 20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the

following conductors on each side.

- |    |                                    |   |
|----|------------------------------------|---|
| a) | All circuits except CT/PT circuits | Minimum of two of 2.5 sq mm copper flexible.    |
| b) | All CT/PT circuits                 | Minimum of 4 nos. of 2.5 sq mm copper flexible. |

20.10 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

20.11 At least 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

20.13 The supplier shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. For equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge overvoltages either transferred through the equipment or due to transients induced from the EHV circuits.

20.14 All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

## **21.0 LAMPS & SOCKETS**

### **21.1 Sockets**

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

### **21.2 Hand Lamp:**

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

### **21.3 Switches and Fuses:**

21.3.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breaker / switchfuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

21.3.2 All fuses shall be of HRC cartridge type conforming to IS:9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

## **22.0 Bushings, Hollow Column Insulators, Support Insulators:**

22.1 Bushings shall be manufactured and tested in accordance with IS:2099 & IEC- 60137

while hollow column insulators shall be manufactured and tested in accordance with IEC-62155/IS:5621. The support insulators shall be manufactured and tested as per IS:2544/IEC-60168 and IEC-60273. The insulators shall also conform to IEC-60815 as applicable. The bidder may also offer composite hollow insulators, conforming to IEC-61462.

- 22.2 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- 22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.
- 22.4 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.
- 22.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.
- 22.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.
- 22.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

#### **22.8 Tests**

In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099 & IS:2544 & IS : 5621.

#### **23.0 MOTORS**

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

##### **23.1 Enclosures**

- a) Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP-55 as per IS: 4691. For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP-44 as per IS: 4691.
- b) Two independent earthing points shall be provided on opposite sides of the motor

for bolted connection of earthing conductor.

- c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.
- d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

### **23.2 Operational Features**

- a) Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise in service.
- b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Section.

### **23.3 Starting Requirements:**

- a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.
- b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.
- c) The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS:325.
- d) Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding atleast two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.
- e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

### **23.4 Running Requirements:**

- a) The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS:325 (for 3 - phase induction motors) after adjustment due to increased ambient temperature specified.
- b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.
- c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

### 23.5 TESTING AND COMMISSIONING

An indicative list of tests is given below. Contractor shall perform any additional test based on specialities of the items as per the field Q.P./Instructions of the equipment Contractor or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

- (a) Insulation resistance.
- (b) Phase sequence and proper direction of rotation.
- (c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

### **ANNEXURE-A**

#### **CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST**

##### **1. General**

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona (for 400kV & above) both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV) for 132kV and above.

##### **2. Test Levels:**

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

##### **3. Test Methods for RIV:**

- 3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.
- 3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.
- 3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.
- 3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400 kV, 220 KV is listed in the detailed specification together

with maximum permissible RIV level in microvolts.

- 3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.
- 3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

#### 4. Test Methods for Visible Corona

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of specified corona extinction voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

For recording purpose, modern devices utilizing UV recording methods such as image intensifier may also be used.

- 4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.
- 4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.
- 4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.
- 4.4 However, both test shall be carried out with the same test set up and as little time

duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

**5. Test Records:**

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

- a) Background noise before and after test.
- b) Detailed procedure of application of test voltage.
- c) Measurements of RIV levels expressed in micro volts at each level.
- d) Results and observations with regard to location and type of interference sources detected at each step.
- e) Test voltage shall be recorded when measured RIV passes through 100microvolts in each direction.
- f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

**ANNEXURE-B**

**SEISMIC WITHSTAND TEST PROCEDURE**

The seismic withstanding test on the complete equipment (for 132kV and above) shall be carried out along with supporting structure.

The Bidder shall arrange to transport the structure from his Contractor's premises/POWERGRID sites for the purpose of seismic withstand test only. The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and any other point as agreed by the Purchaser. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the POWERGRID.

## **SECTION 4**

### **ENCLOSURES TO SPECIFICATIONS**

ANNEXURE 1	CHECK LIST FOR INFORMATION TO BE FURNISHED WITH THE OFFER
ANNEXURE 2	SCHEDULE OF DEVIATION

## CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER

BIDDER SHALL PUT A TICK '✓' IF THE INFORMATION IS ENCLOSED WITH THE OFFER, PUT A CROSS 'X' IF THE INFORMATION IS NOT ENCLOSED OR WRITE 'NOT APPLICABLE' IF THE QUERY/ SCHEDULE IS NOT RELEVANT AND RETURN THIS CHECKLIST AS PART OF THE OFFER DULY SIGNED

The offer may not be considered if the following information and this Checklist are not enclosed with the Offer.

### BIDDER: OFFER REFERENCE:

1. Technical offer with detailed schedules of equipment/ material and spares \_\_\_\_\_
2. Schedule of Deviations listing deviations, if any, clause-wise with respect to technical specification \_\_\_\_\_
3. List of past supplies complete with Purchase Order & Project name, quantity, order reference, etc., where identical equipment have been supplied. \_\_\_\_\_
4. Manufacturer's Quality Plans for approval \_\_\_\_\_
5. Field Quality Plan for approval \_\_\_\_\_
6. General Arrangement drawings with dimensions and weights and foundation/ fixing details \_\_\_\_\_
7. Drawing/ data submission Schedule \_\_\_\_\_
8. Type test reports. The type test reports shall be accompanied with a list listing all the relevant clauses of the applicable standard and the corresponding type test report. The manufacturer shall also furnish a certificate certifying that the test reports have been carried out on equipment identical in all respects to the one offered. In case the reports are for a different equipment and the applicability of the report is permitted as per applicable standards, the justification shall be enclosed to the list of type test reports. \_\_\_\_\_
9. Bar Chart showing time schedule showing time required for design, manufacture, test and inspection, transport, erection, site testing and commissioning \_\_\_\_\_
10. Makes of all important components, like motors, operating switches, fuses, etc. \_\_\_\_\_
11. Any additional information called for in any part of the technical specification. \_\_\_\_\_

Date:

Signature of the authorized representative of Bidder

Company Seal

### SCHEDULE OF DEVIATIONS

Certified that the following are only deviations from the specification (for the equipment and systems being offered)

S.No.	Page No.	Clause No.	Deviation	Reason / Justification
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Date :

Signature :

Name:

Designation :