

RECOMMENDATION

The sub-soil strata with field observations are mentioned in the bore hole logs in the *annexes*-. Thus, based on field and laboratory tests following inferences have been made.

- i) Adopt a safe bearing capacity for *Spread* and *Mat/Raft foundation* at different depths of each site location as given in the *annexes*.
- ii) The allowable B.C. values for different foundation size are found for the foundation design in all bore hole locations.

Spread foundation (Net SBC) :

Depth (m)	Recommended Allowable B.C. Values (KN/m ²)				Saturated Density, γ_{sat} (KN/m ³)	Sub-grade Modulus K_s (KN/m ³)
	1.5 x 1.5	2.0 x 2.0	2.5 x 2.5	3.0 x 3.0		
1.5	31.74	32.69	33.82	34.60	16	3808.99
2.25	47.45	45.36	43.02	41.50	16	5694.24
3.0	53.75	49.37	46.83	45.17	16	6450.50
4.5	76.66	70.40	66.78	64.41	16	9198.80

Mat/Raft foundation: Without Basement Excavation (Net SBC)

Depth (m)	1.5	2.25	3.0	4.5	6.0	7.5
Recommended Allowable B.C. Values (KN/m ²)	43.08	47.28	51.46	73.39	89.39	92.56
Saturated Density, γ_{sat} (KN/m ³)	16	16	16	16	17	17
Sub-grade Modulus K_s (KN/m ³)	5169.43	5673.75	6175.64	8806.84	10726.25	11107.20

- iii) The upper layer about 2.0m depth seems loose or soft soils in all locations. So, any foundation structure would not be considered up to that depth.
- iv) The Plate Load Tests, Trail Pits and CBR Test Results are provided in the *Annexes*.
- v) The water table was not encounter in all bore holes.
- vi) The bearing capacity (B.C.) values are obtained for worst water conditions.
- vii) Liquefaction susceptibility could be seen in the project site upto 12.0m depth.

- viii) The Pile foundation could be considered for the design of foundations.
- ix) The most of the soils are inorganic soils having silicious minerals. So, the swell pressure and free swell index value could not be found at or below the probable foundation level of soil mass.
- x) The soil Type III – Soft/Loose Soils were found in the project site as per IS : 1948 & IS : 2131 is attached in the *annexes*.
- xi) All the assumed geotechnical values, relationships etc. are directly used as per requirement from relevant codes, author's books, published journals and papers.



Measurment table

Direction	RESULT										
	ERT 1	ERT 2	ERT 3	ERT 4	ERT 5	ERT 6	ERT 7	ERT 8	ERT 9	ERT 10	ERT 11
	Resistivity (Ohm-m)	Resistivity (Ohm-m)	Resistivity (Ohm-m)	Resistivity (Ohm-m)	Resistivity (Ohm-m)	Resistivity (Ohm-m)	Resistivity (Ohm-m)	Resistivity (Ohm-m)	Resistivity (Ohm-m)	Resistivity (Ohm-m)	Resistivity (Ohm-m)
East	226.708	221.527	-	-	-	147.47533	163.908	169.874	243.821	89.7098	151.4736
North-East	232.988	214.462	-	162.024	-	118.064	155.5085	134.60133	285.84467	50.554	129.682
North	200.12267	208.496	-	164.3947	191.12133	-	146.8892	128.1905	253.712	132.0684	130.31
West-North	197.7886	170.659	151.76667	136.5272	188.3215	-	155.14112	115.081	-	119.04787	165.62933
West	196.93295	177.5356	143.1055	136.00387	197.8985	148.208	149.15	155.0061	-	-	185.26
South-West	207.3185	194.994	150.1705	155.84867	182.2299	167.2835	-	-	-	-	-
South	265.016	206.0625	142.085	158.256	179.81733	154.488	122.0204	154.488	237.07	127.484	-
East-South	212.892	212.892	139.102	-	-	171.8522	149.35933	78.186	229.0316	64.725867	148.365
Minimum Resistivity	196.93295	170.659	139.102	136.00387	179.81733	118.064	122.0204	78.186	229.0316	50.554	129.682
Maximum Resistivity	265.016	221.527	151.76667	164.3947	197.8985	171.8522	163.908	169.874	285.84467	132.0684	185.26
Average	217.47084	200.82851	145.24593	152.17574	187.87771	151.22851	148.85379	133.63242	249.89585	97.264989	151.95332

ERT Location	Average Resistivity (Ohm-m)
ERT 1	217.47084
ERT 2	200.82851
ERT 3	145.24593
ERT 4	152.17574
ERT 5	187.87771
ERT 6	151.22851
ERT 7	148.85379
ERT 8	133.63242
ERT 9	249.89585
ERT 10	97.264989
ERT 11	151.95332
Average	166.94797

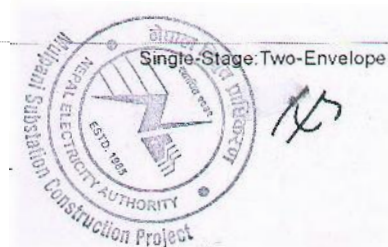


GPS Location: 27.71353, 85.39168

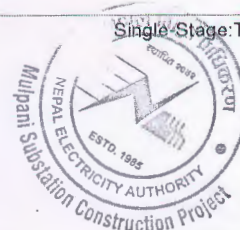
ERT Measurement Values of Mulpani Site
Mulpani Substation Construction Project
PMD/EGMP/TLUP-077/78-01

SECTION 23

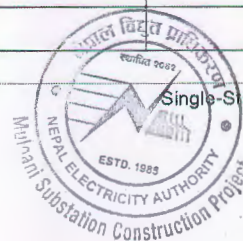
TECHNICAL DATA SHEET



TECHNICAL DATA SHEET (To Be Completed By the Tenderer)				
ITEM No.1: 45MVA POWER TRANSFORMER				Sheet 1 of 6
	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled 132/11kV, 45MVA
1	Manufacturer and Country of Origin			
2	Year of manufacturing experience	Years		
3	Manufacturing's Designation as per submitted catalogue			
4	Applicable standard		IEC	
5	Type		Outdoor, oil immersed, Core Type	
6	Winding / Phase		Three	
7	Cooling		ONAN / ONAF	
8	Ratings			
8.1	Rated MVA			
8.1.1	ONAN	MVA	31.5	
8.1.2	ONAF	MVA	45	
8.2	Rated Voltage			
8.2.1	Primary	kV	132	
8.2.2	Secondary	kV	11	
8.2.3	Tertiary (If Provided)	kV		
8.3	Maximum Voltage			
8.3.1	Primary	kV	145	
8.3.2	Secondary	kV	12	
8.3.3	Tertiary (If Provided)	kV		
8.4	Number of Phases		Three	
8.5	Rated Frequency	Hz	50	
9	Noise Level			
	On ONAN Rating	dB	<73	
	On ONAF Rating Rated Voltage	dB	<75	
10	Temperature Rise			
10.1	Temperature Rise above 45°C ambient			
	- In Oil by Thermometer	°C	50	
	- In Winding By Resistance	°C	55	
10.2	Hottest Spot Temperature in Winding Limited to	°C	55	
10.3	Temperature Indicators Make		KHILSTROM, Sweden or Equi.	
11	Connection			
11.1	High Voltage		Star	
11.2	Low Voltage		Star	
11.3	Tertiary(if provided)		Delta	
11.3	Vector Group Ref in accordance with IEC 76		YNyn0	
	Vector Group		YNyn0 D11	

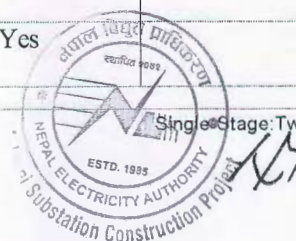


TECHNICAL DATA SHEET (To Be Completed By the Tenderer)				
ITEM No. 2: 45MVA POWER TRANSFORMER				Sheet 2 of 6
	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled 132/11kV, 45MVA
12	Taps			
12.1	Type of Tap changer		OLTC	
12.2	Tap Step		1.25%	
12.3	Tap Range		± 10%	
12.4	Nos. of Tap		17	
13	Cooling Equipment (For ONAF)			
13.1	Manufacturer/ Type			
13.2	Number of Fans Connected	Nos		
13.3	Rated Operating Voltage, Vac	Vac	230/400, 50Hz	
13.4	Rated Control Voltage, V	Vdc	110	
13.5	Rated Power	KW		
14	OLTC Gear		Vacuum Type	
14.1	Manufacturer / Type	MR, Germany, ABB, Sweden or Equivalent		
14.2	Rating			
	- Rated Voltage	KV	Suitable for 132kV	
	- Rated Current	A	class	
	- Step Voltage	V		
	- Numbers of Steps	Nos	17	
14.3	Control Suitable For			
	- Remote / Local Operation		Remote / Local	
	- Auto / Manual Operation		Auto / Manual	
	- Parallel Operation	Yes/No	Yes	
	- Master Slave Operation	Yes/No	Yes	
14.4	Rated voltage of Drive Motor	Vac	230/400 50Hz	
15	Guaranteed losses			
15.1	No Load Losses at Rated Voltage and Frequency on Max. MVA Base.	kW		
15.2	Load Losses at rated Current and at 75°C on max. MVA base	kW		
15.3	Cooler Losses for full load operation on max. MVA base	kW		
16	Impedance at Rated Current and Frequency at 75°C Winding Temperatures on ONAF, MVA Base. (Tolerance ±7.5% of the Declared Value)	%		
16.1	Positive Sequence Impedance at nameplate Normal tap	%	> 11	
16.2	Positive Sequence at Maximum Voltage Tap (Tap 17)	%		
16.3	Positive Sequence at Minimum Voltage Tap (Tap 1)	%		
16.4	Zero Sequence at Nameplate Tap			

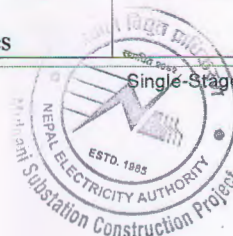


15

TECHNICAL DATA SHEET (To Be Completed By the Tenderer)				
ITEM No. 2: 45MVA POWER TRANSFORMER				Sheet 3 of 6
	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled 132/11kV, 45MVA
17	Reactance at rated current and Frequency at 75°C on Maximum MVA base at a nameplate tap			
18	Efficiency at 75°C Winding Temperature at PF=0.9			
18.1	At 100% Load	%		
18.2	At 75% Load	%		
18.3	At 50% Load	%	Above 99%	
19	Load in Percentage of Full Load and Power Factor at which maximum efficiency occurs.			
20	Regulation at full Load and at 75C			
20.1	At Unity Power Factor			
20.2	At 0.85 Power Factor Lagging			
21	No Load Current in Percentage of rated Current referred to HV and 50Hz.			
21.1	At 90% Rated Voltage	%		
21.2	At 100% Rated Voltage	%	<1	
21.3	At 110% Rated Voltage	%		
22	Clearances			
22.1	Minimum Clearances in air-HV/LV	mm		
22.2	Between Phases Between Phase and Earth	mm		
23	Insulation Level			
23.1	Power Frequency Withstand Voltage (1Min rms)			
23.1.1	Primary	kV	275	
23.1.2	Secondary	kV	28	
23.1.3	Tertiary (if Provided)	kV		
23.2	Impulse Withstand Voltage			
23.2.1	Primary	kV	650 (Crest)	
23.2.2	Secondary	kV	75 (Crest)	
23.2.2	Tertiary (if Provided)	kV		
24	Details of Oil Preservation System			
24.1	Type		Conservator Type	
24.2	Details of Oil Preservation System			
24.3	If Conservator Type, Urethane Air Cell provided	Yes/No	Yes	



TECHNICAL DATA SHEET (To Be Completed By the Tenderer)				
ITEM No. 2: 45MVA POWER TRANSFORMER				Sheet 4 of 6
	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled 132/11kV, 45MVA
24.4	Volume of Conservator	Cu.m		
24.5	Volume of Oil Between the highest and Lowest Levels	Ltrs		
25	Pressure Relief Device Min. pressure setting	Kg/cm2		
26 26.1	Details of Bushings HV / LV / Neutral Manufacturer / Type			
26.2	Voltage class	KV	145/12	
26.2	Creepage Distance	mm	25mm/kV	
26.3	Weight of Bushing	kg		
26.4	Standard Reference		IEC	
26.5	Dry Flash over Voltage	KV	275/28	
26.6	Wet Flash Over Voltage	KV	275/(28	
26.7	Impulse Withstand Voltage	KV	650/75	
27	Insulating Oil			
i	Manufacturer and Country of Origin			
ii	Manufacturer's type designation			
iii	Type		Insulating Oil	
iv	Applicable standard			
v	Technical Specifications			
v.1	Dielectric Breakdown Strength (Min) at 2.5mm gap	kV	30	
v.2	Flash Point (Min)	°C	135	
v.3	Density at 20°C (Max)	g/Cu.cm	0.895	
v.4	Viscosity at 40°C (Max)	mm ² /s	12	
v.5	Viscosity at -30°C (Max)	mm ² /s	1800	
v.6	Acidity Neutralization Value (Max)	mgKOH/g	0.01	
v.7	Sludge Value (Max)		0.1%	
v.8	Pour Point (Max)	°C	-40 C	
v.9	Corrosive Sulphur		Non-corrosive	
v.10	Water Content (Max)	ppm	40	
v.11	Dielectric Dissipation factor at 90 (Max)		0.005	
v.12	Appearance		clean free from sediment and suspended matter	
vi.	PCB Content		Not Detectable	
vii.	Approx. volume of Oil, ltrs			
Viii	Whether First filled of Oil with 5% excess provided	Yes/No	Yes	

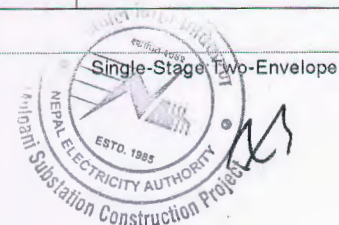


TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 2: 45MVA POWER TRANSFORMER

Sheet 5 of 6

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
28	Core Material			132/11kV, 45MVA
28.1	Maximum flux density at rated voltage on principal tapping and rated frequency:			
	Transformer legs	T		
	Transformer yokes	T		
28.2	Maximum flux density at 110% voltage			
	Transformer legs	T	< 1.9	
	Transformer yokes	T	< 1.9	
28.3	Grade of core used	Prime core		
	Type of Core	CRGO		
	Thickness of core lamination			
	Rated Loss per kg			
29.1	Maximum current density in windings at rated output:			
	Primary (HV)	A/mm ²		
	Secondary (LV)	A/mm ²		
	Weight of copper in windings:			
	Primary (HV)			
	Secondary (LV)			
30	Bushing Current Transformers			
30.1	Numbers of Cores			
	- HV	Nos	1 / phase	
	- LV	Nos	1 / phase	
	- Neutral	Nos	1	
30.2	Accuracy class / Burden/Ratio			
	- HV / HV Neutral		PS / 15VA/200/1	
	- LV / LV Neutral		PS / 15VA/2400/1	
31	Lightning Arrestor mounted on			
	- HV	Yes/No	No	
	- LV	Yes/No	Yes	
32	RTCC Panel Details			
32.1	AVR make / Model	MR, Germany, ABB, Sweden or Equivalent		
32.2	Annunciator 12 Windows provided	Yes/No	Yes	
32.3	Indicating Voltmeter	Yes/No	Yes	
32.4	Facilities and Provision as per specification provided?	Yes/No	Yes	
33	Approximate Overall Dimension (L x W x H)			



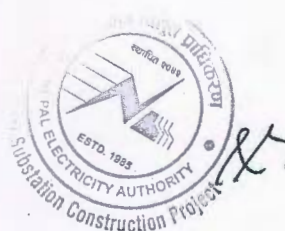
TECHNICAL DATA SHEET (To Be Completed By the Tenderer)				
ITEM No. 2: 45MVA POWER TRANSFORMER				Sheet 6 of 6
	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
34	Approximate Weights			
34.1	Core and Coil	Kg		
34.2	Tank and fittings	Kg		
34.3	Oil	Kg		
34.4	Total Weight	Kg		
35	Delivery of Equipment in Months, following the Award of Contract (Allowing the time for Drawing Approval)		Months	
36	Is manufacturer ISO 9001 holder?	Yes/No	Yes	
37	Type test certificate submitted?	Yes/No	Yes	
38	Has manufacturer exported units?	Yes/No	Yes	
39	User's certificate submitted?	Yes/No	Yes	
40	Technical literature / drawings submitted?	Yes/No	Yes	

NOTE: The bidder must submit the user certificate of the manufacturer of Transformer.

Deviations from technical requirements:

Signed.....

As representative for.....



TECHNICAL SPECIFICATIONS

FOR

Fiber Optic Based Communication Equipments

INDEX

Section 1: Introduction, General Information and General Requirement

Section 2: Network Configuration and Equipment Characteristics

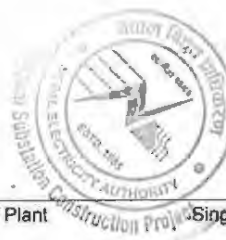
Section 3: Environment, EMI, Power Supply, Cabling and Earthing

Section 4: Inspection, Test and Availability

Section 5: Training and Support Services

Appendix A: Bill of Quantity (BOQ)

Appendix B: Data Requirement Sheets



Chapter 17, Section-1: Introduction, General Information and General Requirement**Table of Content**

<u>1.1</u>	<u>Scope and General Requirements</u>	-----2
<u>1.2</u>	<u>General Requirements</u>	-----2
<u>1.2.1</u>	<u>Synchronization of the Communication Network</u>	-----3
<u>1.3</u>	<u>General Responsibilities and Obligations</u>	-----3
<u>1.3.1</u>	<u>Responsibilities for the Implementation Plan</u>	-----3
<u>1.3.2</u>	<u>Contractor's Responsibilities and Obligations</u>	-----3
<u>1.3.3</u>	<u>The Employer Responsibilities and Obligations</u>	-----4
<u>1.4</u>	<u>Applicable Standards</u>	-----5



77



Section 1

Introduction, General Information and General Requirement

This document describes the technical specifications for Communication Equipment which includes Fibre Optic Terminal Equipment and Multiplexer Equipment for Establishment of Fibre Optic Communication System under the contract. This specification describes the functional and performance requirements of the system.

1.1 Scope and General Requirements

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 optical line interfaces & tributary cards.
- (ii) Associated Termination equipment (Drop-insert multiplexers, subscriber line interfacing card etc.)
- (iii) Local Craft Terminal
- (iv) All cabling, wiring, Digital Distribution Frame patch facilities, equipment MDF's 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) System integration of the supplied equipments (termination equipment system) with existing equipments for seamless transmission of communication channel
- (viii) Integration of supplied system with the User equipments such as RTUs, SCADA system, PLCC equipment, PABX etc.
- (ix) Maintenance of the supplied system

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

1.2 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.

The Bidder's proposal shall address all functional and performance requirements within this specification and shall include sufficient information and supporting documentation in order to determine compliance with this specification without further necessity for inquiries.

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



KS

identify and include all such additional items and services in their proposal.

All equipment provided shall be designed to interface with existing equipment and shall be capable of supporting all present requirements and spare capacity requirement identified in this specification.

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

The Bidders are advised to visit sites (at their own expense), prior to the submission of a proposal, and make surveys and assessments as deemed necessary for proposal submission. The successful bidder (Contractor) is required to visit all sites. The site visits after contract award shall include all necessary surveys to allow the contractor to perform the design and implementation functions. 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) Identify all additional items required for integration for each site/location.

1.2.1 Synchronization of the Communication Network

The Contractor shall be responsible for synchronization of new communication equipment with existing network utilizing the existing clock (if available). The Contractor shall make an assessment of additional clock requirement for synchronization of the communication equipment.

1.3 General Responsibilities and Obligations

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

1.3.1 Responsibilities for the Implementation Plan

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

1.3.2 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



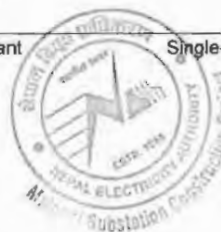
equipment and for wiring to it, with adequate circuit protective breakers. In addition, the Contractor shall be responsible for shielding equipment and cabling to eliminate potential interference to or from the equipment, and for earthing all cabinets and shields.

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

- (1) Site visits, and surveys, necessary to identify and provide all equipment needed to implement the network.
- (2) Equipment Engineering and design specific to each location including review of, and conformance with local environmental and earthing considerations.
- (3) Overall integration of communication equipments/subsystem procured in present and existing network.
- (4) All cabling, wiring including supply, laying and termination etc of the cables, and distribution frame at wideband nodes required for full interconnectivity and proper operation of the telecommunications network including equipment supplied under this package and the connectivity and interfacing of user equipment.
- (5) Installation and integration of network management software, hardware and firmware (as applicable).
- (6) Project management, project scheduling, including periodic project reports documenting progress, review meeting during the contract period.
- (7) Engineering and technical assistance during the contract and warranty period.
- (8) 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.
- (9) Factory and site testing of all hardware, software, and firmware provided.
- (10) Provide documented evidence of satisfactory Type Test performance to the Employer and if required by The Employer, conduct type test.
- (11) Provide a Quality Assurance Plan, ensuring the Employer access to the manufacturing process.
- (12) Training of the Employer personnel.
- (13) Hardware, software, and firmware maintenance, debugging, and support of the equipment through final acceptance, and maintenance on all new equipment through out the warranty period and for a period of six (6) years after warranty period.
- (14) 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.

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

1.3.3 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
- (4) Review and approval of test procedures.
- (5) Participation in and approval of "Type", factory and site acceptance tests where testing is required.
- (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

1.4 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 801-2/3/4/5, IEC-255-4, IEC-255-5, IEC-870-2-1, IEC-721-3-3, IEC-529.
- (ix) International Electrotechnical Commission standards, IEC 1000-4-xx series.
- (x) IEC publication 68, 68-2-2, 68-2-3, 68-2-14, 68-2-27, 68-2-32.
- (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.

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

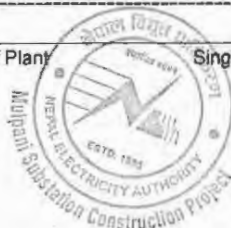


KS

Section 2 Network Configuration and Equipment Characteristics

Table of Content

2.1	<u>Introduction</u>	8
2.2	<u>General Network Characteristics</u>	8
2.2.1	<u>Description</u>	8
2.2.2	<u>Functional Requirement</u>	9
2.2.3	<u>General Systems Requirements</u>	9
2.2.3.1	<u>System Synchronization</u>	9
2.2.3.2	<u>System Maintainability</u>	9
2.2.3.3	<u>System Upgradeability and Expandability</u>	10
2.2.3.4	<u>Equipment Availability</u>	10
2.2.3.5	<u>Revision Levels and Modifications</u>	10
2.2.3.6	<u>Equipment Capacities</u>	10
2.2.3.7	<u>Redundancy Requirements and Protection Schemes</u>	10
2.2.3.8	<u>Lost Signal Recovery</u>	11
2.2.3.9	<u>Software Upgrades</u>	11
2.2.3.10	<u>General Site Considerations</u>	11
2.3	<u>Fibre Optic Transmission System</u>	13
2.3.1	<u>SDH Equipment</u>	13
2.3.1.1	<u>Functional Requirement</u>	13
2.3.1.2	<u>Redundancy and Protection</u>	14
2.3.1.3	<u>Service Channel</u>	14
2.3.1.4	<u>Supervision and Alarms</u>	14
2.3.1.5	<u>Synchronisation</u>	14
2.3.1.6	<u>Electrical and Optical I/O Characteristics and General Parameters</u>	14
2.3.2	<u>Optical Link Performance Requirements</u>	15
2.3.2.1	<u>Link Budget Calculations</u>	15
2.3.2.2	<u>Link Performance</u>	16
2.3.2.3	<u>FODP to SDH Equipment</u>	16
2.4	<u>Termination Equipment Subsystem</u>	16
2.4.1	<u>Functional Description</u>	16
2.4.2	<u>First Order (Primary) Multiplexing</u>	16
2.4.2.1	<u>Drop & Insert Primary Multiplexing</u>	17
2.4.2.2	<u>Channel Banks (Mux, Drop/Insert)</u>	17



147

<u>2.4.2.3 Subscriber Line Units\Subscriber Line Interface Cards</u>	17
<u>2.5 MDF, DDF and Cabling</u>	18
<u>2.5.1 Digital Distribution Frame Functional Requirements</u>	18
<u>2.5.2 Main Distribution Frames</u>	19
<u>2.6 Patch Cords</u>	10
<u>2.6 Telecommunication Management Network / Network Management System</u>	19
<u>(As Applicable)</u>	19
<u>2.7.1 Applicable Standards</u>	19
<u>2.7.2 TMN Architecture</u>	19
<u>2.7.3 Management Functions</u>	20
<u>2.7.3.1 Configuration Management</u>	20
<u>2.7.3.2 Fault Management</u>	21
<u>2.7.3.4 Security Management</u>	22
<u>2.8 Communication Channel Requirement and Integration</u>	23
<u>2.9 Craft Terminal</u>	23
<u>2.10 Hardware Requirements</u>	23
<u>2.10.1 Master Processor, Server/Workstation and Craft Terminal</u>	23
<u>2.10.2 Peripherals and hardware</u>	24
<u>2.10.3 Local/Remote Operator Consoles (As Applicable)</u>	25
<u>2.11 General Software/Firmware Requirements</u>	25
<u>2.11.1 Operating System Software</u>	25
<u>2.11.2 Applications Software</u>	25
<u>2.11.3 Software Utilities</u>	25
<u>2.11.4 Revisions, Upgrades, Maintainability</u>	25
<u>2.11.5 Database(s)</u>	25
<u>2.11.6 Help</u>	26



143

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) MDF, DDF and Cabling

The requirements described herein are applicable to and in support of network requirements. The equipment supplied shall support existing network for Power system operational requirements.

The security related requirements of the equipment shall be as per relevant agency and 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 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 31st March 2013. From 1st April, 2013, the certification shall be got done from authorized and certified agency.

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

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 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-4 (upto 3 MSP protected directions) as identified in the BoQ. The network shall consist of overhead fibre optic links with a minimum bit rate of Synchronous Transport Module-4 (STM-4). 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.



2.2.2 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.

2.2.3 General Systems Requirements

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

2.2.3.1 System Synchronization

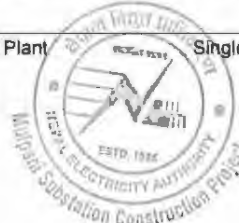
The Contractor shall synchronize the existing equipments and all the new equipments under the contract using existing Master clock, if available. The Contractor shall provide the additional clocks as required under the set of clock indicated in BoQ. In addition to GPS input reference, the synchronization clock must have provision to take INPUT reference coming from other clock. 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 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.

The system equipment requiring "clock" shall be connected to the master clock using external clocking. For this purpose, appropriate interfaces(s) in the transmission & termination equipment being supplied and all other associated hardware shall be provided by the Contractor.

2.2.3.2 System Maintainability

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



2.2.3.3 System Upgradeability and Expandability

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

2.2.3.4 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.

2.2.3.5 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.

2.2.3.6 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.

2.2.3.7 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

Fiber Optic transmission Equipment : SDH equipment Power Supply & Converters ----- Common Control* Cards ----- MUX, DROP/INSERT Power Supply -----	 1:1 APS or distributed power supply 1:1 APS 1:1 APS or distributed power
---	--



25

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

* = Common control cards which are essentially required for operation of the equipment.	supply
---	--------

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.

2.2.3.8 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.

2.2.3.9 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.

2.2.3.10 General Site Considerations

All fiber optic links up to 175 kms transmission line length shall be implemented by the Contractor without repeaters. In order to meet the link budget requirement, the Contractor shall provide all the necessary equipments only in the end stations. The contractor may provide the optical amplifier, wave length translator, optical cards or high capacity SDH equipment with suitable rack/subrack to meet the maximum distance limit. All the provided equipments shall be monitored/managed by Craft Terminal.

2.2.3.11 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:

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



SS

Table-2-2
Optical Fibre Characteristics

Fibre Description:	Dual-Window Single-Mode (DWSM)
Mode Field Diameter:	8.6 to 9.5 μm ($\pm 0.6 \mu\text{m}$)
Cladding Diameter:	125.0 $\mu\text{m} \pm 1\mu\text{m}$
Mode field Concentricity Error:	$\leq 0.6\mu\text{m}$
Core-Clad concentricity error:	$\leq 1.0\mu\text{m}$
Cladding non-circularity	$\leq 1\%$
Cable Cut off Wavelength:	$\leq 1260 \text{ nm}$
1550 loss performance	As per G.652D
Proof Test Level	$\geq 0.69 \text{ Gpa}$
Attenuation coefficient	@1310nm $\leq 0.35 \text{ dB/Km}$ @1550nm $\leq 0.21 \text{ dB/Km}$
Attenuation variation with wavelength 1285 nm - 1330 nm 1525 nm – 1575 nm	Attenuation coefficient @1310 $\pm 0.05 \text{ dB}$ Attenuation coefficient @1550 $\pm 0.05 \text{ dB}$
Point discontinuities	$\leq 0.1\text{dB}$
Chromatic Dispersion; Max.:	18.0 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) @ 1288-1339nm 5.3 ps/(nm x km) @ 1271-1360nm
Zero Dispersion Wavelength: Zero Dispersion Slope:	1300 to 1324nm 0.092 ps/(nm ² xkm) maximum
Polarization mode dispersion coefficient	$\leq 0.2 \text{ ps/km}^{1/2}$
Temperature Dependence:	Induced attenuation $\leq 0.05 \text{ dB}$ (-60 deg C - +85 deg C)
Bend performance:	@1310nm (75 $\pm$ 2 mm dia Mandrel), 100 turns; Attenuation rise $\leq 0.05 \text{ dB}$ @1550nm (30 $\pm$ 1 mm dia Mandrel), 100 turns; Attenuation rise $\leq 0.10 \text{ dB}$ @1550nm (32 $\pm$ 0.5 mm dia Mandrel), 1 turn; Attenuation rise $\leq 0.50 \text{ dB}$

2.2.5 Fibre Optic Link Lengths

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



27

calculating the link length. The exact cable lengths shall be determined by the Contractor during the survey. The same shall be used by the Contractor for final link design during the detailed engineering of the project.

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-4 (upto 3 MSP protected directions) and equipped with 1 nos. of minimum 16 port E1 interface(G.703) card, two no. 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, main and protection channel shall be terminated on separate cards and there shall not be single point of failure.

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

SDH ADM

The aggregate interfaces shall be (at least) STM-4 towards at least two protected directions (Protected as specified in this specifications). At present the equipment shall be equipped with a 1 nos., min.16 E-1 port electrical tributary cards & two no., min.4 port Ethernet interface card as tributaries. The equipment shall provide access to full STM-4 payload.

The offered STM-4 SDH equipment shall be upgradeable to STM-4 by changing optical line cards only. Cross connection (VC4) capability of offered SDH equipment shall be provided



according to STM-4 equipment. The contractor shall demonstrate the STM-4 capability during FAT.

2.3.1.2 Redundancy and Protection

Two fibre rings shall be implemented wherever the network permits. On linear sections of the network, protected links using 4 fibres shall be implemented.

2.3.1.3 Service Channel

Service channels shall be provided as a function of the SDH equipment and shall be equipped with Service Channel Modems that shall provide at a minimum: One voice channel (order wire) with analog interface (0.3 to 3.4 kHz) 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.

2.3.1.4 Supervision and Alarms

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

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

2.3.1.5 Synchronisation

The equipment shall provide synchronisation as per Table 2-3. One 2MHz synchronisation output from each equipment shall be provided.

2.3.1.6 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.

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



KS

Optical Interfaces	Per ITU-T G.957, G.958
Frame and Multiplexing Structure for SDH	Per ITU-T G.707
Synchronization	Per ITU-T G.813
Management Functions	Per ITU-T G.774, G.784
Protection Architectures	Per ITU-T G.841
Built In Testing and Alarms	Per ITU-T G.774, G.783, G.784

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

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

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

2.3.2 Optical Link Performance Requirements

The optical fibre link performance requirements are specified as follows:

2.3.2.1 Link Budget Calculations

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

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

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

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

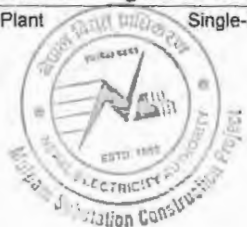
(4) Equipment Parameters: The equipment parameters to be considered for link budget calculations shall be the guaranteed "End of Life (EOL)" parameters. In case, the End of Life parameters are not specified for the SDH equipment, an End of Life Margin of at least 2 dB shall be considered and a similar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

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

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

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

(8) Dispersion: The fibre dispersion shall be taken to be the guaranteed maximum dispersion



Handwritten signature/initials

i.e. 18 ps/nm.Km @1550 nm & 3.5 ps/nm.km @ 1310 nm for DWSM fibres.

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

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

For 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 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:

2.4.1 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:

Primary 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.

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

2.4.2 First Order (Primary) 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 2-4.

2.4.2.1 Drop & Insert Primary Multiplexing

Drop & Insert primary 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 2-4
CEPT E-1 Standard First Order Multiplexing
Electrical Input/Output Characteristics

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

2.4.2.2 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).

2.4.2.3 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:



23

(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.

(C) Synchronous Data

The Contractor shall provide a direct DTE interface for synchronous communications at speed of 64Kbps and compatible with CCITT G.703 Kbit/s, V.35 and X.21 interfaces. Data rate selection shall be switch selectable or programmable.

(D) Nx64 kbps Synchronous Data

There is also a requirement for N x 64 kbps V.35, X.21 interfaces. The tentative quantities have been identified in the appendices. However the final BOQ shall be worked out during detailed design and contract price shall be adjusted accordingly.

2.5 MDF, DDF and Cabling

For the purposes of the specification, the contractor shall provide cabling, wiring, DDF patching facilities and MDFs interfacing to the wideband telecommunications system. Equipment and material components for MDF, DDF and cabling are also part of this procurement. It shall be the Contractor's responsibility to provide all cable support required for full supplied equipment interconnection with the MDF and shall be in accordance with communications industry standard practices and the requirements mentioned in the technical specifications.

2.5.1 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



143

to route both transmit and receive for the same circuit.

2.5.2 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".

2.6 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.

2.6 Telecommunication Management Network / Network Management System (As Applicable)

The Contractor shall provide a Telecommunications Management Network System (TMN) for operational support to the FOTS and associated Termination equipment subsystems. This TMN shall provide the capability to monitor, reconfigure, and control elements of the telecommunications network from a centralized location and at each node of the network where equipment is located. This TMN system shall assist Employer/Owner in the operations and maintenance of the wideband communication resources of the including detection of degraded circuits, system performance, the diagnosis of problems, the implementation of remedial actions and the allocation or reallocation of telecommunications resources and addition/deletion of network elements.

The contractor shall supply preferably a single TMN for all the NEs (Network Elements) such as SDH equipment, Mux, Drop-Insert, DACS etc. In case a single TMN can not be provided for all the NEs, the contractor may supply separate TMNs. Each of the offered TMN shall meet the requirements indicated in this section. The bidder shall provide details of the offered TMN in the bid.

2.7.1 Applicable Standards

The TMN design concept, functional and informational architecture and physical architecture, shall be in compliance with ITU-T Recommendation M.3010. The offered TMN system shall be capable of integration to other supplier's Network Management System (NMS) upwardly through North bound interfaces. The north bound interface in the EMS shall be CORBA/TMF-814 compliant.

2.7.2 TMN Architecture

The TMN shall provide

- a. Collection of Management data from all Network Elements (NEs) supplied under this package. The minimum monitoring and control requirements for the communication equipment shall be as defined in this section.
- b. Processing of above management data by using processor(s) located at control Centre and additional intermediate station processor(s), wherever required.



- c. Monitoring and control of the NEs as defined below:
- I) TMN system at LDC (including local operator console, if applicable) shall support management of all equipments supplied and monitoring of the entire regional network supplied under this package. At a minimum functions of Network management layer (NML) and Element management layer (EML) as defined in CCITT M3010. The detailed functions are listed in TS.
 - II) Monitoring and control of NEs using Craft Terminals as defined in this Section .
- d. Supervisory monitoring and control of the following station associated devices:
- I) Intrusion Detection Alarms
 - II) Power Failure
 - III) Fire and Smoke Detection
 - IV) Environmental Control (Temperature, Humidity etc.)
- e. Communication channel support for TMN System as specified in Technical Specifications (TS).

The supplied TMN system shall be capable of handling all management functions for at least 150% of the final network elements. Further, the centralised TMN system shall also have provision for addition of at least two remote operator consoles. The TMN hardware shall be so designed that failure of a single processor/component (router, switch, converter etc.) shall not inhibit any of the functionality of the TMN at control centre. The Contractor shall submit for Employer's approval the TMN architecture describing in detail the following subsystems/features:

- a. Database used in TMN
- b. Master Processor, server/workstation, LAN, Peripherals and hardware
- c. Software and operating system
- d. Local Consoles/remote consoles
- e. Craft Terminals
- f. Data communication between NEs, Remote/Local Consoles and TMN Processor(s)
- g. Routers/Bridges
- h. Expansion Capabilities

2.7.3 Management Functions

The TMN shall support following Management functions:

2.7.3.1 Configuration Management

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

- a. Provide tools to establish and maintain the backbone topology and configuration information and provide graphical maps depicting the configurations.



- b. Gather descriptive information about the current configuration of the equipment, provide operator displays, and prepare reports.
- c. Provide tools for planning, establishing, and changing the static equipment configuration. Provide for changes to the equipment configuration in response to equipment failures, planned upgrades, and operator requests to take equipment offline for testing.
- d. Provide verification testing to support new equipment installation.

2.7.3.2 Fault Management

Fault management is concerned with detecting, diagnosing, bypassing, directing service restoration, and reporting on all the backbone network equipment, systems, and links. Minimum specific requirements that shall be satisfied include the following:

- a. Display equipment status in a consistent fashion regardless of the source of the data on a graphical topological, map-type display. Status shall be displayed through the use of colours on links and nodes as well as through text.
- b. Obtain status and detect faults through periodic polling, processing of unsolicited alarms and error events, and periodic testing for connectivity.
- c. Maintain an alarm summary of unacknowledged alarm events on the management station display and maintain a log of all received alarms. The operator shall be able to acknowledge and clear alarms individually and as a group. The use of alarm correlation techniques is encouraged to minimize the proliferation of alarms caused by a single, common event. All alarms shall be configurable as critical alarms, major alarms and minor alarms with different colours.
- d. Provide the capability to diagnose and isolate failures through analysis of error and event reports and through the use of both on-line and off-line diagnostic tests and display of monitored data.
- e. The criteria for fail over shall be configurable as automatic fail over to redundant equipment wherever possible and through operator-initiated actions where automatic fail over is not possible. The status of fail over shall be reported to the NMS.
- f. Track network equipment failure history.



2.7.3.3 Performance Management

Performance management is concerned with evaluation of the use of network equipments and their capability to meet performance objectives. Minimum specific requirements that shall be satisfied include the following:

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

2.7.3.4 Security Management

The TMN shall be provided with security features to limit access to monitoring and control capabilities to only authorized personnel. One access level of System Administrator and at least two levels of operator access shall be provided - read (view) only, and write (configure). The system administrator shall be able to create, define and modify operators with different access levels, network domains and perform all kind of maintenance and up gradation of the TMN system. With "read only" access level, network parameters should only be viewed. Access to database maintenance, command control and test functions shall be available with "write " access level. Means shall be provided to ensure only one authorized user has write capability for a selected domain of the network. It shall be possible to define multiple domains for purposes of monitoring and control.



Human error and conflict detection are also required. Such errors and access violations shall be reported to the offending user as error messages and warnings.

2.8 Communication Channel Requirement and Integration

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

The TMN data transport shall utilize the wideband communications transmission system service channel in the overhead whenever possible. This will provide inherent critical path protection

Should the configuration requirements dictate multiple TMN station processors, the TMN Master Station shall require bidirectional data transport with its station processor(s). This communications interfacing shall be via critically protected data channels. It shall be the Contractor's responsibility to provide for and equip all necessary critically protected TMN data channel support.

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

The NMS information of existing PDH & SDH system shall be transported through the new communication network, wherever required, up to the NMS location. The NMS information of the new SDH & PDH system being procured under the package shall be transported through the existing communication network using 64 kbps/2Mbps (G.703) interfaces. Any hardware required for above interfacing shall be provided by the Contractor.

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

2.9 Craft Terminal

Each equipment (SDH equipment, Mux, Drop/Insert and DACS 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.

2.10 Hardware Requirements

2.10.1 Master Processor, Server/Workstation and Craft Terminal

The server/workstation and craft terminal shall have suitable processor(s) which shall be sufficient to meet all the functional requirement and expansion capabilities stipulated in this specification.



Only reputed make like Dell, IBM, HP, Compaq make shall be supplied.

The server shall have minimum configuration of 3GHz for CISC based or 1.6GHz for RISC based processor, 2GB RAM, DVD-ROM drive, redundant 80 GB internal Hard Disk Drive, 101-Enhanced style keyboards, mouse, parallel, serial, USB(2.0) ports and hot swap redundant power supply. VDUs shall be 17" TFT active matrix color LCD with a minimum resolution of 1024 X 768. Appropriate network drive card shall also be provided wherever required. However, the internal hard disk drive for the server shall be redundant and all the data shall be mirrored. Further, the TMN software shall support data mirroring on redundant disk drives.

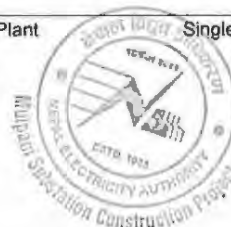
The workstation shall have minimum configuration of 2.4GHz for CISC or 1.4GHz for RISC based processor, 1GB RAM, DVD-RW drive, 160 GB Hard Disk Drive, 101-Enhanced style keyboards, mouse, parallel, serial and USB (2.0) ports. VDUs shall be 19" TFT active matrix color LCD with a minimum resolution of 1024 X 768. Appropriate network drive card shall also be provided wherever required.

CPU enclosures shall be desktop type and shall include available expansion slots except for the Craft Terminal which shall be a laptop. The craft terminal shall have minimum configuration of 2.4 GHz, 2 GB RAM, 256 MB VRAM, DVD RW drive, 160 GB Hard Disk Drive, keyboard, mouse/trackball etc., parallel, serial/USB (2.0) ports to accommodate printers, and Internal/external Data/Fax modem and a battery back-up of at least 60 minutes. VDUs shall be 15" TFT active matrix color LCD with a minimum resolution of 1024 X 768.

2.10.2 Peripherals and hardware

TMN system shall be provided with laser printer. The laser printer shall have a minimum print speed of 17 pages per minute and a minimum resolution of 1200 x 1200 dpi. The laser printer shall have parallel and LAN ports for connecting to TMN system.

The laser printer under this specification shall be black & white and include print enhanced buffering to prevent loss of print data in the event of a print failure.



2.10.3 Local/Remote Operator Consoles (As Applicable)

The Contractor shall provide operator consoles sized and equipped to support the subsystem(s) furnished and in compliance with the specification. The console shall provide hardware interfacing for the TMN users to the software operating support systems. At a minimum, a console shall include the hardware similar to a workstation.

2.10.4 Power Supplies

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

2.11 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.

2.11.1 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.

2.11.2 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.

2.11.3 Software Utilities

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

2.11.4 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.

2.11.5 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.

2.11.6 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.

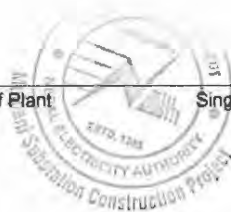
-----End of the Section-----



Section – 3

Environment, EMI, Power Supply, Cabling and Earthing

3.1	<u>Environmental Requirements</u>	28
3.1.1	<u>Temperature and Humidity</u>	28
3.1.2	<u>EMI and Electrostatic Interference</u>	28
3.1.3	<u>Vibration and Shock Resistance</u>	28
3.1.4	<u>Tropicalization</u>	28
3.1.5	<u>Contaminants</u>	29
3.2	<u>Primary Source AC/DC Power Requirements</u>	29
3.2.1	<u>Primary Source AC Power</u>	29
3.2.2	<u>-48V DC Power</u>	29
3.2.3	<u>Power Distribution and Protection</u>	29
3.3	<u>Equipment Construction, Assembly and Installation</u>	30
3.3.1	<u>Identification</u>	30
3.3.1.1	<u>Equipment</u>	30
3.3.1.2	<u>Power Distribution</u>	30
3.3.1.3	<u>Signal Cabling</u>	30
3.3.1.4	<u>Equipment Racks and Enclosures</u>	31
3.3.2	<u>Installation Hardware</u>	31
3.3.2.1	<u>Equipment Sub-Racks and Cabinets (Enclosures)</u>	31
3.3.2.2	<u>Cable Raceways</u>	32
3.3.3	<u>Signaling Distribution</u>	32
3.3.4	<u>Lightning and Transient Voltage Protection</u>	32
3.3.5	<u>Station Safety Earthing and Signal Grounding</u>	33
3.3.6	<u>Interconnections</u>	33
3.3.7	<u>Finish Colors</u>	33
3.4	<u>Location of Equipment, Cable Routes and Associated Civil Works</u>	34
3.4.1	<u>Locations for Supplied Equipment</u>	34
3.4.2	<u>Associated Civil Works</u>	34
3.4.3	<u>Cable Trenches</u>	34



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



123

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) provided under this specification, shall use -48Vdc uninterrupted primary source power. The power supply may vary normally within the voltage range -42 to -58 Vdc and the supplied equipment shall operate satisfactorily within this range.

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

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

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.

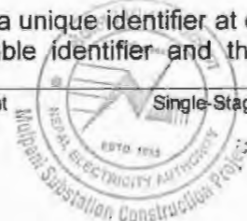
Power distribution panel "Main Disconnect" and circuit breakers shall be clearly marked with a unique identifier. Circuit breaker feed lists shall be clear, accurate and the feed list information shall be posted inside each distribution panel door.

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 fan-out point.

All signal cable, wiring and terminations shall be clearly labeled/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 labeled 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, size, weight and manner of installation for each location.

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

(A) Equipment SubRack Construction

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

- (1) Equipment Sub Racks shall be steel/aluminum fabricated and finished on all surfaces. All metal and welds shall be thoroughly cleaned and sanded to obtain a smooth finish. All surfaces shall be treated for rust and primed to form a bond between metal and the finish coats of paint.
- (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.
- (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.

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 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.

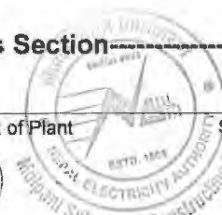
3.4.3 Cable Trenches

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-----



44

Section - 04

Inspection, Test and Availability

Table of Content

4.1	<u>Inspection</u>	36
4.2	<u>Test Plans and Procedures</u>	37
4.2.1	<u>Factory and Site Test Plans</u>	37
4.2.2	<u>Test Procedures</u>	38
4.2.3	<u>Test Records</u>	38
4.2.4	<u>Rejection of Elements</u>	39
4.2.5	<u>Test Periods Defined</u>	39
4.3	<u>Type Testing</u>	40
4.3.1	<u>Type Test Samples</u>	40
4.3.2	<u>List of Type Tests</u>	41
4.3.2.1	<u>List of type test to be conducted on Telecom equipment</u>	41
4.4	<u>Factory Acceptance Tests</u>	45
4.4.1	<u>Sampling for FAT</u>	46
4.4.2	<u>Production Testing</u>	46
4.5	<u>Site Acceptance Tests</u>	47
4.5.1	<u>Phases for Site Acceptance Testing</u>	48
4.5.1.1	<u>Installation Testing</u>	48
4.5.1.2	<u>Link Commissioning Tests</u>	48
4.5.1.3	<u>Integrated Testing</u>	49



KS

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



13

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.

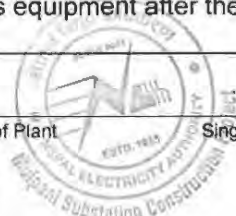
The Contractor shall give the Employer twenty one (21) days written notice of any material being ready for testing. Fifteen days prior to the scheduled testing, the Employer shall provide written notice to the Contractor of any drawings, equipment, material, or workmanship which, in the Employer's opinion, 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

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



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

Item:	Description:
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.



KS

Table 4-3
Test Record Requirements

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

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

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 as part of repeater less links)
- (b) Primary Multiplexer & 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, Primary Multiplexer & Drop – Insert Mux with subscriber interface card 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:



A handwritten signature or mark, possibly initials, in dark ink.

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test.
- (2) Degree of Severity: As per table 5-1: operation to specification range.
- (3) Acceptance Criteria: No degradation of performance during and after the test.

(d) Dry Heat Test: Operation without Damage

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

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

(e) Damp Heat Test

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

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 10 days. Its performance is checked during the test.
- (2) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

(f) Temperature Variation Test

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

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

*KS*

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 4-4:

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 - Level : 1
2	Voltage dips and Interruptions	Yes	Yes	N/A	N/A	
3	1.2/50 - 8/20 μ s surges	Yes	Yes	Yes	N/A	Table 12 of IEC 60870-2-1: 1995 - Level : 4
4	Fast transient bursts	Yes	Yes	Yes	Yes	
5	Damped oscillatory waves	Yes	Yes	Yes	Yes	
6	10/700 μ s surges	N/A	N/A	N/A	Yes	
7	Electrostatic discharge	Yes				Table 13 of IEC 60870-2-1: 1995 - Level : 4
8	Power frequency magnetic field	Yes				Table 14 of IEC 60870-2-1: 1995 - Level : 4
9	Damped oscillatory magnetic field	Yes				
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
-End of Table-						



123

(b) Emission Tests

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

Table 4-5:
Recommended Emission Tests

S. NO.	Emission test	AC Power Supply	DC Power Supply	Contr ol & Signal	Telecom Line	Para- metres
1	LF disturbance voltages CCITT recommendation P.53	N/A	Yes	N/A	N/A	Table 17 of IEC 60870-2-1: 1995 - Class : B
2	RF disturbance voltages CISPR 22	Yes	Yes	N/A	N/A	
3	RF disturbance currents CISPR 22	N/A	N/A	N/A	Yes	
4	RF radiated fields CISPR 22	Yes				
-End Of Table-						

(c) Insulation Withstand Voltages

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

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).



17

The recommended severity shall be $A = 294 \text{ m/s}^2$, $D = 18 \text{ ms}$. Three shocks per axis per direction shall be applied to the equipment packed according to the Contractor's specifications.

Or Free Fall Test

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

Or Bump Test

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

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, associated Subscriber Line Interface Cards 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 and NMS are given in specified Tables in this section. This list of factory acceptance tests shall be supplemented by the Contractor's standard FAT testing program. The factory acceptance tests for the other items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's / supplier's) standard FAT testing program. In general the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces, alarms and diagnostics etc.

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



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.

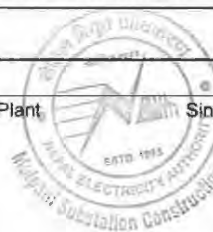
Since FAT testing provides a measure of assurance that the Quality Control objectives are being met during all phases of production, the Employer reserves the right to require the Contractor to investigate and report on the cause of FAT failures and to suspend further testing/ approvals until such a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

Item:	Description:
1.	Physical inspection for conformance to DRS, BOQ, drawings and appearance of equipment
2.	Optical output power
3.	Transmitter lightwave spectral analysis
4.	Low receive level threshold
5.	Generation of bit error rate curve
6.	Measurement of analog and digital service channel parameters as well as service channel functionality
7.	Performance of supervision, alarm, Craftsperson interface, diagnostics, loop backs etc.
8.	Electrical interface 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.	Test of spare card slots



15

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

13.	Checks of power supply/converter voltage margins
14.	Random inspections to verify the accuracy of documentation
15.	Test of spare parts/modules/cards as per applicable tests

Table 4-7
Factory Acceptance Testing Requirements for Termination Equipment (MUX)

Item	Description:
1.	Physical Inspection for conformance to DRS, BOQ, drawings and appearance of equipment
2.	Performance of supervision, alarm, control and switching systems, diagnostics, loopbacks, Craftsperson interface etc.
3.	Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for the channel banks/low-level multiplexers
4.	Framing, signaling, and operational and maintenance tests consistent with applicable ITU-T requirements
5.	Simulation of failure conditions and failover of each redundant unit
6.	Test of spare card slots and test of spare parts/modules/cards as per applicable tests
7.	Checks of power supply/converter voltage margins and short circuit and overvoltage protection
8.	Random inspections to verify the accuracy of documentation

Table 4-8
FAT on Craft Terminal

1	Physical inspection of Craft Terminal hardware for conformance to approved BoQ, DRS & drawing
2	Testing of Craft Terminal to demonstrate proper operation of all functions

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 equipment. 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.

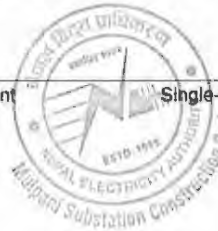
For Ethernet interface: At a minimum the following test requirements shall be demonstrated as per RFC 2544:

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

10% of the total links (Chosen by the Employer, generally to cover links from all configurations used) shall be tested for a duration of 12 Hours. Rest of the links shall be tested for 1 Hour. In case a link does not meet the performance requirements during 1 hour, then the duration of the test shall be increased to 12 hours.

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

This phase of testing shall be conducted by the Contractor and witnessed by the Employer. Field adjustments shall be made to meet established standard, however if the field adjustments fail to correct the defects the equipments may be returned to the Contractor for replacement at his own expense. In case any adjustments are required to be made during the interval of the test then the test shall be repeated.



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 User's interfaces. The integrated testing for a batch shall include end-to-end testing of back-bone network included in that



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
- (3) End-to-end testing of all individual Data Circuits.
- (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

Item:	Description:
1.	Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling
2.	Power supply/converter voltage measurements
3.	Muldem performance testing
4.	Craftsperson interface, alarm and control functional performance

5.	Rack and Local alarms
6.	Network management interface and supervision performance
7.	Channel performance
8.	Safety and signalling earthing system
9.	Simulation of failure conditions and failover of protected components.

Table 4-11
NMS Installation Testing (if Applicable)

Item:	Description:
1.	Physical inspection for conformance to drawings, rack elevations and appearance of equipment and cabling
2.	Workstation hardware inventory, configuration and characteristics
3.	Demonstration of proper operation of all hardware, including workstations peripherals

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

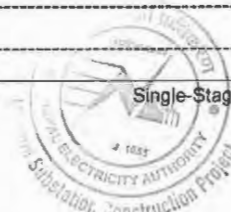


Section-5

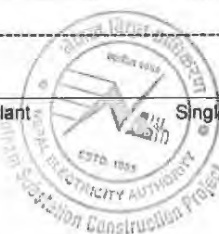
Training and Support Services

Index

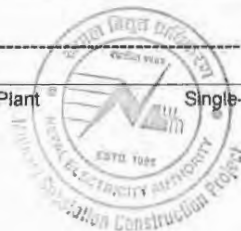
1.1	Scope and General Requirements	2
1.2	General Requirements	2
1.2.1	Synchronization of the Communication Network	3
1.3	General Responsibilities and Obligations	3
1.3.1	Responsibilities for the Implementation Plan	3
1.3.2	Contractor's Responsibilities and Obligations	3
1.3.3	The Employer Responsibilities and Obligations	4
1.4	Applicable Standards	5
2.1	Introduction	8
2.2	General Network Characteristics	8
2.2.1	Description	8
2.2.2	Functional Requirement	9
2.2.3	General Systems Requirements	9
2.2.3.1	System Synchronization	9
2.2.3.2	System Maintainability	9
2.2.3.3	System Upgradeability and Expandability	10
2.2.3.4	Equipment Availability	10
2.2.3.5	Revision Levels and Modifications	10
2.2.3.6	Equipment Capacities	10
2.2.3.7	Redundancy Requirements and Protection Schemes	10
2.2.3.8	Lost Signal Recovery	11
2.2.3.9	Software Upgrades	11
2.2.3.10	General Site Considerations	11
2.3	Fibre Optic Transmission System	13
2.3.1	SDH Equipment	13
2.3.1.1	Functional Requirement	13
2.3.1.2	Redundancy and Protection	14
2.3.1.3	Service Channel	14
2.3.1.4	Supervision and Alarms	14
2.3.1.5	Synchronisation	14
2.3.1.6	Electrical and Optical I/O Characteristics and General Parameters	14
2.3.2	Optical Link Performance Requirements	15
2.3.2.1	Link Budget Calculations	15
2.3.2.2	Link Performance	16



2.3.2.3	FODP to SDH Equipment	16
2.4	Termination Equipment Subsystem	16
2.4.1	Functional Description	16
2.4.2	First Order (Primary) Multiplexing	16
2.4.2.1	Drop & Insert Primary Multiplexing	17
2.4.2.2	Channel Banks (Mux, Drop/Insert)	17
2.4.2.3	Subscriber Line Units\Subscriber Line Interface Cards	17
2.5	MDF, DDF and Cabling	18
2.5.1	Digital Distribution Frame Functional Requirements	18
2.5.2	Main Distribution Frames	19
2.6	Patch Cords	19
2.6	Telecommunication Management Network / Network Management System	19
(As Applicable)		19
2.7.1	Applicable Standards	19
2.7.2	TMN Architecture	19
2.7.3	Management Functions	20
2.7.3.1	Configuration Management	20
2.7.3.2	Fault Management	21
2.7.3.4	Security Management	22
2.8	Communication Channel Requirement and Integration	23
2.9	Craft Terminal	23
2.10	Hardware Requirements	23
2.10.1	Master Processor, Server/Workstation and Craft Terminal	23
2.10.2	Peripherals and hardware	24
2.10.3	Local/Remote Operator Consoles (As Applicable)	25
2.11	General Software/Firmware Requirements	25
2.11.1	Operating System Software	25
2.11.2	Applications Software	25
2.11.3	Software Utilities	25
2.11.4	Revisions, Upgrades, Maintainability	25
2.11.5	Database(s)	25
2.11.6	Help	26
3.1	Environmental Requirements	28
3.1.1	Temperature and Humidity	28
3.1.2	EMI and Electrostatic Interference	28
3.1.3	Vibration and Shock Resistance	28
3.1.4	Tropicalization	28
3.1.5	Contaminants	29



3.2	Primary Source AC/DC Power Requirements	29
3.2.1	Primary Source AC Power	29
3.2.2	-48V DC Power	29
3.2.3	Power Distribution and Protection	29
3.3	Equipment Construction, Assembly and Installation	30
3.3.1	Identification	30
3.3.1.1	Equipment	30
3.3.1.2	Power Distribution	30
3.3.1.3	Signal Cabling	30
3.3.1.4	Equipment Racks and Enclosures	31
3.3.2	Installation Hardware	31
3.3.2.1	Equipment Sub-Racks and Cabinets (Enclosures)	31
3.3.2.2	Cable Raceways	32
3.3.3	Signaling Distribution	32
3.3.4	Lightning and Transient Voltage Protection	32
3.3.5	Station Safety Earthing and Signal Grounding	33
3.3.6	Interconnections	33
3.3.7	Finish Colors	33
3.4	Location of Equipment, Cable Routes and Associated Civil Works	34
3.4.1	Locations for Supplied Equipment	34
3.4.2	Associated Civil Works	34
3.4.3	Cable Trenches	34
4.1	Inspection	36
4.2	Test Plans and Procedures	37
4.2.1	Factory and Site Test Plans	37
4.2.2	Test Procedures	38
4.2.3	Test Records	38
4.2.4	Rejection of Elements	39
4.2.5	Test Periods Defined	39
4.3	Type Testing	40
4.3.1	Type Test Samples	40
4.3.2	List of Type Tests	41
4.3.2.1	List of type test to be conducted on Telecom equipment	41
4.4	Factory Acceptance Tests	45
4.4.1	Sampling for FAT	46
4.4.2	Production Testing	46
4.5	Site Acceptance Tests	47
4.5.1	Phases for Site Acceptance Testing	48
4.5.1.1	Installation Testing	48
4.5.1.2	Link Commissioning Tests	48
4.5.1.3	Integrated Testing	49
5.1	Training	55



5.1.1	System Design & Overview Training	55
5.1.2	Installation & Maintenance Training	56
5.1.3	Training Course Requirements	56
5.1.3.1	Class Size	56
5.1.3.2	Training Schedule	56
5.1.3.3	Manuals and Equipment	56
5.2	Support Services	56
5.2.1	Technical Support	57
5.2.2	Contractor's Future Hardware/Software Changes	57
5.3	Spare Parts and Test Equipment	57
5.3.1	Mandatory Spare Parts	57
5.4	System Maintenance	57
5.4.1	Warranty Period	57
5.4.2	Contractor's Maintenance Responsibility	58
5.5	Miscellaneous Supplies	58
5.6	Documentation	58



Section-5

Training and Support Services

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

5.1 Training

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 personnel. 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

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

- (1) FO Transmission System Training
- (2) Termination Equipment System 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.

5.1.3 Training Course Requirements

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

5.1.3.1 Class Size

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

5.1.3.2 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.

5.1.3.3 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, Primary Mux, Drop/Insert etc.)

5.4 System Maintenance

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. In addition to the responsibilities covered under contract during Defect Liability Period, the Contractor shall also be responsible for maintenance of the Fibre Optic Transmission System, Termination Equipment, etc. supplied under this Package.



5.4.2 Contractor's Maintenance Responsibility

The Contractor shall be responsible for carrying out "Comprehensive Maintenance" of the Communication System for a period of six years after warranty period for ensuring the successful operation of the system. The Contractor shall be responsible for achieving the system availability and the response time mentioned in technical specifications. The bidder shall quote the Annual Maintenance Charges for six years after Warranty Period which shall be considered in the bid evaluation. Bidder shall submit the detailed procedure for achieving above in the bid. Upon expiry of the six years AMC period Employer may, at its discretion, extend this Maintenance for additional one year at the same price & terms and conditions.

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.

5.6 Documentation

The Contractor shall submit following documents during detailed engineering:

- (a) Data Requirement sheets
- (b) Link Budget calculations
- (c) MQP, FQP
- (d) Bill of Quantity including mandatory spares
- (e) Previous Type test reports
- (f) Factory Test report
- (g) Manuals for each equipment
- (h) Schematic drawing
- (i) Numbering, Marking, labelling document
- (j) Synchronization plan
- (k) Test schedule
- (l) Training manual
- (m) Configuration diagram
- (n) Transportation & handling Procedure
- (o) Installation Manuals
- (p) Maintenance Manuals

