ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

DISC / PORCELAIN LONG ROD INSULATORS FOR SUBSTATION AND TRANSMISSION LINE WORKS

TECHNICAL SPECIFICATION FOR DISC / PORCELAIN LONG ROD INSULATORS FOR SUBSTATION AND TRANSMISSION LINE WORKS.

1.0 SCOPE.

1.1 This specification provides for design, manufacture, engineering, inspection and testing before dispatch, packing and delivery FOR (destination) for Indian manufacturers of disc / porcelain long rod Insulators as per technical requirements furnished in this specification.

These insulators are to be used in suspension and tension insulator strings for the suspension and anchoring of the conductors on EHV transmission line towers.

1.2 Following are the list of documents constituting this package.

(i) Technical specification.
(ii) Technical data sheet.
(iii) Drawings of insulators

1.3 All the above volumes along with amendments there of shall be read and interpreted together. However, in case of a contradiction between the “Technical Specification” and any other volume, the provisions of this volume will prevail.

1.4 The insulators shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or material which in his judgment, is not in full accordance therewith.

2.0 **STANDARDS**:

2.1 Except as modified in this specification, the disc/porcelain long rod insulators shall conform to the following Indian Standards, which also includes latest revisions and amendments if any. Equivalent International and Internally recognized standards to which some of these standards generally correspond are also listed below.

Sl. No.	Indian Standard	Title.	International Standard.
1.	IS: 206	Method for Chemical Analysis of Slab Zinc.	
2.	IS: 209	Specification for Zinc.	BS: 3436
3.	IS: 731	Porcelain insulators for overhead power lines with a normal voltage greater than 1000V	BS: 137(I&II); IEC 60274 IEC 60383
4.	IS: 2071 Part-(I)	Method of High Voltage Testing.	

	Part-(II) Part-(III)		
5.	IS: 2121 (Part-I)	Specification of Conductors and Earth wire Accessories for Overhead Power lines. Armour Rods, Binding wires and tapes for conductor.	
6.	IS: 2486	Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V.	
	Part – I	General Requirement and Tests.	BS: 3288
	Part – II	Dimensional Requirements.	IEC: 60120
	Part – III	Locking devices.	IEC: 60372
7.	IS: 2629	Recommended practice for Hot Dip Galvanisation for iron and steel.	
8.	IS: 2633	Testing for Uniformity of Coating of Zinc coated articles.	
9.	IS: 3138	Hexagonal Bolts & Nuts.	ISO/R 947 & ISO/R 272
10.	IS: 3188	Dimensions for Disc Insulators.	IEC: 60305
11.	IS: 4218	Metric Screw Threads	ISO/R 68-1969 R 26-1963, R 262-1969 & R965-1969
12.	IS: 6745	Determination of weight of zinc coating on zinc coated iron and steel articles.	
13.	IS: 8263	Methods of RIV Test of HV insulators.	IEC 60437 NEMA Publication No.107/1964 CISPR
14.	IS: 8269	Methods for switching impulse Test on HV insulators.	IEC: 60506
15.		Thermal mechanical performance test and mechanical performance test on string insulator units.	IEC: 60575
16	IEC	Ceramic Long Rod Insulators	IEC: 60433

2.2 The standards mentioned above are available from:

Reference.	Abbreviation.	Name & Address:
BS		British Standards, British Standards

		Institution, 101, Pentonvile Road, N-19 ND,U
IEC / CISPR		International Electro technical commission Electro Technique International. 1, Rue de verembe Geneva SWITZERLAND.
IS		Bureau of Indian Standards, Manak Bhavan, 9 Bahadurshah Zafar Marg, New Delhi-110001, ORISSA
ISO		International Organisation for Standardization. Danish Board of Standardization Dansk Standardizing Sraat Aurehoegvej-12 DK-2900 Helleprup DENMARK.
NEMA		National Electric Manufacturers Association 1`55, East 44th. Street New York, NY 10017 USA

3.0 PRINCIPAL PARAMETERS.

3.1 DETAILS OF DISC INSULATORS:

3.1.1 The Insulator strings shall consist of standard discs for use in three phases. 50 Hz effectively earthed 33/132/220 KV transmission system of OPTCL in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type, radio interference and have characteristics as shown in Table-I and all ferrous parts shall be hot dip galvanized as per the latest edition of IS 2629. The zinc to be used for making sleeves shall be 99.95 % pure.

3.1.2 The size of disc insulator, minimum creepage distance the number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string along with hardware shall be as follows:

PRINCIPAL PARAMETERS OF THE DISC INSULATORS:-

Sl. No.	Type of String.	Size of disc. Insulator (mm)	Minimum creepage distance of each disc (mm),	No. of standard discs 132 KV /220 KV/400kV	Electro-mechanical strength of insulator string fittings (KN)
1.	Single suspension	255 x 145	320	1x9/1x14 /-	70 KN/90 KN Normal Disc Insulator
2.	Double suspension.	-do-	-do-	2x9/2x14 /-	70 KN/90 KN Normal Disc Insulator
3	Single suspension	255 x 145	430	1x9/1x14 /-	70 KN/90 KN Antifog Insulator
4	Double suspension.	-do-	-do-	2x9/2x14 /-	70 KN/90 KN Antifog Disc Insulator

5.	Single Suspension	280 x 145	430	1x10/1x15 /-	120 KN Anti fog Disc insulator
6.	Double suspension	280 x 145	430	2x10/2x15 /-	120 KN Anti fog Disc insulator
7.	Single Tension	305 X 170	475	1x10/1x15/1x25	160 KN Anti fog Disc insulator
8.	Double Tension	305 X 170	475	2x10/2x15/2x25	160 KN Anti fog Disc insulator
9.	Single Suspension	280 x 145	430	1x10/1x15/1x25	120 KN Anti fog Disc insulator
10.	Double suspension	280 x 145	430	2x10/2x15/2x25	120 KN Anti fog Disc insulator

3.2 SPECIFICATION DRAWINGS:

3.2.1: The Specification in respect of the disc insulators are described, The specification is for information and guidance of the bidder only. The drawings to be furnished by the supplier shall be as per his own design and manufacture and in line with the specification.

4.0 GENERAL TECHNICAL REQUIREMENTS FOR DISC INSULATORS:

4.1 Porcelain:

The porcelain used in the manufacture of the shells shall be nonporous, of high dielectric, mechanical and thermal strength, free from internal stresses blisters, laminations, voids, forgone matter imperfections or other defects which might render it in any way unusable for insulator shells. Porcelain shall remain unaffected by climatic conditions ozone, acid, alkalis, zinc or dust. The manufacturing shall be by the wet process and impervious character obtained by through vitrification.

The insulator shall be made of highest grade, dense, homogeneous, wet-process porcelain, completely and uniformly vitrified throughout to produce uniform mechanical and electrical strength and long life service. The porcelain shall be free from warping, roughness, cracks, blisters, laminations, projecting points, foreign particles and other defects, except those within the limits of standard accepted practice. Surfaces and grooves shall be shaped for easy cleaning. Shells shall be substantially symmetrical.

4.1.1 Porcelain glaze:

The finished porcelain shall be glazed in brown colour. The glaze shall cover all exposed parts of the insulator and shall have a good lusture, smooth surface and good performance under the extreme weather conditions of a tropical climate. It shall not crack or chip by ageing under the normal service conditions. The glaze shall have the same coefficient of expansion as of the porcelain body throughout the working temperature range.

4.2 METAL PARTS:

4.2.1 Cap and Ball Pins:

Ball pins shall be made with drop forged steel caps with malleable cast iron. They shall be in one single piece and duly hot dip galvanized. They shall not contain parts or pieces joined together welded, shrink fitted or by any other process from more than one piece of materials. The pins shall be of high tensile steel, drop forged and heat-treated. The caps shall be cast with good quality black heart malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity. The bidder shall specify the grade composition and mechanical properties of steel used for caps and pins. The cap and pin shall be of such design that it will not yield or distort under the specified mechanical load in such a manner as to change the relative spacing of the insulators or add other stresses to the shells. The insulator caps shall be of the socket type provided with nonferrous metal or stainless steel cotter pins and shall provide positive locking of the coupling.

4.2.2 Security Clips:

The security clips shall be made of phosphor bronze or of stainless steel.

4.3 FILLER MATERIAL:

Cement to be used, as a filler material be quick setting, fast curing Portland cement. It shall not cause fracture by expansion or loosening by contraction. Cement shall not react chemically with metal parts in contact with it and its thickness shall be as small and as uniform as possible.

4.4 MATERIALS DESIGN AND WORKMANSHIP:

4.4.1 GENERAL:

(I) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw material quality control and to stage testing/ quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on Transmission lines.

(II) The design, manufacturing process and material control at various stages be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish elimination of sharp edges and corners to limit corona and radio interference voltages.

4.4.2 INSULATOR SHELL:

The design of the insulator shells shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. Shells with cracks shall be eliminated by temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity and temperature.

4.4.3 METAL PARTS:

i) The pin and cap shall be designed to transmit the mechanical stress to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the pinball shall be suitably designed so that when the insulator is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of a string or when a string is placed in position.

ii) Metal caps shall be free from cracks, seams, shrinks, air holes, blowholes and rough edges. All metal surfaces shall be perfectly smooth with no projecting part or irregularities, which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stress uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids.

4.4.4 GALVANIZING:

All ferrous parts, shall be hot dip galvanized in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, smoothly adherent, reasonably light, continuous and free from impurities such as flux, ash, rust stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

4.4.5 CEMENTING:

The insulator design shall. Be such that the insulating medium shall not directly engaged with hard metal. The surface of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials. High quality Portland cement shall be used for cementing the porcelain to the cap & pin.

4.4.6 SECURITY CLIPS (LOCKING DEVICES)

The security clips to be used as locking device for ball and socket coupling shall be 'R' shaped hump type to provide for positive locking of the coupling as per IS: 2486 (Part-IV). The legs of the security clips shall allow for spreading after installation to prevent complete withdrawal from the socket. The locking device shall resilient corrosion resistant and of sufficient mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation, which placed in position, and under no circumstances shall it allow separation of insulator units and fittings. 'W' type security clips are also acceptable. The hole for the security clip shall be counter sunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked positions shall not be less than 50 N (5 kg.) or more than 500 N (50 kgs.).

4.4.7 MARKING:

Each insulator shall have the rated combined mechanical and electrical strength marked clearly on the porcelain surface. Each insulator shall also bear symbols identifying the manufacturer, month, and year of manufacture. Marking on porcelain shall be printed, not impressed, and shall be applied before firing

4.5 BALL AND SOCKET DESIGNATION:

The dimensions of the ball and sockets for 70 and 90 KN insulator strings shall be of 16 mm and for 120 KN and 160 KN insulator strings shall be of 20 mm designation in accordance with the standard dimensions stated in IS: 2486 (Part-II).

4.6 DIMENSIONAL TOLERANCE OF INSULATOR DISCS:

It shall be ensured that the dimensions of the disc insulators are within the limits specified below:

(a)

Sl. No.	Diameter of Disc (mm)	Standard in Mm	Maximum	Minimum
1.	70 KN/90 KN & 120 KN	**255/255 & 280**	As per IS	As per IS
2.	160 KN	305	As per IS	As per IS

(b) Sl. No.	Ball to Ball spacing Between Discs (mm)	Standard in Mm	Maximum	Minimum
1.	70 KN/90 KN/120 KN	**145**	As per IS	As per IS
2.	160 KN	170	As per IS	As per IS

NOTE: Tolerance as per relevant IS (Latest edition).

(4.7) GUARANTEED TECHNICAL PARTICULARS

FOR ANTIFOG DISC INSULATORS

Sl. No.	DESCRIPTION	70 KN	90 KN	120KN	160 KN
1.	Manufacture's name &address				
2	Type of Insulator	Ball & Socket	Ball & socket	Ball & socket	Ball & socket
3	Size of ball & socket	16B	16B	20	20
4	Dimensions				
(a)	Disc diameter	255	255	280	305
(b)	Unit spacing	145	145	145	170
(c)	Creepage distance of the single insulator-mm	430	430	430	475
5	Electro-mechanical strength of single insulator-kN	70	90	120	160
6	Materials of shell	Porcelain	Porcelain	Porcelain	Porcelain
7	**Electrical value**				
7.1	Power frequency Withstand Voltage Disc (a) Dry-kV (rms) (b) Wet-kV (rms)	 80 45	 80 45	 85 50	 90 50
7.2	Power frequency Withstand Voltage Disc (a) Dry-kV (rms) (b) Wet-kV (rms)	 85 50	 85 50	 90 55	 95 55
7.3	Impulse Withstand Voltage Disc 1.2/50 micro second (a) Positive – kV(Peak) (b) Negative – kV(Peak)	 125 125	 125 125	 130 130	 135 135
7.4	Impulse Flashover Voltage Disc 1.2/50 micro second (a) Positive – kV(Peak) (b) Negative – kV(Peak)	 135 130	 135 130	 140 135	 145 140

4.8 INTERCHANGEABILITY:

The insulators inclusive of the ball and socket fittings shall be of standard design suitable for use with hardware fittings of any make conforming to relevant Indian Standards.

4.9 CORONA AND RIV PERFORMANCE:

All surfaces shall be even, smooth, without cuts, abrasions or projections. No part shall be subject to excessive localized pressure. The metal parts and porcelain shall not produce any noise-generating corona under all operating conditions.

5.0 SUITABILITY FOR LIVE LINE MAINTENANCE:

The insulator shall be compatible for use with hot line or live line maintenance techniques so that usual hot line operation can be carried out with easy speed and safety.

5.1 FREEDOM FROM DEFECTS:

Insulators shall have none of the following defects:

1)Ball pin shake.

2)Cementing defects near the pin like small blow holes, small hair cracks lumps etc.

3)Sand fall defects on the surface of the insulator.

5.2 INSULATOR STRINGS:

5.2.1 TYPE AND RATING:

The insulator strings shall be formed with standard discs described in this specification for use on 3 phases 132/22 KV 50 Hz effectively earthed systems in an atmosphere with pollution level as indicated in project synopsis. Suspension insulator strings for use with suspension/tangent towers are to be fitted with discs 70/90 KN EMS rating while tension insulator strings for use with Anchor/ Tension towers are to be fitted with discs of 120 KN / 160 KN EMS level rating.

5.2.2 STRING SIZE:

The sizes of the disc insulator, the number to be used in different types of strings, their electro-mechanical strength and minimum nominal creep age distance shall be as given in clause 3.12

5.3 STRING CHARACTERISTICS

5.3.1 The characteristics of the complete string shall be as follows:

Sl. No.	Description.	Suspension.		Tension.	
		132KV	220kV	132KV	220KV
I	Switching surge withstand voltage (dry& wet)KV Peak	-	-	-	-
Ii	Lighting impulse withstand voltage (dry) KV Peak.	650	1050	650	1050
Iii	Power frequency without voltage (wet) KV r.m.s.	275	460	275	460
Iv.	Corona extinction voltage level KV rms	-	176	-	176
v.	Max. RIV for comp. Etc. strong including corona rings at 156 KV (rms). … hours clamps etc. at 1.1. times maximum knee to ground voltage (micro volts).	-	500	-	500
vi.	Mechanical failing load for each string (kgf)	6500	11500	11500	15500
Vii.	No deformation load for each string (kgf)	-	7705	-	10385
Viii.	Max. voltage across any disc.	13%	13%	13%	13%

5.3.2 Insulator units after assembly shall be concentric and coaxial within limits as permitted by Indian Standards.

5.3.3 The strings design shall be such that when units are coupled together there shall be contact between the shell of one unit and metal of the adjacent unit.

5.4 TECHNICAL DESCRIPTION OF PORCELAIN LONG ROD INSULATORS

5.4.1 Details of Long Rod Insulators

5.4.2 The insulator string shall consist of standard porcelain long rod insulators with normal sheds for a three phase, 50 Hz, effectively earthed 132/220/400 kV transmission system. Insulators shall be long rod type with Ball and socket connections.

5.4.3 Insulators shell has normal sheds/alternate sheds with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be strictly in accordance with the recommendation of IEC-60815.

5.4.4 The size of long rod insulator, minimum creepage distance, the number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string alongwith hardware fittings shall be as follows :

5.4.5 Description of long rod insulator string (equivalent to disc insulator string)

5.5 PRINCIPAL PARAMETERS OF THE PORCELAIN LONG ROD INSULATORS:-

Sl. No.	System Voltage (kV)	Type of String.	Length of Porcelain long rod Insulator (mm)	Minimum creepage distance of Porcelain long rod Insulator(mm),	No. of Porcelain long rod Insulator units per string	Electro- mechanical strength of Porcelain long rod Insulator string fittings (KN)
1.	132	Single Suspension	1305	2628	1 X 1	1 X 70kN
2.	132	Double Suspension	1305	2628	2 X 1	2 X 70kN
3.	132	Single Tension	1450	2920	1 X 1	1 X 120kN
4.	132	Double Tension	1450	2920	2 X 1	2 X 120kN
5.	132	Single Suspension	1305	3625	1 X 1	1 X 70kN
6.	132	Double Suspension	1305	3625	2 X 1	2 X 70kN
7.	132	Single Tension	1450	3625	1 X 1	1 X 120kN
8.	132	Double Tension	1450	3625	2 X 1	2 X 120kN
9.	132	Single Tension	1700	3625	1 X 1	1 X 160kN
10.	132	Double Tension	1700	3625	2 X 1	2 X 160kN
11.	220	Single Suspension	2030	4088	1 X 2	1 X 90kN
12.	220	Double Suspension	2030	4088	2 X 2	2 X 90kN
13.	220	Single Tension	2175	4380	1 X 2	1 X 120kN
14.	220	Double Tension	2175	4380	2 X 2	2 X 120kN
15.	220	Single Suspension	2030	5180	1 X 2	1 X 90kN

16.	220	Double suspension	2030	5180	2 X 2	1 X 90kN
17.	220	Single Tension	2175	5550	1 X 2	1 X 120kN
18.	220	Double Tension	2175	5550	2 X 2	2 X 120kN
19.	220	Single Tension	2550	5550	1 X 2	1 X 160kN
20.	220	Double Tension	2550	5550	2 X 2	2 X 160kN
21.	400	Single Suspension	3335	9200	1 X 3	1 X 120kN
22.	400	Double suspension	3335	9200	2 X 3	2 X 120kN
23.	400	Single Tension	3910	9200	1 X 3	1 X 160kN
24.	400	Double Tension	3910	9200	2 X 3	2 X 160kN

(i) Bidders may quote for the relevant strings.
(ii) Length of long rod insulator strings shall be matching with the corresponding disc insulator strings.

5.5.1 STANDARD TECHNICAL PARTICULARS FOR 132kV PORCELAIN LONG ROD INSULATOR STRING

Sl.	Description	Unit	Standard Technical Particular value		
			70 KN/ 90KN Insulator	**120 KN Insulator**	**160 KN Insulator**
1.0	**General**				
a)	Size and Designation of ball & Socket assembly	mm	16 mm Alt-B as per IS 2486 / IEC: 60120	20 as per IS 2486/ IEC: 60120	20 as per IS 2486/ IEC: 60120
2.0	**Dimensions**				
a)	Core diameter	mm	55 to 75	60 to 75	75 to 85
b)	Tolerance on core diameter	± mm	(0.04d+1.5)	(0.04d+1.5)	(0.04d+1.5)
c)	Minimum nominal creepage distance 1. Normal 2. Anti Fog	mm	2628 3625	2920 3625	----- 3625
3.0	Colour of glaze of finished porcelain insulator		Brown	Brown	Brown
4.0	Mechanical Strength of Long Rod	kN	70	120	160
5.0	**Minimum electrical values**				
a)	Power frequency **Withstand** voltage (DRY/WET)	kV rms	310/275	310/275	310/275
b)	Power frequency **Flashover** voltage (DRY/WET)	kV rms	325/295	325/295	325/295
c)	Impulse **Withstand** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	650/650	650/650	650/650
d)	Impulse **Flashover** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	670/670	670/670	670/670

6.0	**Eccentricity of Long Rod**				
a)	Max. axial/radial run out		1.2 % of insulator length	1.2 % of insulator length	1.2 % of insulator length
b)	Max. angular displacement	deg	15	15	15
7.0	**Galvanizing**				
a)	Minimum mass of zinc coating	Gm/ sq.m.	600	600	600
b)	Minimum no. of one minute dips in the standard preece test	Nos.	6 dips	6 dips	6 dips
c)	Minimum purity of zinc used for galvanizing	%	99.95	99.95	99.95

5.5.2 STANDARD TECHNICAL PARTICULARS FOR 220kV PORCELAIN LONG ROD INSULATOR STRING

Sl.	Description	Unit	Standard Technical Particular value			
			70 KN Insulator	90 KN Insulator	120 KN Insulator	160 KN Insulator
1.0	**General**					
a)	Size and Designation of ball & Socket assembly	mm	-----	16 mm Alt-B as per IS 2486/ IEC: 60120	20 as per IS 2486/ IEC: 60120	20 as per IS 2486/ IEC: 60120
2.0	**Dimensions**		-----			
a)	Core diameter	mm	-----	55 to 75	60 to 75	75 to 85
b)	Tolerance on core diameter	± mm	-----	(0.04d+1.5)	(0.04d+1.5)	(0.04d+1.5)
c)	Minimum nominal creepage distance 1. Normal	mm	-----	4088	4380	-----
	2. Anti Fog		-----	5180	5550	5550
3.0	Colour of glaze of finished porcelain insulator		-----	Brown	Brown	Brown
4.0	Mechanical Strength of Long Rod	kN	-----	90	120	160
5.0	**Minimum electrical values**		-----			
a)	Power frequency **Withstand** voltage (DRY/WET)	kV	-----	500/460	500/460	500/460
b)	Power frequency **Flashover** voltage (DRY/WET)	kV	-----	520/480	520/480	520/480
c)	Impulse **Withstand** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	-----	1050/1050	1050/1050	1050/1050
d)	Impulse **Flashover** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	-----	1100/1100	1100/1100	1100/1100
e)	Corona extinction voltage level	kV	-----	156	156	156
f)	Max. RIV for string including corona rings at 156kV rms	micro volts	-----	500	500	500
6.0	**Eccentricity of Long Rod**					

a)	Max. axial/radial run out		-----	1.2 % of insulator length	1.2 % of insulator length	1.2 % of insulator length
b)	Max. angular displacement	deg	-----	15	15	15

7.0	**Galvanizing**					
a)	Minimum mass of zinc coating	Gm/ sq.m.	-----	600	600	600
b)	Minimum no. of one minute dips in the standard preece test	Nos.	-----	6 dips	6 dips	6 dips
c)	Minimum purity of zinc used for galvanizing	%	-----	99.95	99.95	99.95

5.5.3 STANDARD TECHNICAL PARTICULARS FOR 400kV PORCELAIN LONG ROD INSULATOR STRING

Sl.	Description	Unit	Standard Technical Particular value			
			70 KN Insulator	90 KN Insulator	120 KN Insulator	160 KN Insulator
1.0	**General**					
a)	Size and Designation of ball & Socket assembly	mm	-----	-----	20 as per IS 2486/ IEC: 60120	20 as per IS 2486/ IEC: 60120
2.0	**Dimensions**		-----	-----		
a)	Core diameter	mm	-----	-----	60 to 75	75 to 85
b)	Tolerance on core diameter	± mm	-----	-----	(0.04d+1.5)	(0.04d+1.5)
c)	Minimum nominal creepage distance 1. Normal	mm	-----	-----	-----	-----
	2. Anti Fog		-----	-----	9200	9200
3.0	Colour of glaze of finished porcelain insulator		-----	-----	Brown	Brown
4.0	Mechanical Strength of Long Rod	kN	-----	-----	120	160
5.0	**Minimum electrical values**		-----	-----		
a)	Power frequency **Withstand** voltage	kV rms	-----	-----	720/680	720/680
b)	Power frequency **Flashover** voltage	kV rms	-----	-----	740/700	740/700
c)	Impulse **Withstand** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	-----	-----	1550/1550	1550/1550
d)	Impulse **Flashover** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	-----	-----	1600/1600	1600/1600
e)	Wet Switching impulse withstand voltage (POSITIVE / NEGATIVE)	kV(peak)	-----	-----	1050/1050	1050/1050
f)	Corona extinction voltage level	kV rms	-----	-----	320	320
g)	Max. RIV for string including corona rings at 320kV rms	micro volts	-----	-----	1000	1000
6.0	**Eccentricity of Long Rod**					
a)	Max. axial/radial run out		-----	-----	1.2 % of insulator length	1.2 % of insulator length
b)	Max. angular displacement	deg	-----	-----	15	15
7.0	**Galvanizing**					
a)	Minimum mass of zinc coating	Gm/	-----	-----	600	600
b)	Minimum no. of one minute dips in	Nos.	-----	-----	6 dips	6 dips
c)	Minimum purity of zinc used for	%	-----	-----	99.95	99.95

6.0 SPECIFICATION DRAWINGS:

The specification in respect of the long rod insulators indicated above is given at Annexure-II. This specification is for information and guidance of the bidder only. The drawings to be furnished by the supplier shall be as per his own design and manufacture and shall be in line with the specification.

7.0 GENERAL TECHNICAL REQUIREMENTS:

7.1 **PORCELAIN**:

The porcelain used in the manufacture of the shell shall be nonporous of high dielectric, mechanical and thermal strength free from internal stress blisters and thermal strength from internal stresses blisters, laminations, voids, foreign matter. Imperfections or other defects, which might render it in any way unsuitable for insulator shells. Porcelain shall remain unaffected by climatic conditions, ozone, acid alkalis, and zinc of dust. The manufacturing shall be by the wet process and impervious character obtained by through vitrification.

7.2 PORCELAIN GLAZE:

Surfaces to come in contact with cement shall be made rough by stand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature coefficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the colour of the glaze shall be brown. The glaze shall have a visible luster and smooth on surface and be capable of satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body throughout the working temperature range.

7.3 METAL PARTS:

7.3.1 Cap and Ball pins:

Twin Ball pins shall be made with drop forged steel and caps with malleable cast iron. They shall be in one single piece and duly hot dip g galvanized. They shall not contain parts or pieces joined together, welded, shrink fitted or by any other process from more than one piece of material. The pins shall be of high tensile steel, drop forged and heat malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity with minimum of 6 dips. The bidder shall specify the grade, composition and mechanical properties of steel used for caps and pins.

7.3.2 SECURITY CLIPS:

The security clips shall be made of phosphor bronze or of stainless steel.

7.4 FILLER MATERIAL:

Cement to be used as a filler material shall be quick setting, for curing Portland cement. It shall not cause fracture by expansion or loosening by contraction. Cement shall not react chemically with metal parts in contract with it and its thickness shall be as small and as uniform as possible.

8.0 MATERIAL DESIGN AND WORKMANSHIP:

8.1 GENERAL:

i) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw materials quality control and to stage testing quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on Transmission lines.

ii) The design, manufacturing process and material control at various stages be such as to give maximum working load, highest mobility, best resistance to corrosion good finish, elimination of sharp edges and corners to limit corona and radio interference voltage

8.2 INSULATOR SHELL:

The design of the insulator shell shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. Shells with cracks shall be eliminated by temperature cycle test followed by temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity

and temperature.

8.3 METAL PARTS:

i) The twin ball pin and cap shall be designed to transmit the mechanical stresses to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the insulator or is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of a string or when a string is placed in position.

ii) Metal caps shall be free from cracks, seams, shrinks, air holes, blowholes and rough edges. All metal surfaces shall be perfectly smooth with no projecting parts or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly. Pins shall not show any macroscopically visible cracks, insulations and voids.

8.4 GALVANIZING:

All ferrous parts shall be hot dip galvanized six times in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 as per IS: 209. The zinc coating shall be uniform, smoothly adherent, reasonably light, continuous and free from impurities such as flux ash, rust stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

8.4.1 CEMENTING:

The insulator design shall be such that the insulating medium shall not directly engage with hard metal. The surfaces of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials.

8.5 SECURITY CLIPS (LOCKING DEVICES

The security clips to be used as locking device for ball and socket coupling shall be 'R' shaped hump type to provide for positive locking of the coupling as per IS: 2486 (Part-IV). The legs of the security clips shall allow for sore adding after installation to prevent complete withdrawal from the socket. The locking device shall be resilient corrosion resistant and of sufficient mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation when placed in position and under no circumstances shall it allow separation of insulator units and fitting 'W' type security clips are also acceptable. The hole for the security clip shall be countersunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked position shall not be less than 50 N (5 Kgs.) or more than 500N (50 Kgs.)

8.6 BALL AND SOCKET DESIGNATION:

The dimensions of the balls and sockets for 80 KN long rod insulators shall be of 16mm and for 120 KN shall be of 20mm designation in accordance with the standard dimensions stated in IS: 2486 (Part-III).

8.7 DIMENSIONAL TOLERANCE OF PORCELAIN LONG ROD INSULATORS

It shall be ensured that the dimensions of the long rod insulators are within the limits as per relevant IEC/ ISS.

9.0 TESTS (FOR DISC/PORCELAIN LONG ROD INSULATORS) :

9,1 The following tests shall be carried out on the insulator string and disc insulators.

9.2 TYPE TEST:

This shall mean those tests, which are to be carried out to prove the design, process of manufacture and general conformity of the material and product with the intents of this specification. These tests shall be conducted on a representative number of samples prior to commencement of commercial production. The Bidder shall indicate his schedule for carrying out these tests.

9.3 ACCEPTANCE:

This shall mean these tests, which are to be carried out on samples taken from each lot offered for pre-despatch inspection for the purpose of acceptance of the lot.

9.4 ROUTINE TESTS:

This shall mean those tests, which are to be carried out on each insulator to check the requirements, which

are likely to vary during production.

9.5 TESTS DURING MANUFACTURE:

Stage tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture to ensure quality control such that the end product is of the designed quality conforming to the intent of this specification.

9.6 TEST VALUE:

For all type and acceptance tests the acceptance values shall be the value guaranteed by the bidder in the guaranteed technical particulars of the acceptance value specified in this specification of the relevant standard whichever is more stringent for that particular test.

9.7 TEST PROCEDURE AND SAMPLING NORMS:

The norms and procedure of sampling for the above tests shall be as per the relevant Indian Standard or the Internationally accepted standards. This will be discussed and mutually agreed to between the supplier and purchaser before placement of order. The standards and normal according to which these tests are to be carried out are listed against each test. Where a particular test is a specific requirement of this specification, the norms land procedure for the same shall be as specified in Annexure-IV attached hereto as mutually agreed to between the supplier and the purchaser in the quality assurance programme.

9.8 TYPE TESTS:

The following type test shall be conducted on a suitable number of individual unit components, materials or complete strings.

9.8.1 On the complete insulator string with hardware fittings.

a)	Power frequency voltage withstand test with corona control rings and under wet condition.	: IEC: 60383
b)	Switching surge voltage withstand test under wet condition (For 400kV and above only)	: IEC: 60383
c)	Impulse voltage withstand test under dry condition.	: IEC: 60383
d)	Impulse voltage flashover test under dry condition.	: IEC: 60383
e)	Voltage distribution test.	: Applicable only for Disc insulators only
f)	Corona & RIV test under dry condition.	: As per this specification
g)	Mechanical strength test.	: As per this specification
h)	Vibration.	: As per this specification

9.8.2 On Insulators:

a)	Verification of dimensions.	: IS: 731/ IEC: 60383
b)	Thermal mechanical performance test:	: IEC:60575
c)	Power frequency voltage withstand and flashover (I) dry (ii) wet.	: IEC: 60383
d)	Impulse voltage withstand flashover test (dry)	: IEC: 60383
e)	Visible discharge test (dry)	: IS:731
f)	RIV test (dry)	: IS:8263/ IEC: 60437

All the type tests given under clause No.9.8.1 above shall be conducted on single suspension and Double Tension insulator string alongwith hardware fittings.

9.9 ACCEPTANCE TESTS:

9.9.1 For insulator:

a) Visual examination	: IS:731/IEC:60383
b) Verification of dimensions.	: IS:731/IEC:60383
c) Temperature cycle test.	: IS:731/IEC:60383
d) Galvanizing test.	: IS:731/IEC:60383
e) Mechanical performance test.	: IEC:60575
f) Test on locking device for ball and socket coupling.	: IEC:60372
g) Eccentricity test.	: IEC: 60383
h) Electro-mechanical/Mechanical strength test.	: IEC: 60383 (Disc/Long Rod)
i) Puncture test.	: IS:731 (Applicable only for Discs)
j) Porosity test.	: IS:731/IEC:60383

9.10 ROUTINE TESTS:

9.10.1 For insulators:

a) Visual inspection.	: IS:731/IEC:60383
b) Mechanical routine test.	: IS:731/IEC:60383
c) Electrical routine test.	: IEC:60383 (Applicable only for Discs)

9.11 TEST DURING MANUFACTURE: On all components as applicable**.**

a) Chemical analysis of zinc used for galvanizing.	: As per the Specification
b) Chemical analysis, mechanical and metallographic test and magnetic particle inspection for malleable castings.	: As per the Specification
c) Chemical analysis, hardness test and magnetic particle inspection for forgings.	: As per the Specification
d) Hydraulic Internal Pressure tests on shell.	: Applicable only for Discs
e) Crack detection test for metal parts.	: As per the Specification

9.12 ADDITIONAL TEST:

The purchaser reserves the right for carrying out any other tests of a reasonable nature at the works of the supplier/ laboratory or at any other recognized laboratory/ research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the purchaser to satisfy that the material complies with the intent of this specification.

9.13 CO-ORDINATION FOR TESTING:

For insulator strings, the supplier shall arrange to conduct testing of their disc/Porcelain long rod insulators with the hardware fittings to be supplied to the purchaser by other suppliers. The supplier is also required to guarantee overall satisfactory performance of the disc/Porcelain long rod insulator with the hardware fittings.

NOTE:

In respect of electrical tests on a complete string consisting of insulators and hardware guarantee of values of responsibility of testing shall be with hardware manufacturer of RIV, corona and voltage distribution test (Applicable for Disc insulator strings only) and with insulator manufacturer for all other tests.

9.14 TEST CHARGES AND TEST SCHEDULE:

9.14.1 TYPE TEST:

The insulator offered shall be fully type tested as per this specification. In case the equipment of the type and design offered, has already been type tested in an independent test laboratory. The bidder shall furnish four sets of type test reports alongwith the offer. These tests must not have been conducted earlier than five years. The purchaser reserves the right to demand repetition of some or all type tests in the presence of purchasers' carrying representative. For this purpose the bidder may quote unit rates for carrying out each type test. These prices shall be taken into consideration for bid evaluation. For any change in the design/type already type tested and the design/type offered against this specification, purchaser reserves the right to demand repetition of tests without any extra cost.

9.14.2 ACCEPTANCE AND ROUTINE TEST:

All acceptance and routine tests as stipulated herein shall be carried out by the supplier in the presence of purchaser's representative.

9.14.3 Immediately after finalisation of the programme of type/ acceptance/ routine testing, the supplier shall give sufficient advance intimation to the purchaser to enable him to depute his representative for witnessing the tests.

For type tests involving tests on a complete insulator string with hardware fittings, the purchaser will advice the supplier of the hardware fittings to provide the necessary fittings to the place of the test.

9.14.4 In case of failure of the complete string in any type tests, the supplier whose product has failed in the tests, shall get the tests repeated at his cost. In case of any dispute, assessment of the purchaser as to the items that has caused the failure in any of the type tests shall be final and binding.

10. INSPECTION:

10.1

i. Purchaser and its representative shall at all times be entitled to have access to the works and to all places of manufacturer where insulators are manufactured and the supplier shall afford all facilities to them for unrestricted inspection of the works, inspection of materials, inspection of manufacturing process of insulators and for conducting necessary tests as specified herein.

ii. The supplier shall keep the purchaser informed in advance of the time of starting and of progress of manufacture of insulators in its various stages so that arrangements could be made for inspection.

iii. No material shall be dispatched from its point of manufacture unless the materials has been satisfactorily inspected and tested.

iv. The acceptance of any quantity of insulators shall in no way relieve the supplier of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection, if such insulators are later found to be defective.

10.2 IDENTIFICATION / MARKING:

10.2.1 Each unit of insulator shall be legibly and indelibly marked with the trade mark of the supplier, the year of manufacture, the guaranteed combined mechanical and electrical strength in kilo-newtons abbreviated by 'KN' to facilitate easy identification and proper use.

10.2.2 The marking shall be on porcelain for porcelain insulators. The marking shall be printed and not impressed and the same shall be applied before firing.

11. QUALITY ASSURANCE PLAN:

11.1 The bidder hereunder shall invariably furnish following information alongwith his offer, failing which the offer shall be liable for rejection.

i. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw material are tested, list of tests normally carried out on raw materials in presence of

bidder's representative, copies of test certificates.

ii. Informations and copies of test certificates as in (i) above in respect of bought out materials.

iii List of manufacturing facilities available.

iv Level of automation achieved and lists of area where manual processing exists.

v List of areas in manufacturing process, where stage inspections are normally carried out in quality control and details of such tests and inspection.

vi Special features provided in the equipment to make it maintenance free.

vii. List of testing equipping available with the bidder for final testing of equipment specified and test plant limitation, if any, vis-à-vis the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

11.2 The supplier shall within 30 days of placement of order submit the following information to the owner.

i) List of raw material and the names of sub-suppliers selected from those furnished alongwith the offer.

Sl.No.	Description	EMS value	No of Discs	Size of Disc (mm)	CD of Disc (mm)	No of PLRI	Size of PLRI (mm)	CD of PLRI (mm)
1	132kV Single Suspension string	70/90KN – Normal	1 X 9	255 x 145	320	1 X 1	1305	2628
2	132kV Double Suspension string	70/90KN – Normal	2 X 9	255 x 145	320	2 X 1	1305	2628
3	132kV Single Suspension string	70/90KN – Anti Fog	1 X 9	255 x 145	430	1 X 1	1305	3625
4	132kV Double Suspension string	70/90KN – Anti Fog	2 X 9	255 x 145	430	2 X 1	1305	3625
5	132kV Single Suspension string	120KN – Anti Fog	1 X 10	280 x 145	430	1 X 1	1450	3625
6	132kV Double Suspension string	120KN – Anti Fog	2 X10	280 x 145	430	2 X 1	1450	3625
7	132kV Single Tension string	160KN – Anti Fog	1 X 10	305 x 170	475	1 X 1	1700	3625
8	132kV Double Tension string	160KN – Anti Fog	2 X10	305 X 170	475	2 X 1	1700	3625
9	220kV Single Suspension string	90KN – Normal	1 X 14	255 x 145	320	1 X 2	2030	4088
10	220kV Double Suspension string	90KN – Normal	2 X 14	255 x 145	320	2 X 2	2030	4088
11	220kV Single Suspension string	90KN – Anti Fog	1 X 14	255 x 145	430	1 X 2	2030	4380
12	220kV Double Suspension string	90KN – Anti Fog	2 X 14	255 x 145	430	2 X 2	2030	4380
13	220kV Single Suspension string	120KN – Anti Fog	1 X 15	280 x 145	430	1 X 2	2175	5180
14	220kV Double Suspension string	120KN – Anti Fog	2 X15	280 x 145	430	2 X 2	2175	5180

15	220kV Single Tension string	160KN – Anti Fog	1 X 15	305 x 170	475	1 X 2	2550	5550
16	220kV Double Tension string	160KN – Anti Fog	2 X15	305 X 170	475	2 X 2	2550	5550
17	400kV Single Suspension string	120KN – Anti Fog	1 X 25	280 x 145	430	1 X 3	3335	9200
18	400kV Double Suspension string	120KN – Anti Fog	2 X25	280 x 145	430	2 X 3	3335	9200
19	400kV Single Tension string	160KN – Anti Fog	1 X 25	305 x 170	475	1 X 3	3910	9200
20	400kV Double Tension string	160KN – Anti Fog	2 X25	305 X 170	475	2 X 3	3910	9200

ODISHA TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

FOR HDG STEEL MONOPOLE

TECHNICAL SPECIFICATION FOR SUPPLY OF HDG STEEL MONOPOLES

1.0: SCOPE:

1.01: The designs of multi circuit and double circuit steel monopole towers and their extensions should be conforming to the design parameter specified herein. The scope of supply of towers also includes supply of design calculations and test reports for towers and extensions including detailed structural/shop drawings of towers, extensions and stub-setting templates and design and drawings of foundations in various types of soil, sag templates, sag tension chart for conductor and ground wire etc.

1.02: The fabricated steel poles shall be include base plate with its required accessories, monopole body (including extensions, if required), Cross Arms. Monopole shall be joined with friction clip or Flanged joint. Cross Arms shall be also Polygonal with structural jointing arrangement. The accessories shall include strain plates, D-shackles with nuts, bolts and washers, U-Bolts with nuts and washers, space washers, links for providing attachment to the E.W and Conductor , ant climbing devices and any other equipment/ material / article to complete the works as per the scope given in this specification.

1.03: The monopoles shall be fully galvanized. Provision will be made at the Cross Arm level for fixing phase plates and Bird guards. The holes for fixing the Earthing bonds at the peak and for grounding the monopoles at bottom or any other holes, which the purchaser may require, shall be provided at the convenient locations on the monopoles.

2.00: TYPE OF MULTI CIRCUIT AND DOUBLE CIRCUIT STEEL MONOPOLE

2.1.1: The **multi circuit** monopole will have four circuits (twelve cross arms), self-supporting, designed for the specified loading conditions. There will generally be following type of towers:-
(i) Monopole type **MP0:** Tangent type tower with maximum line deviation up to 2° to be used with Single/Double suspension insulator strings.
(ii) Monopole type **MP30**: Medium angle tower to be used for line deviation from 2° to 30° with Single/Double tension insulator strings.
(iii) Monopole type **MP60**: Heavy angle tower to be used for line deviation from 30° to 60° and also as dead end tower with Single/Double tension insulator strings.

2.1.2: The **double circuit** Monopole will have two circuits (six cross arms), self-supporting, designed for the specified loading conditions. There will generally be following type of towers:-
(i) Monopole type **MP0:** Tangent type tower with maximum line deviation up to 2° to be used with Single/Double suspension insulator strings.
(ii) Monopole type **MP30:** Medium angle tower to be used for line deviation from 2° to 30° with Single/Double tension insulator strings.
(iii) Monopole type **MP60:** Heavy angle tower to be used for line deviation from 30° to 60° and also as dead end tower with Single/Double tension insulator strings.

2.02: The bidder may also quote for up gradation work using the categories of Monopole available with him. In such case the bidder will have to indicate the type of monopoles and extensions proposed to be used by him for up gradation work.

2.03: EXTENSIONS:
Suitable extension of 3M, 6M, 9M & 12M height shall be designed for use with all type of towers.

2.04: <u>DESIGN: (220 KV/132KV) as per ASCE-48-05</u>:
2.04.01: The bidder will furnish a design as per **ASCE-48-05** for each of the offered monopoles with extensions based on the loading conditions indicated herein. The suspension monopoles shall be designed with using `I' suspension string.

2.04.02: Please note that in case of suspension monopole, full wind condition is to be considered in the design in case of security requirement i.e. transverse load due to wind action on tower structure, conductors, ground wire and insulators shall be computed as per clause **12.1.1(i), page 10 of IS 802 (Part-1) 1995 or its latest**. The mechanical tension of conductor/ground wire is the tension corresponding to 100% design wind pressure at everyday temperature or 36% design wind pressure at minimum temperature after accounting for drag coefficient and gust response factor as defined in clause **11.3.2.1 page 10 of IS 802 (Part-1) 1995 or its latest**. The longitudinal loads shall correspond to 50% of mechanical tension of conductor as per clause **11.3.2.1, page 10 of IS 802 (Part-1):1995 or its latest**.

2.04.03: The monopole will have one conductor per phase (Zebra/Panther ACSR) in vertical formation and one ground-wire of (**7/3.66**/**7/3.15**mm) galvanized stranded steel wire of 95kg/sq.mm grade placed on the top of the monopole. The conductor and ground-wire particulars are given in clause 2.04.07.

2.04.04: The ground-wire at its suspension point shall provide a shielding angle of 30° with respect to the top most conductors. The drop of ground-wire suspension assembly should be taken into account so as to determine the shielding angle.

2.04.05: The minimum mid-span vertical clearance between Ground-wire and Conductor in still air shall be **8.5/6.1** Mtrs for **220/132** KV respectively.

2.04.06: The minimum electrical clearance between conductors shall be **8.4/6.8** Mtrs for **220/132** KV respectively (Horizontal) for **220/132** kV tower.

2.04.07: The conductor and Ground wire parameters to be considered in the design of 132kV towers (ACSR Panther) & 220 kV tower (ACSR Zebra) are as under:-
<u>220 KV</u>
<u>ACSR Zebra Conductor:</u>
a) Stranding and wire diameter 54/3.18 mm Al.,07/3.18mm Steel
b) Total sectional area 484.5 mm²
c) Approximate overall diameter 28.62 mm
d) Approximate weight 1621 kg/km
e) Approximate calculated breaking load 13290 Kg
f) Co-efficient of linear expansion 19.35 x10-6 per degree C
g) Final modules of elasticity 0.7034 x 106 kg/cm² **95 Kg/mm²**

<u>Ground wire:</u>
a) Stranding and wire diameter 7/3.66mm.
b) Total sectional area 73.65 mm²
c) Approximate overall diameter 10.98 mm
d) Approximate weight 583 kg/km
e) Approximate calculated breaking load 6972 kg
f) Co-efficient of linear expansion 11.5x10-6 per degree C
g) Final modules of elasticity 1.9329 x 106 kg/cm²

132 KV

ACSR Panther Conductor:

a) Stranding and wire diameter 30/3.00 mm Al.,07/3.00mm Steel
b) Total sectional area 212.1 mm²
c) Approximate overall diameter 21 mm
d) Approximate weight 973 kg/km
e) Approximate calculated breaking load 89.67 KN
f) Co-efficient of linear expansion 17.8 x 10^{-6} per degree C
g) Final modules of elasticity 0.815 x 10^{6}Kg/CM^2 (80GN/M^2)

Ground wire:

a) Stranding and wire diameter 7/3.15mm.
b) Total sectional area 54.55 mm²
c) Approximate overall diameter 9.54 mm
d) Approximate weight 428 kg/km
e) Approximate calculated breaking load 5810 kg
f) Co-efficient of linear expansion 11.50 x 10^{-6} per deg. C.
g) Final modules of elasticity 1.938 x 106 Kg/Cm2

2.05: CLEARANCES:

The following minimum clearances may be made available between the live parts and the nearest monopole bay.

Suspension string Jumper in case of tension monopoles

Swing Clearance:

Sl No.	Description	220 KV in mm	132 KV in mm
1	Still air(Nil)	2130	1530
2	15 deg	1980	1530
3	30 deg	1830	1370
4	45 deg	1675	1220
5	60 deg	-	1070

The above clearances are based on maximum and minimum string lengths of insulators as per standard practice. If Pilot string is used in case of 60° monopole; swing of the pilot string shall be 15 deg. The clearance shall be available from grading ring if the same happens to be the nearest to the monopole body at any point of time.

2.06: DESIGN SPANS:

The wind span for the purpose of computing the wind load on conductors and ground-wire shall be indicated in the offer. Similarly the weight span shall also be indicated.

2.07: WIND LOAD:

The wind load on conductors, earth wire, towers and insulator strings shall be taken as per recommendations of **IS: 802 (Part-I) -1995 or its latest** with latest revision thereof, for following conditions:-

(a) **Wind zone** - **6 (Six) (55 mtrs/sec)**

(b) **Reliability level** –

(a) 1.0 (one) for 220/132 kV double circuit monopoles

And, **(b)** 2.0 (Two) for 220/132 kV multi circuit monopoles.

(c) **Terrain category** - 1 (one)

2.08: TEMPERATURE VARIATION:

The maximum working tension of conductor and ground-wire and the uplift conditions shall correspond to the minimum temperature of 0° C. The maximum conductor sag and ground clearance beneath should correspond to the maximum working temperature of 75° C. The Maximum ground-wire temperature shall be taken as 53° C.

2.09: STRUCTURAL STEEL:

2.09.01: Structural steel shall be conforming to **ASTM A572-65 (450 Mpa) & 50 (345 Mpa) or equivalent** and plates/sheets not less than 5 mm thickness. The sheets/plates of monopole shall be from **TATA/SAIL/JSW/ESSAR/RINL**.

2.09.02: Permissible stresses in the design of self-supporting steel monopole tower shall conform to **ASCE: 48-05** latest edition or equivalent code of latest edition.

2.10: LOADS ON MONOPOLES:

Transmission lines are subjected to various loads during their life time. These loads are classified into three distinct categories, namely

a) Climatic Loads: related to the reliability requirements.

b) Failure containment Loads: related to security requirements.

c) Construction & Maintenance Loads: related to safety requirements.

a) Climatic Loads:

These are random loads imposed on monopole, insulator string; conductor & ground wire due to action of wind on transmission line & do not act continuously. Climatic loads shall be determined under either of the following climatic conditions whichever is more stringent:

(1)100 percent design wind pressure at every day temperature (32°C)

or

(2) 36 percent design wind pressure at minimum temperature (0°C)

b) Failure Containment Loads:

- Anti cascading Loads &
- Torsional & Longitudinal Loads

Anti-Cascading Loads:

Cascade failure may be caused by failure of items such as insulators, hardware, joints failures of major components such as monopoles, foundations, conductor due to defective material or Workman ship or from climatic overloads sometimes from casual events such as misdirected aircraft, avalanches, sabotage etc. The security measures adopted for containing cascade failures in the line is to provide angle monopoles at specific intervals which shall be checked for Anti-cascading loads.

Anti-cascading checks:

i) Suspension monopoles shall be checked for narrow front wind with a wind speed of 2.0 of basic wind speed.

ii) Angle monopoles shall be checked for the following anti cascading conditions with all the conductors & ground wire intact only on one side of the monopole.
 Transverse load: These loads shall be taken under no wind condition.
 Vertical Load: These loads shall be the sum of weight of conductor/ground wire as per weight span of intact conductor/ground wire, weight of insulator strings and accessories.
 Longitudinal Loads: These loads shall be the pull of conductor/ground wire at every day temperature & no wind applied simultaneously at all points on one side with zero degree line deviation.

Torsional & Longitudinal Loads:
These loads are caused by breakage of conductors and/or ground wire. All the monopoles shall be designed for these loads for the number of conductor(s) and or ground wire considered broken as per provisions of this specification.

c) Construction & Maintenance Loads:
These are loads that are imposed on monopoles during constructions & maintenance of transmission lines.
Computation of Loads & loading combinations: The computation of loads is to be done in line with relevant provisions/ sections of IS 802- 1992 (latest amendment)

Tension Limits:
Conductor/ground wire tension at everyday temperature & without external load, should not exceed the following percentage of the ultimate tensile strength of the conductor:
Initial unloaded tension **22 percent**, Final unloaded tension **25 percent** provided that the ultimate tension under everyday temperature & **100 percent** design wind pressure or minimum temperature & **36 percent** design wind pressure does not exceed **70 percent** of the ultimate tensile strength of the conductor/ground wire.

2.11: TRANSVERSE LOADS
The transverse loads due to wind on conductors and ground-wire shall be calculated
(i) For Normal span: 250 Mtrs.
(ii) For Wind span: 275 Mtrs.
(iii) For Weight span: 375 Mtrs.
under normal condition. Under broken wire conditions 50% of the intact span and 10% of the broken span shall be assumed as wind span. In addition to this, transverse loads due to line deviation, wind on towers, and wind on insulator strings should also have to be taken into consideration in the design of the towers.

2.12: CONDUCTOR AND GROUND-WIRE SAG:
The maximum sag for the conductor should be calculated for 75° C and no wind with an allowance of 4% of maximum sag to allow for plotting and sagging errors.

2.13: GROUND CLEARANCE:
The minimum ground clearance of **8/7 (220/132 KV respectively**) Meters shall be available corresponding to the maximum working temperature and normal span.

2.14: BROKEN WIRE CONDITIONS:

2.14.01: Following broken wire conditions should be assumed in the design of towers:-
a. **Suspension monopole-** Any one of power conductor broken or ground-wire broken which ever condition is more stringent for design.

b. **Angle monopole** (2° to 30°) **-** Any two of power conductors broken on the same side and on the same span or any one of the power conductor broken and ground-wire broken on the same span whichever combination constitutes the most stringent condition for design of a particular member.

c. **Angle tower (**30° to 60°**) -** Any Three power conductors broken on the same side and on the same span or any two of the power conductor broken and ground-wire broken on the same side and same span whichever combination constitutes the most stringent condition for design. Further this monopole shall also be designed for dead end condition i.e. all conductors and ground wire broken on the same side and same span.

2.14.02: In all type of monopoles, the power conductor's supports and ground-wire supports should be designed for broken wire conditions also.

2.15: FACTORS OF SAFETY FOR MONOPOLES:

The factors of safety for design of monopoles shall be as under:-

(i) Normal condition – **1.05.**

(ii) Broken wire condition – **1.05**

DEFLECTION CRITERIA: 1.5% of the height under safety normal condition and 5% of height under ultimate wind for both suspension and tension poles.

2.16: BOLTS AND NUTS AND WASHERS:

2.16.01: The design of the monopoles should be based on use of HRH mild steel hot dip galvanized bolts having grade **6.8(for foundation bolts)/8.8(for connection bolts).** The connections shall be designed on the basis of use of **24 mm** dia bolts. The spring washers shall be provided for insertion under all nuts. These washers shall be of steel, electro galvanized, positive lock type and of minimum 3.5mm thickness.

2.16.02: The nuts shall be forged and tapped after galvanizing and then lubricated. The nuts shall be chamfered on one face only, the other face shall be machined.

2.16.03: The bolts and nuts shall be free from forging and threading defects such as cuts, splits, burrs, bulging, taper, eccentricity, loose fit etc.

2.16.04: The bolts shall be threaded up to standard length only as per relevant Indian Standard and not to full length.

2.16.05: The bolts and nuts shall confirm to IS 1367-1971 Part-III and Part-IV, IS 12427, IS 1363-92, IS 1367 Part-XIII with latest amendment.

2.16.06: The spring washers after coiling shall be suitably heat treated so as to result in the finished washer having hardness 43 to 50 HRC when tested in accordance with IS 1586- 1968.

2.16.07: The surface of the washers shall be free of scales and burrs. The washers shall be coiled without any kinks (except for the shape with turned-up ends). The ends of the washer shall not about when the washers are compressed. The ends shall be so served as to prevent tangling.

2.17: LOAD ON FOUNDATIONS:

2.17.01: The foundations shall withstand the ultimate loads on the superstructure as specified in this specification, for the full footing reactions along the stub angle slopes obtained from the structural stress analysis.

2.17.02: The reactions on the footing shall be composed of the following types of loads for which they shall be required to be checked.
(a) Maximum tension or uplift.
(b) Maximum compression or down-thrust.
(c) Maximum horizontal shear or side thrust.

2.17.03: The additional weight of concrete in the footing below ground level over the earth weight and full weight of concrete above the ground level in the footing and embedded steel parts will also be taken into account adding to the down-thrust.

2.18: STABILITY ANALYSIS:

2.18.01: The following primary types of soil resistances shall be assumed to act in resisting the loads imposed on the footings in earth:

(a) Resistance against uplift:
The uplift loads will be assumed to be resisted by weight of earth in an inverted frustum of a conical pyramid of earth on the footings pad whose sides make an angle equal to the angle of repose of the earth with the vertical in average soil. The weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift. In case where the frustum of earth pyramids of two adjoining legs super-impose each other, the earth frustum will be assumed truncated by a vertical plane passing through the centre line of the tower base.

(b) Resistance against down-thrust:
The down -thrust loads combined with the additional weight of concrete above earth will be resisted by bearing strength of the soil assumed to be acting on the total area of the bottom of the footings.

(c) Resistance against side thrust:

The bidder shall describe in detail the methods followed by them to check the stability of foundations for horizontal shears.

OR

*Side-thrust along with the relevant reference (**IS or other standard**) in support of their contentions*.

2.18.02: In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over-turning, uprooting, sliding and tilting of the foundation.

2.19: DESIGN OF FOUNDATIONS:
The bidder is requested to submit the design of foundations. It is recommended to give Single Pile Foundation.

2.20: FACTORS OF SAFETY FOR FOUNDATION:

The minimum factors of safety/overload factor based on the ultimate strength of the foundation material when the monopoles are under full working loads under various conditions of loadings combined with the other loads specified for the foundations shall be as given below:-

(a) Normal condition - 1.5
(b) Broken wire condition - 1.5

3.0: TYPE TEST:

Monopoles are to be type tested for each type.

Type test is waived off, if the manufacturer/supplier having successfully type (suspension & angle monopoles) tested in **CPRI/ in any independent NABL accredited testing centres** for **(i)** 132 KV & above for 132 KV monopole and **(ii)** 220 KV & above for 220 KV monopole and conducted during last 3 years from the date of submission of drawings for approval subject to submission of report for verification.

ODISHA POWER TRANSMISSION CORPORATION LIMITED

VOLUME-II

Technical Specification for Fiber Optic Terminal Equipment

INDEX

1. FIBER OPTIC TERMINAL EQUIPMENT (FOTE)

1.1 SCOPE

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

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

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

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

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

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

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

1.2 GENERAL REQUIREMENT

The digital multiplex equipment shall be designed to operate in electrical high-voltage networks and shall be suitable for installations in substations with harsh environment and high electromagnetic interference. It shall be highly reliable and provide secure communications for real time signals such as voice, SCADA, teleprotection, data including IP/Ethernet and status/control signals.

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

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

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

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

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

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

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

Analogue subscriber interface: subscriber and exchange side

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

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

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

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

All optical ports shall support SFPs (small-factor pluggable unit) for short, medium, long and extra-long optical communication. ALS (Automatic Laser Shut-down) shall be fully supported.

1.3 FUNCTIONAL REQUIREMENT

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

1.3.1 Equipped Minimum Configuration

Each FOTE Equipment shall consist of below interfaces at minimum:

a) Redundant Power supply units

b) Redundant Cross Connect Units

c) Nos. STM-1 ports which can also be used for STM-4 also. (Type of SFPs and quantity to be proposed by the bidder avoiding the requirement of repeaters)

d) E1 Card- Minimum 16 E1s.

e) Ethernet Ineterface Card with Layer-2 Switching Capability with minimum 8 FE ports

f) 4-wires E & M channel interface Card with minimum 8 channels

g) Low speed RS232 data Channels(600 -1200 bps)- minimum 8 channel

h) 2-Wire FXO Card- minimum 12 channels to interface with Exchange

i) 2-Wire FXS Card- minimum 6 channels to interface with Remote Subscriber

Note:

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

1.3.2 Other interfaces supported by the equipment

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

a) IEEE C37.94 Interface Card – Minimum 4 ports for Differential Protectio and direct connectivity with Current Differential Relays.

b) Teleprotection Module with minimum 4 Input /Output Commands and same shall be upgradeable to 8 Input/Output Commands.

c) Router Card with minimum 8 FE ports with Layer-3 features and supporting WAN protocols i.e. Static, RIP-I, RIP-II and OSPF routing protocols.

d) 2 Wire Hotline Interface Card- Minimum 4 Channels

e) SDH Tributary/Branching Card with minimum 2 x STM-1 Interfaces

1.3.3 Teleprotection Module

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

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

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

1.4 GENARAL EQUIPMENT CHARACTERISTICS

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

1.4.1 Salient Features to be supported by the FOTE System

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

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

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

1.4.2 General Equipment Characteristics

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

a Channel capacity: Digital Cross Connection

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

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

b. Redundant centralized functions

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

c. Power Supply

The multiplex equipment shall operate from a nominal 48Volt DC battery with positive ground. The equipment shall work satisfactorily over battery voltage variations of + / – 15% (40.8 volts through 55.2 volts). Redundant power-supply (1+1 hot-standby) shall be supported. The equipment shall support dual power feed i.e. that two power sources can be connected directly to the equipment (two connection points).

d. Safety

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

e. Electromagnetic compatibility and safety regulations

The equipment shall comply Comply with IEC TS 61000-6-5: “Immunity for power station and substation environments”
EN55022 Class A, EN50024/EN300386, FCC Part 15 Class A

f. Ambient Conditions

Storage and transport:
Temperature range: - 25°C ... +70°C
Humidity: max. 98% (no condensation)

Operation:
Temperature range: - 5°C … +55°C
Humidity: max. 95% (no condensation)

g. Mechanical construction

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

h. Network configuration/management system

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

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

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

i. Local User Terminal

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

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

j. Network protection

The equipment shall provide means to protect the network by SNCP and MSP. It shall be possible to use two independent links: one as the main and the other as the standby. The system shall automatically switch to the standby connection and generate an alarm if the main connection is disturbed.

The switching shall be done within the multiplexer without using the Network Management System.

k. Network Topology

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

l. Synchronization

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

n. Alarms

Each module shall supervise its functions and shall have an alarm-indication LED on its front. All alarms shall be collected by the NMS. Each node shall be capable of collecting up to 50 external alarms.

o. Test Loops

The equipment shall provide means to loop signals on 64kBit/s level as well as on 2Mbit/s level. It shall indicate an alarm if a loop is activated.

p. Maintenance facilities

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

1.5 TRANSMISSION INTERFACES

a SDH Modules

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

The following main functions shall be supported:

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

The following Optical interfaces shall be available:

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

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

b. PDH Modules

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

c. DSL Trunk Modules

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

1.6 USER SIGNAL INTERFACES

a. 4-Wire Interface (VF interface)

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

The level shall be software adjustable within the following range:

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

b. Analogue Subscriber Interface (FXS)

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

The following main functions shall be supported: Downstream signaling

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

c. Exchange Interface (FXO)

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

- pulse dialing, tone dialing (DTMF), earth key function, metering function(12 kHz or 16 kHz), flash impulse, polarity reversal, indication of busy lines The following parameters shall be configurable by software:
- Input voice level -5.. +4dBr, output voice level -7.5… -1dBr
- metering pulse enable/disable, signaling bit definition,
- loop back of voice to the telephone

d. Engineering Order Wire

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

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

e. Data Interfaces

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

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

f. 64kbit/s Co-directional Interface

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

g. IP/Ethernet Interface

Ethernet module shall comply with the following specification:

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

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

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

h. Alarm Interface

This module shall provide means to collect minimum 4 external alarms, which shall be displayed on the Network Management System. It shall be used to supervise external equipment by the Network Management System. Minimum 4 outputs, which can be switched by the Network Management System. It shall be possible to connect an input to an output so that if an alarm occurs, the output contact will be switched.

I Teleprotection Signalling Equipment (For distance protection scheme)

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

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

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

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

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

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

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

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

.

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

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

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

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

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

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

K. Module for transmission of Binary Signals

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

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

1.7 NETWORK MANAGEMENT SYSTEM (NMS)

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

Network management is crucial for the overall performance and availability of the communication network. The task of the network management system (NMS) is to provide complete and efficient supervision of the alarm state of the network (fault management), to facilitate the adaptation of the configuration to changing needs (configuration management) and to strictly control the access to the various NMS features (security management).
The NMS design concept, functional and informational architecture and physical architecture, shall be in compliance with ITU-T Recommendation M.3010. For ease of management and monitoring by the System shall be able to manage all the offered communication equipment SDH/PDH, Differential Protection Interface and Teleprotection equipment from a single software and hardware.

a) Supported Network Elements

FOTE (SDH/PDH/Teleprotection) Equipment
PLCC Terminal Equipment

b) Graphical User Interface

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

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

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

c) Configuration Management

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

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

II. Gather descriptive information about the current configuration of the equipment, provide operator displays, and prepare reports.

III. Provide tools for planning, establishing, and changing the static equipment configuration. Provide for changes to the equipment configuration in response to equipment failures, planned upgrades, and operator requests to take equipment offline for testing.

IV. Provide verification testing to support new equipment installation.

d) NMS Configuration

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

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

e) Hardware Requirement

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

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

II. The workstation shall have minimum configuration of 2.4GHz, 1GB RAM, DVD+/-RW drive, 160 GB Hard Disk Drive, 101-Enhanced style eyboards, mouse, parallel, serial and USB (2.0) ports. VDUs shall be 19" TFT active

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

III. The craft terminal shall have minimum configuration of 2.4 GHz, 2 GB RAM,256 MB VRAM, DVD RW drive, 160 GB Hard Disk Drive, integrated Gigabit Ethernet network interface, keyboard, mouse/trackball etc., parallel, serial/USB (2.0) ports to accommodate printers, RS 232 serial port and Internal/external Data/Fax modem and a battery back-up of at least 60 minutes. VDUs shall be 15" TFT active matrix colour LCD with a minimum resolution of 1024 X 768.

IV. NMS system shall be provided with laser printers. The laser printers shall have a minimum print speed of 17 pages per minute and a minimum resolution of 1200 x 1200 dpi. The laser printer shall have parallel and LAN ports for connecting to NMS system. All laser printers under this specification shall be black & white and include print enhanced buffering to prevent loss of print data in the event of a print failure.

1.8 OPTICAL LINK BUDGET CALCULATION

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

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

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

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

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

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

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

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

8) Dispersion: The fibre dispersion shall be taken to be the guaranteed maximum dispersion i.e. 18 ps/nm.Km @1550 nm & 6 ps/nm.km @ 1310 nm for 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 in the Bid.

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

1.8.1 OPTICAL FIBER SPECIFICATION

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

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

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

DWSM Optical Fibre Characteristics

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

1.9 SUMMARY OF STANDARDS

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

ETSI

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

IEC

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

IEEE

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

The PDH Interfaces shall conform to the following Recommendations:

ITU

- ITU - T G.702: General Aspects of Digital Transmission Systems – Terminal Equipment - Digital Hierarchy Bit Rates
- ITU - T G.703: Digital Transmission Systems – Terminal Equipment – General Physical / Electrical Characteristics of Hierarchical Digital Interfaces
- ITU - T G.704: Digital Transmission Systems – Terminal Equipment – General Synchronous Frame Structures used at 1544, 6312, 2048, 8448 and 44 736 kbps Hierarchical Levels
- ITU - T G.706: General Aspects of Digital Transmission Systems – Terminal Equipment - Frame Alignment and Cyclic Redundancy Check (CRC) Procedures relating to Basic Frame Structures defined in recommendation G.704
- ITU - T G.711: Pulse Code Modulation (PCM) of Voice Frequencies
- ITU – T G.712: Transmission Performance Characteristics of Pulse Code Modulation Channels
- ITU - T G.732: General Aspects of Digital Transmission Systems – Terminal Equipment - Characteristics of Primary PCM Multiplex Equipment operating at 2048 kbps
- ITU - T G.735: Characteristics of Primary Multiplex Equipment operating at 2048 kbps and offering Synchronous Digital Access at 384 kbps and / or 64 kbps
- ITU - T G.736: General Aspects of Digital Transmission - Characteristics of a Synchronous Digital Multiplex Equipment operating at 2048 kbps
- ITU - T G.737: Characteristics of External Access Equipment operating at 2048 kbps and offering Synchronous Digital Access at 384 kbps and / or 64 kbps
- ITU - T G.823: The Control of Jitter and Wander within Digital Networks, which are based on the 2048 kbps Hierarchy
- ITU - T G.826: Error Performance Parameters and objectives for International, Constant Bit Rate Digital Paths at or above the Primary Rate

The Architecture of Optical SDH Interfaces shall conform to the following Recommendations:

ETS / EN

- ETS 300 147: Synchronous Digital Hierarchy Multiplexing Structure
- ETS 300 417: Transmission and Multiplexing (TM); Generic Requirements of Transport Functionality of Equipment
- ETS 300 417 – 1 - 1 / EN 300 417 – 1 - 1 V1.1.2: Generic Processes and

Performance
- ETS 300 417 – 2 - 1 / EN 300 417 – 2 - 1 V1.1.2: SDH and PDH Physical Section Layer

Functions
- ETS 300 417 – 3 - 1 / EN 300 417 – 3 - 1 V1.1.2: STM - N Regenerator & Multiplex Section

Layer Functions
- ETS 300 417 – 4 - 1 / EN 300 417 – 4 - 1 V1.1.2: SDH Path Layer Functions

ITU
- ITU - T G.707: Network Node Interface for the Synchronous Digital Hierarchy
- ITU – T G.783: Characteristics of Synchronous Digital Hierarchy (SDH): Equipment Functional Blocks
- ITU-T G.803: Architecture of Transport Networks based on the Synchronous Digital Hierarchy (SDH)
- ITU - T G.805: Generic Functional Architecture of Transport Networks
- ITU - T G.826: Error Performance Parameters and Objectives for International, Constant Bit Rate Digital Paths at or above the Primary Rate
- ITU - T G.841: Types and Characteristics of Synchronous Digital Hierarchy (SDH) Network Protection Architectures
- ITU - T G.957: Optical Interfaces for Equipment and Systems relating to the Synchronous Digital Hierarchy
- ITU - T G.958: Digital Line Systems based on the Synchronous Digital Hierarchy for use on Optical Fibre Cables
- ITU - T M.2101.1: Performance Limits for bringing into Service and Maintenance of International SDH Paths and Multiplex Section
- ITU - T T.50: International Reference Alphabet (IRA) - Information Technology 7 Bit Coded Character Set for Information Interchange

The Synchronisation and Timing of Optical SDH Interfaces shall conform to the following Recommendations:

ETS / EN
- ETS 300 417 – 6 - 1 / EN 300 417 – 6 - 1 V1.1.2: Synchronisation Layer Functions
- ETS 300 462 - 1 / EN 300 462 – 1 - 1 V1.1.1: Transmission and Multiplexing (TM); Generic Requirements for Synchronization Networks; Part 1: Definitions and Terminology for Synchronization Networks
- EN 300 462 – 4 - 1 V1.1.1: Transmission and Multiplexing (TM); Generic Requirements for Synchronization Networks; Part 4 - 1: Timing Characteristics of Slave Clocks suitable for Synchronization Supply to Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) Equipment
- ETS 300 462 - 5 / EN 300 462 – 5 - 1 V1.1.2: Transmission and Multiplexing (TM); Generic Requirements for Synchronization Networks; Part 5: Timing Characteristics of Slave Clocks suitable for Operation in Synchronous Digital Hierarchy (SDH) Equipment

ITU
- ITU - T G.813: Timing Characteristics of Synchronous Digital Hierarchy (SDH) Equipment Slave Clocks (SEC)

ABBREVIATIONS

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

	Cyclic Redundancy Check
DTMF	Dual Tone Multi - Frequency
EN	European Norm
EOW	Engineering Order Wire
ETS	European Telecommunications Standards
GPS	Global
HDSL	High Density Subscriber Line
IEC	International Electrical Commission
ITU	International Telecommunication Union
IP	Internet Protocol
ISDN	Integrated Services Digital Network
MCMI	Multi Coded Mark Inversion
MS	Multiplex Section
NE	Network Element
NMS	Network Management System
LAN	Local Area Network
OS	Optical Section
OSPF	Open Shortest Path First
PDH	Plesiochronous Digital Hierarchy
PPP	Point – to - Point Protocol
RS	Regenerator Section
SDH	Synchronous Digital Hierarchy
SNMP	Simple Network Management Protocol
SOH	Section Overhead
STM	Synchronous Transport Module
TCP	Transmission Control Protocol
TTI	Trail Trace Identifier
VC	Virtual Container
VF	Voice Frequency

1.10 TABLE OF COMPLIANCE

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

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

NAME OF MANUFACTURER:
MODEL:
TYPE:

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

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

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

EMISSION OF THE EQUIPMENT (SUBSTATION ENVIRONMENT)

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

IMMUNITY OF THE EQUIPMENT (SUBSTATION ENVIRONMENT)

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

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

QUALIFICATION REQUIREMENTS FOR FOTE SYSTEM

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

[PART-A] Technical requirement:

a) The bidder or its parent company has its own product of FOTE (SDH/PDH) with integrated Access Multiplexer, Teleprotection and PLCC equipment. The offered equipments should have been designed, manufactured, tested & comply with relevant Standards.

b) The bidder or its parent company as a Prime Contractor must have supplied, installed, tested & commissioned at least 100 no. SDH, PDH and Teleprotection equipments each in substations (132 kV and above) in last Six (6) years. One of such certificate should be from National or State Transmission/Power Utilities/IPPs/CPPs. The certificates being attached for experience proof along with the bid shall be certified by Chartered Accountant.

c) The bidder or its parent company as a prime contractor shall have executed at least One Turnkey contract of value not less than 10 Crore in last Six (6) years involving Supply, Installation, Testing and Commissioning of similar equipments.

d) At least one of the above projects shall be in successful operation for at least two (02) years as on scheduled date of Bid Opening with followings:
   - Shall be involving 35 Nos. of substations (132kv and above)
   - Shall be involving 50 no. of SDH and PDH equipments
   - Shall be involving 50 nos. of Teleprotection equipments

e) The bidder or its parent company must possess valid ISO 9001:2008 certification.

[PART-B] Financial Requirement

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

Additional Documents:

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

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