



Annexure -1

TECHNICAL SPECIFICATION

FOR

**SUPPLY & INSTALLATION OF OPGW(48F) CABLE ON MSETCL 220KV TROMBAY-
NERUL / TIFIL D/C LINE**

(OPTICAL FIBER GROUND WIRE)

DOCUMENT NO: TD-SP-OPGW(48F)-226-R0

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OPGW (OPTICAL FIBER GROUND WIRE) CABLE

1. SCOPE

1.1 This specification covers the technical requirements, design, manufacturing, assembly, testing at manufacturer's works, packing, transportation, loading, unloading at site Including installation, & commissioning of OPGW(Optical fiber ground wire) at site complete with all accessories for efficient and trouble-free operation.

2. CODES AND STANDARDS

2.1 The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant Indian Standards and IEC publications and any other standards, if any, except where modified and /or supplemented by this specification.

IEC 61232	Aluminum-clad steel wires for electrical purposes
IEC 61089	Round wire concentric lay overhead electrical stranded conductors
IEC 60793-1	Part-1 Optical Fiber ,generic specification, measurement and test
IEC 60793-2	Part-2 Optical Fiber Cable Product Specification
IEC 60793-4	Part-4 Sectional Specification- Aerial optical cables along electrical power lines
IEC 60793-4-10	Part 4-10 Aerial optical cables along electrical power lines – Family specification for OPGW(Optical Ground Wire)
IEC 60794-2	Part-2 Optical Fiber Cable Product Specification
ITU-T G.652D	Characteristics of Single Mode Optical Fibre Cable
IEC 61328	Guidelines for installation of transmission line conductor and earth wires

The component and devices which are not covered by the above standards shall conform to, and comply with, the latest applicable standards, codes and regulations of the internationally recognized standardizing bodies / professional societies as may approved by the purchaser. The manufacturer shall list all applicable standards; codes etc and provide copies thereof for necessary approval.

In the case of conflict between various requirements /order documents, the precedence of authority of documents shall be as follows:

- i. Technical Requirement of this Specification
- ii. Applicable codes & standards
- iii. Approved drawings
- iv. Guaranteed Technical Particulars (GTP)
- v. Type test result acceptance
- vi. Other acceptable documents

3. TERMS AND DEFINATION

MAT	Maximum Allowable Tension
RTS	Rated Tensile Strength
MAOC	Maximum allowable ovality
OPGW	Optical ground Wire
SM	Single Mode
DWSM	Dense Wavelength Division Multiplexing
WDM	Wavelength Division Multiplexing
GPa	Giga Pascal
PMD	Polarization Mode Dispersion
SDH	Synchronous Digital Hierarchy

4. FIBER ATTRIBUTES

- 4.1 The optical fiber shall consist of a glass fibre core and glass cladding in accordance with construction of optical fiber category B1.3 Single mode fiber as given in IEC 60793-2 or ITU-T G.652D.
- 4.2 Single mode optical fibres shall meet the requirement in accordance with IEC 60793-2-50 or ITU-T G.652D.
- 4.3 The Optical fibre shall be such that it shall be used from 1265nm to 1625nm
- 4.4 Fibre shall be coated with material suitable for protecting the cladding material from damage.
- 4.5 The coating shall be in close contact with the cladding material to preserve the initial integrity of the surface
- 4.6 The coating shall consists of one or more layers of the same or different materials
- 4.7 The coating shall be removable for connecting purpose
- 4.8 The interstices between the coated fibre and loose buffer shall be filled with suitable fluid or easily deformable materials
- 4.9 Dual Window Single Mode optical fibre characteristics shall meet the following dimensional ,mechanical , transmission and environmental requirement as per ITU-T G652.D and IEC-60793-2-50 as detailed below:-
- 4.10 Dimensional Requirement:-

Attributes	Unit	Limits
Cladding Diameter	mm	125 ± 1
Cladding Non-circularity	%	≤1.0
Core concentricity error	mm	≤0.6
Primary coating diameter - uncolored	mm	235 to 255
Primary coating diameter – colored	mm	235 to 265
Primary coating diameter – cladding concentricity error	mm	≤12.5
Fiber Length	km	4

4.11 Mechanical Requirement

Attributes	Unit	Limits
Proof Stress Level	GPa	≥0.69
Coating Strip Force (average)	N	1.0 ≤ F _{avg} ≤ 5.0
Coating Strip Force (peak)	N	1.0 ≤ F _{peak} ≤ 8.9
Fiber curl radius	M	≥2
Tensile strength for 0.5m specimen length	GPa	≥3.8
Stress corrosion susceptibility constant, n _d		≥18

4.12 Transmission Requirement

Attributes	Unit	Limits
Attenuation Co-efficient from 1310nm to 1625nm	dB/km	≤0.40
Attenuation Co-efficient from 1383nm ± 3nm	dB/km	≤0.40
Attenuation Co-efficient at 1550nm	dB/km	≤0.30
Zero dispersion Wavelength, λ_0	Nm	$1300 \leq \lambda_0 \leq 1324$
Zero dispersion slope	Ps/nm ² .km	≤0.092
Nominal MFD range at 1310 nm	mm	8.6 – 9.5
MFD Tolerance	mm	±0.6
Cable cut-off Wavelength	Nm	≤1260
Macro bending loss at 1625nm, 100 turns on a 30mm radius mandrel	dB	≤0.1
Polarization mode dispersion (PMD) coefficient	ps/√km	<0.2

4.13 Environmental Requirement:-

- Fibre optical and mechanical characteristics shall comply the environmental attributes such as heat, temperature and water
- Change in Optical Characteristics – attenuation from the initial value shall not be less than the values detailed below

Environment	Wave length Nm	Maximum attenuation increase dB/km
Damp Heat	1550	≤0.05
Dry Heat	1550	≤0.05
Change in temperature	1550	≤0.05
Water Immersion	1550	≤0.05

- Attenuation shall be measured periodically during the entire exposure to each environment and after removal.
- Mechanical attributes such as coating strip force, tensile strength, stress corrosion susceptibility shall comply to environmental condition test.

e. Coating strip force

Environment	Average strip force N	Peak strip force N
Damp Heat	$1.0 \leq F_{avg} \leq 5.0$	$F_{peak} \leq 8.9$
Water Immersion	$1.0 \leq F_{avg} \leq 5.0$	$F_{peak} \leq 8.9$

f. Tensile strength

Environment	Median Tensile strength (GPa), specimen length 0.5m	15 percentile of tensile strength distribution (GPa),specimen length 0.5m
Damp Heat	≥ 3.03	≥ 2.76

g. Stress corrosion susceptibility

Environment	Stress corrosion susceptibility constant , n_d
Damp Heat	≥ 18.0

4.14 Attenuation

4.14.1 Attenuation Co-efficient

- Typical maximum attenuation co-efficient of the cables fibres at 1310 nm is 0.4dB/km and/or 0.3dB/km at 1550nm
- Attenuation Co-efficient shall be measured in accordance with IEC 60793-1-40.

4.14.2 Attenuation Uniformity

- Local attenuation shall not have point of discontinuities in excess of 0.1dB

4.15 Cut-Off wavelength of cabled fiber

- The cabled fiber cut-off wavelength λ_{cc} shall be less than the operational wavelength and measured in accordance with IEC 60793-1-44.

4.16 Fiber Coloring

- If the primary coated fibres are colored for identification, the colored coating shall be readily identifiable throughout the life time of the cable and shall reasonably match to IEC 60304
- The coloring shall permit sufficient light to be transmitted through the primary coating to allow local light injection and detection.
- The fibers shall be marked by using a set 12 different colours as per ITU G652D for first 12 fibers.
- For next 12 fibers the same set of different colours will be accompanied by a single marking over the color at a uniform length
- For future next 12 fibers the same set of different colours will be accompanied by a double marking over the color at a uniform length

- f. For future next 12 fibers the same set of different colours will be accompanied by a triple marking over the color at a uniform length
- g. Marking shall be distinctive color rings. Printed marking shall be adhered satisfactory
- h. Marking shall be easily identifiable with a constant repeated distance
- i. The colour used for fibre colour-coding does not inhibit the operation of LID (Light Injection and Detection) devices (splicing devices, attenuation measuring systems etc.). The colour is made of an UV-cured acrylate material.
- j. The optical fibres colors are stable during temperature cycling and do not subject to fading or smearing onto each other or into the gel filling material.
- k. The color coating should withstand the Acetone wiping more than 10 times if wiped with tissue paper

4.17 Polarisation mode dispersion

- a. PMD shall be in accordance with IEC 60793-1-48

5. CABLE ELEMENT

- 5.1 Components of cable element shall take into account the cable application, operating environment and manufacturing process, protecting fibre during handling and cabling.
- 5.2 The materials used for a cable element shall be selected to be compatible with the other elements in contact with it. An appropriate compatibility test shall be included in type test
- 5.3 Optical elements and each fibre within a cable element shall be uniquely identified by colours, positional scheme, markings or as specified in the product specification.
- 5.4 The cable element shall be have a metallic steel tube
- 5.5 Primary coated and coloured fibres shall be packaged in a metallic hermetically sealed tube
- 5.6 The cable element shall be filled with a suitable jelly compound to avoid water penetration
- 5.7 The inside surface of the tube shall be smooth without any defects.

6. OPTICAL FIBER CABLE CONSTRUCTION

- 6.1 The cable shall be designed and manufactured for a perdicated operating lifetime of 25 years The attenuation of the installed cable at the operating wavelength shall not Relevant parts of sectional Specification IEC 60794-4.
- 6.2 Optical Fibre cable length are provided as transmission route length
- 6.3 The bidder shall ensure the requirement of the cable length as per site conditions
- 6.4 There shall be no fibre splice in a delivery length
- 6.5 It shall be possible to identify each individual fibre throughout the length of the cable.
- 6.6 Optical fibre unit shall protect the optical fibers from environmental or mechanical forces such as longitudinal compression, crushing, bending, twisting, tensile stress, long and short term heat effects.

7. OPGW

- 7.1 OPGW cable construction shall comply to IEC- 60794-4-10
- 7.2 OPGW cable shall meet construction and performance requirement such that the ground wire function, optical fibre integrity and optical transmission characteristics are suitable for the proposed in installation

- 7.3 OPGW cable shall be suitable for installation on 220kV Transmission line
- 7.4 OPGW shall be suitable for installation under live line condition
- 7.5 OPGW length defined shall be between Gantry of termination stations
- 7.6 The fibre optic cable construction shall be designed and installed such that optic fibres experience no strain under all loading conditions throughout entire life cycle of the cable.
- 7.7 MAT strain shall be less than or equal to MWT strain margin of the cable
- 7.8 The sag shall not exceed the earth wire sag in all conditions
- 7.9 The MAT shall also be less than or equal to 0.4 times the UTS
- 7.10 The every day tension shall not exceed 20% of the UTS for the OPGW Cable
- 7.11 The sag-tension chart of OPGW cable indication MAX tension,cable strain and sag shall be calculated for minimum and maximum wind and ice condition
- 7.12 The composite fibre optic overheadground wire shall be made of single buffer tube embedded in water tight aluminium alloy/stainless steel with aluminium coating protective central fibre optical unit surrounded by concentric-lay stranded metallic wires in single or multiple layers
- 7.13 The actual delivered cable length shall consider other factors such as sag,service loops ,splicing,working length and wastage
- 7.14 Central Fibre Optic Unit
- 7.15 The central fiber optic shall be designed to house and protect mutiple buffered optical fibre units from damage due to forces such as crushing,bending,twisting,tensile stress and moisture
- 7.16 The central fibre unit and the outer stranded metallic conductor shall be an integral part to protect the optical fibre from degradation due to dynamic environmental conditions
- 7.17 The central optical unit shall be necessarily of stainless steel tube with aluminium coating
- 7.18 Cable construction
- 7.19 The cable construction and material shall be in accordance to IEC 61089
- 7.20 The cable mechanical and electrical characteristics shall comply to IEC-61089
- 7.21 The conductor shall be of aluminium clad steel wires with 27% conductivity
- 7.22 The base metal shall be steel produced by the open hearth ,electric furnace or basic oxygen process and shall be of such composition that the finished clad wires shall have properties and charcteristics as per IEC-61232.
- 7.23 The aluminium for covering shall have a minimum purity of 99.5% and quality sufficient to meet thickness and electrical resistance requirement.
- 7.24 The wires shall be smooth and fress from all imperfactions such as fissures,roughness,grooves,includions which may endanger the performance of the OPGW cable.
- 7.25 The density of the aluminium clad steel wires shall be in accordance to table-1 of IEC-61232.
- 7.26 The wires shall not depart from the nominal diameter by more than the value given in table-2 of IEC 61232.
- 7.27 The minimum aluminium thickness of wires at any point shall comply with table 3 of IEC 61232.
- 7.28 The wire tensile strength shall with table-5 of IEC-61232.

- 7.29 Elongation of the wire shall comply with the requirement of 1% minimum elongation after fracture or 1.5% minimum total elongation at fracture the test and result shall be as defined in Clause 6.3.2 of IEC 61232.
- 7.30 Resistivity of wires shall conform to the requirement given in table-5 at a temperature of 20°C.
- 7.31 The wires shall withstand without fracture not less than 20 twists in a length equivalent to 100 times the nominal diameter of the wire.
- 7.32 The wire shall conform to the requirement of stress at 1% extension given in table-5 of IEC-61232.
- 7.33 The shall be no joints of any kind made in the finished wire.
- 7.34 The lay ratio for the 6-wire layer of the 7 steel cores shall be not less than 16 nor more than 26.
- 7.35 Cable construction shall be bare concentric lay stranded metallic wires with the outer layer having left hand lay
- 7.36 The wires may be of multiple layers with a combination of various metallic wires in each layer.
- 7.37 The finished wires shall have no joints or splices
- 7.38 The wires shall be so stranded when the complete OPGW is cut the individual wires can be readily grouped and the held in place.
- 7.39 The rated tensile strength(RTS) of homogenous steel conductors shall be taken as the sum of RTS of all wires at failure.
- 7.40 The conductivity of the homogeneous conductors with aluminium clad steel wires shall be calculated based on the relevant conductivity in IEC 61232
- 7.41 The conductor cross-section, wire diameter ,conductor diameter ,linear mass rated strength and DC resistance shall comply to IEC61089 table D.23
- 7.42 Breaking Strength
- 7.43 The rated breaking strength of the complete OPGW shall be no more than 90% of the sum of rated breaking strength of the individual wires,calculated from their nominal diameter and the specified minimum tensile strength
- 7.44 The rated breaking strength shall not include the strength of the optical unit
- 7.45 The fibre optic unit shall not be considered a load bearing tension member while determining the total rated breaking strength of the composite conductor
- 7.46 Rated tensile strength for the conductor shall be comply IEC-61089 table D.23
- 7.47 Electrical and Mechanical requirement
- 7.48 Minimum electrical and mechanical performance characteristics shall be as detailed below
- a. Everyday Tension shall less than or equal to 20% of UTS of OPGW
 - b. DC Resistance at 20°C shall be less than 1Ω/km

7.49 OPGW conductor element shall comply to following parameters as per IEC-61232

Characteristic	Unit	Value
Standard diameter	mm	4.05
Tolerance of diameter	%	± 1.5
Minimum tensile strength	MPa (kgf/mm ²)	1080 (110)
Minimum elongation in 250mm	%	1.5
Minimum conductivity	%	27
Minimum number of twisting	-	20
Minimum thickness of aluminum	Mm	0.30 1
Breaking load	N (kgf)	15,680 (1,600)
Standard cross-sectional area	mm ²	14.52
Standard mass	kg/km	85.83
Standard resistance at 20°C	W/km	4.40

7.50 OPGW cable shall comply to following paramteres

Characteristic	Unit	Value
Number and Type of Fibres		48/DWSM
Details description of the cable design		
Overall Diameter	Mm	12.8
Calculated Cross Sectional area concerning calculation of RTS	mm ²	87.13
Calculated mass	kg/km	560
RTS – Rated Tensile Strength	KN	
Modulus of elasticity	MPa	140
Coefficient of linear expansion	10 ⁻⁶ /K	13.4 X10 ⁻⁶
Calculated D.C. resistance at 20°C	Ω/km	0.743
Fault Current Capacity I_t	(kA) ² s	10 ² x 0.5
MAT – Maximum allowable Tension	kN	84.7
Allowable temperature range for storage ,installation and operation	°C	
Strain margin point	%	
Lay ratio (P/D)	-	10 – 16
Lay direction of outer layer		Left Hand Lay

Min bending radius during installation	mm	
Min bending radius installed.	mm	
Hydrogen effect		
Type and amount of Grease		
Construction Aluminum-clad steel wire Steel tube	Nos./mm Nos./mm	6 / 4.3 1 / 4.1
Minimum breaking load	kN	84.7
Short circuit current capacity for 0.5sec Conductor temperature	kA (°C)	10 (200)
Maximum length per reel	m	4000±2%

8. CABLE WIRE TESTS

8.1 Following minimum tests shall be done in the factory before stranding

- a. Appearance
- b. Finish
- c. Diameter
- d. Tensile stress
- e. Elongation
- f. Torsion
- g. Resistivity
- h. Minimum aluminum thickness
- i. Stress at 1% extension

9. CABLE TESTS

9.1 Following minimum test shall be included in the type test ,factory acceptance test and routine test of the optical fibre cable

- a. Tensile Performance
- b. Stress –strain test
- c. Breaking strength test
- d. Sheave test
- e. Aeolin Vibration test
- f. Creep
- g. Temperature Cycling
- h. WPT
- i. Short Circuit
- j. Lightening test

9.2 Factory acceptance test

- a. Design Test
- b. Visual inspection of cable element
- c. Lay Length of armouring
- d. Diameter of cable
- e. Weight of cable
- f. DC Resistance of Cable

- g. Breaking strength test
- h. Optical Fibre attenuation coefficient at operational wavelength

9.3 Routine Test

- a. Inspection of raw material
- b. Optic Fibre attenuation coefficient at operational wavelength
- c. Cable design
- d. Quality of cable surface
- e. Lay Length of armouring
- f. Diameter of cable and cable components
- g. Mechanical and electrical cable components characteristics

10. INSTALLATION HARDWARE

- 10.1 The scope of supply of the optical cable includes the assessment, supply and installation of all required fittings and hardware. The Contractor shall determine the exact requirements of all accessories required to install and secure the OPGW.
- 10.2 The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in IEC-61284.
- 10.3 The shear strength of all bolts shall be at least 1.5 times the maximum installation torque.
- 10.4 The bidder shall provide the OPGW hardware & accessories drawing & Data Requirement Sheets (DRS) document for all the assemblies & components.
- 10.5 All component reference numbers, dimensions and tolerances, bolt tightening torques & shear strength and ratings such as UTS, slip strength etc shall be marked on the drawings.
- 10.6 The hardware fittings shall be capable of withstanding maximum temperature during short circuit
- 10.7 The fittings must be of the helical, preformed type. However alternate fittings which have a satisfactory track record shall also be acceptable.
- 10.8 The fittings shall secure proper and safe grip of the OPGW in the whole range of tensile strength and shall not influence any parameters of the OPGW – mechanical, electrical, optical.
- 10.9 Jointing box for OPGW shall be hermetically seal and shall have a degree of protection of IP68.
- 10.10 The fittings and accessories described herein are indicative of installation hardware typically used for OPGW installations and shall not necessarily be limited to the following:-
 - 10.10.1 Suspension Assemblies:-
 - a. Preformed armour grip suspension clamps and aluminium alloy armour rods/ reinforcing rods shall be used.
 - b. The suspension clamps shall be designed to carry a vertical load of not less than 25 KN.
 - c. The suspension clamps slippage shall occur between 12kN and 17kN.
 - d. The bidder shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pins, etc.

- e. The total drop of the suspension assembly shall not exceed 150 mm (measured from the centre point of attachment to the centre point of the OPGW).

10.10.2 Dead End Clamp Assemblies:

- a. All dead end clamp assemblies shall preferably be of the performed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates.
- b. Dead end clamps shall allow the OPGW to pass through continuously without cable cutting. The slip strength shall be rated not less than 95% of the rated tensile strength of the OPGW.

10.10.3 Clamp Assembly Earthing Wire:

- a. Earthing wire consisting of a 1500 mm length of aluminium or aluminium alloy conductor equivalent in size to the OPGW shall be used to earth suspension and dead end clamp assemblies to the tower structure.
- b. The earthing wire shall be permanently fitted with lugs at each end.
- c. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.

10.10.4 Structure Attachment Clamp Assemblies:

- a. Clamp assemblies used to attach the OPGW to the structures shall have two parallel grooves for the OPGW, one on either side of the connecting bolt.
- b. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed.
- c. The tower attachment plates shall locate the OPGW on the inside of the tower and shall be attached directly to the tower legs/cross-members without drilling or any other structural modifications.

10.10.5 Vibration Dampers:

- a. Vibration dampers having four (4) different frequencies spread within the Aeolian frequency bandwidth shall be used for suspension and tension points in each span.
- b. The design of Vibration damper shall be without messenger cable and in case messenger cable is to be used, it shall be of stainless steel.
- c. The bidder shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis as specified in appendices.
- d. Design calculation for installation of Vibration dampers shall be submitted by the vendor.
- e. Vibration damper clamps shall be made of aluminium or aluminium alloy,
- f. Is shall support the dampers during installation and shall maintain the dampers in position without damage to the OPGW and without causing fatigue.
- g. Armour or patch rods made of aluminium or aluminium alloy shall be provided as required to reduce clamping stress on the OPGW.
- h. The vibration damper body shall be cast zinc alloy.

10.11 Line Fibre Optic Splice Enclosures

10.11.1 All in-line splices shall be encased in In-Line Fibre Optic Splice Enclosures.

10.11.2 Suitable splice enclosures shall be provided to encase the optical cable splices in, moisture and dust free environment.

10.11.3 In line splice enclosures shall comply to ingress protection class IP 68 or better.

10.11.4 The splice enclosures shall be designed for the storage and protection of a minimum of 48 optical fibre splices and equipped with sufficient number of splice trays for splicing all fibres in the cable.

10.11.5 In-line splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract.

10.11.6 Splice enclosures shall be appropriate for mounting on EHV transmission towers above anti-climb guard levels at about 10 metres from the ground level and shall accommodate pass-through splicing.

10.11.7 No more than 6 fibres shall be terminated in a single splice tray.

10.12 Optical Fibre Splice

10.12.1 All optical fibre splice shall comply with the following.

- a. No.of Optical Splice along the entire route shall be minimised
- b. No midspan splices shall be allowed along the entire route
- c. All Fibre splices shall be accomplished through fusion splicing
- d. Each fibre splice shall be fitted with splice protection sheath fitted over the final splice
- e. All splices and bare fibre shall be nearly installed in covered splice trays
- f. No more than 6 fibre shall be installed in each splice tray
- g. For each link, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05dB and no single splice loss shall exceed 0.1dB at 1550nm.
- h. For splicing, fibre optic cable service loops of adequate length shall be provided so that all splices occurring at the tower structure can be performed at ground level

10.13 Fibre optic approach Cables:-

10.14 A fibre approach cable shall be armoured underground fibre optical cable to connect Overhead Fibre Optic Cable (OPGW) between the final in-line splice enclosures on the gantry/tower forming the termination of the fibre cable on the powerline and Fibre Optic Distribution Panel (FODP) installed within the sub-station.

10.15 Approach cable shall be such that it can be layed in 40mm HDPE pipe within the sub-station upto FODB in control room.

10.16 Primary coated fibre shall be protected by loose tube packaging within the tube which shall be filled with thixotropic jelly.

10.17 Fiber cable shall have 48 fibre cores and number of fibre per loose tube shall be in-line with the OPGW cable loose tubes.

10.18 Strength members in the cable shall keep the fibre strain within permissible values

10.19 The optical fibre cable shall have a solid non-Metallic FRP strength members in the center of the cable core.

10.20 Primary coated fibres in loose tubes stranded together around the central strength member using helical or reverse lay techniques shall form the cable core.

10.21 Filling compound used in the loose tubes and in the cable core shall be compatible to fibre ,secondary protection of fibre ,core wrapping and swellable tape etc.,the fibre movement shall not be constrained by stickiness and shall be removable easily for splicing

- 10.22 Outer sheath shall be a non-metallic moisture barrier over and above the cable core .the sheath shall not have any pinholes ,cracks,be continous and should be smooth .the sheath with armouring shall be able to pass the spark test (11kV).The core shall be covered with tough weather resistant ,anti termite polyethylene compound.
- 10.23 Outersheath shall be flame retardant accrosing to IEC 332 and Low smoke ,Low zero Halogen (LSOH)in compliance with IEC 1034 and IEC 754.
- 10.24 Rip Cord Two nos of anti wicking type rip cord shall be used to rip open the sheaths and armour ,one used to open the armouring and the outersheath shall be of 3ply and aramid type only.
- 10.25 The maximum attenuation of the optical fibres shall conform to or better than defined in IEC 60793-1
- 10.26 The optical fibre cable shall be solid ,non hygroscopic and shall fill the cross section such that the transmission of gas and hydrocarbons along the length of the cable under normal pressure is not possible
- 10.27 Optical fibre cable shall be designed to withstand without fiber elongation or damage a pulling force of not less than 4000N.
- 10.28 Optical fibre cable shall have a crush resistance of not less than 4000N per 10cm.
- 10.29 Optical fiber cable shall be flame retardant to reduce the risk of fire spread .Cable flame retardancy shall comply with the applicable standards.
- 10.30 Tests for cable flame retardancy shall be in accordance with the reference standards
- 10.31 Optical fibre cable in all respect shall be suitable for operation under service conditions ,the cables shall have a design life of 25 years.
- 10.32 The cable shall be suitable for operation when installed direct buried in the ground ,underground ducts ,above ground,below ground in air enclosed trenches fastened to cable ladder rack or tray.
- 10.33 Installation of approach cable
- Approach cable shall be layed in 40mm HDPE pipe in all condition.
 - Existing trenches and cable tray shall be used for Fibre optic approach Cables
 - In case existing cable trenches are not available suitable alternatives shall be provided after prior approval from the customer.
 - All required fittings, supports, accessories, ducts, conduits, riser required for laying and installation of the approach cables shall be supplied by the bidder
- 10.34 Optical Fibre Termination and Splicing
- 10.35 Optical Fibre termination shall be installed in Fibre Optic Distribution Panels designed to provide protection for fibre splicing of preconnectrized pigtails and to accommodate connectorized termination and coupling of fibre cables .
- 10.36 Fiber Optic Distribution Panel
- FODP shall be a metal rack designed to accommodate fiber management system in the control room
 - Panel shall have 19" mounting rails – 2 pairs
 - Panel shall have minimum four numbers vertical cable managers
 - Panel shall consist of one number horizontal cable manager,
 - Panel shall have 6 point 15 Amp power strip, integrated side cover and one CFL Connection with door limit switch.

- f. Panel shall have both Front & Back side Opening.
- g. Panel shall have 2 nos of gland plates for Cable entry at the back side with provision of minimum 15 cables entries.
- h. Panel shall have opaque glass front door.
- i. Panel shall have metallic Rear Door.
- j. Panel shall have powder coating.
- k. Panel shall have Black color RAL 7032.
- l. Panel shall have Fan on the top.

11. FMS RACK

11.1 FMS Fiber Management System multi-element management system shall contain sub-assemblies with one or more splice trays and other functional parts.

11.2 FMS shall contain all necessary function related to distribution, junction or connection between the ends of incoming and outgoing cables.

11.3 FMS shall content parts fulfilling the functions of splice tray or organizer, fiber storage & guiding elements Parts & Content of a Fiber Management.

11.4 Splice tray:-

- a. Splice Tray shall be designed to use the same splice tray for different management systems i.e Single circuit management or single element management.
- b. Splice Tray shall have minimum 2 entry points from the rear and entry port design shall deploy strain relief
- c. Strain relief shall be done from any of the following manners or all
 - Slot with cable ties
 - Slot with rubber bushes
 - Slot with clamping devices
 - Cable tie holes
 - Additional pads or inserts
- d. The Fiber over length shall be stored in the same tray as the splices to permit the movement of the splice to the splicing equipment and back to the splice holder.
- e. The Length should be such that it allows a number of re-splices if reconfiguration is necessary, the over length should be sufficient to allow re-routing and storage of a splice in any defined splice position in the fiber management system.
- f. For optimized handling and to avoid falling short of minimum bending radius, guiding element shall be provided.

11.5 Splice holder:

- a. Splice Holder is a device in which a number of protected optical fibre splices are stored
- b. Splice Holder shall be integral part of the tray

11.6 Splice protection:

- a. Splice protection shall be heat shrink protection with rigid bar inside

11.7 Guiding Elements

- a. Guiding element constitute the system for routing fibres from the incoming cable to the splice and storage device as well as to the outgoing cables.
- b. These elements have to protect fibres from stresses such as: Bend, Crush Torsion, and Tension.
- c. These Four basic systems shall be used for guiding fibres as required.
- d. Fiber in cable tube (Loose Tube).
- e. Fiber in Transportation Tube.
- f. Fiber in guiding channels (slots, grooves or ducts).
- g. Individual elements (discrete bend controls)
- h. They shall also be intended to aid installation and subsequent maintenance

11.8 Bending Radius

- a. Bending Radius influences additional optical fiber losses laser safety and life time of fibres Bending radius shall fulfill the requirement of the fiber and cable manufacture .

11.9 Fiber Storage

- a. Fiber storage shall be design for atleast following requirement such as reserve length for re-splicing, non active fibres, Uncut Fibres. Remote Splicing. Patch cords & pigtailed. Reserve length for future needs.
- b. Function of Fiber storage is to provide long term protection and should fulfill the requirement for storage of fiber in fiber tray, splice tray, splice organizer, or Fiber management system

11.10 Optic Fibre Connector Pigtail & connectors

- a. Optical Fibre shall be connectrized with FC-PC type connector
- b. Optical Fibre pigtails shall meet the following optical characteristics

Sr.No.	Parameter:	Unit:	Particulars:
1.	Optical Fiber	mm	Type-Single Mode
2.	Mode Field Diameter	µm	9.5+/-1 ⇒ 1.31 µm
3.	Cladding Diameter	µm	125 +/-2 µm
4.	Outer Coating diameter	mm	0.9+/- .1 mm
5.	Reinforcement		Aramid yarn
6.	Outer jacket material		PVC
7.	Outer jacket colour		Yellow
8.	Outer jacket diameter	µm	2 +/- 0.2 µm
9.	Permissible Bending Radius	mm	Min.40
10.	Insertion loss		≤0.5 dB at ⇒ 1.31 µm
11.	Operating Temperature		0 to +60 deg.
12.	Storage Temperature		0 to +60 deg.

12. TESTING TOOLS

- 12.1 2 Nos of OTDR for testing the fiber length shall be used and handed over to the customer
- 12.2 One No. of Splicing kit for splicing of the optical fibre core shall be used for splicing and handed over to the customer.

13. METHODOLOGY FOR INSTALLATION AND TERMINATION

- 13.1 All optical fibre cable termination, installation, stringing and handling plans, guide and procedures and engineering analysis shall be submitted to the customer for review and approval in the engineering phase/design phase of the project prior to establishing the final cable lengths.
- 13.2 Installation procedures including details of personnel and time required shall be documented and submitted for approval
- 13.3 Installation procedures shall ensure protection of the personnel installing against induced voltage and current caused by energized lines
- 13.4 Installation procedures shall ensure protection of the personnel against hazards which can be result of accidental line energization.
- 13.5 Installation procedure shall ensure adequate protective earthing system is being done
- 13.6 Installation procedure shall ensure use of correct work methods and specialized training.
- 13.7 Installation procedures shall ensure use of proper equipment and devices to protect the person from all the hazards such as electromagnetic induction, electrostatic field induction, switching error, accidental contact of the conductor or ropes being installed and lightning strikes in the vicinity or on the conductor being installed.
- 13.8 Conductor Stringing Method and equipment:-
 - 13.8.1 Tension Stringing method or alternate proven methods shall be used for stringing of the OPGW cable
 - 13.8.2 It shall ensure to keep conductor from contacting the earth surface or other obstacles between the towers to avoid surface damage.
 - 13.8.3 It shall ensure to keep conductor to easily pass over the energised circuits, railways or major roads without contacting them.
 - 13.8.4 Stringing equipment used during the process such as tensioners, puller, reel winders, reel stands, pilot rope puller, pilot rope, pulling rope, stringing blocks, stringing block earth, running earth shall minimum suffice the criteria mentioned in IEC-61238.
 - 13.8.5 Requirement for Installation of pilot or pulling rope, stringing of conductors, splicing of conductors, sagging of conductors, dead ending and installation of jumper loops shall be met detailed in IEC-61238.
 - 13.8.6 Type test of earth clamps, earth cable shall be in accordance to IEC 61230.
- 13.9 Communications:-
 - 13.9.1 Tension stringing methods shall ensure availability of proper communication system for puller operator, tensioner puller, supervisors,
 - 13.9.2 Communication system shall be a radio system with a channel that is free from outside interference and is located at their operating position

13.9.3 The radio or telecommunication system used by the puller operator or tensioner operator shall be portable set with earphones and microphone but with no conductive wire connection to the machine

13.10 Special Earthing requirement:-

13.10.1 Maximum earthing requirements shall be ensured during installation as recommended in IEC-61328

13.10.2 Use of running earths, earth mats at work sites and stringing block earth shall be sized and designed for a fault current where direct contact with an energised line is possible

13.10.3 Minimum recommended earthing procedure for conductor stringing sequence shall be complied in accordance to IEC-61328.

13.10.4 The size of the earth cables and clamps for bonding and earthing shall be adequate for the maximum steady state induced currents as well as the largest fault currents to which they are likely to be exposed

13.10.5 All equipments used in the process of stringing conductors should have at least one earth attachment point at some convenient point on the frame

13.10.6 All conductor stringing equipment shall have a special earthing bar welded to the frame for attachment of the earth clamp.

13.11 All cable segments shall include service loops as specified in this specification

13.12 The maximum allowable stringing tension, maximum allowable torsional shear stress, crush strength and other physical parameters of the cable shall not be exceeded

13.13 Optical fibre attenuation shall be measured after installation and before splicing .

13.14 Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable segment failure

13.15 In the event of cable damage or fibre damage the complete section shall be replaced without any midspan joints.

14. INSPECTION & TESTING

Test item		Test method	Number of samples
Optical fiber	Mode field diameter	Conforming to ITU-T G.650	All in 10% of OPGW reels
	Cladding diameter		
	Mode field concentricity Error		
	Cladding non-circularity		
	Cut-off wavelength		
	Buffer coating diameter		
	Number of fibers	Visual inspection	10% of OPGW reels
	Fiber identification		
	Attenuation	Conforming to IEC 60793	All in all OPGW reels
	Dispersion	Conforming to ITU-T G.650	All in 10% of OPGW reels (test on bare fibers)
Aluminum-clad steel wire	Appearance	Conforming to IEC 61232	10% of bobbins
	Diameter		
	Tensile strength		
	Elongation		
	Conductivity		
	Number of twisting		
	Thickness of aluminum		
Steel tube	Appearance	(Micrometer)	10% of OPGW reels
	Diameter		
Completed OPGW	Appearance	Conforming to IEC 61089	10% of OPGW reels

	Overall diameter		
	Construction		
	Lay ratio		
	Lay direction		
	Breaking load		

All tests and inspection shall be made in accordance with above mentioned standard specification.

Routine test	All the tests in line with relevant IEC ,IS standards with latest amendments
Type test	-OPGW cable must be of "type tested" quality. Type test report shall be submitted for the type, size and rating of the cable offered, along with the bid.
Inspection	-All type tests shall be carried out in accordance with relevant IEC,IS standards -The buyer reserves the right to witness all Incoming, In-process & Final process of cable manufacturing -The buyer reserves the right to inspect the Seller's works at any time prior dispatch, to verify compliance with the specifications. -In-process and final inspection call intimation shall be given in advance to purchaser.
Test Certificates	Three sets of complete test certificates shall be submitted along with the dispatch documents.

15. OPERATING CONDITIONS:

Project	
Site Location	Mumbai
Altitude	<1000m
Atmospheric pressure	1.01246 bar
Seismic Zone	IS:1893 Zone III
Pollution level	G3 as per ISA 71.04
Ambient temperature	50°C
Relative Humidity	
a) Maximum	99%
Wind Data	
a)Wind design pressure for structure	As per IS:875
b)Wind zone	As per IS:875
c)Basic Wind Speed	47 m/sec

16. SYSTEM GUARANTEE/WARRANTY

- 16.1.1 System guarantee / warranty period shall be minimum two year or as stated in the order.
- 16.1.2 System guarantee / warranty period shall be applicable from the date of issue of the Handing Over / system completion certificate by owner.
- 16.1.3 System guarantee/warranty shall be applicable for all the supplied equipment and services.
- 16.1.4 During the guarantee/Warranty period Bidder shall replace any faulty equipment! system component / device with a new item at his expense, including the supply of parts and any other defected component of the system that was supplied by him including all it's accessories and components.
- 16.1.5 During the Warranty Period Bidder shall carry out preventive maintenance of the system. Preventive maintenance shall include complete testing of the system, sensitivity adjustment, equipment calibration and necessary repairs.
- 16.1.6 Bidder shall submit a summary report indicating all the adjustment and repairs that were carried out by the bidder
- 16.1.7 Bidder shall provide support for the quated hardware for a minimum period of 10 years from the date of the purchase order
- 16.1.8 The guarantee warranty period will start after successful implementation and User Acceptance Test (UAT).

17. GTP

17.1 GTP OPGW-Complete cable

Sr. No.	Details	Unit	AEML Particulars	Vendor to Specify
1	Nominal cross sectional area	mm ²	79	
2	Centre -Stainless steel tube - No./Dia.	mm	1/4.0	
3	L1-Aluminium clad steel wires - No./Dia.	mm	6/4.1	
4	Lay direction - outer layer	LH/RH	Left Hand	
	General design data			
Sr. No.	Details	Unit	Particulars	
1	Nominal overall diameter	mm	12.3	
2	Ultimate conductor tensile strength	kgf	8190	
3	Approximate total mass	Kg/Km	504	
4	Electrical resistance at 20 C	Ω/Km	0.806	
5	Modules of elasticity	N/mm ²	140000	
6	Coefficient of linear expansion	x10 ⁻⁶ / °C	13.4	
7	S.C.Current capacity (Amb.53 C)	KA2 s	40	
	Optical Data			
Sr. No.	Details	Unit	Particulars	
1	Optical Fibre type		Single Mode G.652D	
2	Manufacturer		OFS	
3	Mode Field Diameter-1310nm	µm	9.2 ± 0.4	
4	Mode Field Diameter-1550nm	µm	10.4 ± 0.8	
5	Cladding Diameter	µm	125.0 ± 0.7	
6	Core-Clad Concentricity	µm	≤ 0.5	
7	Cladding Non-Circularity	%	≤ 1.0	
7	Coating Diameter (Uncolored)	µm	245 ± 5	
8	Coating-Cladding Concentricity	µm	< 12	
9	Attenuation Coefficient-1310nm	dB/km	≤ 0.35	
10	Attenuation Coefficient-1550nm	dB/km	≤ 0.21	
11	Cable cut-off Wavelength	nm	≤ 1260	
12	Zero Dispersion Wavelength	nm	1302 – 3022	

17.2 GTP OPGW Cable – Construction Details

Sr.No.	Details	Unit	AEML Particulars	Vendor to Specify
1	Fibre Manufacturer DWSM		OFS	
2	No.Of Fibres DWSM	Each	48	
3	Buffer Type		SS Loose Tube	
4	Buffer Tube Diameter	mm	4	
5	Buffer Tube Material		Stainless Steel	
6	No.of Buffer Tube	Each	1	
7	No.of Fibre / Tube	Each	48	
8	Identification No.of Individual tubes		NA	
9	No.of empty Tubes	Each	NA	
10	Filling Material		Water Blocking Gel	
11	Filling Material complaint with Tech.Specs	Y/N	Y	
12	20% Aluminium Clad steel wire			
	(1) Diameter	mm	4.1 (27%ACS)	
	(2) Number	Each	6	
13	Aluminium alloy wires		None	
	(1) Diameter	mm		
	(2) Number	Each		
14	Aluminium tube inner diameter	mm	3.5 (SS tube Dia.)	
15	Aluminium tube Outside diameter	mm	4.0 (SS tube Dia.)	
16	Cable Diameter (Nominal ± Deviation)	mm	12.3 ± 1%	
17	Cable cross - section area (Nominal)	mm ²	79	
18	Cable cross - section area (Effective)	mm ²	79	
18	Is complaint with IEEE P1138	Y/N	Y	
	<u>Mechanical Properties Of Cable</u>			
1	Max.Breaking Load (UTS)	kN	8190 kgf	
2	Fibre Strain Margin	%	≥ 0.6%	
3	Zero Fibre Strain Up To Load	kN	60% UTS	
4	Weight	kg/km	504	
5	Crush Strength	kg/km	A load of 312kg applied to cable for 10 min.without any permanent or Temporary change in attenuation of more than 0.1db	
6	Equivalent Module of Elasticity	kN/mm ²	140	
7	Minimum Bending Radius without micro	mm	50(For Optical Fibre)	

	bending			
8	Maximum Bending Radius :-			
	Short Term	mm	300(During Installation)	
	Long Term (Continuous)	mm	400(For Fix Position)	
9	Tensile proof test (Screening) Level	kN/mm ²	0.69	
10	Maximum permissible tensile stress	kN/mm ²	0.61	
11	Permissible CTS tensile stress	kN/mm ²	0.203	
12	Everyday tension, No wind	% of UTS	20%	
13	Maximum tension at Everyday condition with full wind pressure of 178.45 Kg/m ² on full projected area 400 meter span	Kg	60% UTS	
	<u>Thermal Properties of Cable</u>			
1	Co-efficient of Linear expansion	Per °C	0.0000134	
2	Co-efficient of expansion			
	Cladding	Per °C	0.0000005	
	Core	Per °C	0.0000005	
3	Nominal operating temperature range	°C	-40°C to +85°C	
4	SC Current transient peak temperature	°C	200°C	
5	Maximum allowable temperature for Lightning strike	°C	200°C	
	<u>Installation</u>			
1	Splice Loss :-			
	Maximum	dB	0.05(At 1550nm)	
	Average	dB	0.04(At 1550nm)	
2	Operating Temperature Range	°C	-40°C to +85°C	
3	Expected Cable Life	Yrs	40	
4	Maximum Possible span for specified Operating Condition		600	
5	Cable Swing Angles			
	Worst Case		78	
	Everyday		0	

17.3 GTP OPGW-OPTICAL PARAMETERS

Sr.No.	Parameter	Unit	AEML Particulars	Vendor to Sp
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				ecif y
1	Fiber Manufacturer (s) / Type		OFS / DWDM	
2	Fiber Production Method		VAD	
3	Attenuation Co-efficient :-			
	@ 1310 nm	dB / km	0.35	
	@ 1550 nm	dB / km	0.21	
4	Attenuation Variation with Wave length(+25nm)	dB / km	0.05dB/km Max.	
5	Attenuation at Water Peak	dB / km	0.31	
6	Point Discontinuity :-			
	@ 1310 nm	dB	≤ 0.1	
	@ 1550 nm	dB	≤ 0.1	
7	Temperature Dependence (Induced attenuation)	dB	≤ 0.05	
8	Nominal Mode field Diameter :-			
	@ 1350 nm		9.2	
	@ 1550 nm	μm	10.4	
9	Mode Field Diameter Deviation :-			
	@ 1350 nm		± 0.4	
	@ 1550 nm	μm	± 0.8	
10	Mode Field Non-Circularity	%	≤ 6	
11	Chromatic Dispersion Co-efficient :-			
	@ 1310 (1288-1339) nm		3.5	
	@ 1310 (1271-1360) nm	ps/nm.km	5.3	
	@ 1550 nm		18	
12	Zero Dispersion Wavelength	nm	1302-1322	
13	Zero Dispersion Slope	ps/nm ² .km	≤ 0.092	
14	Cut-off Wave length	nm	≤ 1260	
15	Refractive Index		1.468 at 1310nm	
16	Refractive Index Profile		Step Index	
17	Cladding Design		Matched Cladding	
18	Numerical Aperture		0.14	
	Physical and Mechanical Properties			
Sr. No..	Parameter	Unit	Particulars	
1	Bend Performance :-			
	(37.5 mm radius,100 turns) @1310 nm & @ 1550 nm	dB	≤ 0.05@1310nm	
	(16 mm radius, 1 turn) @ 1550 nm	dB	≤ 0.10@1550nm	
		dB	≤ 0.50	
2	Core Diameter (Nominal +- Deviation)	μm	8.3 ± 0.4	
3	Core Non- circularity	%	≤ 6	
4	Cladding Diameter (Nominal+- Deviation)	μm	125 ± 0.7	

5	Core-clad Concentricity Error	μm	≤ 0.5	
6	Cladding No Circularity	%	≤ 1.0	
7	Fiber Cut-off Wave length	μm	≤ 1260	
8	Protective Coating Type & Material			
	Primary :-		UV Cured Acrylate	
	Secondary :-		UV Cured Acrylate	
9	Protective Coating Diameter (Nominal+- Deviation)	μm	245 ± 5	
10	Protective Coating Removal Method		Mech.Stripping	
11	Coating Concentricity	μm	< 12	
12	Polarization Mode Dispersion Co-efficient	ps/km ^{1/2}	≤ 0.5	
13	Proof Test Level	kpsi	≥ 100	
14	Whether Color codig scheme complaint with EIA/TIA 598 or IEC 60304 or Bell Core GR-20	Y/N	Y	
15	whether Color material complaint with tech.spec.	Y/N	Y	

17.4 GTP Armoured Fibre Cable

Sr No	Description	Buyers Requirement	Vendor to Specify
1	Type of fibre	Single Mode	
	Geometrical Characteristics :		
2	Nominal MFD at 1310 nm	9.3 ± 0.5 µm	
3	Nominal Cladding Dia	125 µm ± 1.0 µm	
4	Cladding Non-circularity	≤ 1%	
5	Mode field concentricity error	<=/ 0.5 µm	
6	Diameter over primary coated with double UV cured acrylate	245 µm ± 10 µm	
	Cable Diameter		
	Transmission Characteristics		
7	Attenuation		
a	At 1300 nm	≤ 0.34 dB/Km	
b	Between 1285 nm to 1310 nm	≤ 0.38 dB/Km	
c	At 1550 nm	≤ 0.20 dB/Km	
Note 1	Sudden Irregularity	<=/ 0.1 dB	
Note 2	Measurement of spectral attenuation	On uncabled fibre	
8			
A	Total Dispersion		
	In 1285-1330 nm band	<=/ 3.5 ps/nm.km	
	In 1270-1340 nm band	<=/ 5.3 ps/nm.km	
	At 1550 nm	<=/ 18.0 ps/nm.km	
B	Polarization Mode dispersion at 1310 & 1550 nm		
	Fibre	<=/ 0.2 ps/√km	
	Cabled Fibre	<=/ 0.3 ps/√km	
C	Zero Dispersion Slope	<=/ 0.092 ps/(nmsq,km)	
D	Zero Dispersion wavelength	1300-1324 nm	
9	Cut off wavelength		
A	For fibres used in cable	1320 nm Max	
	For fibres used in patch cords	1240 nm Max	
10	Mechanical Characteristics		
A	Proof Test for minimum strain level	1%	
B	Strip ability force to remove primary coating of the fibre	1.3 < N < 8.9 N	
	Un-aged	> 440 KPSI	
	Aged	> 550 KPSI	
D	Dynamic Fatigue	>=/ 20	
E	Static Fatigue	>=/ 20	

11	Change in attenuation measured at 1550nm when fibre is coiled with 100 turns on 30 ± 1.0 mm radius mandral	<= 0.50 dB	
12	Fibre Curl	>= 4 meters radius of curvature	
	Fibre micro bend (1 turn around 32 ±0.5 mm diameter mandate)	0.5dB at 1550 nm	
13	Other performance Characterization		
A	Effective Group Index	1.4670 at 1310 nm 1.4675 at 1550 nm	
B	Refractive Index Difference	0.33%	
1	Temperature Range (IEC 60794-1-2-F1)	0 to 60 Deg.C	
2	Bending Radius(IEC 60794-1-E11)	15 x D, D = Cable Diameter (cable core)	
3	Tensile force(IEC 60794-1-E1)	9.8X3XW,	
4	Torsion resistance(IEC 60794-1-E7)	10 Cycle (± 180°) 10 Kg Weight, L= 2 Mtr	
5	Crush resistance(IEC 60794-1-E)	4000 N (100 X 100 mm) for 600 sec	
6	Impact resistance(IEC 60794-1-E4)	Height 500 mm, Weight = 5 Kg, 3 Nos at different place	
7	Kink resistance(IEC 60794-1-E10)	10 x D, D = Cable Diameter	
8	Water penetration(IEC 60794-1-F5)	1 meter water head, 3 mtr cable sample, 24 Hrs	
9	Repeated bending EIA-455104)	30 Cycle 20 X D 10 Kg Load D = Cable Diameter	
10	Construction		
a	Primary coated Fiber	4 Fibers /Tube	
b	Tube filling compound	Thixotropic gel	
c	Loose tubes	Poly butylenes Terephthalate	
d	Cable filling compound	Thixotropic gel	
e	Strength member	FRP Rod	
f	Core wrapping material	Polyester tape	
g	Inner sheath (Thickness-0.8 mm nom.)	HDPE	
h	Armour (Thickness-0.15 mm)	Corrugated steel tape	
i	Outer jacket (Thickness-1.5 mm Nom.)	Thermoplastic outer sheath with HFFR & UV property	
14	DRUM IDENTIFICATION LABEL		
a	Drum No		
b	Type of cable (MM/SM)		
c	Physical cable length/Drum		

d	No of fibre		
e	Length of each fiber measured by OTDR		
f	The cable factor		
g	Attenuation per Km		
h	User's/Consignee's name		
i	Manufacturer's name, Month year & Batch No		
j	Group refractive index of fiber		
k	Cable length initial reading & end reading marked on Drum No		

17.5 GTP OPGW-HARDWARE

Sr.No.	Description	Unit	Buyer's Requirement	Supplier's Data
1	Minimum Vertical Strength	kN	70	
2	Maximum Slip Strength	kN	20% RTS OPGW	
3	Minimum Slip Strength	kN	14% RTS OPGW	
4	Length (Nominal)	mm	1854	
5	Weight (Nominal)	kg	5.98	
6	Total Drop (Including Shackles) Max.	mm	250	
7	Tightening Torque (Nominal)	Nm	NA	
8	Details of Armor Rod Set			
	a) No. of Rods per Clamp		11	
	b) Direction of Lay		Left Hand	
	c) Overall Length	mm	1854	
	d) Diameter of Each Rod	mm	3.7	
	e) Tolerances :-			
	(1) Diameter of Each Rod	±%	3	
	(2) Length of Each Rod	±%	4	
	f) Material Of Manufacture		Alu.Alloy	
	g) UTS of Each Rod	kN	NA	
h) Weight	Kg	1.1		
9	Details of Protection Splice Set (Reinforcing Rod)			
	a) No. of Rods per Clamp		10	
	b) Direction of Lay		Left Hand	
	c) Overall Length	mm	1168	
	d) Diameter of Each Rod	mm	6.4	
	e) Tolerances :-			
	(1) Diameter of Each Rod	±%	3	
	(2) Length of Each Rod	±%	4	
	f) Material Of Manufacture		Alu.Alloy	
	g) UTS of Each Rod	kN	NA	
h) Weight	kg	0.6		
DEAD END CLAMP ASSEMBLY				
1	Minimum Slip Load	kN	95% RTS OPGW	
2	Length (Nominal)			
	a) Reinforcing Rods	mm	1372	
	b) Dead End	mm	960	
3	Weight (Nominal)			
	a) Reinforcing Rods	kg	0.8	
	b) Dead End	kg	0.9	

4	Breaking Strength (Minimum)		111	
5	Wire Size			
	a) Reinforcing Rods	mm	2.9	
	b) Dead End	mm	3.2	
<u>VIBRATION DAMPER</u>				
1	Total Weight	kg	1.7	
2	Weight of Each Damper	kg	0.7 & 0.5	
3	Material of Damper Weight		GI	
4	Clamp Material		Aluminum	
5	Clamp Bolt Tightening Torque	Nm	41	
6	Clamp Bolt Material		Steel	
7	Messenger Cable Material		Steel	
8	No.of Strands in Messenger Cable		7	
9	Breaking Strength of Messenger Cable	kN	NA	
10	Resonance Frequencies			
	a) First Frequency	Hz	8	
	b) Second Frequency	Hz	18	
	c) Third Frequency	Hz	34	
	d) Forth Frequency	Hz	45	
11	Minimum Slip Strength of Damper Clamp			
	a) Before Fatigue Test	kN	2.5	
	b) After Fatigue Test	kN	2.5	
<u>DOWN LEAD CLAMP (FASTENING CLAMP)</u>				
1	Material		Galvanized Steel	
2	Suitable for OPGW (Dia.Range)	mm	10 to 20	
3	Tightening Torque	Nm	NA	
4	Vertical Load	kN	NA	
5	Filler Details			
	(a) Material		Galvanized Steel	
	(b) Diameter	mm	NA	
6	Tower Attachment Arrangement		Less Than 450	
<u>IN LINE SPLICE ENCLOSURE (Junction Box)</u>				
1	Dimensions H*W*D	cm	230*487*173	
2	Weight	kg	7	

3	Color and Finish		Stainless steel AISI 304	
4	Cable Glanding & Fixing		Mechanical	
5	Construction Materials & Gauge		Stainless steel 15110 Aluminum .Alloy	
6	Locking Arrangements		Mechanical(Bolts & nuts)	
7	Installation Clearances (All Sides)	cm	NA	
8	IP Protection	Class	IP 68	
9	Total No. of Optical Couplings	Each	150	
10	Provision of Pass Through Splicing	Y/N	Y	
11	Whether Filled with Suitable Encapsulate	Y/N	N	
12	Method(s) for Mounting with the tower		Hose Clamp	
	Optical Fibre Cable Accommodations			
13	Cable Glanding		Silica Gel	
14	Max No. of Cables that can be Accommodated	Each	4	
15	Diameter of Cables that can be Accommodated		As Required	
	Cable Termination Splice Accommodations			
16	Details of Splice Trays :-			
	Dimension		180*108*11	
	Material / Gauge		Plastic	
	Weight	kg	0.04	
	Color & Finish		Black	
	Method of Mounting		Pin Lock	
17	Maximum No.of Splice Trays		10	
18	Number of Splice Tray		6	
19	Provision of Splice Organizers		NA	
20	Do Splice trays require a separate enclosure	Y/N	N	
21	Excess Length of Fibre Service Loops	m	3-4 Mtr	

18. PACKING, MARKING, SHIPPING, HANDLING AND SITE SUPPORT:

Packing	The OPGW cable shall be provided with steel drum. a) Drum identification labels: List shall be attached to the outside and Inside of the drum flanges. Labels shall be protected by transparent Plastic envelopes and shall give the following information : i) Drum No. ii) Type of cables iii) Physical Cable length iv) User's / Consignee's Name v) Manufacturer's Name, Month, Year and Batch No. vi) Cable length initial reading & end reading shall be marked on drum. Cable starting end shall be taken out from winding to read this drum reading with proper sealing to protect against external damaged viii) The drum progressive length of cable at every meter. (Zero point being the cable end at its inner coil on the cable drum)
Packing identification label	To show purchaser name, address, purchase order number, equipment name, quantity. Note 1: The supplier shall supply the cable in Steel drum of MS spindle plate with nut bolts Note 2- The supplier shall be held responsible for all transit damage due to improper packing
Accessories & tools	Packed in separate wooden case or box

18.1 Submission with Bid (1 soft copy)

- a. GA drawing.
- b. Guaranteed technical particulars
- c. BOM (Bill of Material)
- d. Quality plan
- e. Type test reports

18.2 Submission of final approved documents (4 hard copies + 2 soft copies in CD format

- a. GA drawing
- b. BOM (Bill of Material)
- c. Quality plan
- d. GTP (Guaranteed Technical Particulars) _
- e. Installation, commissioning manual.
- f. Operation & maintenance manual.

18.3 After receipt of purchase order(PO) kick of meeting will be carried out with M/s ABB.

18.4 All the schedules of documents submission will be decided in kick of meeting.

18.5 Drawings will be approved within 7 days after incorporating all our comments/queries.

18.6 Delivery schedule:

- a. Delivery period start date - from date of purchase order
- b. Delivery period end date - as agreed with supplier in PO
- c. Material dispatch clearance - after inspection by purchaser

19. LIST OF RECOMMENDED SPARES

Sr.No.	Description	Quantity	Nature of spare	Nature of storage for healthiness
1	2	3	4	

NOTE:

In Column `4' indicate nature of spare by a letter as applicable:

- C - Consumable
- E - Emergency
- S - Susceptible to damage during erection, testing and commissioning.

Name of Firm

Signature of Bidder

Name of Bidder

Designation

Date

Seal of Company

20. LIST OF TOOLS & TACKLES

- List of instruments, testing equipment, tools and tackles for erection and maintenance
- Instruments, testing equipment, tools and tackles for erection (to be taken back by bidder after completion of job)
- Instruments, testing equipment, tools and tackles for maintenance (to be taken back by bidder after completion of job)
- Special instruments, testing equipment, tools and tackles for erection (to be retained by the purchaser).
- Special instruments, testing equipment, tools and tackles for maintenance (To be retained by the Purchaser)

21. SCHEDULE

Maintenance Tools and Tackles

Bidder shall furnish below item wise list of proposed special maintenance tools and tackles
For which prices shall be indicated in the price schedule AB:

S.No.	System/sub-system	Description	Quantity
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Note: Additional sheets of similar size and format may be annexed as per bidders Requirement.

Signature of Bidder: _____

Name : _____

Designation : _____

Company seal : _____

Date: _____

22. DEVIATIONS

Technical Deviation Schedule (Technical)

If the proposal has got any deviation from the technical specification, scope of supply, etc., Bidder shall tabulate those deviations and sign below. Attach more sheets if necessary. It will automatically be confirmed that except these deviations, as tabulated hereunder, the complete offer is in agreement with the specification requirement. Deviations for Technical and Commercial Conditions shall be given separately.

Specification Part	Page No.	Clause & Reference	Deviation taken	Effect on lump sum proposal price (+) or (-) indicate currency
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Note:
 Any deviations taken by the Bidder to the stipulations of the Bid document shall be brought as per this format only and enclosed along with offer.
 Any deviations not brought out in this form and written elsewhere in the Bid documents shall not be recognized and the same is treated as null and void.

Name of Firm
 Signature of Bidder
 Name of Bidder
 Designation
 Date

Seal of Company

23. ANNEXURE A: BOQ: BILL OF QUANTITY.

Sr No:	Description	Quantity