SECTION – 2.4

OPTICAL GROUND WIRE (OPGW)

1.0.0 INTENT OF SPECIFICATION

The broad scope of this specification includes the design, engineering, manufacturing, supply, transportation, insurance, delivery at site, unloading, handling, storage, supervision of erection/ installation, installation, splicing, termination, testing, demonstration for acceptance and commissioning and documentation for:

(i) 24F and 48 F OPGW including all associated hardware, accessories & fittings as per project requirement.

(ii) Fibre Optic approach cables as per project requirement

(iii) Fibre Optic Joint Boxes (SS 304), Splicing), Splicing of optical cables etc as per project requirement.

(iv) Supply of spares

(v) Supply of all test equipment. In case the offered make/model of test equipment has multiple options for the parameters, the option of higher range shall be acceptable. The supplied test equipment shall be suitable for use in the high EMI/EMC environment.

(vi) All other associated work/items described in the technical specifications and GTS (General Technical Specification).

This section of the technical specification describes the functional and technical specifications of OPGW cabling and associated hardware and fittings for 400kV transmission line package of 2375 MW Capacity Solar / Wind Hybrid RE Park at Great Rann of Kutch Area, Gujarat. The entire OPGW system shall be as per CEA regulations which is mentioned in Codes & Standards section of GTS.

2.0.0 CODES AND STANDARDS

Sl. No.	Standard	Title
1.	IEC 60304	Standard colours for insulation for low-frequency cables and wires
2.	IS802/ IEC826:ASE52:BS8 100	Code of Practice for Use of Structural. Steel in Overhead Transmission Line Towers,
3.	IEC 60794-1-F-5.	Optical fibre cables-Generic specification-Water penetration
4.	IEEE-1138	Standard for Testing and Performance for Optical Ground Wire (OPGW)
5.	IEC 61089	Round wire concentric lay overhead electrical stranded conductors
6.	IEC 61284	Requirements and tests for fittings
7.		

Material meeting with the requirements of other authoritative standards, which ensure equal or better performance than the standards mentioned above, shall also be considered. When the material offered by the bidder conforms to other standards, salient points of difference between standards adopted & the standards specified in this specification shall be clearly brought out in the relevant schedules.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 OPGW cable construction shall comply with latest IEEE-1138. The cable provided shall meet both the construction and performance requirements such that the ground wire function, the optical fibre integrity and optical transmission characteristics are suitable for the intended purpose. The cable shall consist of optical fibre units as defined in this specification. There shall be no factory splices within the cable structure of a continuous cable length.

3.2.0 All optical fibre cabling including fibre itself and all associated installation hardware shall have a minimum guaranteed design life span of 25 years.

3.3.0 Documentary evidence in support of guaranteed life span of cable & fibre shall be submitted by the Contractor during detailed engineering.

3.4.0 Dual-Window Single mode (DWSM), G.652D optical fibres shall be provided in thefibre optic cables

3.5.0 The attenuation coefficient for wavelengths between 1525 nm and 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.05 dB/km. The attenuation coefficient between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.05 dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.10 dB.

3.6.0 The overall optical fibre path attenuation shall not be more than calculated below:

Maximum attenuation @ 1550nm: 0.21 dB/km x total km + 0.05 dB/splice x no. of splices + 0.5 dB/connector x no. of connectors
Maximum attenuation @ 1310nm: 0.35dB/km x total km + 0.05 dB/splice x no. of splices + 0.5 dB/connector x no. of connectors

Table -1 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
Mode field concentricity error	≤ 0.6µm
Cladding non-circularity	≤ 1%
Cable Cut-off Wavelength l cc	≤ 1260 nm
1550 nm loss performance	As per ITU-T G.652 D
Proof Test Level	≥ 0.69 GPa
Attenuation Coefficient:	@ 1310 nm ≤ 0.35 dB/km &@ 1550 nm ≤ 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^2 x km) maximum
Polarization mode dispersion coefficient	≤ 0.2 ps/km^½
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60°C - +85°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

3.7.0 The OPGW cable to be supplied shall be designed to meet the overall requirements of all the transmission lines. Normally the tower span of the lines shall not exceed 600m; however, some of the spans may be up to around 1000m or more.

3.8.0 The estimated optical fibre link lengths shall be provided by Contractor for transmission line route length. However, the Contractor shall supply & install the optical fibre cable as required based on detailed site survey carried out by the contractor.

3.9.0 The actual cable lengths to be delivered shall take into account various factors such as sag, service loops, splicing, workinglengths & wastage etc.

3.10.0 Individual optical fibres within a fibre unit and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bell core GR-20 colour-coding scheme. Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogeneous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing. Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibres is included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibres shall be suitably bundled, tagged and identified at the factory by the vendor.

3.11.0 Loose tube construction shall be implemented. The individually coated optical fibre(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the cable. The fibre coating and buffer shall be strippable for splicing and termination. Each fibre unit shall be individually identifiable utilizing colour coding. Buffer tubes shall be filled with a water-blocking gel.

3.12.0 The OPGW cable shall be designed and installed such that the optical fibres experience no strain under all loading conditions defined in IS 802. Zero fibre strain condition shall apply even after a 25 year cable creep.

3.13.0 The Sag-tension chart of OPGW cable indicating the maximum tension, cable strain and sag shall be calculated and submitted along with the bid under various conditions mentioned below:

a. 53° C, no wind and no ice

b. 32° C, no wind and no ice
c. 0°C, no wind and no ice
d. 32° C, full wind and no ice
e. 32° C, 75% full wind and no ice
f. 0° C, 2/3rd / 36% of full wind (IS 802)

3.14.0 The above cases shall be considered for the spans from 100 m to 600 m or higher span length in the range of 50 m spans. Max. Vertical sag, max. tension and max sag at 0°C & no wind shall be considered in line with the design parameter of transmission line. The full wind load shall be considered as the design wind load for all the specified transmission lines as per relevant IS 802 version and the sag-tension chart shall be submitted considering the transmission lines. In case of any span higher than 600m, suitable OPGW cable meeting sag-tension requirement of transmission line shall also be provided by the Contractor. The Contractor shall submit the stringing chart for review of GIPCL.

3.15.0 The interstices of the fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any water longitudinal migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC 60794-1-F-5.

3.16.0 The filling compound used shall be a non-toxic homogenous waterproofing compound that is free of dirt and foreign matter, non-hygroscopic, electrically nonconductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable.

3.17.0 The waterproofing filling materials shall not affect fibre coating, colour coding, or encapsulant commonly used in splice enclosures, shall be dermatologically safe, non-staining and easily removable with a non-toxic cleaning solvent.

3.18.0 When the fibre optic cable design incorporates metallic elements in its construction, all metallic elements shall be electrically continuous.

3.19.0 Drum Markings: Each side of every reel of cable shall be permanently marked in white lettering with the vendors' address, the Purchaser's destination address, cable part number and specification as to the type of cable, length, number of fibres, a unique drum number including the name of the transmission line & segment no., factory inspection stamp and date.

3.20.0 Cable Drums: All optical fibre cabling shall be supplied on sturdy, corrosion resistant, steel drums suitable for long periods of storage and re-transport & handling. All drums provided with lagging or PP sheets of adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. Both ends of the cable shall be sealed as to prevent the escape of filling compounds and dust & moisture ingress during shipment and handling. Spare cable caps shall be provided with each drum as required.

3.21.0 The spare cable shall be supplied on sturdy, corrosion resistant, steel drums suitable for long periods of storage and re-transport & handling.

3.22.0 There shall be no factory splices allowed within a continuous length of cable. Only one continuous cable length shall be provided on each drum. The lengths of cable to be supplied on each drum shall be determined by a "schedule" prepared by the Contractor and approved by the owner.

3.23.0 The composite fibre optic overhead ground wire shall be made up of multiple buffer tubes embedded in a water tight aluminium/ aluminium alloy/stainless steel with aluminium coating protective central fibre optic unit surrounded by concentric-lay stranded metallic wires in single or multiple layers. In case of central Aluminum tube type OPGW, each buffer tube shall have maximum 12 no. of fibers and all fibers in single buffer tube are not acceptable. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical

transmissionproperties of optical fibre.

3.24.0 The central fibre optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibres from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen.

3.25.0 The OPGW design of dissimilar materials such as stainless steel tube with aluminium or aluminium–clad-steel wire strands are not allowed. Central fiber optic unit may be of aluminium or stainless steel tube with aluminium protective coating. In case of aluminium protective coating, the coating must completely cover the tubes leaving no exposed areas of tubing that can make electrical contact either directly or indirectly through moisture, contamination, protrusions, etc. with the surrounding stranded wires. The tube may be fabricated as a seamless tube, seam welded, or a tube without a welded seam.

3.26.0 The OPGW cable construction shall conform to the applicable requirements of this specification, applicable clauses of IEC 61089 related to stranded conductors. In addition, the basic construction shall include bare concentric-lay stranded metallicwires with the outer layer having left hand lay. The wires may be of multiple layerswith a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed. The finished wires shall contain nojoints or splices unless otherwise agreed to by the GIPCL and shall conform to all applicable clauses of IEC 61089 as they pertain to stranded conductors. The wires shall be so stranded that when the complete OPGW is cut, the individualwires can be readily regrouped and then held in place by one hand.

3.27.0 The rated breaking strength of the completed OPGW shall be taken as not more than 90 percent of the sum of the rated breaking strengths of the individual wires, calculated from their nominal diameter and the specified minimum tensilestrength.

3.28.0 The rated breaking strength shall not include the strength of the optical unit. Thefibre optic unit shall not be considered a load bearing tension member when determining the total rated breaking strength of the composite conductor.

3.29.0 For the purposes of determining the appropriate Max Working Tension limit for the OPGW cable, IS 802 shall be applied. However, the OPGW installation sag & tension charts shall be based on IS 802 version to which the line is originally designed. For the OPGW cable design selection and preparation of sag tension charts, the limits specified in this section shall also be satisfied.

Table 2- OPGW ELECTRICAL AND MECHANICAL REQUIREMENTS

1)	Everyday Tension	≤ 20% of Ultimate Tensile Strength (UTS) of OPGW
2)	D.C. Resistance at 20ºC:	< 1.0 ohm/Km
3)	Short Circuit Current	Short Circuit shall be applicable as per the voltage level of the line >63kA for 3 secs
4)	Ultimate tensile Strength(UTS)	The following parameter of the existing earthwire also shall be considered for UTS design
4a)	Outer diameter(400kV)	≥13.3 mm (Single Layer) ≥ 15.6mm (Double Layer)

4b)	UTS (400kV)	≥59 KN (Single Layer) ≥ 92KN (Double Layer)
4c)	Weight per Km (400kV)	≥450 kg/km (Single Layer) ≥ 729 kg/km (Double Layer)
The parameters are indicative, and the bidder shall provide suitable OPGW characteristics considering the system fault level, short circuit forces, span, project location, etc for proper functioning of the system. The bidder shall prove the parameters offered/selected by the bidder with technical calculations.		

3.30.0 Since OPGW shall be located at the top of the transmission line support structure,it will be subjected to Aeolian vibration, Galloping and Lightning strikes. It will also carry ground fault currents. Therefore, its electrical and mechanical properties shall be same or similar as those required of conventional ground conductors.

3.31.0 Fibre Optic Approach Cables

Fibre optic approach cable is defined as the Armoured underground fibre optic cable laid in HDPE conduit required to connect Overhead Fibre Optic Cable (OPGW) between the final in line splice enclosure on the gantry / tower forming the termination of the fibre cable on the power line and the Fibre Optic Distribution Panel (FODP) installed within the substations.

Jacket Construction & Material: The Approach Cable shall be a UV resistant, rodent proof, armoured cable with metallic type of armouring. The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall conform to ASTM D1248 for density.Optical, Electrical and Mechanical Requirements : Approach cable shall contain fibres with identical optical/ physical characteristics as those in the OPGW cables. The cable core shall comprise of tensile strength member(s), fibre support/bedding structure, core wrap/bedding, and an overall impervious jacket.

3.32.0 **Installation Hardware**

The scope of supply includes all required fittings and hardware such as Tension assembly, Suspension assembly, Vibration dampers, reinforcing rods, Earthing clamps, Down-lead clamps, splice enclosure etc. The Bidder shall provide documentation justifying the adequacy and suitability of the hardware supplied. The quantity of hardware & fittings to meet any eventuality during site installation minimum @ 1% shall also be provided as part of set/ km for each transmission line without any additional cost to GIPCL

The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in clause 4.0 of EN 61284: 1997 (IEC 61284). The shear strength of all bolts shall be at least 1.5 times the maximum installation torque. The OPGW hardware & accessories drawing & GTP (DRS) document shall consist of three parts:

(1) A technical particular sheet

(2) An assembly drawing i.e. level 1 drawing and

(3) Component level drawings i.e. level 2 & lower drawings. 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.

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:

(a) Suspension Assemblies: Preformed armour grip suspension clamps and aluminium alloy armour rods/ reinforcing rods shall be used. The suspension clamps shall be designed to carry a vertical load of not less than 25 KN. The suspension clamps slippage shall occur between 12kN and 17 kN as measured.

The Contractor shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pins, etc. 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). The design of the assembly shall be such that the direction of run of the OPGW shall be the same as that of the conductor.

(b) Dead End Clamp Assemblies: All dead-end clamp assemblies shall preferably be of preformed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates. 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.

(c) Clamp Assembly Earthing Wire: 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. The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.

(d) Structure Attachment Clamp Assemblies: 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. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. 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.

(e) Vibration Dampers: Vibration dampers type 4R Stockbridge or equivalent, having four (4) different frequencies spread within the Aeolian frequency bandwidth corresponding to wind speed of 1m/s to 7 m/s, shall be used for suspension and tension points in each span. The Contractor shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis as specified in technical specifications.

One damper minimum on each side per OPGW cable for suspension points and two dampers minimum on each side per OPGW cable for tension points shall be used for nominal design span of 400 meters. For all other ruling spans, the number of vibration damper shall be based on vibration analysis.

The clamp of the vibration damper shall be made of high strength aluminum alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chaffing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the OPGW cable without damaging the strands or causing premature fatigue failure of the OPGW cable under the clamp. The clamp groove shall be in uniform contact with the OPGW cable over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the OPGW cable when the clamp is installed. Clamping bolts shall be provided with self-locking nuts and designed to prevent corrosion of threads or loosening in service.

The messenger cable shall be made of high strength galvanised steel/stainless steel. It shall be of

preformed and post formed quality in order to prevent subsequent drop of weight and to maintain consistent flexural stiffness of the cable in service. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS:4826 for heavily coated wires.

The damper mass shall be made of hot dip galvanised mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defectssuch as cracks, shrinkage, inclusions and blow holes etc. The surface of thedamper masses shall be smooth.

The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip outof the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other-than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably andeffectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.

The contractor must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 kN and 5 kN. The clamp when installed on the OPGW cable shall not cause excessive stress concentration on the OPGW cable leading to permanent deformationof the OPGW strands and premature fatigue failure in operation.

Sl No.	Description	Technical Particulars
1	Span Length in meters (i) Ruling design span: (ii) Maximum span: (iii) Minimum Span:	 400 meters 1100 meters 100 meters
2	Configuration:	As per Specifications
3	Tensile load in each:	As per sag tension calculations
4	Armour rods used:	Standard preformed armour rods/AGS
5	Maximum permissible dynamic strain:	5 +/- 150 micro strains

The damper placement chart for spans ranging from 100m to 1100m shall be submitted by the Contractor. Placement charts should be duly supported with relevant technical documents and sample calculations.

The damper placement charts shall include the following:

(1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per OPGW cable per span.

(2) Placement distances clearly identifying the extremities between which the distances are to be measured.

(3) Placement recommendation depending upon type of suspension clamps (viz Free center

type/Armour grip type etc.)

(4) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.

All splices shall be encased in Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. Splice enclosures shall comply with ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of required number of optical fibre splices and equipped with sufficient number of splice trays for splicing all fibres in the cable. Not more than 12 fibres shall be terminated in a single splice tray. They shall be filled with suitable encapsulate that is easily removable should re-entry be required into the enclosures.

3.33.0 Splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on transmission line towers above anti-climb guard levels at about 10 metres from top of the tower and shall accommodate pass-through splicing. Contractor shall be responsible for splicing of fibres and installation of splice enclosures.

3.34.0 Splicing of the optical fibre cabling shall be minimized through careful Contractor planning. There shall be no mid-span splices allowed. All required splices shall be planned to occur on tower structures. All optical fibre splicing shall comply with the following:

(a) All fibre splices shall be accomplished through fusion splicing.

(b) Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.

(c) All splices and bare fibre shall be neatly installed in covered splice trays.

(d) For each link, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05 dB and no single splice loss shall exceed 0.1 dB when measured at 1550 nm.

(e) For splicing, fibre optic cable service loops of adequate length shall be provided so that all splices occurring at tower structures can be performed at ground level.

3.35.0 Service Loops

For purposes of this specification, cable and fibre service loops are defined as slack (extra) cable and fibre provided for facilitating the installation, maintenance and repair of the optical fibre cable plant.

(a) Outdoor Cable Service Loops: In-line splice enclosures installed outdoors and mounted on the utility towers shall be installed with sufficient fibre optic cable service loops such that the recommended minimum bend radius is maintained while allowing for installation or maintenance of the cable to be performed in a controlled environment at ground level.

(b) Fibre Units Service Loops: For all fibre optic cable splicing, the cable shall be stripped back a sufficient length such that the fan-out of fibre units shall provide for at least one (1) metre of fibre unit service loop between the stripped cable and the bare fibre fan-out.

(c) Pigtail Service Loops: Connectorised pigtails spliced to bare fibres shall provide at least 1 metre of service loop installed in the FODP fibre organizer and at least one (1) metre of service loop to the couplings neatly stored behind the FODP coupling panels.

(d) Fibre Service Loops: At least 0.5 metre of bare fibre service loop shall be provided on each side of all fibre splices. The bare fibre service loops shall be neatly and safely installed inside covered splice trays

4.0.0 INSPECTION & TESTING REQUIREMENTS

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

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

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

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

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

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

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

4.1.0 Test Plans and Procedures

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

The Contractor shall give the GIPCL twenty-one (21) days written notice of any material being ready for testing. Five days prior to the scheduled testing, the GIPCL shall provide written notice to the Contractor of any drawings, equipment, material, or workmanship in which the GIPCL's opinion, are not compliant to the specification. The contractor shall give due consideration to such objections, if valid, effecting the corrections as necessary or shall prove, in writing, that said modifications are unnecessary for contract compliance.

4.2.0 Factory and Site Test Plans

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

4.3.0 Test Procedures

Test procedures for factory and site testing shall be submitted for the GIPCL approval at least four (4) weeks before each individual test. Testing shall not commence without approved test procedures.

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

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

4.4.0 Test Records

Complete and indexed records of all factory and site acceptance tests results shall be maintained and provided to the GIPCL by the Contractor in hard & soft copy. The records shall be keyed to the steps enumerated in the test procedures.

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

4.5.0 Rejection of Elements

Any item or component which fails to comply with the requirements of this Specification in any respect, at any stage of manufacture, test, erection or on completion at site may be rejected by the GIPCL either in whole or part as considered necessary. Material or components with defects of such a nature that do not meet the requirements of the Specification by adjustment or modification shall be replaced by the Contractor at his own expense. After adjustment or modification, the Contractor shall submit the items to the GIPCL for further inspection and/or tests.

Testing Requirements: Following are the requirements of testing:

1. Type Testing
2. Factory Acceptance Testing
3. Site Acceptance Testing

4.6.0 Type Testing

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

b. All cable & equipment being supplied shall conform to type tests as per technical specification.

c. The test reports submitted shall be of the tests conducted within last five (5) years for OPGW cable prior to the date of proposal/offer submitted. In case the test reports are older than five (5) years for OPGW cable on the date of proposal/offer, the Contractor shall repeat these tests at no extra cost to the GIPCL.

d. The Contractor shall submit, within 30 days of Contract Award, copies of test reports for

all of the Type Tests that are specified in the specifications and that have previously (before Contract award) been performed.

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

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

g. In case the Type Test is required to be carried out, then following shall be applicable: -

h. Type Tests shall be certified or performed by reputed laboratories using material and equipment data sheets and test procedures that have been approved by the GIPCL. The test procedures shall be formatted as defined in the technical specifications and shall include a complete list of the applicable reference standards and submitted for GIPCL approval at least four (4) weeks before commencement of test(s). The Contractor shall provide the GIPCL at least 30 days written notice of the planned commencement of each type test.

i. The Contractor shall provide a detailed schedule for performing all specified type tests. These tests shall be performed in the presence of a representative of the GIPCL.

j. The Contractor shall ensure that all type tests can be completed within the time schedule offered in his Technical Proposal.

k. In case of failure during any type test, the Supplier is either required to manufacture a fresh sample lot and repeat all type tests successfully or repeat that particular type test(s) at least three times successfully on the samples selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

4.7.0 Type Test Samples

The Contractor shall supply equipment/material for sample selection only after the Quality Assurance Plan has been approved by the GIPCL. The sample material shall be manufactured strictly in accordance with the approved Quality Assurance Plan. The Contractor shall submit for GIPCL approval, the type test sample selection procedure. The selection process for conducting the type tests shall ensure that samples are selected at random. For optical fibres/ Fibre Optic cables, at least three reels/ drums of each type of fibre/cable proposed shall be offered for selection. For FO cable installation hardware & fittings at least ten (10) samples shall be offered for selection. For Splice enclosures at least three samples shall beoffered for selection.

4.8.0 List of Type Tests

The type testing shall be conducted on the following items

(a) Optical fibres

(b) OPGW Cable

(c) OPGW Cable fittings

(d) Vibration Damper

(e) Splice Enclosure (Joint Box)

4.9.0 Type Tests for Optical Fibres

The type tests listed below in Table 6d shall be conducted on DWSM fibres to be supplied as part of overhead cables. The tests specific to the cable type are listed in subsequent sections.

Table 4: TYPE TESTS FOR OPTICAL FIBRES

Sl NO.	TEST NAME	TEST PROCEDURE
1	Attenuation	IEC 60793-1-40 Or EIA/TIA 455-78A
2	Attenuation Variationwith Wavelength	IEC 60793-1-40 Or EIA/TIA 455-78A
3	Attenuation at WaterPeak	IEC 60793-1-40 Or EIA/TIA 455-78A
4	Temp. Cycling (Temp dependence ofAttenuation)	IEC 60793-1-52 Or EIA/TIA 455-3A, 2 cycles
5	Attenuation with Bending (Bend Performance)	IEC 60793-1-47 Or EIA/TIA 455-62A
6	Mode Field dia.	IEC 60793-1-45 Or EIA/TIA 455-164A/167A/174
7	Chromatic Dispersion	IEC 60793-1-42 Or EIA/TIA 455-168A/169A/175A
8	Cladding Diameter	IEC 60793-1-20 Or EIA/TIA 455-176
9	Point Discontinuities of Attenuation	IEC 60793-1-40 Or EIA/TIA 455-59
10	Core –Clad concentricityerror	IEC 60793-1-20 Or EIA/TIA 455-176
11	Fibre Tensile Proof Testing	IEC 60793-1-30 Or EIA/TIA 455-31B

4.10.0 Type Tests for OPGW Cables

The type tests to be conducted on the OPGW cable are listed in Table 6e Type Testsfor OPGW Cables. Unless specified otherwise in the technical specifications or thereferenced standards,

the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table 5: TYPE TESTS FOR OPGW CABLE

SR. NO.	TEST NAME	TEST DESCRIPTION	TEST PROCEDURE	
1	Water Ingress Test	IEEE 1138 :2021	IEEE 1138 (IEC 6074-1-2 Method F5 or EIA/TIA 455-82B)	Test duration: 24 hours
2	Seepage of filling compound	IEEE 1138:2021	IEEE 1138 (EIA/ TIA 455-81B)	Preconditioning period: 72 hours. Test duration: 24 hours.
3	Short Circuit Test	IEEE 1138:2021	IEEE 1138	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. A suitable temperature sensor such as thermocouple shall be used to monitor and record used to monitor and record the temperature inside the OPGW tube in addition to monitoring & recording the temperature between the strands and between optical tube and the strands as required by IEEE 1138. Test shall be conducted with the tension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test.
		Or IEC 60794-4-10/IEC 60794-1-2 (2003) Method H1		Initial temperature during the test shall be greater than or equal to ambient field temperature.
4	Aeolian Vibration Test	IEEE 1138:2021	IEEE 1138	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalentmeans. The vibration frequency and amplitude shall be monitored and recorder continuously.

		Or IEC60794-4-10 / IEC 60794-1-2, Method E19		All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring. Test shall be conducted with the tension/ suspension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test.
5	Galloping test	IEEE 1138:2021	IEEE 1138-2009	Test shall be conducted with the tension/suspension clamps proposed to be supplied. The cable and clamps shall be visually inspected for mechanical damage and photographed after the test. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring.
6	Cable Bend Test	Procedure 2 in IEC 60794-1-2 Method E11		The short-term and long-termbend tests shall be conducted in accordance with Procedure 2 in IEC60794-1-2 E11 to determine the minimum acceptable radius of bending without any increase in attenuation or any other damage to the fibre optic cable core such as bird caging, deformation, kinking andcrimping.
7	Sheave Test	IEEE 1138 :2021 OR IEC 60794-1-2 Method E1B	IEEE 1138	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The Sheave dia. shall be basedon the pulling angle and the minimum pulley dia employed during installation. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring.
8	Crush Test	IEEE 1138:2021	IEEE 1138-(IEC 60794-1-2, Method E3/ EIA/TIA 455-41B)	The crush test shall be carriedout on a sample of approximately one (1) metre long in accordance with IEC 60794-1-2 E3. A load equal to 1.3 times the weight of a 400-metre length of fibre optic cable shall be applied for a period of 10 minutes. A permanent or temporarily increase in optical

				attenuation value greater than 0.1 dB change in sample shall constitute failure. The load shall be further increased in small increments until the measured attenuation of the optical waveguide fibres increases and the failure load recorded along with results.
9	Impact Test	IEEE 1138:2021	IEEE 1138 , (IEC 60794-1-2 E4/ EIA/TIA 455- 25B)	The impact test shall be carried out in accordance with IEC 60794-1-2 E4. Five separate impacts of 0.1-0.3kgm shall be applied. The radius of the intermediate piece shall be the reel drum radius ± 10%. A permanent or temporary increase in optical attenuation value greater than 0.1 dB/km change in sample shall constitute failure.
10	Creep Test	IEEE 1138:2021	IEEE 1138	As per Aluminium Association Method, the best-fit straight line shall be fitted to the recorded creep data and shall be extrapolated to 25 years. The strain margin of the cable at the end of 25 years shall be calculated. The time when the creep shall achieve the strain margin limits shall also be calculated.
11	Fibre Strain Test	IEEE 1138:2021	IEEE 1138	
12	Stress strain Test	IEEE 1138:2021	IEEE 1138	
13	Cable Cut-off Wavelength test	IEEE 1138:2021	IEEE 1138	
14	Temperature Cycling Test	IEEE 1138:2021	IEEE 1138 or IEC 60794-1-2, Method F1	
15	Corrosion Test (Salt Spray)	EIA/TIA 455-16A/IEEE 1138: 2009		

16	Tensile Performance Test	IEC 60794-1-2 E1 / EIA/TIA455-33B	The test shall be conducted on a sample of sufficient length in accordance with IEC 60794-1- 2 E1. The attenuation variation shallnot exceed 0.05 dB/Km up to 90% of RTS of fibre optic cable.The load shall be increased at asteady rate up to rated tensile strength and held for one (1) minute. The fibre optic cable sample shall not fail during theperiod. The applied load shall then be increased until the failing load is reached, and the value recorded.
17	Lightning Test	IEC 60794-4-10 / IEC 60794-1-2	The OPGW cable construction shall be tested in accordance with IEC 60794-1-2, MethodH2 for Class 1.
18	DC Resistance Test (IEC 60228)	On a fibre optic cable sample of minimum 1 metre length, two contact clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The tests shall be repeated at least five times and the average value recorded after correcting at 20°C.	

4.11.0 Type Test on OPGW Cable Fittings

The type tests to be conducted on the OPGW Cable fittings and accessories arelisted below:

(i) Mechanical Strength Test for Suspension/Tension Assembly

Applicable Standards: IEC 61284:1997

A) SUSPENSION ASSEMBLY

The armour rods /reinforcement rods are assembled on to the approved OPGW using the Installation Instructions to check that the assembly is correctly fitted and is the same that will be carried out during installations.

Part 1:

The suspension assembly shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased and held for one minute for the test rig to stabilize. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. The angle between the cable, the Suspension Assembly and the horizontal shall not exceed 16^{O}. This load shall then be removed in a controlled manner and the Protection Splice disassembled. Examination of all the components shall be made and any evidenceof visual deformation shall be documented.

Part 2:

The Suspension clamp shall then be placed in the testing machine. The tensile load shall gradually be increased up to 50% of the specified Minimum Failure Load of the Suspension Assembly and held for one minute for the Test Rig to stabilize and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached, and the value shall be documented.

B) TENSION ASSEMBLY

The Tension Assembly is correctly fitted and is the same that will be carried out during installations.

Part 1:

The tension assembly (excluding tension clamp) shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased ata constant rate and held for one minute for the test rig to stabilize. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. This load shall then remove in a controlled manner and the Tension Assembly disassembled. Examination of the Tension Dead-End and associated components shall be made, and any evidence of visual deformation shall be documented.

Part 2:

The Tension Dead-End and associated components shall then be reassembled, and bolts tightened as before. The tensile load shall gradually be increased up shall gradually be increased up to 50% of the specified Minimum Failure Load of the Tension Assembly and held for one minute for the Test Rig to stabilize and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached, and the value shall be documented.

Acceptance Criteria for Tension/Suspension Assembly:

- No evidence of binding of the Nuts or Deformation of components at end of Part1 of Test.
- No evidence of Fracture at the end of one minute at the minimum failure loadduring Part 2 of the Test.

Any result outside these parameters shall constitute a failure

(ii) Clamp Slip Strength Test for Suspension Assembly

The suspension assembly shall be vertically suspended by means of a flexibleattachment. A suitable length fibre optical cable shall be fixed in the clamps.

Once the Suspension Clamp has been assembled, the test rig is tensioned to 1 kN and the position scale on the recorder ‘zeroed’. The test rig is then tensioned to 2.5 kN and the relative positions of the Reinforcing Rods, ArmourRods and Suspension Clamp shall be marked by a suitable means to confirm any slippage after the test has been completed. The relative positions of the helical Armour Rods and associated Reinforcing Rods at each end shall be marked and also 2 mm relative position between clamp body and Armour Rods shall be marked on one side. The load shall be increased to 12 kN at a loading rate of 3 kN/min and held for one minute. At the end of this one minute period, the relative displacement between clamp body and the armourrods shall be observed. If the slippage is 2 mm or above, the test shall be terminated. Otherwise, at the end of one minute the position of the clamp body and 2

mm. relative positions between clamp body and armour rods shallbe marked on the other side. After the one minute pause, the load shall be further increased at a loading rate of 3 kN/min, and recording of load and displacement shall continue until either the relative Position displacement between clamp body and armour rods reaches more than 2 mm or the load reaches the maximum slip load of 17 kN. On reaching either of the above values the test is terminated. Visual examination of all paint marks shall be recorded, and a measurement of any displacement recorded in the Table of Results.

Acceptance Criteria:

The Suspension Clamp has passed the Slip Test if the following conditions aremet:

No slippage* shall occur at or below the specified minimum slip load.

Definition of no slippage in accordance with IEC 61284: - Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the cable as a result of the test itself are not regarded as slippage.

Slippage shall occur between the specified maximum and minimum slip load of 12 - 17 kN.

There shall be no slippage of the Reinforcing Rods over the cable, and no slippage of the Armour Rods over the Reinforcing Rods.

The relative movement (i.e. more than 2 mm between Armour Rods & Clamp body) between minimum 12 kN and maximum slip 17 kN, shall be consideredas slip.

The Armour Rods shall not be displaced from their original lay or damaged**.

** Definition of no damage in accordance with convention expressed in IEC 61284 no damage, other than surface flattening of the strands shall occur.

Any result outside these parameters is a failure.

(iii) Slip Strength Test of Tension Clamp

Tension clamps shall be fitted on an 8 m length of fibre optic cable on both ends. The assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A tensile load shall gradually be applied up to 20% of the RTS of OPGW. Displacement transducers shall be installed to measure the relative movement between the OPGW relative to the Reinforcing Rods and Tension Dead –End relative to Reinforcing Rods. In addition, suitable marking shall be made on the OPGW and Dead-End to confirm grip. The load shall be gradually increased at a constant rate up to 50 % of the UTS and the position scale of the recorder is zeroed. The load shall then gradually have increased up to 95 % of the UTS and maintained for one minute. After one minute pause, the load shall be slowly released to zero and the marking examined and measured for any relative movement.

Acceptance Criteria:

- No movement* shall occur between the OPGW and the Reinforcing Rods, or between the Reinforcing Rods and the Dead-End assembly.
- No failure or damage or disturbance to the lay of the Tension Dead-End, Reinforcing Rods or OPGW.
- Definition of no movement as defined in IEC 61284: Any relative movementless than 2 mm is accepted. The possible couplings or elongations producedby the conductor as a result of the test itself are not regarded as slippage.

Any result outside these parameters shall constitute a failure

(iv) Grounding Clamp and Structure Mounting Clamp Fit Test

For structure mounting clamp, one series of tests shall be conducted with two fibre optic cables installed, one series of tests with one fibre optic cable installed in one groove, and one series of tests with one fibre optic cable in the other groove. Each clamp shall be installed including clamping compound as required on the fibre optic cable. The nut shall be tightened on to the bolt by using torque wrench with a torque of 5.5 kgm or supplier's recommended torque and the tightened clamp shall be held for 10 minutes. After the test remove the fibre optic cable and examine all its components for distortion, crushing or breaking. Also, the fibre optic cable shall be checked to ensure free movement within the core using dial calipers to measure the diameter of the core tube. The material shall be defined as failed if any visible distortion, crushing, cracking or breaking of the core tube is observed or the fibre optic cable within the core tube is not free to move, or when the diameter of the core tube as measured at any location in the clamped area is more than 0.5 mm larger or smaller of the core diameter as measured outside the clamped area.

(v) Structure Mounting Clamp Strength Test

The clamp and mounting assembly shall be assembled on a vertical 200 mm x 200 mm angle and a short length of fibre optic cable installed. A vertical load of 200 kg shall be applied at the end of the mounting clamp and held for 5 minutes. Subsequently, the load shall be increased to 400 kg and held for 30 seconds. Any visible distortion, slipping or breaking of any component of the mounting clamp or assembly shall constitute failure.

4.12.0 Type Test on Vibration Damper

(a) Dynamic Characteristic Test

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for Critical Aeolian Vibration frequency band ranging from 0.18/d to 1.4/d – where d is the OPGW cable diameter in meters. The damper assembly shall be vibrated vertically with±1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at 0.5 mm to determine following characteristics with the help of suitable recording instruments.

(i) Force Vs frequency

(ii) Phase angle Vs frequency

(iii) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the Aeolian vibration frequency-band between the lower and upper dangerous frequency limits determined by the vibration analysis of fibre optic cable without dampers.

Acceptance criteria for vibration damper:

(i) The above dynamic characteristics test on five dampers shall beconducted.

(ii) The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.

(iii) The above mean reactance response curve should lie within followinglimits:

V.D. for OPGW - 0.060 f to 0.357 f kgf/mm*Where f is frequency in Hz.

(iv) The above mean phase angle response curve shall be between 25^{o} to 130^{o} within the frequency range of interest.

(v) If the above curve lies within the envelope, the damper design shall beconsidered to have successfully met the requirement.

(vi) Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values.

(b) Vibration Analysis

The vibration analysis of the fibre optic cable shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach. The following parameters shall be taken into account for the purpose of analysis.

(i) The analysis shall be done for single fibre optic cable without armour rods. The tension shall be taken as 25% of RTS of fibre optic cable for a span ranging from 100 m to 1100 m.

(ii) The self-damping factor and flexural stiffness (EI) for fibre optic cable shall be calculated on the basis of experimental results. The details to experimental analysis with these data shall be furnished.

(iii) The power dissipation curve obtained from Damper Characteristics Test shall be used for analysis with damper.

(iv) Examine the Aeolian Vibration level of the fibre optic cable with and without vibration damper installed at the recommended location or windvelocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.

(v) From vibration analysis of fibre optic cable without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.

(vi) From vibration analysis of fibre optic cable with damper(s) installed at the recommended location, the dynamic strain level at the clamped span extremities, damper attachment points and the antinodes on the fibre optic cable shall be determined. In addition to above damper clamp vibration amplitude and antinodes vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment point, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatiguelimits.

(c) Fatigue Tests

(i) **Test Set Up**

The fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30m. The fibre optic cable shall be tensioned at 25% of RTS of fibre optic cable and shall not be equipped with protective armour rods at any point. Constant tension shall be maintained within the span by means of lever arm arrangement.

After the fibre optic cable has been tensioned, clamps shall be installed to support the fibre optic cable at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the fibre optic cable. There shall be no loose parts, such as suspension clamps, U bolts, on the test span supported

between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

(ii) **Fatigue Test**

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminatestray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass.

For dampers involving torsional resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at verticalmodes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than
±25/f mm where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the test, if resonance shift is observed, the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned herein shall be repeated after fatigue tests without retorquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from fibre optic cable and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristics of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part.There shall not be significant deterioration or wear of the damper. The fibre optic cable under clamp shall also be free from any damage.

For purposes of acceptance, the following criteria shall be applied:

(1) There shall not be any resonant frequency shift before and after the testby more than ± 20%

(2) The power dissipation of the damper before and after test at the individual resonant frequencies do not differ by more than ± 20%

Beside above tests, the type tests listed below in the table shall also be conducted on Vibration Damper

Sl No.	Test Name	Test Procedure
1	Visual examination & Dimensional and material verification	IEC 61897 :2020, Clause 7.1 & 7.2
2	Clamp Slip test	IEC 61897 :2020, Clause 7.5
3	Clamp bolt tightening test	IEC 61897 2020, Clause 7.7
4	Attachments of weights to messengercable	IEC 61897 2020, Clause 7.8

5	Attachment of clamps to messenger cable	IEC 61897 2020, Clause 7.8
6	Damper effectiveness evaluation	IEC 61897 2020, Clause 7.11.3.2

4.13.0 Type Tests for Splice Enclosures (Joint Box)

Following Type tests shall be demonstrated on the Splice Enclosure(s) (Splice Enclosure/Box). For certain tests, lengths of the fibre optic cable shall be installed in the splice box, and the fibres must be spliced and looped in order to simulate conditions of use. The attenuation of the fibres shall be measured, during certain tests, by relevant Fibre Optic Test Procedures (EIA/TIA 455 orIEC 60794-1 procedures).

(i) Temperature Cycling Test

FO cable is installed in the splice enclosure and optical fibres spliced and looped. The box must be subjected to 5 cycles of temperature variations of - 40°C to +65°C with a dwell time of at least 2 hours on each extreme.

Fibre loop attenuation shall be measured in accordance with EIA 455-20 / IEC 60794-1-C10. The variation in attenuation shall be less than ±0.05dB. The final humidity level, inside the box, shall not exceed the initial level, at the closing of the box.

(ii) Humid Heat test

The sealed splice enclosure, with fibres spliced and looped inside, must be subjected to a temperature of +55°C ±2°C with a relative humidity rate of between 90% and 95% for 5 days. The attenuation variation of the fibres during the duration of the test shall be less than ±0.05dB, and the internal humidity rate measured, less than 2%.

(iii) Rain Withstand Test / Water Immersion test

The splice enclosure with optical fibres cable installed and fibres spliced fixed, shall be subjected to 24 hours of simulated rain in accordance with IEC 60060 testing requirements.

No water seepage or moisture shall be detected in the splice enclosure. The attenuation variation of the fibres after the test shall be less than ±0.05dB.

(iv) Vibration Test

The splice enclosure, with fibres united inside, shall be subjected to vibrationson two axes with a frequency scanning of 5 to 50 Hz. The amplitude of the vibrations shall be constant at 0.450mm, peak to peak, for 2 hours, for each ofthe vibrations' axes. The variation in attenuation, of the fibres, shall be less than ±0.05dB. The splice enclosure shall be examined for any defects or deformation. There shall be no loosening or visible damage of the FO cable at the entry point.

(v) Bending and Torsion test

The splice enclosure, with fibres spliced inside, shall be firmly held in place and be subjected to the following sequence of mechanical stresses on the cable:

a) 3 torsion cycles of ±180° shall be exercised on the cable. Each cycle shall beless than one minute.

b) 3 flexure cycles of the cable, of ±180° with one cycle less than one minute.

The variation in the attenuation, of the fibres, shall be less than ±0.05dB. The cables connection ring shall remain securely fixed to the box with the connection maintained firmly.

No defects/fissures shall be noted on the joint ring or on the splice enclosure

(vi) Tensile test

The splice enclosure with cable fixed to the boxes shall be subjected to a minimum tension of 448 N for a period of two minutes. No fissure shall be noted in the connections or on the box.

(vii) Drop Test

With 2 lengths of 11 meters of cable fixed to the box, it shall be dropped five times from a height of 10 meters. There shall be no fissure, at all, of the box, and the connections shall remain tight. The test surface shall be carried out inaccordance with IEC 60068-2-32.

4.14.0 Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out onOPGW Cable and associated hardware & fittings, Approach Cable, Joint Box, FODP etc. and all other items for which price has been identified separately in the Bid Price Schedules.

Material shall not be shipped to the GIPCL until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the GIPCL, and the GIPCL has issued Material Inspection & Clearance Certificate (MICC).

Successful completion of the factory tests and the GIPCL approval to ship, shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the GIPCL's authorised representatives unless waiver for witnessing by GIPCL's representatives is intimated to the contractor.

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

The factory acceptance tests for the supplied items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's / supplier's) standard FAT testing program. In general, the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces etc.

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

4.15.0 Sampling for FAT

From each batch of equipment presented by the Contractor for Factory acceptance testing, the GIPCL shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples.

The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum 1) for all items. The physical verification shall be carriedout on 100% of the offered quantities as per the approved FAT procedure. In case any of the selected samples fail, the

failed sample is rejected, and additional 20% samples shall be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected.

For the OPGW cable hardware fittings & accessories, the minimum sampling rate, and batch acceptance criteria shall be as defined in IS 2486.

The Sampling rate for the Factory acceptance tests shall be 10% of the batch size (minimum 2) for FO cable drums, FODPs, Joint box and other similar items.

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

4.16.0 Production Testing

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

The production tests would normally not be witnessed by the GIPCL. However, the GIPCL reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

4.17.0 Factory Acceptance Tests on Optical Fibre to be supplied with OPGW

The factory acceptance tests listed in table below are applicable for the Optical fibres to be supplied. The listed tests follow testing requirements set forth in IEEE standard 1138/IEC 60794. The referenced sections specify the detailed test description. The acceptance norm shall be as specified in the above-mentioned IEEE standards unless specified otherwise in the technical specifications.

Table 6: Factory Acceptance Tests for Optical Fibres: Optical Tests

Sr. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation Coefficient	As per T S	EIA/TIA 455- 78A
2	Point Discontinuities of attenuation	As per T S	EIA/TIA 455-59
3	Attenuation at Water Peak	As per T S	EIA/TIA 455- 78A
4	Chromatic Dispersion		EIA/TIA 455-168A/169A/175A
5	Core – Clad Concentricity Error		EIA/TIA 455-/176
6	Cladding diameter		EIA/TIA 455-176
7	Fibre Tensile Proof Testing		EIA/TIA 455-31B

The test report for the above tests for the fibers carried out by the Fiber Manufacturer and used in the OPGW cables shall be shown to the inspectorduring OPGW cable FAT and shall be submitted along with the OPGW cable FAT report.

4.18.0 Factory Acceptance Test on OPGW Cable

The factory acceptance tests for OPGW cable specified below in Table follow the requirements set forth in IEEE standard 1138 / IEC 60794. The FAT shall be carried out on 10% of offered drums in each lot as specified in technical specifications and the optical tests shall be carried out in all fibres of the selected sample drums. The Rated Tensile Strength test shall be carried out on one samplein each lot.

Table 7: Factory Acceptance Tests on OPGWApplicable standard: IEEE 1138 / IEC 60794

Sr. No.	Factory Acceptance Test on Manufactured OPGW
1	Attenuation Co-efficient at 1310 nm and 1550 nm
2	Point discontinuities of attenuation
3	Visual Material verification and dimensional checks as per approved DRS/Drawings
4	Rated Tensile Strength
5	Lay Length Measurements

4.19.0 Factory Acceptance Test on OPGW Fittings

The factory acceptance tests for OPGW Fittings as specified below. The samplingplan shall be as per relevant standard:

Factory Acceptance Tests on OPGW Fittings

S. No.	Factory Acceptance Test
Suspension Assembly	
1	UTS/ Mechanical Strength of the assembly
2	Clamp Slip Test
3	Visual Material verification and dimensional checks as per approved DRS/ Drawings
4	Mechanical strength of each component
5	Galvanizing test
Tension Assembly	
6	Clamp Slip Strength test

7	Visual Material verification and dimensional checks as per approved DRS/Drawings
8	Mechanical strength of each component
9	Galvanizing Test
Vibration Damper	
10	Galvanizing test on damper, masses and messenger wires
11	Damper response (resonant frequencies)
12	Clamp Slip test
13	Strength of messenger wires
14	Attachments of weights to messenger cable
15	Attachments of clamps to messenger cable
16	Clamp bolt tightening test
17	Clamp bolt torque test
18	Dynamic characteristic test.
19	Visual Material verification and dimensional checks as per approved DRS/Drawings
Structure Mounting Clamp	
20	Clamp fit test
21	Clamp Strength test
22	Visual Material verification and dimensional checks as per approved DRS/Drawings

4.20.0 Factory Acceptance Test on Splice Enclosure (Joint Box) /FODP

The factory acceptance tests for Splice Enclosures/FODP as specified below.

Factory Acceptance Tests on Splice Enclosures (Joint Box)/FODP

Sr. No.	Factory Acceptance Test
1	Visual check of Quantities and Specific Component Number for each component of Splice Enclosure/FODP and dimensional checks against the approved drawings.

4.21.0 Factory Acceptance Test on Test Equipment & other items

As per technical specification and approved Documents/QAP

4.22.0 Site Acceptance Tests

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

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

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

4.23.0 Minimum Site Acceptance Testing Requirement for FO Cabling

Prior to installation, every spooled fibre optic cable segment shall be tested for compliance with the Pre-shipment data previously received from the manufacturer. This requirement will preclude the installation of out of specification cable segments that may have been damaged during shipment.

4.24.0 Phases of Site Acceptance Testing

SAT shall be carried out link by link from Tap tower joint enclosure to Gantry side joint enclosure. SAT may be performed in parts in case of long links.

The tests, checks, adjustments etc. conducted by the Contractor prior to offering the equipment for SAT shall be called Pre-SAT activities. The Pre-SAT activities shall be described in the installation manuals and Field Quality Plan documents.

Sag and tension of OPGW shall generally be as per approved sag-tension chart and during installation, sag and tension of OPGW shall be documented. Upon completion of a continuous cable path, all fibres within the cable path shall be demonstrated for acceptance of the cable path. Fibre Optic cable site testing minimum requirements are provided in Tables below:

Fibre Optic Cable Pre-Installation Testing

Item	Description
1	Physical Inspection of the cable assembly for damage
2	Optical fibre continuity and fibre attenuation with OTDR at 1550nm
3	Fibre Optic Cable length measurement using OTDR
Fiber Optic Cable Post-Installation Testing (Each section)	
4	Physical Inspection of the installed OPGW and hardware fittings
5	Optical fiber continuity, fiber attenuation and cable length withOTDR

Fibre Optic Cable Splicing Testing

Item	Description
1	Per splice bi-directional average attenuation with OTDR
2	Physical inspection of splice box/enclosure for proper fibre /cable routing techniques
3	Physical inspection of sealing techniques, weatherproofing, etc.

Fibre Optic Cable Commissioning Testing

Item	Description
1	End to End (Joint Box to CTU end FODP including patch cord) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by OTDR.
2	End to End bi-directional average attenuation of each fibre at1310 nm and 1550 nm by Power meter.
3	Bi-directional average splice loss by OTDR of each splice as wellas for all splices in the link.
4	Proper termination and labelling of fibres & fibre optic cables atas per approved labeling plan.

5.0.0 INSTALLATION OF OPGW CABLING

5.1.0 OPGW cable installation

The OPGW cable shall be installed at the top of the tower. The OPGW shall be installed generally in accordance with the IEEE Guide to the Installation of Overhead Transmission Line Conductors (IEEE STD. 524 with latest revisions), with additional instructions and precautions for fibre optic cable handling. The stringing procedure shall be submitted by the Contractor prior to stringing for GIPCL's approval.

The OPGW cable sections shall normally be terminated & spliced only on tension towers. In exceptional circumstances and on GIPCL specific approval, cable may be terminated on Suspension towers, but in this case tower strength shall be examined to ensure that tower loads are within safe limits and if required, necessary tower strengthening shall be carried out by the Contractor.

The stringing shall be carried by the Transmission Line Contractor as per the stringing chart/ procedure submitted by them and approved by GIPCL. Thefollowing shall be under the scope of OPGW Cabling Package Contractor:

- Supply of OPGW Cable & Hardware Fittings needed to tie the OPGW cable to the towers/gantries.
- Supervision of stringing of OPGW Cable at sites as per instruction by GIPCL. The supervision shall include the inspection as per stringing procedure, proper location of drum site, installation of stringing blocks/pulleys, proper sagging, proper installation of hardware, proper tension as per Sag-Tension chart, provision of service loops of OPGW in jointing locations
- The Splicing work of OPGW Cable and after that testing of link.

While handing over the OPGW drums, the testing (fibre loss and length measurement using OTDR) of OPGW in each drum shall be carried out by bidder in presence GIPCL representative. After installation of OPGW cable, the testing of each section shall be carried out again by the Fibre Optic Cabling Package Contractor in presence of Transmission Line Package contractor(s) and GIPCL representative. In case of any damage/ high loss in the fibre, the total length of that particular section of OPGW cable shall be replaced by Transmission Line Package Contractor(s). Fibre Optic Cabling Package Contractor shall supply new OPGW cable in place of damaged cable. The Contract price shall be adjusted accordingly.

5.2.0 Installation Hardware

All required hardware's shall be installed along with OPGW Cable.

5.3.0 Methodology for Installation and Termination

All optical fibre cable termination, installation, stringing and handling plans, guides and procedures, and engineering analysis (e.g. tension, sag, vibration etc.) shall be submitted to the GIPCL for review and approval in the engineering/design phase of the project. All installation practices shall be field proven, and ISO accredited.

All cable segments shall include service loops as specified in this specification. Themaximum allowable stringing tension, maximum allowable torsional shear stress, crush strength and other physical parameters of the cable shall not be exceeded. The preventative measures to be taken shall be documented in detail and submitted to GIPCL in advance of installation.

Optical fibre attenuation shall be measured after installation and before splicing. Any increase in attenuation or step discontinuity in attenuation shall not beacceptable and shall constitute a cable segment failure. In the event of cable damage or any fibre damage, the complete section (tension location to tension location) shall be replaced as mid-span joints are not acceptable.

Any or all additional steel work or modifications required to attach the fibre cabling to the overhead transmission/ distribution line towers shall also be carried out by the Contractor. It shall be the Contractors responsibility to provide adequate communications among all crew members and support staff to ensure safe and successful installations.

5.4.0 Cable Raceways

The Contractor is required to provide and install any additional indoor cable raceways which may berequired for proper implementation of the fibre optic cabling system. This requirement shall be finalized during survey.

The cable raceways shall conform to the following:

(a) All cable raceways shall be sized to support full loading requirements plus at least a 200% safety loading factor.

(b) Indoor cable raceways shall be fabricated from construction grade aluminium, galvanized iron or anodized sheet metal or any other suitable material approved by the GIPCL. Suitable anticorrosion measures shall be provided. Steel fabricated raceways shall be finished inside and out, treated to resist rust and to form a metal-to- paint bond.

(c) Mechanical construction drawings of the cable raceways shall be submitted for GIPCL's information & review.

Expected Contents & Structure of FO Cable Installation Manual for Overhead FOcable		
Sl no.	Chapters	Description
1	Installation procedure	Description of activities of installation gangs: Preparation & Setting up, Stringing, sagging, attaching hardware, attaching down lead clamps &cable routing on the tower, securing cable ends (for protection before work by jointing gang). Precautions for preventing cable damage shall be highlighted.
2	Safety Instructions	Instructions & procedures related to ensuring installation crew safety: personnel grounding &safety, installation equipment safety, Safety for power system & environment (viz preventing accidental tripping, precaution for railway crossings etc.)
3	Description of Installation Equipment	Sketches, drawings, photographs, safe workingratings of installation equipment, tools & tackles etc., handling instructions & precautions.
4	Cable routing	Illustrations of the positions of tower attachmentclamps (down lead clamps), routing of FO cable onthe tower, service loop(s), joint box position. References to other related documents coveringthe test
5	References	installation, jointing & testing, such as SAT administrative & functional test plans & procedures
		Jointing Procedures
		Field Quality Plan & Field Quality Audit Storage &Handling Instructions
		FO cable & hardware drawings, technical parameters, DRS etc.
		GIPCL & Statutory safety rules, safety manuals, standards, codes of practices etc.

DRS Form 1

DATA REQUIREMENTS SHEETS FOR OVERHEAD FIBRE OPTIC CABLE

OPTICAL GROUND WIRE (OPGW) – 2 x 24 Fibre

Manufacturer:

Part:

Configuration:

CABLE CONSTRUCTION			
Sr. No.	**Parameter**	**As per Technical Specification**	**As per Bidder Offering**
1	No. of Fibres Dual Window Single-Mode:	2 x 24	
2	Buffer Type:	Loose Tube	
3	Buffer Tube material	As applicable	
4	No. of Buffer Tubes:	As applicable	
5	No. of Fibers per Buffer Tube:	As applicable	
6	Expected Cable Life	25 Year	

DRS Form 2

DATA REQUIREMENTS SHEETS FOR OVERHEAD FIBRE OPTIC CABLE

OPTICAL GROUND WIRE (OPGW) – 48 F Fibre

Manufacturer:

Part:

Configuration:

CABLE CONSTRUCTION			
Sr. No.	**Parameter**	**As per Technical Specification**	**As per Bidder Offering**
1	No. of Fibres Dual Window Single-Mode:	48 F	
2	Buffer Type:	Loose Tube	
3	Buffer Tube material	As applicable	
4	No. of Buffer Tubes:	As applicable	
5	No. of Fibers per Buffer Tube:	As applicable	
6	Expected Cable Life	25 Year	

DATA REQUIREMENTS SHEETS FOR OPTICAL FIBRE
DUAL-WINDOW SINGLE MODE (DW-SM)

OPTICAL PARAMETERS			
Sr. No.	**Parameter**	**As per Technical Specification**	**As per Bidder Offering**
1	Fibre manufacturer(s)/Type:		
2	Attenuation Coefficient @ 1310 nm: @ 1550 nm:	 ≤ 0.35 dB/km ≤ 0.21 dB/km	
3	Point discontinuity @ 1310nm: @ 1550nm:	 ≤ 0.05 dB ≤ 0.05 dB	
4	Nominal Mode Field Diameter @ 1310 nm: @ 1550 nm:	 8.6 to 9.5 µm (± 0.6µm)	
5	Chromatic Dispersion Coefficient @ 1310 (1288-1339) nm: @ 1310 (1271-1360) nm: @ 1550 nm:	 3.5 ps/ (nm x km) 5.3 ps/ (nm xkm) 18 ps/ (nm x km)	
6	Zero dispersion wavelength:	1300 to 1324 nm	
7	Cutoff wavelength:	≤1260 nm	
PHYSICAL AND MECHANICAL PROPERTIES			
8	Bend Performance: (37.5 mm radius, 100 turns) @1310 nm (30 mm radius, 100 turns) @1550 nm (16mm radius, 1 turn) @1550nm	 ≤ 0.05 dB ≤ 0.05 dB ≤ 0.50 dB	
9	Cladding Diameter (nominal ± deviation):	 125.0 µm ± 1 µm	
10	Polarization mode dispersion coefficient	≤ 0.2 ps/km$^{1/2}$	
11	Proof test level	≥ 0.69 GPa	

PART – III GUARANTEED TECHNICAL PARTICULARS FOR OPTICAL GROUND WIRE (OPGW) & ACCESSORIES

The following sets of GTP are required to be filled up by the bidders to aid in the evaluation process. The response shall be brief and to the point and shall be supported by the printed product description and other literature. The same GTP format duly filled and the relevant drawings shall also be submitted during the detailed engineering along with the relevant technical brochures.

The bidder shall fill in the guaranteed technical particulars in the Proforma given inthis section and submit the same with his tender, without which bid will not be considered.)

TABLE OF CONTENTS

GTP-1 GUARANTEED TECHNICAL PARTICULARS OF OPTICAL GROUND WIRE(OPGW)			
Manufacturer:			
Model Name:			
GENERAL PARAMETERS			
Sl. No	**Parameter**	**Units**	**Particulars**
1	Fibre Manufacturer Dual Window Single-Mode		
2	No. of Fibres Dual Window Single-Mode:	Each	
3	Buffer Type		
4	Buffer Tube Diameter	Mm	
5	Buffer Tube material		
6	No. of Buffer Tubes	Each	
7	No. of Fibers per Tube	Each	
8	Identification/numbering of individual tubes		
9	No. of empty tubes (If any)		
10	Filling material		
11	Filling material compliant with technical specifications?		
12	Strength member(s)		
13	Binding yarn/ tape		
14	Describe Central Core Design		
15	Aluminum Clad steel wire Diameter Number	 mm each	
16	Aluminum alloy wires Diameter Number	 mm each	
17	Aluminum tube inner diameter	Mm	
18	Aluminum tube outside diameter	Mm	
19	Cable Diameter (nominal ± deviation)	Mm	
20	Cable cross-section area (Nominal)	mm^2	
21	Cable cross-section area (Effective)	mm^2	
22	Fully Compliant with IEEE 1138	Yes/No	
Mechanical Properties of Cable			
23	Max. breaking load/ Ultimate Tensile Strength (UTS)	kN	

24	Fibre strain margin	%	
25	Zero fibre strain up to load	kN	
26	Weight	kg/km	
27	Crush strength	kg/mm	
28	Equivalent Modulus of elasticity	KN/mm2	
29	Minimum Bending Radius withoutmicro bending	Mm	
30	Maximum Bending Radius: Short Term: Long Term(Continuous)	Mm	
31	Tensile proof test (Screening) level	KN/mm^2	
32	Maximum permissible tensile stress	KN/mm^2	
33	Permissible CTS. tensile stress	KN/mm^2	
34	Maximum sag at maximum temperature and design span with nowind	Mm	
35	Everyday tension at 32ºC, no wind	% of UTS	
36	Maximum tension at Every day condition with full wind pressure	Kg	
	Thermal Properties of Cable		
37	Coefficient of linear expansion	per °C	
38	Coefficient of expansion Cladding : Core :	 per °C per °C	
39	Nominal operating temperaturerange	°C	
40	SC current transient peak temperature	°C	
41	Maximum allowable temperature for lightning strike	°C	
	CABLE SPOOL and DRUM		
42	Available length per spool Maximum : Nominal :	M	
43	Size of drum :	M	
44	Weight of empty drum :	Kg	
45	Weight of drum with cable spooled :	Kg	
46	Will drum length scheduling be practiced to match transmission line span lengths?	Yes/No	
47	Describe Drum materials :		

48	Describe cable end capping and protection against abrasion etc. :		
INSTALLATION			
49	Splice Loss Maximum : Average :	 dB dB	
50	Operating Temperature Range :	°C	
51	Rated Isokeraunic No.		
52	Expected Cable Life :	Years	
53	Installation rate per team :	km/day	
54	No. of persons per team :	no.	
55	Max. possible span for specified operating conditions :	M	
56	Mid span sag at 0°C with no wind loading :	Mm	
57	Mid span sag at max temp. with no wind loading :	Mm	
58	Mid span sag at max temp. and wind loading	Mm	
59	Cable swing angles Worst Case : Everyday :		
60	Describe Installation method(s) :		
Sag tension chart parameters like sag and tension at various spans and applicablewind and ice load conditions shall be submitted along with the DRS. The cable parameters like coefficient of liner expansion, modulus of elasticity shall also beindicated.			

GTP- 2			
GUARANTEED TECHNICAL PARTICULARS OF DUAL-WINDOW SINGLE MODE(DWSM)			
OPTICAL PARAMETERS			
Sl. No.	**Parameter**	**Unit**	**Particulars**
1	Fiber manufacturer(s)/Type :		
2	Fiber production method :		
3	Attenuation Coefficient@ 1310 nm : @ 1550 nm :	 dB/km dB/km	
4	Attenuation Variation with Wavelength (±25 nm) :	dB/km	
5	Attenuation at water peak :	dB/km	
6	Point discontinuity @ 1310nm : @ 1550nm :	dB dB	
7	Temperature dependence (induced attenuation) :	dB	
8	Nominal Mode Field Diameter @ 1310 nm : @ 1550 nm :	 Mm	
9	Mode Field Diameter Deviation @ 1310 nm : @ 1550 nm :	 Mm	
10	Mode field non-circularity :	%	
11	Chromatic Dispersion Coefficient @ 1310 (1288-1339) nm : @ 1310 (1271-1360) nm : @ 1550 nm :	 Ps/nm.km	
12	Zero dispersion wavelength :	Nm	
13	Zero dispersion Slope :	ps/nm2.km	
14	Cut-off wavelength :	Nm	
15	Refractive Index :		
16	Refractive Index profile :		
17	Cladding Design :		

18	Numerical aperture :		
PHYSICAL and MECHANICAL PROPERTIES			
Sl. No.	**Parameter**	**Unit**	**Particulars**
19	Bend Performance : (37.5 mm radius, 100 turns) @1310nm (30 mm radius, 100 turn) @1550 nm (16mm radius, 1 turn) @ 1550nm	dB dB	
20	Core Diameter (nominal± deviation) :	Mm	
21	Core non-circularity :	%	
22	Cladding Diameter (nominal ± deviation) :	Mm	
23	Core- Clad concentricity Error :	Mm	
24	Cladding non-circularity :	%	
25	Fibre cut-off wavelength	Mm	
26	Protective Coating type & material Primary : Secondary :		
27	Protective Coating Diameter (nominal ± deviation) :	Mm	
28	Protective Coating removal method :		
29	Coating Concentricity	Mm	
30	Polarisation mode dispersion coefficient	ps/km1/2	
31	Proof test level	Kpsi	
32	Colour coding scheme compliant with EIA/TIA 598 or IEC 60304 or Bellore GR-20.	Yes/No	
33	Colouring material compliant with technical specs?	Yes/No	

GTP- 3 GUARANTEED TECHNICAL PARTICULARS FOR HARDWARE AND ACCESSORIES			
Suspension Clamp Assembly			
Manufacturer:			
Type:			
Drawing No.			
Sl. No.	**Parameter**	**Unit**	**Particulars**
1	Minimum vertical Strength	kN	
2	Maximum Slip Strength	kN	
3	Minimum Slip Strength	kN	
4	Length (nominal)	mm	
5	Weight (nominal)	kg	
6	Total Drop (maximum) including shackles	mm	
7	Tightening torque (nominal)	Nm	
8	Details of Armour Rod Set		
	No. of rods per clamp		
	Direction of Lay		
	Overall length	mm	
	Diameter of each Rod	mm	
	e) Tolerances (i) Diameter of each rod (ii) Length of each rod	 ±% ±%	
	Material of manufacture		
	UTS of each Rod	kN	
	Weight	kg	
9	Details of Protection Splice Set (Reinforcing Rods)		
	i) No. of rods per clamp		

	j) Direction of Lay		
	k) Overall length	mm	
	l) Diameter of each Rod	mm	
	m) Tolerances (i) Diameter of each rod (ii) Length of each	 ±% ±%	
	n) Material of manufacture		
	o) UTS of each Rod	kN	
	p) Weight	kg	
6	Tower attachment arrangement		
Earth lead assembly			
Manufacturer:			
Type:			
Drawing No.:			
1	Weight	kg	
2	Material		
3	length	mm	
4	Short circuit current	KA	

GTP- 4 GUARANTEED TECHNICAL PARTICULARS FOR SPLICE ENCLOSURES (JOINT BOX)FOR OVERHEAD FO CABLE			
Splice Enclosures (Joint Box)			
Manufacturer:			
Type:			
Drawing No.:			
1	Dimensions H * W * D :	cm	
2	Weight :	Kg	
3	Colour and Finish :		
4	Cable Glanding& Fixing		
5	Construction materials & Gauge		
6	Locking arrangements :		
7	Installation Clearances : Front Access : Rear Access : Top * Bottom * Sides :	cm	
8	IP Protection	Class	
9	Total number of optical couplings	ea	
10	Provision of pass through splicing	Yes/No	
11	Whether filled with suitable encapsulant	Yes/No	
12	Method(s) for mounting withthe tower :		
Optical Fibre Cable Accommodations			
13	Cable Glanding :		
14	Maximum number of cables that can beaccommodated :		
15	Diameter(s) of cables that canbe accommodated :	each	
16	Describe Cable entries :		
Cable Termination Splice Accommodations			
17	Details of Splice Trays :		
	Dimension :		

	Material/Gauge :		
	Weight :	kg	
	Colour & Finish		
	Method of mounting		
18	Maximum number of splice trays	ea	
19	Number of splices per tray	ea	
20	Provision of Splice organisors		
21	Do splice trays require a separate enclosure? If so	Yes/No	
	Manufacturer		
	Dimensions H * W * D	cm	
	Weight:	Kg	
	Colour and Finish:		
	Method(s) of Mounting:		
	Construction materials & Gauge:		
	Locking arrangements:		
22	Installation Clearances Front Access : Rear Access : Top * Bottom * Sides : Excess length of fibre service loops	m	