GUJARAT ENERGY TRANSMISSION CORPORATION LTD.

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TECHNICAL SPECIFICATIONS FOR

SUPPLY & ERECTION OF OPGW (48F DWSM) AND ASSOCIATED HARDWARES

GETCO / E / TS – OPGW (48F) 4101/ R2, Sep 2023

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SECTION 1

1.1 Scope

The scope of this specification includes Design, engineering, manufacturing, testing, demonstration for acceptance, documentation, supply of OPGW and associated hardware & fittings and In-line Splices, loading, transportation, unloading, transit insurance and delivery at site and erection of the same on new line and / or on existing line by replacing existing Earth wire as specified in schedule A and dismantling of existing earth wire along with accessories & splices. Earth wire shall be wound on wooden drum. Wooden drum shall be in line with related relevant IS. The earth wire, hardware & accessories shall be credited at the GETCO store as per instruction of Engineer In charge without extra cost to GETCO. Transportation from site is also in the scope of bidder without any extra cost to GETCO.

1.2 General Requirements

This specification defines the design, performance and testing requirements for supply of OPGW cable & its associated hardware & fittings.

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

It should be noted that design information and bill of quantity are provisional only. The Contractor shall verify the design data during the site surveys for ultimate design & system performance.

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

The Bidder's proposal shall clearly identify all features described in the specifications or in any supporting reference material that will not be implemented; otherwise, those features shall become binding as part of the final contract.

An analysis of the functional and performance requirements of this specification and/or site survey, design, and engineering may lead the Bidder to conclude that additional items (hardware/software) are required that are not specifically mentioned in this specification. The Bidder shall be responsible for providing at no added cost to the Owner i.e. GETCO, all such additional items. Such materials shall be considered to be within the scope of the contract. To the extent possible, the Bidders shall identify and include all such additional items (hardware/ software) in their proposal.

OPGW cable & associated hardware & fittings shall be designed to operate in varying environments. Adequate measures shall be taken to provide protection against rodents, contaminants, pollutants, water & moisture, lightning & short circuit, vibration and electro- magnetic interference etc.

The Bidder shall demonstrate a specified level of performance of the OPGW cable & associated hardware & fittings during well structured factory tests.

The bidders are advised to visit sites/routes (at their own expense), prior to the submission of proposal, and make surveys and assessments as deemed necessary for proposal submission. The successful bidder is required to visit all sites. The site visits/routes shall include all necessary surveys to allow the bidder to perform the design and implementation functions. The bidder shall inform their site/route survey schedule to the Owner well in advance. The site/route survey schedule shall be finalized in consultation with the Owner. The Owner may be associated with the bidder during their site/route survey activities.

After the site/route survey the Bidder shall submit to the Owner a survey report on each link and site. This report shall include at least the following items:

a. List of all span lengths and the total link length
b. Suitability for live line installation of OPGW cable on the present infrastructure, Towers etc.
c. Suitability for off line installation of OPGW cable, if required, on the present Infrastructure, towers etc.
d. Tower wise identification detail for type with extension for proposed splice locations to be submitted with duly approved by concern engineer in-charge along with Numbers of fittings & accessories required.
e. Proposed splice locations and cable drum schedules.
f. Proposed routing of the approach cable from the end tower/gantry to the communication room to be marked on the site layout drawing. The existing cable trenches/cable raceways proposed to be used shall be identified. In case suitable existing cable trenches are not available, suitable alternatives shall be suggested.
g. Any other thing to complete the work in Toto.

1.3 General Responsibilities and Obligations

This section describes the general responsibilities and obligations of the Bidder and the Owner.

1.3.1 Responsibilities for the Implementation Plan

The Bidder's technical proposal shall include a project implementation plan and schedule that is consistent with the implementation plan detailed in the technical specification. The Implementation plan shall include the activities of both the Bidder and the Owner, showing all key milestones and clearly identifying the nature of all information and project support expected from the Owner. The Owner and Bidder shall finalize the detailed Implementation plan following award of the contract.

The Bidder shall be responsible for collecting the tower & the transmission line details for the proposed fibre optic links required for cable designing & tower structural analysis. A tower structural analysis shall be carried out by the Bidder to ensure that with the replacement of

existing earth wire with the OPGW cable, the tower members remain within the statutory safety limits as per Indian Electricity rules and if required the Bidder shall carry out the tower strengthening as necessary. The OPGW cable sections shall normally be terminated & spliced only on tension towers. In exception circumstances, and on Owner 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 Bidder.

1.3.2 Bidder Responsibilities and Obligations

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

(1) Provide OPGW cabling that meets the functional and performance requirements of this specification.

(2) Engineering and design specific to each location including review of, and Conformance with local environmental and earthing requirements.

(3) Testing and documentation for OPGW cable & its associated hardware & fittings.

(4) Project management, project scheduling, including monthly project reports documenting Progress during the contract period.

(5) Studies necessary to identify and provide OPGW cable.

(6) Suitability for OPGW cable for live line installation.

(7) Design of the mechanical assemblies and accessories, including vibration dampers required for installation of all overhead fiber cable.

(8) Factory acceptance testing of all equipment provided.

(9) Conduct type tests and provide documented evidence of satisfactory Type Test Performance to the Owner.

(10) Provide a Quality Assurance Plan ensuring the Owner access to the manufacturing process (MQP).

(11) Shipment of all equipment and documentation to the Owner designated locations and/or Staging areas.

(12) All documentation and drawings as specified.

(13) Field Quality Plan

(14) Collection of tower and transmission line details for proposed fiber optic links required for Cable designing and tower structural analysis.

(15) Sag tension calculation of OPGW to match with the sag tension characteristic of existing earth wire.

(16) Re analyzing and restrengthning of existing tower for fitment of OPGW if required.

(17) Bidder has to check the loading of existing tower and accordingly strength the tower peak or increase the height of tower peak. All material and erection of tower will be in Bidder's scope.

Detailed descriptions of the Bidder's obligations, in relation to individual items of hardware, software, functions and services, are delineated in other sections of this specification.

1.3.3 The Owner Responsibilities and Obligations

The Owner will provide the following items and services as part of the procurement Project:

(1) Review and approval of the Bidder's designs, drawings, and recommendations.
(2) Review and approval of test procedures.
(3) Participation in and approval of Type test and factory acceptance tests.
(4) Providing support and access to facilities at the sites.

1.4 General Bidding Requirements

The Bidder shall be responsive to the Owner's technical requirements as set forth in this specification. To be considered responsive, the Bidder's proposal shall include the following

(1) The Technical Proposal including the documents listed in the table 1-1: Bid Documents Checklist shall be provided in the bid.
(2) A detailed project implementation plan and schedule that is consistent with the scope of the project and Owner's specified objectives. The plan shall include the activities of both the Bidder and Owner, show all key milestones, and clearly identify the nature of all information and project support to be provided by Owner. Manpower resources proposed to be deployed by the Bidder during the implementation shall be clearly indicated.

TABLE 1.1
Bid Documents Checklist

Sl. No	Description	Enclosure Reference	
1	Type Test Certificates for OPGW cable & its associated hardware & fittings (As per relevant Sections of Technical Specs Volume II)	Page no. Ref no	
2	Completed Data Requirement Sheets (As per relevant Sections of Technical Spec Volume II)	Page no. Ref no	
3	Quality Assurance Program (As per relevant Sections of Technical Specs Volume II)	Page no. Ref no	
4	Detailed Project Implementation Plan (As per relevant Sections of Technical Specs Volume II)	Page no. Ref no	

1.5 Organization of The Technical Specification Document

Sections 2 through 5 and appendices A through C provides the technical & implementation requirements of the Package.

Section 2 contains the hardware description and specifications for the fiber optic cable.
Section 3 contains the inspection and test requirements.
Section 4 contains the documentation requirements
Section 5 describes project management and implementation requirements.

Appendix A – General requirements, Implementation Schedule and BOQ
Appendix B – Type test/FAT procedure
Appendix C - GTP

1.6 Applicable Standards

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

(1) American Society for Testing and Materials ASTM-B415, ASTM-D1248, ASTM D 3349.
(2) ITU-T/CCITT Recommandations G.650, G.652, G.653, G.655.
(3) Institute of Electrical and Electronics Engineers IEEE-812, 1138-1994, IEEE-524, IEEE-828 & 830 and latest amendment of IEEE 1138.
(4) Electronic Industries Association, EIA-455-3, 455-31B, 455-32, 455-91, 455-78, 455-59, 455-80, 455-169, 455-81, EIA RS 598
(5) International Electro technical Commission standards, IEC -1396 and IEC - 1089.
(6) International Electro technical Commission standards, IEC 793-1, 793-2, 794-1, 794-2, IEC-529, IEC 60794-1-2, IEC 60794-4-10.

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

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

1.7 References

(1) CIGRE Guide for Planning of Power Utility Digital Communications Networks
(2) CIGRE Optical Fibre Planning Guide for Power Utilities
(3) CIGRE New Opportunities for Optical Fibre Technology in Electricity Utilities
(4) CIGRE guide to fittings for Optical Cables on Transmission Lines.

SECTION 2

Specifications and Functional Description of Fiber Optic Cable

This section describes the functional & technical specifications for supply of OPGW cable & its associated hardware & fittings.

2.1 Fiber Optic Cabling

2.1.1 General

The Bidder shall supply 48 fibre (DWSM) OPGW fibre optic cables. The cable length requirement is indicated in the appendices.

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

2.1.2 Required Optical Fibre Characteristics

The characteristics of optical fibre to be provided under this specification are as follows.

2.1.2.1 Physical Characteristics

Dual-Window Single mode (DWSM), G.652 telecommunication grade optical fibres shall be provided in fibre optic cables. DWSM optical fibres shall meet the requirements defined in Table 2-1(a).

2.1.2.2 Attenuation

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. The fibre attenuation characteristics specified in Table 2-1(a) shall be “guaranteed” fibre attenuation of any & every fibre reel.

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 2-1(a)

DWSM Optical Fibre Characteristics

Fibre Description	Dual-Window Single-Mode
Mode Field Diameter	8.6 to 9.5 µm (± 0.6µm)
Cladding Diameter	125.0 µm ± 1 µm
Core concentricity error	≤ 0.6 µm at 1310 nm
Cladding non-circularity	≤ 1 %
Cable Cut-off Wavelength λ_{cc}	≤1260 nm
1550 nm loss performance	As per G.652 D
Proof stress Level	≥ 0.69 GPa
Attenuation Coefficient	@ 1310 nm ≤ 0.35 dB/km @ 1550 nm ≤ 0.21dB/km
Attenuation at water peak	≤ 0.35 dB/km
Chromatic Dispersion Maximum	18 ps/(nm x km) 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm
Zero Dispersion Wavelength: Zero Dispersion Slope	1300 to 1324nm 0.092 ps/(nm^2xkm) maximum
Polarization mode dispersion coefficient	≤ 0.2 ps/km^1/2
Temperature Dependence	Induced attenuation ≤ 0.05 dB (-60oC - +85 oC)
Bend Performance	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB/km @ 1550 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.10 dB/km @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB/km

2.1.3 Fibre Optic Cable Construction and Link Lengths

Overhead Fibre Optic Cables shall be OPGW (Optical Ground Wire). The OPGW cable is proposed to be installed on the 400kV/220 kV/132kV transmission lines spread across Gujarat as specified in Annexure-A. The design of cable shall account for the varying operating and environmental conditions that the cable shall experience while in service. The OPGW cable to be Supplied shall be designed to meet the overall requirements of all the transmission lines.
The exact details shall be collected by the Contractor during survey. To meet the overall

requirement of all the transmission lines, the contractor may offer more than one design without any additional cost to GETCO. It may also be noted that some of the transmission lines route may be added during the engineering stage.

The estimated optical fibre link lengths are provided in Annexure-A. However, the Contractor shall supply & install the optical fibre cable as required based on detailed site survey to be carried out by the Contractor during the project execution.

For the purpose of payment, the optical fibre link lengths are defined as transmission line route lengths from Gantry at one terminating station to the Gantry in the other terminating station. The actual cable lengths to be delivered shall take into account various factors such as sag, service loops, splicing, working lengths & wastage etc. and no additional payment shall be payable in this regard. The unit rate for FO cable quoted in the Bid price Schedules shall take into account all such factors.

2. 1.3.1 EHV Transmission Line- Earth wire/Conductor Details

Details of maximum spans, voltage levels and the relevant characteristics of the earth wire/conductor required for design of OPGW cable shall be collected by Bidder.

2.1.3.2 Optical Fibre Identification.

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 color-coding scheme.

Coloring utilized for color coding optical fibres shall be integrated into the fibre coating and shall be homogenous. The color 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.

2.1.3.3 Buffer Tube

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. Buffer **tube (i.e. Steel tube)** shall be filled with a water-blocking gel.

2.1.3.4 Optical Fibre Strain

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

For the purpose of these specifications, the following definitions shall apply:

- Maximum Working Tension (MWT) is defined as the maximum cable tension at which there is no fibre strain.
- The no fibre strain condition is defined as fibre strain of less than or equal to 0.05%, as determined by direct measurements through IEC/ ETSI (FOTP) specified optical reflectometry techniques.
- The Cable strain margin is defined as the maximum cable strain at which there is no fibre strain.
- The cable Maximum Allowable Tension (MAT) is defined as the maximum tension experienced by the Cable under the worst case loading condition as defined in IS 802.
- The cable max strain is defined as the maximum strain experienced by the Cable under the worst case loading condition as defined in IS 802.
- The cable Every Day Tension (EDT) is defined as the maximum cable tension on any span under normal conditions viz at 32 °C and no wind.
- The Ultimate /Rated Tensile Strength (UTS/ RTS/ breaking strength) is defined as the maximum tensile load applied and held constant for one minute at which the specimen shall not break.

While preparing the Sag-tension charts for the OPGW cable the following conditions shall be met:

1 The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/ Strain margin of the cable.
2 The sag shall not exceed the earth wire sag in all conditions.
3 The Max Allowable Tension shall also be less than or equal to 0.4 times the UTS of OPGW. However, Max Allowable Tension up to 0.5 times the UTS of OPGW may be accepted, subject to no fibre strain.
4 The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the cable strain at Max Allowable Tension (MAT) is less than or equal to the cable strain margin.
5 The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable.

The Sag-tension chart indicating the maximum tension, cable strain and sag shall be calculated for the following conditions as specified in IS 802:1977/1995:

a. 53 °C, no wind, no ice
b. 32 °C, no wind, no ice
c. 0 °C, no wind, no ice
d. 32 °C, full wind, no ice
e. 0 °C, 2/3rd / 36% of full wind (IS 802:1977/1995)
The above cases shall be considered for the spans from 100 m to max. span length in the range of 50 m spans. The full wind load shall be considered as the design wind load as per relevant IS 802 version and the sag-tension chart shall be submitted accordingly.

2.1.3.5 Cable Materials

The materials used for optical fibre cable construction, shall meet the following requirements:

2.1.3.5.1 Filling Materials

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.

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.

The filling compound shall remain stable for ambient temp. between -20°C and +65°C and shall not drip, flow or leak with age or at high temperatures during short duration lightning strikes and short circuit currents The filling compound shall meet the requirements of “Seepage of Filling Compound test” as per EIA/TIA 455-81.

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.

2.1.3.5.2 Metallic Members

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

2.1.3. 5.3 Marking, Packaging and Shipping

This section describes the requirements for marking, packaging and shipping the overhead fibre optic cable.

(a) Drum Markings: Each side of every reel of cable shall be permanently marked in a minimum of 1 cm high white lettering with the vendors' address, the Owner's destination address, cable part number and specification as to the type of cable, length, number of fibres, a unique drum number & segment no., factory inspection stamp and date.

(b) 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 provided with lagging 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.

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 by

the Bidder on each drum shall be as per drum schedule approval given by GETCO during the detailed engineering. Steel drums supplied shall be as per GETCO technical specification for Steel Drum for Conductor, enclosed herewith.

2.1.3.6 Optical Ground Wire (OPGW)

OPGW cable construction shall comply with IEEE-P 1138, IEEE- 1138-2009 and IEC publication 1396. 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 composite fibre optic overhead ground wire shall be made up of **bundled** optical fibre units embedded in a water tight stainless steel protective central **tube** surrounded by concentric-lay stranded metallic wires in single or multiple layers. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre.

2.1.3.6.1 Central Fibre Optic Unit

The central **Steel tube** shall be designed to house and protect multiple **bundled** optical fibre units from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central **Steel tube** 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.

2.1.3.6.2 Basic Construction

The cable construction shall conform to the applicable requirements of this Technical Specification, applicable clauses of IEC 61089 related to stranded conductors and Table 2.2(a) OPGW Mechanical and Electrical Characteristics. In addition, the basic construction shall include bare concentric-lay-stranded metallic wires with the outer layer having left/right hand lay. However, hardware and accessories shall be suitable to lay direction of OPGW proposed. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed.

2.1.3.6.3 Breaking Strength

The rated breaking strength of the completed OPGW shall be taken as no 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 tensile strength.

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

2.1.3.6.4 Electrical and Mechanical Requirements

Table 2-2(a) provides OPGW Electrical and Mechanical Requirements for the minimum performance characteristics. Additionally, the OPGW mechanical & electrical characteristics shall be similar to the electrical & mechanical characteristics of the earth wire being replaced such that there is no or minimal consequential increase in stresses on towers. The existing earth wire parameters are listed in appendices. For the purposes of determining the appropriate Max Working Tension limit for the OPGW cable, IS 802:1995 and IS 875: 1987 shall be applied. However, the OPGW sag & tension charts shall be based on IS 802. For the OPGW cable design selection and preparation of sag tension charts, the limits specified in this section shall also be satisfied. The Bidder shall submit sag-tension charts for the above cases with their bids.

Table 2.2(a)

OPGW Electrical and Mechanical Requirements

Sr. No.	Parameter	Requirement
1	Everyday tension at 32 deg. C, no wind	≤ 20% of UTS of OPGW
2	D.C. Resistance at 20 deg. C	< 1 Ohm/Km (Tolerance + 10 %)
3	Short Circuit Current	≥ 6.32 KA for 1 sec

2.1.3.6.5 Operating conditions

Since OPGW shall be located at the top of the EHV 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 the same or similar as those required of conventional ground wire.

2.1.3.6.6 Live Line Installation Suitability

OPGW shall be suitable for installation under live line condition, i.e. with all circuits charged to the rated line voltage as specified in this section shall be generally in accordance with the IEEE guide to the installation of overhead transmission line conductor (IEE STD.524 with latest revisions), with additional instructions and precaution for live line working and fibre optic cable handling. The stringing procedure shall be submitted by the Contractor prior to stringing.

A tower structural analysis shall be carried out by the Contractor, based on the relevant data to be provided by Owner, to ensure that with the replacement of existing earthwire with the OPGW cable, the tower members remain within the statutory safety limits as per Indian Electricity rules and if required the Contractor shall carry out the tower strengthening as necessary. The OPGW cable sections shall normally be terminated & spliced only on tension towers. In exceptional circumstances, and on Owner 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.

2.1.3.6.7 Installation Hardware

The scope of supply of the optical cable includes the assessment, supply and installation of 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 Bidder shall determine the exact requirements of all accessories required to install and secure the OPGW. The quantity of hardware & fittings to meet any eventuality during site installation minimum @ 2% of total BOQ quantity or at least 1 No., whichever is higher, of each hardware including splice enclosure for each transmission line shall be provided as spare quantity without any additional cost to GETCO. The quantity of hardware & accessories left out balance after completion of OPGW work of each individual line shall be credited to GETCO store as per instruction of nodal officer after getting done reconciliation for utilization of quantity (location wise) on transmission line duly certified as per enclosed Format A. Also, at the time of submitting report for OPGW work completion of each transmission line by contractor, to whom order has been placed by GETCO, the valid document duly sealed and signed by respective store authority of GETCO, for balance quantity of hardware & accessories including any length of OPGW cable, FOAC cable which supplied on account of GETCO and remain balance after completion of OPGW work, shall also be submitted.

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 Bidder shall provide the OPGW hardware & accessories drawing & Data Requirement Sheets (DRS) document for all the assemblies & components. However, DRS format of assemblies has been enclosed in the appendices. 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 aluminum alloy armour rods/ reinforcing rods shall be used. The suspension clamps shall be designed to carry a minimum vertical load not less than 70% of UTS of OPGW. The suspension clamps slippage shall occur between 8% and 15% of UTS of OPGW as measured in accordance with type test procedures specified in appendix B, Vol. IIC.

The Bidder 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).

(b) Dead End Clamp Assemblies: 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. 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, shall be used for suspension and tension points in each span. The Bidder shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis as specified in appendices. Vibration damper clamps shall be made of aluminium or aluminium alloy shall support the dampers during installation and shall maintain the dampers in position without damage to the OPGW and without causing fatigue. Armour or patch rods made of aluminium or aluminium alloy shall be provided as required to reduce clamping stress on the OPGW. The vibration damper body shall be hot-dip galvanized mild steel/cast iron or shall be permanent mould cast zinc alloy.

2.1.4 In-Line Fibre Optic Splice Enclosures and Optical fibre Splices

All in-line splices shall be encased in In-Line Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. In line splice enclosures shall comply to ingress protection class IP 66 or better. 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. In-line splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Provision for Minimum three OPGW cable entry shall be provided. Splice enclosures shall be appropriate for mounting on EHV transmission towers above anti-climb guard levels at about 10 meters from the ground level and shall accommodate pass through splicing. The bidder shall be responsible for splicing of fibres and installation of splice enclosures.

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 the accessories like transport tube, PVC Adhesive tape, cable tie, Sealant glue, fiber identification boar, splice protection sleeve etc required for neat dressing and identification of fiber, also to maintain ingress protection shall be provided with joint box.

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 splice, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05 dB
(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.

2.1.5. Fibre Optic Approach Cables

For purposes of this specification, a fibre optic approach cable is defined as the armoured underground fibre optic cable required to connect Overhead Fiber Optic Cable (OPGW) between the final in line splice enclosure on the gantry/tower forming the termination the fibre cable on the power line and the Fibre Optic Distribution Panel (FODP) installed within the building. The estimated fibre optic approach cabling length shall be decided during site survey or Detailed Engineering. However, the Bidder shall supply minimum 400 m for each 220kV Substation end and 500 m for each 400kV Substation end & install the optical fibre approach cable as required based on detailed site survey to be carried out by the Bidder during the project execution

2.1.5.1 Basic Construction

The cable shall be suitable for direct burial, laying in trenches & PVC/Hume ducts, laying under false flooring and on indoor or outdoor cable raceways.

2.1.5.2 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.

2.1.5.3 Optical, Electrical and Mechanical Requirements

Approach cable shall contain fibres with identical optical/ physical characteristics as those in the OPGW cables. The cable shall comprise of Outer Sheath, metallic armour, Inner sheath, tensile strength member (Glass yarn), water blocking tape, polyester tape with binder, flooding jelly, fiber support/bending structure and Rip cords. Minimum Tensile Strength shall be 2300 N @ 0% of fiber strain, Crush Resistance of 4000 N / 100 X 100 MM and Impact strength: 25 NM.

2.1.5.4 Installation of Approach Cable

A network of cable trenches and/or ducts may exist at some sites but shall require expansion and/or new construction at most stations. It shall be a responsibility of the Bidder to cooperate fully with the Owner and all other on-going project Bidders in the planning and efficient use of existing and new-construction infrastructure supporting on-station communications cabling. The existing cable trenches/ cable raceways proposed to be used shall be identified in the survey report. The Bidder shall make its best effort to route the cable through the existing available cable trenches. Where suitable existing cable trenches are not available, suitable alternatives shall be proposed for Owner approval. However, the approach cable shall be laid in the HDPE pipe in all conditions. HDPE duct shall be as required by TEC/GR/TX/CDS-008/03/MAR-11. The Owner shall provide any additional outdoor cable raceways and/or cable trenches required for such approved alternatives.

It may be noted that in order to utilize the existing trenches, the approach cable may be required to be co-located with HV and LV cables. Accordingly, the approach cable shall be installed in corrosion resistant flexible conduit. Suitable provisions shall be made by the Bidder to ensure adequate safety earthing and insulated protection for the approach cable.

Approach cables exiting from the ground or passing through floors shall be protected against mechanical damage.

Approach cables shall penetrate buildings through cable ducts. The cabling shall route within buildings in cable raceways or under raised floors. The Bidder may utilize existing ducts, building penetrations, cable trays, racks, etc., where appropriate and approved by the Owner.The cables shall be affixed to cable supports using approved ties, clips or cleats at regular intervals.

On short approach cable runs for which cable supports are not required, the Bidder shall fix the cable to the structure of the building using approved fixings and cable cleats.
The Bidder shall be responsible for new building penetrations required for approach cabling. Caution shall be taken to ensure existing equipment and site personnel are protected from dust and debris incident to the cable penetration work. Penetrations shall be neatly formed and sealed for protection from moisture, dust, wind and vermin intrusion.

All required fittings, supports, accessories, ducts, inner ducts, conduits, risers and any item not specially mentioned but required for lay and installation of approach cables shall be supplied and installed by the Bidder.

In addition to above, following points shall must be followed for FOAC cable when ask to lay with underground power cable lines

(a) Fiber optic approach cable (FOAC) shall be laid with 220kV/132kV cable system strictly as per approved method of construction i.e. MOC.
(b) For each run of FOAC cable, some extra loop length shall be buried underground at foot of both end termination tower after laying FOAC cable with 220kV/132kV cable as per MOC.
(c) Each run of FOAC cable length remaining outside the ground level shall be at least the height of each termination tower at both end and it should be brought up to third cross arm of termination tower through HDPE pipes properly tied with tower.
(d) Extra length of FOAC cable (i.e. Approximately half of tower height) after binging the FOAC cable above third cross arm shall be managed in rings by properly fixing clamp arrangement to hold it on end termination tower. Also, each run of FOAC cable shall be terminated at individual joint box on each termination tower.

(e) After laying FOAC cable, each length laid shall be tested for end to end test using power meter and OTDR. Original copy of Test report duly sealed and signed with date, name, designation of testing person, executing contractor and witnessing officer nominated from respective EE(Telecom)/EE(TR)/EE(const.), shall be submitted to concern EE (Const)/EE (TR) & one copy to respective telecom unit, invariably without fail.

(f) Only after getting clearance on validity of test report in written by email by corporate office/concern respective telecom unit further necessary action on commercial part may be taken from concern authority of field office.

2.1.6 Optical Fibre Termination and Splicing

Optical fibre terminations shall be installed in Fibre Optic Distribution Panels (FODP) designed to provide protection for fibre splicing of pre-connectorized pigtails and to accommodate connectorized termination and coupling of the fibre cables. The Bidder shall provide floor mounted / Wall Mounted Fibre Optic Distribution Panels (FODPs) as per GETCO requirement and shall terminate the fibre optic cabling up to the FODPs. The location of FODP rack shall be fixed at the time of detailed engineering.

2.1.6.1 Fibre Optic Distribution Panels

At each location requiring the termination of at least one fibre within a cable, all fibres within that cable shall be connectorized and terminated in Fibre Optic Distribution Panels in a manner consistent with the following:

(a) All fibre optic terminations shall be housed using FODPs provisioned with splice organizers and splice trays. All fibres within a cable shall be fusion spliced to preconnectorized pigtails and fitted to the "Back-side" of the provided fibre optic couplings.

(b) FODPs shall be suitable for use with each of the cable types provided as part of this contract. FODPs shall accommodate pass-through splicing and fibre terminations.

(c) FODPs for indoor use shall be supplied in suitable cabinets or racks with locking arrangements.

(d) All FODPs shall be of corrosion resistant, robust construction and shall allow both top or bottom entry for access to the splice trays. Specific selection of the entry points shall be made at the time of installation. Ground lugs shall be provided on all FODPs and the Bidder shall ensure that all FODPs are properly grounded. The FODP for indoor installation shall meet or exceed ingress protection class IP55 specifications.

2.1.6.2 Optical Fibre Connectors

Optical fibres shall be connectorized with FC-PC, LC or any other better connector decided in detailed Engineering. Fibre optic couplings supplied with FODPs shall be appropriate for the fibre connectors to be supported. There shall be no adapters.

2.1.7 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) Indoor Cable Service Loops:

FODPs shall provide at least three (3) metres of cable service loop. Service loops shall be neatly secured and stored, coiled such that the minimum recommended bend radius is maintained.

(c) 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.

(d) Pigtail Service Loops:

Connectorized 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.

(e) 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.

2.1.8 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 Owner for review and approval in the engineering/design phase of the project, prior to

establishing the final cable lengths for manufacture. Installation procedures including details of personnel and time required shall be documented in detail and submitted to Owner for approval. All installation practices shall be field proven and ISO accredited.

All cable segments shall include service loops as specified in this specification. The maximum allowable stringing tension, maximum allowable torsion 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 Owner 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 be acceptable and shall constitute a cable segment failure. In the event of cable 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 Bidder. The Bidder shall supply all tools & accessories required for installation. It shall be the Bidders responsibility to provide adequate communications among all crew members and support staff to ensure safe and successful installations.

SECTION 3

Inspection & testing requirements

This section describes the specific requirements for inspection & testing requirement for supply of OPGW cable & its associated hardware & fittings.

3.1 General

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 Owner.

The entire cost of testing for factory acceptance test, routine tests, 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/Owner's representative. 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 Bidder as necessary to correct the noted deficiencies at no cost to the Owner. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The test shall be considered complete when (a) all variances have been resolved (b) all the test records have been submitted (c) Owner acknowledges in writing the successful completion of the test.

3.1.1 Inspection

Access to the Bidder's facilities while manufacturing and testing are taking place, and to any facility where systems/equipment are being produced/tested for Owner shall be available to Owner representatives. The Bidder shall provide to Owner representatives sufficient facilities, equipment, and documentation necessary to complete all inspections and to verify that the equipment is being fabricated and maintained in accordance with the Specification. Inspection rights shall apply to the Bidder's facilities and to sub-Bidder facilities where equipment is being manufactured.

Inspections will be performed by Owner, which will include visual examination of hardware, enclosure cable dressings, and equipment and cable labeling. Bidder documentation will also be examined to verify that it adequately identifies and describes all wiring, hardware and spare parts. Access to inspect the Bidder's hardware quality assurance standards, procedures, and records that are applicable to the facilities shall be provided to Owner.

3.1.2 Inspection Certificate

The Bidder shall give the Owner two weeks in case of domestic supplies and six weeks in case of foreign supplies written notice of any material being ready for testing. Such tests shall be to the Bidder's account except for the expenses of the Inspector. The Owner, unless witnessing of the tests is waived, will attend such tests on the scheduled date for which Owner has been so

notified or on a mutually agreed alternative date. If Owner fails to attend the testing on the mutually agreed date, Bidder may proceed with the test which shall be deemed to have been made in the Inspector's presence and Bidder shall forthwith forward to the Inspector, duly certified copies of the test results in triplicate.

The Owner shall, within fourteen (14) days from the date of inspection as defined herein, give notice in writing to the Bidder of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Bidder shall give due consideration to such objections and shall make the modifications that may be necessary to meet said objections. When the factory tests have been completed successfully at the Bidder's or Sub-Bidder's works, the Owner shall issue a certificate to this effect within fourteen (14) days after completion of tests but if the tests are not witnessed by the Owner, the certificate shall be issued within fourteen (14) days of receipt of the Bidder's Test Certificate by the Owner. The completion of these tests or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection, be found not to comply with the Contract.

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

The inspection by Owner and issue of Inspection Certificate thereon, shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Program forming a part of the Contract.

The Bidder shall keep the Owner informed in advance of the time of starting of the progress of manufacture of material in its various stages so that arrangements can be made for inspection.

Record of routine test reports shall be maintained by the Bidder at his works for periodic inspection by the Owner's representative.

Certificates of manufacturing tests shall be maintained by the Bidder and produced for verification as and when desired by the Owner. No material shall be dispatched from its point of manufacture until it has been satisfactorily inspected and tested. Testing shall always be carried out while the inspection may be waived off by the Owner in writing only.

However, such inspection by the Owner's representative(s) shall not relieve the Bidder from the responsibility for furnishing material, software, and equipment to conform to the requirements of the Contract; nor invalidate any claim which the Owner may make because of defective or unsatisfactory material, software or equipment.

3.1.3 Reporting of Variance

A variance report shall be prepared by either Owner or Bidder personnel each time a deviation from specification requirements is detected during inspection or testing. All such variances shall be closed in mutually agreed manner.

However, at any stage if Owner feels that quality of variances calls for suspension of the testing the testing shall be halted till satisfactory resolution of variances, which may involve retesting also.

3.2 Test Plans and Procedures

Test plans for factory acceptance tests shall be provided by the Bidder to ensure that each test is comprehensive and verifies all the features of the equipment are tested. The test plans for factory tests shall be submitted for Owner approval before the start of testing.
The Bidder shall prepare detail testing procedure in line to specification and submit for Owner's approval. The procedure shall be modular to the extent possible, which shall facilitate the completion of the testing in the least possible time.

3.2.1 Test Records

The complete record of all factory acceptance tests results shall be maintained by the Bidder. The records shall be maintained in a logical form and shall contain all the relevant information. The test reports shall be signed by the testing engineer and the engineer witnessing the tests.

3.3 Testing Requirements

Following are the requirements of testing for supply of OPGW Cable:
1. Type Testing
2. Factory Acceptance Testing

3.3.1 Type Testing

The Bidder shall submit the complete type test reports as stated in Appendix -B for the offered item along with the offer. The Type test reports shall not be older than Five years. Type Test shall be valid as on the last date of submission of bid. In case of non-submission / partial submission or type test reports of which validity is over, bidder shall submit pending type test reports from NABL accredited laboratory, in the event of an order, before commencement of supply without affecting delivery schedule, free of cost to GETCO. Confirmation for above shall be invariably submitted along with technical bid.

3.3.2 Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of a Fibre Optic Cable & associated hardware & accessories to be supplied. Factory acceptance testing shall be carried out on overhead fibre optic cable (OPGW) & FO cable hardware fittings & accessories splice enclosures and all other items.

Equipment shall not be shipped to the Owner until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Owner, and the Owner has issued Material Dispatch & Clearance Certificate (MDCC). Successful completion of the factory tests and the Owner 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 Owner's authorized representatives unless waival for witnessing by Owner's representatives is intimated to the Bidder.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation in this Section by the Owner.

The factory acceptance test shall demonstrate the technical characteristics of the Fibre Optic cable & associated accessories in relation to this specifications and approved drawings and documents. List of factory acceptance tests for OPGW and FO cable hardware fittings & accessories are given in Appendix B. This list of factory acceptance tests shall be supplemented by the Bidder's standard FAT testing program. The factory acceptance tests for the splice enclosures shall be proposed by the Bidder in accordance with technical specifications (mentioned in Appendix-B) and Bidder's (including Sub-Bidder's / supplier's) standard FAT testing program.

3.3.2.1 Sampling for FAT

From each batch of equipment presented by the Bidder for Factory acceptance testing, the Owner 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. 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. Physical inspection shall be carried out on 100% basis for all the equipment/items offered.

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

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

3.3.2.2 Production Testing

Production testing shall mean those tests which are to be carried out during the process of production by the Bidder to ensure the desired quality of end product to be supplied by him. The production tests to be carried out at each stage of production shall be based on the Bidder’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 Owner. However, the Owner reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

SECTION 4

DOCUMENTATION AND DELIVERABLES

This section describes the documentation requirements and provides a list of deliverable that the Bidder shall provide to Owner.

The Bidder shall submit a comprehensive list of the document as applicable for the offered system for Owner's approval immediately after signing of the Contract and the documents shall be finalized as per the approved list. The Schedule for submission/approval of documents shall be in line with overall project schedule.

4.1 Documentation

To ensure that the proposed systems conform to the specific provisions and general intent of the Specification, the Bidder shall submit documentation describing the systems to Owner for review and approval. Further the Bidder shall also submit the drawings/documents for testing of the system. The Bidder shall obtain approval of Owner for the relevant document at each stage before proceeding for purchase, manufacturing, factory testing etc.

Each document shall be identified by a Bidder document number, the Owner document number, and the Owner purchase order number. Where a document is revised for any reason, each revision shall be indicated by a number, date, and description in a revision block along with an indication of official approval by the Bidder's Project Manager. Each revision of a document shall highlight all changes made since the previous revision.

The Bidder shall submit three hard copies of each document/drawing for Owner's review and approval along with soft copy with each submission. After approval two set of all the documents/drawings shall be submitted as final documentation, however, for site specific documents two sets of documents shall be provided for each site. In addition to paper copies all the documents shall also be provided on electronic media in two copies. In case any documentation requirement is specified in the relevant section the same shall apply for the equipment /system defined in that section. The following document shall be submitted as applicable for the subsystem.

(a) Data Requirement sheets
(b) Sag tension charts
(c) Bill of Quantity (Drum Schedule & Hardware BOQ)
(d) Standard documents
(e) Previous type test report
(f) Manufacturing Quality Plan
(g) Test Procedure (Type test & FAT)
(h) Test report (Type test &FAT)
(i) Test Schedule
(j) Transportation & handling procedure
(k) Numbering, Marking, labeling document

The documentation pertaining to third party or OEM products may be supplied in the format as available from the third party/OEM. If both formats (Paper/electronic) are available then the

above mentioned copies of documents shall be supplied in both the formats, however, in exceptional cases where the Bidder is not able to get more copies due to copyright laws restriction, the issue will be mutually agreed upon on case to case basis. The document to be submitted shall include the following:

4.1 System Functional Description Document

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

4.2 Test Documentation

The Bidder shall provide documentation for all type tests and factory tests & field tests. The test documentation shall include the following:

(a) Type test documents (Procedures & Reports)
(b) Factory Acceptance Test Documents (Procedures & Reports)
(c) Site Acceptance Test Documents (Procedures & Reports)

4.3 Drawings

All drawings submitted by the Bidder shall indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component, break-up for packing and shipment, shipping arrangement required, the dimensions required for installation and any other information specifically requested in the Specifications. Each drawing submitted by the Bidder shall be clearly marked with the Owner name, the unit designation, the specification title, the specification number and the name of the Project. All titles, notes, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in metric units. The drawing revision level/ issue no, issue date shall be marked on each drawing and the drawing shall carry issue history information and appropriate signatures (e.g.: originator, checker and approving authority).

SECTION – 5

Project Management, Schedule and Implementation Plan

This section describes the project management, schedule, quality assurance and implementation plan requirements for the supply of OPGW Cable & associated hardware and fittings.

5.1 Project Management

The Bidder shall assign a Project Manager with the authority to make commitments and decisions that are binding on the Bidder. The Project Manager's responsibility shall include interface and coordination with the Project Bidder. The Owner will designate a Project Manager to coordinate all the Owner project activities. All communications between the Owner and the Bidder shall be coordinated through the Project Managers.

5.2 Project Review Meetings

Progress meetings shall be scheduled by the Project Manager and attended by the Bidder and Owner each reporting period to review progress of the project. Progress meetings shall be used to review the progress report, written correspondence exchanged since the last meeting, and open action items.

The Bidder shall also attend technical meetings as required to discuss technical aspects of the project and to review Owner comments on approval documents. When appropriate, these technical meetings shall be conducted as extensions to the progress meetings. The consultant shall also attend the meeting as and when required by Owner. The Project Manager shall schedule and attend Progress Meetings as deemed necessary but no less than once every months.

5.3 Progress Report

A progress report shall be prepared by the Bidder each month against the activities listed in the project schedule. The report shall be made available to Owner on a monthly basis, e.g., the 10th of each month. The progress report shall include all the completed, ongoing and scheduled activities and transmittals issued and received for the month.

5.3 Transmittals

Every document, letter, progress report, change order, and any other written exchanged between Bidders and the Owner shall be assigned a unique transmittal number. The Bidder shall maintain a correspondence index and assign transmittal numbers consecutively for all Bidder documents. The Owner will maintain a similar correspondence numbering scheme identifying documents and correspondence that the Owner initiates.

5.4 Quality Assurance and Quality Control Program

All materials and parts of the system/sub-system to be supplied under the project shall be of current manufacture from a supplier regularly engaged in the production of such equipment.

The Bidder shall maintain a Quality Assurance/Quality Control (QA/QC) program that provides that equipment, materials and services under this specification whether manufactured, designed or performed within the Bidder's plant, in the field, or at any sub-Bidder source shall be controlled at all points necessary to assure conformance to contractual requirements. The program shall provide for prevention and ready detection of discrepancies and for timely and positive corrective action. The Bidder shall make objective evidence of quality conformance readily available to the Owner. Instructions and records for quality assurance shall be controlled and maintained at the system levels. The Bidder shall describe his QA/QC program in the Technical Proposal, (along with samples from his QA/QC manual) and shall submit his QA/QC Manual for review and acceptance by the Owner.

Such QA/QC program shall be outlined by the Bidder and shall be finally accepted by Owner after discussions before the award of Contract. A Quality Assurance Program of the Bidder shall generally cover but not be limited to the following:

(a) The organization structure for the management and implementation of the proposed Quality Assurance Program.
(b) Documentation control system.
(c) Qualification data for key personnel.
(d) The procedure for purchase of materials, parts/components and selection of sub Bidder's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases, etc.
(e) System for shop manufacturing including process controls.
(f) Control of non-conforming items and system for corrective action.
(g) Control of calibration and testing of measuring and testing equipments.
(h) Inspection and test procedure for manufacture.
(i) System for indication and appraisal of inspection status.
(j) System for quality audits.
(k) System for authorizing release of manufactured product to Owner.
(l) System for maintenance of records.
(m) System for handling, storage and delivery.
(n) A Quality Plan detailing out the specific quality control procedure adopted for Controlling the quality characteristics of the product.

The Quality Plan shall be mutually discussed and approved by the Owner after incorporating necessary corrections by the Bidder as may be required. Neither the enforcement of QA/QC procedures nor the correction of work mandated by those procedures shall be cause for an excusable delay. An effective Quality Assurance and Quality Control organization shall be maintained by the Bidder for at least the duration of this Contract. The personnel performing QA/QC functions shall have well defined responsibility, authority, and organizational freedom to identify and evaluate quality problems and to initiate, recommend, or provide solutions during all phases of the Contract. The QA/QC organization of the Bidder shall be an independent administrative and functional structure reporting via its manager to the Bidder's top management. The QA/QC manager(s) shall have the authority within the delegated areas of responsibility to resolve all matters pertaining to quality to the satisfaction of Owner when actual quality deviates from that stated in the Work Statement.
The Bidder shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Owner's inspection of equipment/materials.

The Owner or his duly authorized representative reserves the right to carry out Quality Audit and Quality Surveillance of the systems and procedures of the Bidder's/his vendor's Quality Management and Control Activities.

The scope of the duties of the Owner, pursuant to the Contract, will include but not be limited to the following:

(a) Review of all the Bidder's drawings, engineering data etc.
(b) Witness or authorize his representative to witness tests at the manufacturer's Works or at site, or at any place where work is performed under the Contract.
(c) Inspect, accept or reject any equipment, material and work under the Contract in accordance with the specifications.
(d) Issue certificate of acceptance and/or progressive payment and final payment certificate
(e) Review and suggest modification and improvement in completion schedules from time to time; and
(f) Monitor the Quality Assurance program implementation at all stages of the works.

5.6 Project Schedule

The project implementation plan is given in Appendix - A. Based upon this the Bidder shall submit a preliminary project implementation schedule along with the bid. The detail project implementation schedule shall be submitted by the Bidder after award for Owner’s approval, which shall include at least the following activities:

(a) Documents, DRS, Drawing submission and approval
(b) Type Testing Schedule
(c) Manufacturing
(d) Factory Testing Schedule
(e) Dispatch Schedule
(f) Receipt & Storage

The project implementation schedule shall include the estimated period for completion and its linkage with other activities. The Project implementation schedule shall also contain Owner activities required for the Bidder to complete the system.

5.7 Implementation Schedule

Appendix A of this Technical Specifications provides a implementation schedule for the supply of OPGW Cabling.

The Bidder shall submit a detailed project schedule showing the activities of both the Bidder and Owner and also including the documentation schedule and training schedule. The Owner and the Bidder shall finalize the detailed implementation plan following the award of the contract.

APPENDIX A

GENERAL REQUIREMENTS, IMPLEMENTATION SCHEDULE & BILL OF QUANTITIES

Table-1
Details of Tower/Earth wire/Conductor

Sl. No	Volt (KV)	Every Day Temp. (as per design)(^{0}C)		Details of Earth wire Conductor				Ground Fault Current (KA)
		Conductor	E/wire	Size (mm)	UTS (KN)	Weight (Kg/Km)	Overall diameter (mm)	
1	400KV	35	35	7/3.66	72.9	575	10.98	40
2	220KV / 66KV	35	35	7/3.15	56	428	9.45	40/31.5

Table 2: BOQ for OPGW & associated Hardwares

Sl. No.	Item Description	Unit	Quantity
1	48 fibre (DWSM) OPGW fibre optic cable.	Km.	As specified in schedule-A
2	Installation Hardware set* for above OPGW i.e. all Cable fittings & accessories like suspension clamps, tension clamps, vibration dampers, earthing clamps, down lead clamps, in-line splice enclosures etc.	Set*	
3	Fibre Optic Approach Cabling (DWSM 48F) including installation hardware like ties/clips/cleats, conduits, ducts, supports, fittings, accessories etc. for extending OPGW from sub-station end tower/gantry to FODP at control/communication room by splicing fibres of OPGW with FOAC in joint box at tower/gantry and splicing FOAC in FODP at control/communication room .	Meter	

Note: (*)
1) One set of installation hardware shall contain all installation hardware fittings as may be required for 1 km of OPGW cabling.
2) Hardware set shall be supplied as per approved drawing during detailed engineering.

However, Bidder may be asked to provide Unit rate of following HW and accessories items if required.

Sr No	Description	Unit Rate
1	Single Suspension Assembly	
2	Single tension assembly for dead end location	
3	Double tension assembly for joint box location	
4	Double tension assembly for pass through location	
5	Vibration damper with protection rods	
6	Joint Box (3Way, 48 Nos of splicing)	
7	Down lead clamp	
8	Surplus cable support	
9	FODP (48F)	
10	FODP (48F)	
11	Double tension assembly for Suspension location (used only after getting approval from corporate office)	
12	Fibre Optic Approach Cable (FOAC) (48F) (With installation hardware like ties/ clips/ cleats, conduits, ducts, supports, fittings etc.)	

Table- 3
Type testing requirement

Sl. No.	Item Description	Unit
1	Type tests for Optical Fibres	1
2	Type tests for OPGW cable	1
3	Type tests for OPGW cable fittings	1
4	Type tests for in line splice enclosure	1

Appendix -B
TYPE TESTING/ FACTORY ACCEPTANCE TESTS REQUIREMENTS

The following tests from NABL accredited laboratory shall be carried out in accordance with latest / amended / up to date IS/IEC. The bidder has to submit the all type test reports as stated hereunder for the offered item along with the technical bid. The type test reports from NABL approved laboratory shall not be older than **five years**. Type Test shall be valid as on the last date of submission of bid.

In case of non-submission/partial submission or type test reports of which validity is over, bidder shall submit pending type test report/s from NABL accredited laboratory, in the event of an order, before commencement of supply without affecting delivery schedule, free of cost to GETCO. Confirmation for above shall be invariably submitted along with technical bid.

Wherever the referenced test procedures or the technical specifications call for visual inspection for damage, the test report shall include a full description of observed status of the sample. (Visually inspected samples shall also be colour photographed and copies of colour photographs shall be included in type test report).

B-1 Type Tests for Optical Fibres

The type tests listed below in table B-1.1 shall be conducted on DWSM fibres. The tests specific to the cable type are listed in subsequent sections.

Table B-1.1
Type Tests For Optical Fibres

Sl. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
2	Attenuation Variation with Wavelength	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
3	Attenuation at Water Peak	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
4	Temp. Cycling (Temp dependence of Attenuation)		EIA/TIA 455- 3A, 2 cycles
5	Attenuation With Bending (Bend Performance)		EIA/TIA 455- 62A
6	Mode Field dia.		EIA/TIA 455-164A/167A/174
7	Chromatic Dispersion		EIA/TIA 455-168A/169A/175A
8	Cladding Diameter		EIA/TIA 455-176
9	Point Discontinuities of attenuation		EIA/TIA 455-59
10	Core -Clad concentricity error		EIA/TIA 455-176
11	Fibre Tensile Proof Testing		EIA/TIA 455-31B

B-2 Type Tests for OPGW Cables

The type tests to be conducted on the OPGW cable are listed in table B-2.1: Type Tests for OPGW Cables. Unless specified otherwise in the technical specifications or the referenced 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 B-2.1 Type tests for OPGW Cable

Sl. NO.	Test Name	Test Description	Test Procedure	
1	Water Ingress Test	IEEE 1138 Section 4.1.1.1	IEEE 1138, Section 5.1.1.1 (IEC 794-1-F5 /EIA/TIA 455-82B) : Test duration : 24 hours	
2	Seepage of filling compound	IEEE 1138 Section 4.1.1.2	IEEE 1138 Section 5.1.1.2 (EIA/TIA 455-81B)	Preconditioning period : 72 hours. Test duration : 24 hours.
3	Short Circuit Test	Section 4.1.1.3 Or	IEEE 1138 Section 5.1.1.3	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 the temperature inside the OPGW tube in addition to monitoring & recording the temperatures between the strands and between optical tube and the strand 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.
		IEC 60794-1-2(2003) Method H1		Initial temperature during the test shall be greater than or equal to ambient field temperature. However, maximum temperature recorded on any component of OPGW cable shall not exceed the Short Circuit transient peak temperature guaranteed by the Bidder during design.
4	Aeolian Vibration Test	IEEE 1138 Section 4.1.1.4	IEEE 1138 Section 5.1.1.4	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The vibration frequency and amplitude shall be monitored and recorded continuously. All fibres of the test cable sample shall be spliced together in

				serial for attenuation monitoring. Test shall be conducted with 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 Section 4.1.1.5	IEEE 1138 Section 5.1.1.5	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:794-1-E11		The short-term and long-term bend tests shall be conducted in accordance with Procedure 2 in IEC:794-1-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 and crimping.
7	Sheave Test	IEEE 1138 Section 4.1.1.6 Or IEC 60794-1-2 (2003) Method E18B	IEEE 1138 Section 5.1.1.6	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The Sheave dia. Shall be based on 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 Section 4.1.1.7	IEEE 1138 Section 5.1.1.7 (IEC 794-1-E3/ EIA/TIA 455-41B)	The crush test shall be carried out on a sample of approximately one (1) metre long in accordance with IEC:794-1-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 Section 4.1.1.7	IEEE 1138, Section 5.1.1.7 (IEC 794-1-E4/ EIA/TIA 455-25B)	The impact test shall be carried out in accordance with IEC:794-1-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 Section 4.1.1.8	IEEE 1138 Section 5.1.1.8	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 Section 4.1.1.9	IEEE 1138 Section 5.1.1.9	
12	Strain Margin Test	IEEE 1138 Section 4.1.1.10	IEEE 1138 Section 5.1.1.10	
13	Stress strain Test	IEEE 1138 Section 4.1.1.11	IEEE 1138 Section 5.1.1.11	
14	Cable Cut-off wavelength Test	IEEE 1138 Section 4.1.1.12	IEEE 1138 Section 5.1.1.12	
15	Temperature Cycling Test	IEEE 1138 Section 4.1.1.13	IEEE 1138 Section 5.1.1.13	
16	Corrosion (Salt Spray) Test	EIA/TIA 455-16A		
17	Tensile Performance Test	IEC 794-1-E1 / EIA/TIA 455-33A	The test shall be conducted on a sample of sufficient length in accordance with IEC:794-1-E1. The attenuation variation shall not exceed 0.05 dB/km up to 90% of RTS of fibre optic cable. The load shall be increased at a steady rate up to rated tensile strength and held for one (1) minute. The fibre optic cable sample shall not fail during the period. The applied load shall then be increased until the failing load is reached and the value recorded.	
18	Fault Current/ lightning Test	IEEE Std. 4-1978 or	Tension equal to 20% of the OPGW RTS shall be applied to a sample with minimum length of 15 m of cabled fibres and two separate 4/10 micro second current impulses each having a peak value of 150 KA and a negative polarity shall be applied through a 1 cm gap. The attenuation during the tests shall be continuously measured. After the tests the same shall be visually inspected. Any increase in optical waveguide fibres attenuation measured at 1550 nm shall constitute failure. Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The tensile performance test shall be repeated on the sample subjected to the lightning arc test.	

		IEC 60794-1-2(2003)	The cable construction shall be tested in accordance with Method H2
19	DC Resistance Test	On a fibre optic cable sample of minimum 1 meter 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 meter and subsequently one meter apart. The tests shall be repeated at least five times and the average value recorded after correcting at 20°C.	
20	Twist test	IEEE Std 1138: 2021, Cl. No. 6.5.2.4	
21	Ultimate tensile strength test	IEEE Std 1138: 2021, Cl. No. 6.5.1.4	

B-3 Type Test on OPGW Cable Fittings

The type tests to be conducted on the OPGW Cable fittings and accessories are listed Below.

B-3.1 Mechanical Strength Test for Suspension/Tension Assembly

Applicable Standards: IS : 2486 / IEC : 61284 :1997.

1. 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°. 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 evidence of 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 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.

2. 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 at a 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 removed 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 part 1 of Test.
- No evidence of Fracture at the end of one minute at the minimum failure load during

Part 2 of the Test.
Any result outside these parameters shall constitute a failure.

B-3.2 Clamp Slip Strength Test for Suspension Assembly

The suspension assembly shall be vertically suspended by means of a flexible attachment. 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, Armour Rods 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 8% of UTS of OPGW 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 armour rods 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 position between clamp body and armour rods shall be 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 15% of UTS of OPGW. 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 are met:

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

  *Definition of no slippage in accordance with IEC 61284:1997:-
  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 8 to 15% of UTS of OPGW.
- 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 and maximum slip, shall be considered as 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 : 1997 no damage, other than surface flattening of the strands shall occur. Any result outside these parameters is a failure.

B-3.3 Slip Strength Test of Tension Clamp

Tension clamps shall be fitted on a 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 increase 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 movement less than 2 mm is accepted. The possible couplings or elongations produced by the conductor as a result of the test itself are not regarded as slippage. Any result outside these parameters shall constitute a failure.

B-3.4 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 kg-m 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.

B-3.5 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.

B-3.6 Type Test on Vibration Damper

B-3.6.1 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 as determined through vibration analysis of undamped OPGW. The damper assembly shall be vibrated vertically with a ±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.

(a) Force Vs frequency
(b) Phase angle Vs frequency
(c) 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.

The above dynamic characteristics test shall be conducted on five dampers. The variations between the samples tested shall conform to the sample test limits.

B-3.6.2 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.

(d) The analysis shall be done for single fibre optic cable without armour rods. The tension shall be taken as max Permissible Every Day Tension (20% of UTS), for a span ranging from 100 m to 1100 m.

(e) 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.

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

(g) 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.

(h) 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 point 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 fatigue limits.

B-3.7 Vibration Damper Clamp Slip and Fatigue Tests

B-3.7.1 Test Set Up

The clamp slip and 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 15 kN 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.

B-3.7.2 Clamp Slip Test

The vibration damper shall be installed on the test span. The damper clamp, after tightening with the manufacturer's specified tightening torque, when subjected to a longitudinal pull of 2.5 kN parallel to the axis of fibre optic cable for a minimum duration of one minute shall not slip, i.e., the permanent displacement between fibre optic cable and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased until the clamp starts slipping. The load at which the clamp slips shall not be more than 5 kN.

B-3.7.3 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 eliminate stray 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 vertical modes. 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 above 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:

(i) There shall not be any frequency shift by more than ±2 Hz for frequencies lower than 15 Hz and ±3 Hz for frequencies higher than 15 Hz.

(j) The force response curve shall generally lie within guaranteed % variation in reactance after fatigue test in comparison with that before fatigue test by they Supplier.

(k) The power dissipation of the damper shall not be less than guaranteed % variation in power dissipation before fatigue test by the Supplier. However, it shall not be less than minimum power dissipation which shall be governed by lower limits of reactance and phase angle indicated in the envelope.

B- 3.8 Chemical composition of each components as per relevant IS for

(a) Suspension assembly
(b) Tension assembly including yoke plate
(c) Vibration damper
(d) Down lead clamp & loop bracket

B- 3.9 Galvanizing Test:

All ferrous parts of OPGW hardware shall be galvanized in accordance with IS: 2629/1966 (with latest amendment) 'Recommended practice for hot dip galvanizing of iron and steel'. The method for testing weight, thickness and uniformity of coating of hot dip galvanized articles shall be in accordance with IS: 2633/1972 (with latest amendment). The hardware shall have Zinc coating of 610 gm/m2.

The Zinc used for galvanizing shall conform to grade Zn of IS: 209 - Relevant extract from IS: 209 (with latest amendment).

The threads in nuts and tapped holes shall be cut after galvanizing and shall be well lubricated or greased. All other threads shall be cut before galvanizing. The bolt threads shall be undercut to take care of increase in diameter due to galvanizing.

Spring washers shall be electro-galvanized.

B-4 Type Tests for In Line Splice Enclosures

Following Type tests shall be demonstrated on the In Line 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 or IEC 794-1 procedures).

B-4.1 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 794-1- 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.

B-4.2 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% .

B-4.3 Rain Withstand 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 60 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.

B-4.4 Vibration Test

The splice enclosure, with fibres united inside, shall be subjected to vibrations on 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 of the 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.

B-4.5 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 be less 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.

B-4.6 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.

B-4.7 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 shall be carried out in accordance with procedure described in IEC-68-2-32.

B- 5 Type Tests for Fibre Optic Approach Cable

The type tests to be conducted on the Fibre Optic Approach cable are listed in Table 3-6: Type Tests for Approach Cable. Unless specified otherwise in the technical specifications or the referenced 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 B-5
Type Tests for Approach Cable

Sl. No	Test Name	Test Procedure
1	Water Ingress Test	IEC 794-1-F5/EIA 455-82B
2	Seepage of filling compound	EIA 455-81A
3	Crush Test	IEC 794-1-E3/EIA 455-41
4	Impact Test	IEC-794-1-E4/EIA 455-41
5	Stress strain Test	EIA 455-33A
6	Cable Cut-off wavelength Test	EIA-455-25A
7	Temperature Cycling Test	IEC794-1-F1/EIA-455-3A
8	Tensile Strength test	IEC-60794-1-2E1
9	Cable bend test	IEC-60794-1-2-E11A
10	Torsion test	IEC-60794-1-2-E7

B- 5.1 Impact Test
The Impact test shall be carried out in accordance with IEC: 794-1-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 0.05 dB/km shall constitute failure.

B-6 Factory Acceptance Tests On Fibre Optic Cables

As specified in technical specifications, the Factory acceptance tests shall be conducted on random sampling of fibre optic cable to be supplied for the present procurement, prior to any shipment. FAT shall be carried out as per GETCO approved MQP.

B-6.1 FAT on Fibre: Optical Acceptance Tests

The Optical acceptance tests listed in table B 6.1 below are applicable for the fibres of all types of Fibre Optic Cables i.e. OPGW and approach cable to be supplied. The listed tests follow testing requirements set forth in IEEE standard 1138 section 4.2.2.1 and section 5.2.2.1. 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. FAT shall be carried out in all fibres on 10% of offered drums for each Line in each lot as specified in technical specifications and as per GETCO approved MQP.

Table B-6.1

Factory Acceptance Tests for Fibres of all FO cables: Optical Tests

Sl. No	Test Name	Acceptance Criteria	Test procedure
1	Attenuation Coefficient	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
2	Point Discontinuities of attenuation		EIA/TIA 455-59
3	Attenuation at Water Peak		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

The test reports for the above tests including “Fibre Tensile Proof Testing” for all types of the fibres carried out by the Fibre Manufacturer and used in the OPGW cables and approach cable shall be shown to the inspector during OPGW / FOAC cable FAT and shall be submitted along with the OPGW / FOAC cable FAT report.

B-6.2 Factory Acceptance Test On OPGW Cable

The factory acceptance tests for OPGW cable specified below in Table B-6.2 follow the requirements set forth in section 4.1.2 and section 5.1.2 of IEEE standard 1138. The FAT shall be carried out on 10% of offered drums for each Line in each lot as specified in technical specifications and as per GETCO approved MQP. The optical tests shall be carried out on all fibres of OPGW of the selected sample drums as per Table B-6.1.

Table B-6.2
Factory Acceptance Tests On OPGW
Applicable standard: IEEE 1138

Sl. No	Factory Acceptance Test on Manufactured OPGW
1	Visual Material verification and dimensional checks as per approved DRS/Drawings like diameter of SS Tube, Overall diameter
2	D.C Resistance Test
3	Rated Tensile Strength and Ultimate Tensile Strength
4	Lay Direction & Lay Length Measurements
5	Water Ingress Test
6	Seepage of flooding compound test
7	Tensile performance Test (Format enclosed) i) Initial reading @ 1310 & 1550 nm ii) At 40% UTS for 1310 & 1550 nm and change in attenuation w.r.t (i) above iii) At 90% RTS for 1310 & 1550 nm and change in attenuation w.r.t (i)
8	Test on Individual ACS/AA wires of finished OPGW Cable -Appearance -Diameter -Tensile Strength -Elongation -Resistivity & Conductivity -Thickness of Aluminum Coating -Twist Test

B-6.3 Factory Acceptance Test on OPGW Fittings

The factory acceptance tests for OPGW Fittings as specified below in Table B-5.3 and as per GETCO approved MQP. The sampling plan shall be as per IS 2486:

Table B-6.3

Factory Acceptance Tests On OPGW Fittings

Sl. No.	Factory Acceptance Test
Suspension Assembly	
1	Visual Material verification and dimensional checks as per approved DRS/Drawings
2	UTS/Mechanical Strength of the assembly
3	Clamp Slip Test
4	Mechanical strength of each component
5	Chemical test
6	Galvanizing tests on ferrous parts
Tension assembly	
1	Visual Material verification and dimensional checks as per approved DRS/Drawings
2	UTS/Mechanical Strength of the assembly
3	Clamp Slip Strength test
4	Mechanical strength of each component
5	Chemical test
6	Galvanizing tests on ferrous parts
Vibration Damper	
1	Visual Material verification and dimensional checks as per approved DRS/Drawings
2	Galvanizing test on damper, masses and messenger wires
3	Damper response (resonant frequencies) by Electro dynamic shaker
4	Clamp Slip test
5	Dimensions & Strength of messenger wires
6	Mass pull off test
7	Attachment of clamp to messenger wire
8	Weight of each Mass & weight of whole assembly
9	Clamp bolt tightening torque
Structure Mounting Clamp	
1	Visual Material verification and dimensional checks as per approved DRS/Drawings
2	Clamp fit test
3	Clamp Strength test
4	Chemical test
5	Galvanizing tests

Loop bracket	
1	Visual Material verification and dimensional checks as per approved DRS/Drawings
2	Chemical test
3	Galvanizing tests

B-6.4 Factory Acceptance Test on In Line Splice Enclosures

The factory acceptance tests for In Line Splice Enclosures as specified below in Table -B-6.4 and as per GETCO approved MQP

Table B-6.4
Factory Acceptance Tests on In Line Splice Enclosures (Joint box)/FODP

Sl No.	Factory Acceptance Test
1	Visual check Kit Quantities and Specific Component Number for each component of In Line Splice Enclosure and dimensional checks against the approved drawings.

B – 6.5 Factory Acceptance Test On Approach Cable

The factory acceptance tests for Approach Cable specified below in Table B- 6.5 and as per GETCO approved MQP. The optical tests shall be carried out on all fibres of Approach Cable of the selected sample drums as per Table B-6.1.

Table B-6.5
Factory Acceptance Tests On Approach Cable

Sl. No.	Factory Acceptance Test
1	Visual Material verification and dimensional checks as per approved drawings

B- 6.6 Factory Acceptance Tests on Test Equipment, pigtail & other

As per technical specification and approved DRS/Documents.

B – 6.7 Site Acceptance Tests

The Bidder shall be responsible for the submission of all equipment including Test equipment supplied in this contract for site tests and inspection as required by the Owner. 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. A minimum Site Acceptance Testing requirement for FO cables is outlined in following section. This testing shall be supplemented by the Bidder's standard installation testing program, which shall be in accordance with his quality plan(s) for FO cabling installation.

During the course of installation, the Owner 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 Owner to demonstrate that it is entirely suitable for commercial operation.

6.7.1 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.

6.7.2 Phases of Site Acceptance Testing

SAT shall be carried out link by link from FODP to FODP. SAT may be performed in parts in case of long links. **Test results shall be recorded in formats enclosed at the end of this specification for tests performed for pre-Installation & post-Installation testing and shall be submitted duly signed/certified in hard copy as well as soft copy and copy of files of measurements done with OTDR for each transmission line.**

The tests, checks, adjustments etc conducted by the Bidder 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 be as per approved sag-tension chart and during installation, sag and tension of OPGW shall be documented. During the installation, spliced cable segments shall be tested and documented. Upon completion of a continuous cable path (equipment to equipment locations), 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 Table 6-7 (a) to 6-7 (c*).*

Table 6-7(a)
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 & 1310nm
3.	Fibre optic cable length measurement using OTDR

Table 6-7(b)
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 routing techniques
3.	Physical inspection of sealing techniques, weatherproofing, etc.

Table 6-7(c)
Fibre Optic Cable Commissioning Testing

Item:	Description:
1.	End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by OTDR.
2.	End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by Power meter.
3.	Bi-directional average splice loss by OTDR of each splice as well as for all splices in the link (including at FODP also)
4.	Proper termination and labelling of fibres & fibre optic cables at FODP as per approved labelling plan.
5.	Checking Quality of work and Quantity verification of OPGW Hardware as per Format A

SCHEDULE – B

GUARANTEED TECHNICAL PARAMETERS

The following sets Sheets 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 DRS format duly filled and the relevant drawings shall also be submitted during the detailed engineering along with the relevant technical brochures. The DRS forms have been included for the major items, however, the DRS or each item along with sufficient details shall be submitted.

1. OPGW Construction

OPTICAL GROUND WIRE

CABLE CONSTRUCTION

Seq.	Parameter	Unit	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)	each	
10	Filling material		
11	Filling material compliant with technical specifications?	Yes/No	
12	Strength member(s)		
13	Binding yarn/ tape		
14	Describe Central Core Design		
15	Aluminum Clad steel wire % IACS Diameter: Number:	 % mm each	
16	Aluminum alloy wires Diameter: Number:	mm each	
17	SS tube inner diameter	mm	
18	SS tube outside diameter	mm	
19	Cable Diameter: (nominal ± deviation)	mm	
20	Cable cross-section area	Sq. mm	

	(Nominal)		
21	Cable cross-section area (Effective)	Sq. mm	
22	Fully Compliant with IEEE P1138	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/mm^2	
29	Minimum Bending Radius without micro bending	mm	
30	Maximum Bending Radius Short Term Long Term (Continuous)	mm	
31	Tensile proof test (Screening) Level (For Fiber)	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 no wind	mm	
35	Everyday tension , no wind	% of UTS	
36	Maximum tension at Every day condition with full wind pressure of . ...Kg/m_2 on full projected are, 400 meter span		

Thermal Properties of Cable

37	Coefficient of linear expansion	per °C	
38	Coefficient of expansion Cladding: Core:	 per °C per °C	
39	Nominal operating temperature range	°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:	 Meter Meter	
43	Size of drum	Meter	
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

Seq.	Parameter	Unit	Particulars
49	Splice Loss: Maximum: Average	 dB dB	
50	Operating Temperature Range	°C	
51	Rated Isoceraunic 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	Meter	
56	Midspan sag at 0°C with no wind loading	mm	
57	Midspan sag at max temp. with no wind loading	mm	
58	Midspan 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 applicable wind and ice load conditions shall be submitted along with the DRS. The cable parameters like coefficient of liner expansion, modulus of elasticity shall also be indicated.

2. OPGW Optical Parameters

DUAL WINDOW SINGLE MODE

OPTICAL PARAMETERS

Seq.	Parameter	Unit	Particulars
1	Fiber manufacturer(s)/Type		
2	Fiber production method		
3	Attenuation Coefficient @ 1310 nm: @ 1550 nm:	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	µm	
9	Mode Field Diameter Deviation @ 1310 nm @ 1550 nm	µm	
10	Chromatic Dispersion Coefficient @ 1310 (1288-1339) nm @ 1310 (1271-1360) nm @ 1550 nm	ps/nm.km	
11	Zero dispersion wavelength	nm	
12	Zero dispersion Slope	$ps/nm^2.km$	
13	Cable Cutoff wavelength	nm	
14	Refractive Index		
15	Refractive Index profile		
16	Cladding Design		
17	Numerical aperture		

PHYSICAL and MECHANICAL PROPERTIES

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

3. HARDWARE AND ACCESSORIES

Suspension Clamp Assembly:

Manufacturer:
Part

Seq.	Description	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 a) No. of rods per clamp b) Direction of Lay c) Overall length d) Diameter of each Rod e) Tolerances (i) Diameter of each rod (ii) Length of each rod f) Material of manufacture g) UTS of each Rod h) Weight	 mm mm ±% ±% kN kg	
9	Details of Protection Splice Set (Reinforcing Rods) i) No. of rods per clamp j) Direction of Lay k) Overall length l) Diameter of each Rod m) Tolerances (i) Diameter of each rod (ii) Length of each n) Material of manufacture o) UTS of each Rod p) Weight	 mm mm ±% ±% kN kg	

Dead End Clamp Assembly

Manufacturer:

Part

Seq.	Description	Unit	Particulars
1	Minimum Slip Load	kN	
2	Length (nominal) a) Reinforcing Rods b) Dead end	 mm mm	
3	Weight (nominal) a) Reinforcing Rods b) Dead end	 kg kg	
4	Breaking strength (minimum)	kN	
5	Wire Size a) Reinforcing Rods b) Dead end	 mm mm	

Vibration Damper

Manufacturer:
Part

Seq.	Description	Unit	Particulars
1	Total Weight	Kg	
2	Weight of each Damper	Kg	
3	Material of Damper Weight		
4	Clamp Material		
5	Clamp bolt tightening torque	Nm	
6	Clamp bolt material		
7	Messenger Cable Material		
8	No. of Strands in Messenger Cable		
9	Breaking Strength of Messenger Cable	kN	
10	Resonance Frequencies a) First Frequency b) Second Frequency c) Third Frequency d) Forth Frequency	 Hz Hz Hz Hz	
11	Minimum Slip Strength of Damper Clamp a) Before Fatigue Test b) After fatigue Test	 kN kN	

Down Lead Clamp /Fastening Clamp

Manufacturer:
Part

Seq.	Description	Unit	Particulars
1	Material		
2	Suitable for OPGW (range):	mm	
3	Tightening torques	Nm	
4	Vertical load	kN	
5	Filler details		

	(a) Material (b) diameter:	mm	
6	Tower attachment arrangement		

In Line Splice Enclosures

Manufacturer:
Model :

Seq.	Description	Unit	Particulars
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		
10	Provision of pass through splicing	Yes/No	
11	Whether filled with suitable encapsulant	Yes/No	
12	Method(s) for mounting with the tower		

Optical Fibre Cable Accommodations			
13	Cable Glanding		
14	Maximum number of cables that can be accommodated	each	
15	Diameter(s) of cables that can be accommodated		
16	Describe Cable entries		
17	Details of Splice Trays Dimension Material/Gauge Weight Colour & Finish Method of mounting	Kg	

18	Maximum number of splice trays	each	
19	Number of splices per tray	each	
20	Provision of Splice organizers		
21	Do splice trays require a separate enclosure? If so Manufacturer Dimensions H * W * D Weight Colour and Finish Method(s) of Mounting Construction materials & Gauge Locking arrangements	Yes/No cm Kg	
22	Installation Clearances Front Access Rear Access Top * Bottom * Sides	m	
23	Excess length of fibre service loops	m	
24	List of accessories provided for dressing, splicing of optical fibers and sealing of joint box		

Optical Fiber Distribution Panel (FODP)

Manufacturer:
Model:

Seq.	Parameter:	Unit:	Particulars:
1	Dimensions H * W * D:	cm	
2	Weight:	kg	
3	Colour and Finish:		
4	Cable Glanding and Fixing:		
5	Construction materials & Gauge:		
6	Locking arrangements:		
7	Installation Clearances Front Access: Rear Access: Top * Bottom * Sides:	 cm	
8.	IP Protection		
9.	Total number of optical couplings:	each	
10.	Provision of pass through splicing	Yes/No	
11	Whether filled with encapsulant	Yes/No	
12	Method(s) for mounting:		

Optical Fibre Cable Accommodations			
13.	Cable Glanding:		
14.	Maximum number of cables that can be accommodated:	each	
15.	Diameter(s) of cables that can be accommodated:		
16.	Describe Cable entries:		
Cable Termination Splice Accommodation			
17	Details of Splice Trays: Dimension: Material Gauge: Weight: Colour and Finish: Method of mounting:	 kg 	
18	Maximum number of splice trays:	each	
19	Number of splices per tray:	each	
20	Provision of Splice organisers		
21	Do splice trays require a separate enclosure? If so: Manufacturer: Dimensions H * W * D: Weight: Colour and Finish: Method(s) of Mounting: Construction materials & Gauge: Locking arrangements:	Yes/No cm kg 	

22	Installation Clearances Front Access: Rear Access: Top * Bottom * Sides: Excess length of Fibre service loops	m	
23	List of accessories provided for dressing, splicing of optical fibers and sealing of FODP		

Approach Cable

Manufacturer:
Model :

Seq.	Parameter:	Unit:	Particulars:
1	No. of Fibres Dual Window Single-Mode:	Each	
2	Fibre Manufacturer Dual Window Single-Mode:		
3	Buffer Type:		
4	Buffer Tube Diameter:	mm	
5	Buffer Tube material		
6	No. of Buffer Tubes:	Each	
7	No. of Fibres per Tube:	Each	
8	Identification/numbering of individual tubes:		
9	No. of empty tubes (If any):	Each	
10	Filling material:		
11	Filling material compliant with technical specifications?	Yes/No	
12	Strength member(s):		
13	Binding yarn/ tape:		
14	Describe Central Core Design:		
15	Outside Jacket Coating (if any)		
16	Jacket Thickness	mm	
17	Jacket non-circularity	%	
18	Cable Diameter: (nominal ± deviation)	mm	
19	Cable cross-sectional area	mm^2	
20	Rip-cord provided	Yes/No	
21	Fully Compliant with-IEC 60794-3	Yes/No	

Mechanical Properties of Approach Cable

Seq.	Parameter:	Unit:	Particulars:
22	Max. breaking load/ Ultimate Tensile Strength (UTS):	kN	
23	Fibre strain margin:	%	
24	Zero fibre strain up to load	kN	
25	Weight:	kg/km	
26	Crush strength:	kg/m^2	
27	Equivalent Modulus of elasticity:	kN/mm^2	
28	Minimum Bending Radius without micro bending:	mm	
29	Maximum Bending Radius: Short Term: Long Term (Continuous):	mm	
30	Tensile proof test (Screening) level:	kN/mm^2	
31	Maximum permissible tensile stress:	kN/mm^2	
32	Permissible CTS. tensile stress:	kN/mm^2	
33	Everyday Tensile Stress	N	
34	Torsion	twist/m	

Thermal Properties of Cable

Seq.	Parameter:	Unit:	Particulars:
35	Coefficient of linear expansion:	**Each**	
36	Coefficient of expansion Cladding: Core:		
37	Nominal operating temperature range:		

Cable Spool and Drum

Seq.	Parameter:	Unit:	Particulars:
38	Available length per spool Maximum: Nominal:	m	
39	Size of drum:	m	
40	Weight of empty drum:	kg	
41	Weight of drum with cable: spooled	kg	
42	Will drum length scheduling be practiced to match transmission line span lengths?	Yes/No	

43. Describe Drum materials

44. Describe cable end capping and protection against abrasion etc.

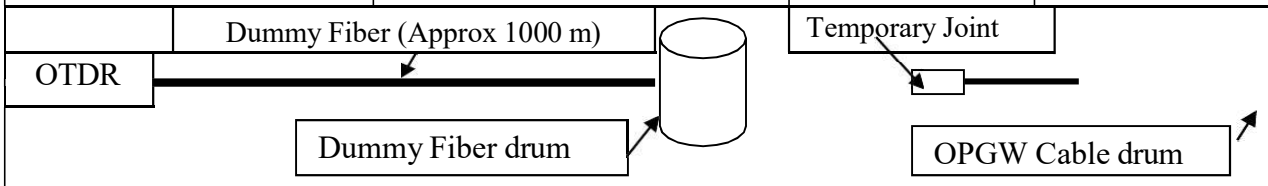
For other Items/Materials being supplied under the Package and not covered in GTP

The following items shall be described as a minimum:
1. Name of item:
2. Make & Model Number:
3. All Major Parameters:
4. Different options available and the specific option proposed to be supplied:
5. Operation Temperature range:

However, the technical brochure from the Manufacturer must be submitted along with the above GTPs in support of the various parameters. The DRS shall also include the list of suppliers for all bought out it

PRE-INSTALLATION TEST REPORT FOR OPGW & APPROACH CABLE (DRUM TEST)

Report No.	Line:		
Date:	Section:		
	Drum No:		
	Drum Length:	(As per Pre-shipment date)	
Type of OTDR:	Drum Length:	(Actual Site)	
	Wave Length	Refractive Index	Max Attenuation
Testing Date:	1310 nm		0.35 dB/Km
	1550 nm		0.21 dB/Km



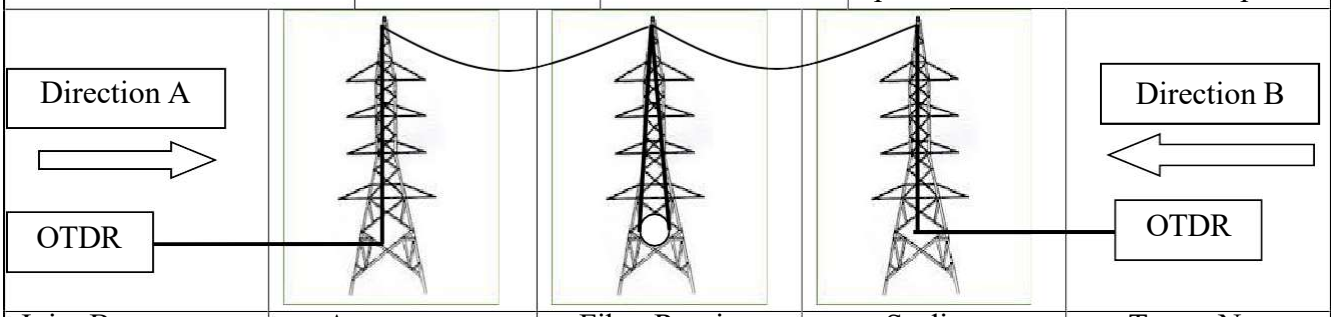
Physical Appearance of cable assembly	
Drum Marking	
Sealing of cable ends	

Tube color	Fiber No.	Fiber color	Length (Km)	Attenuation		Remarks
				1310 nm (dB/Km)	1550 nm (dB/Km)	
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
up to 48F	24					

OTDR Trace results attached for all fiber (Yes/No):		
Tested By	Witnessed By	Approved By

SPLICE TEST REPORT FOR OPGW (1310 nm)

Report No.	Line:		
Date:	Section:		
	Tower No:		
Type of OTDR:	Wave Length	Refractive Index	Acceptance criteria
	1310 nm		Max Splice loss : 0.1 dB (Individual Splice) & Average splice loss in a link 0.05 dB/Splice
Testing Date:			



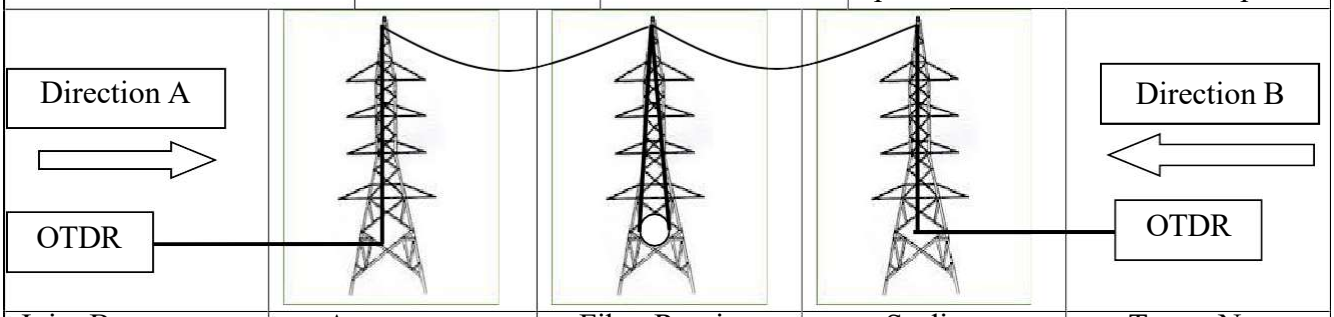
Joint Box	Appearance	Fiber Routing	Sealing	Tower No.

Tube color	Fiber No.	Fiber color	Splicing Date	Splice Loss (dB) Direction-A	Splice Loss (dB) Direction-B	Actual Loss (dB) = (A+B)/2
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
up to 48F	24					

Tested By	Witnessed By	Approved By

SPLICE TEST REPORT FOR OPGW (1550 nm)

Report No.	Line:		
Date:	Section:		
	Tower No:		
Type of OTDR:	Wave Length	Refractive Index	Acceptance criteria
	1550 nm		Max Splice loss : 0.1 dB (Individual Splice) & Average splice loss in a link 0.05 dB/Splice
Testing Date:			



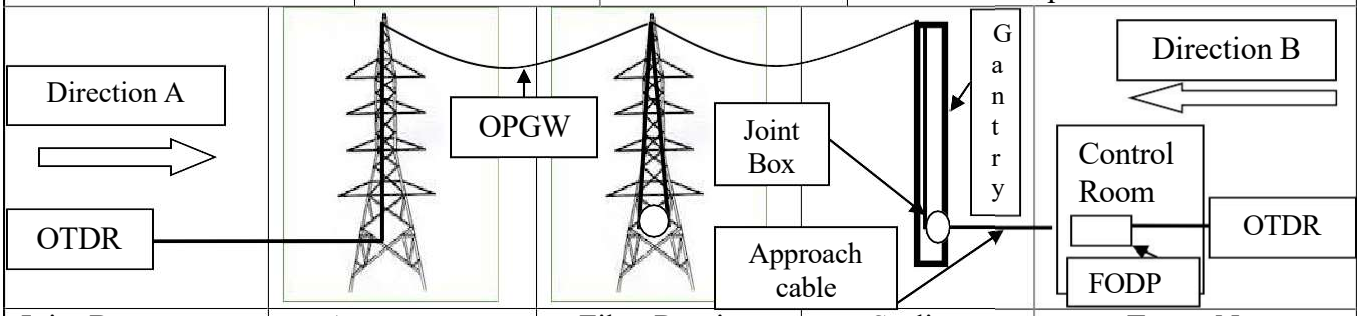
Joint Box	Appearance	Fiber Routing	Sealing	Tower No.

Tube color	Fiber No.	Fiber color	Splicing Date	Splice Loss (dB) Direction-A	Splice Loss (dB) Direction-B	Actual Loss (dB) = (A+B)/2
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
up to 48F	24					

Tested By	Witnessed By	Approved By

SPLICE TEST REPORT FOR SPLICING OPGW & APPROACH CABLE (1310 nm)

Report No.	Line:		
Date:	Section:		
	Tower No:		
Type of OTDR:	Wave Length	Refractive Index	Acceptance criteria
	1310 nm		Max Splice loss : 0.1 dB (Individual Splice) & Average splice loss in a link 0.05 dB/Splice
Testing Date:			



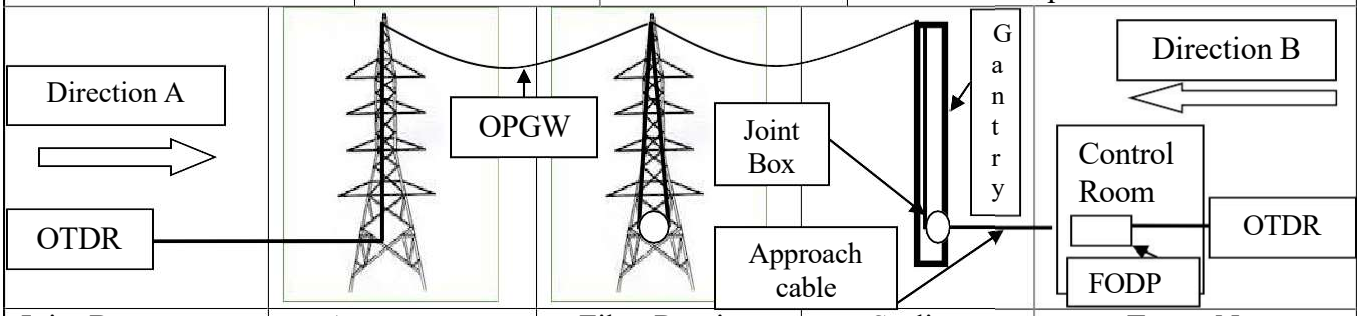
Joint Box	Appearance	Fiber Routing	Sealing	Tower No.

Tube color	Fiber No.	Fiber color	Splicing Date	Splice Loss (dB) Direction-A	Splice Loss (dB) Direction-B	Actual Loss (dB) = (A+B)/2
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
up to 48F	23					
	24					

Tested By	Witnessed By	Approved By

SPLICE TEST REPORT FOR SPLICING OPGW & APPROACH CABLE (1550 nm)

Report No.	Line:		
Date:	Section:		
	Tower No:		
Type of OTDR:	Wave Length	Refractive Index	Acceptance criteria
	1550 nm		Max Splice loss : 0.1 dB (Individual Splice) & Average splice loss in a link 0.05 dB/Splice
Testing Date:			



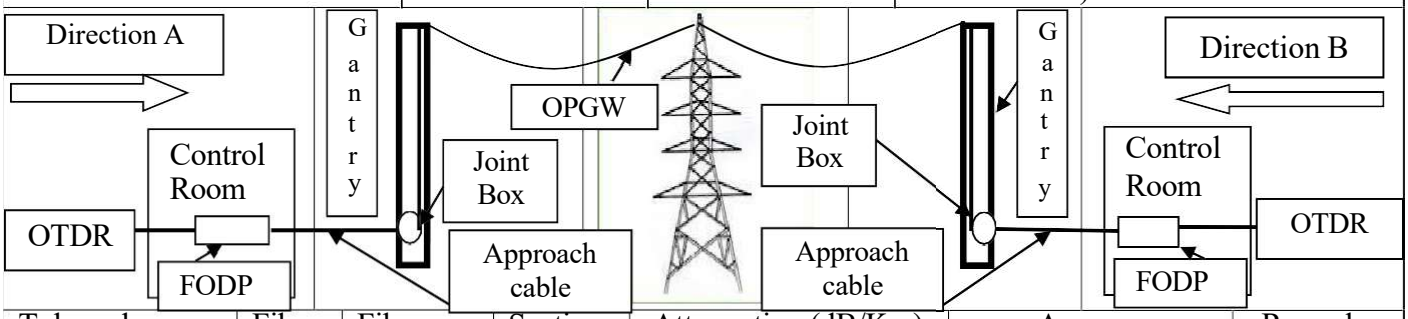
Joint Box	Appearance	Fiber Routing	Sealing	Tower No.

Tube color	Fiber No.	Fiber color	Splicing Date	Splice Loss (dB) Direction-A	Splice Loss (dB) Direction-B	Actual Loss (dB) = (A+B)/2
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
up to 48F	24					

Tested By	Witnessed By	Approved By

FO CABLE END TO END TEST USING OTDR (1310 nm)

Report No.	Line:		
Date:	Section:		FODP TO FODP
Type of OTDR:	Wave Length	Refractive Index	Max Attenuation
	1310 nm		(0.35 dB/Km X Total FO length in Km) + (0.05 dB/Splice x Total No. of Splice) + (0.5 dB/Connector x No. of connectors)
Testing Date:			



Tube color	Fiber No.	Fiber color	Section length (Km)	Attenuation (dB/Km)		Average Attenuation (dB/km) = (A+B)/2	Remarks
				Direction-A	Direction-B		
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
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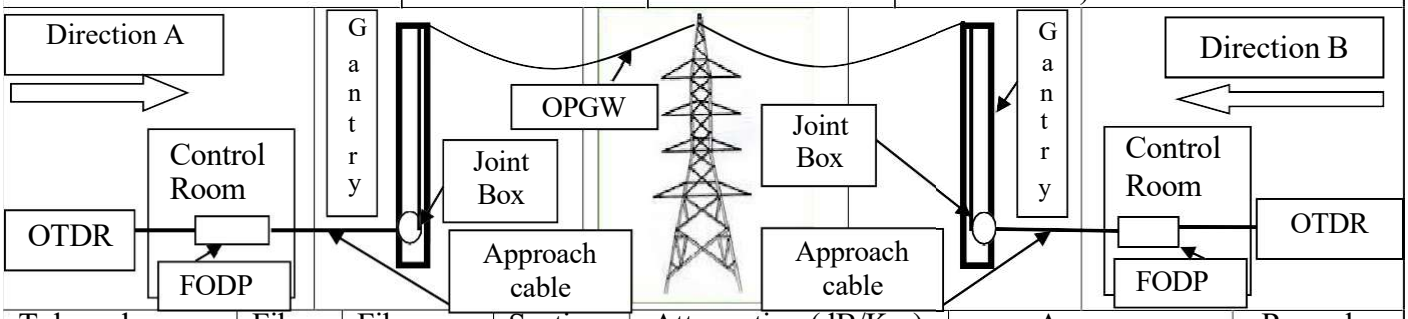
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
	23						
up to 48F	24						

OTDR trace results attached for all fiber (Yes/No) :

Tested By Witnessed By Approved By

FO CABLE END TO END TEST USING OTDR (1550 nm)

Report No.	Line:		
Date:	Section:		FODP TO FODP
Type of OTDR:	Wave Length	Refractive Index	Max Attenuation
	1550 nm		(0.21 dB/Km X Total FO length in Km) + (0.05 dB/Splice x Total No. of Splice) + (0.5 dB/Connector x No. of connectors)
Testing Date:			



Tube color	Fiber No.	Fiber color	Section length (Km)	Attenuation (dB/Km)		Average Attenuation (dB/km) = (A+B)/2	Remarks
				Direction-A	Direction-B		
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
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	11						
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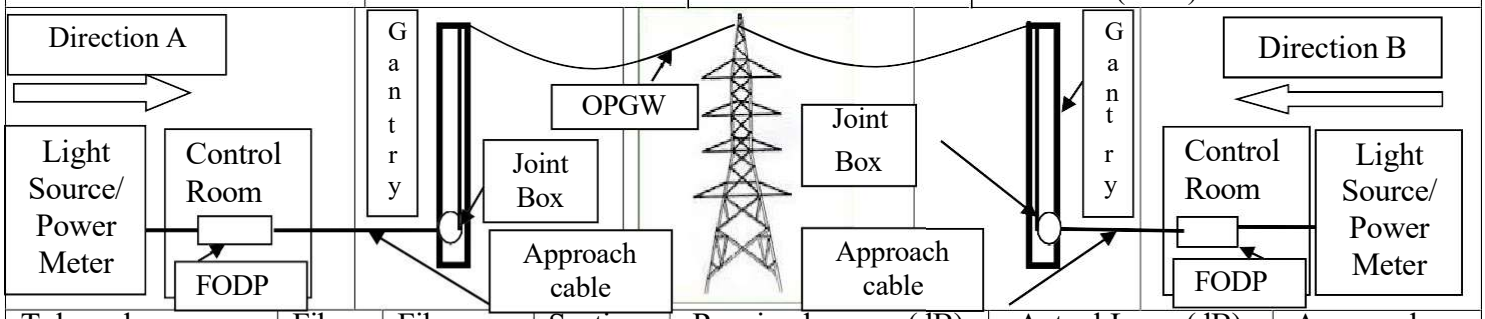
	19						
	20						
	21						
	22						
	23						
up to 48F	24						

OTDR trace results attached for all fiber (Yes/No) :

Tested By Witnessed By Approved By

FO CABLE END TO END TEST USING POWER METER (1310 nm)

Report No.	Line:	
Date:	Section:	FODP TO FODP
Wave Length	Type of Power Meter:	Reference Power = Pr (dBm):
1310 nm	Type of Light Source:	A= Power Measuring from 'A' Direction (dBm)
Testing Date:	P1 = Pr – A dBm P2 = Pr – B dBm	B= Power Measuring from 'B' Direction (dBm)



Tube color	Fiber No.	Fiber color	Section length (Km)	Received power (dB) Direction-A (P1)	Received power (dB) Direction-B (P2)	Actual Loss (dB) P= (P1+P2)/2	Average loss (dB/Km) = P/Section length
	1						
	2						
	3						
	4						
	5						
	6						
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	17						
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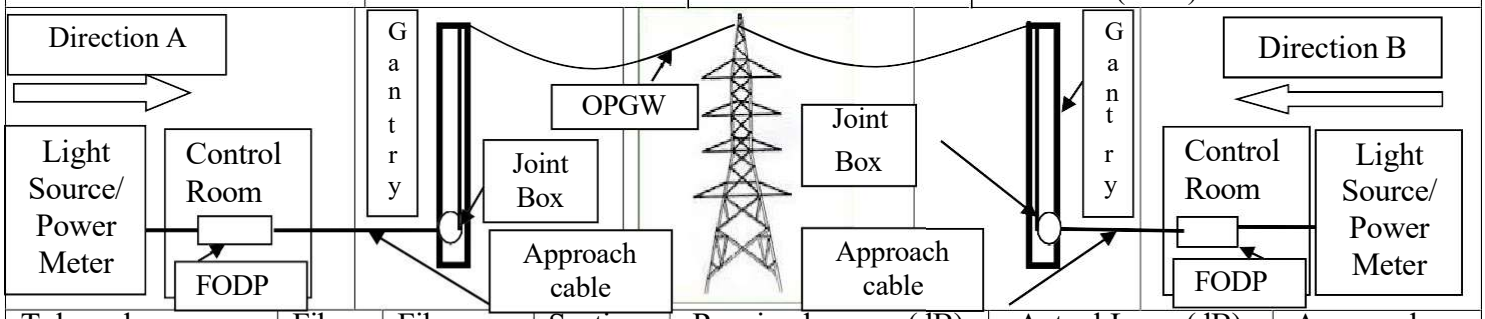
	20						
	21						
	22						
	23						
up to 48F	24						

Tested By	Witnessed By	Approved By

FO CABLE END TO END TEST USING POWER METER (1550 nm)

Report No.	Line:		
Date:	Section:		FODP TO FODP
Wave Length	Type of Power Meter:		Reference Power = Pr (dBm):
1550 nm	Type of Light Source:		A= Power Measuring from 'A' Direction (dBm)
Testing Date:	P1 = Pr – A dBm P2 = Pr – B dBm		B= Power Measuring from 'B' Direction (dBm)



Tube color	Fiber No.	Fiber color	Section length (Km)	Received power (dB) Direction-A (P1)	Received power (dB) Direction-B (P2)	Actual Loss (dB) P= (P1+P2)/2	Average loss (dB/Km) = P/Section length
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
	23						
up to 48F	24						

Tested By Witnessed By Approved By

POWER METER TEST RESULT FOR SECTION:								
Fiber No.	1310 nm			1310 nm			P=(P1 + P2) /2 (dB)	P/Section Length
	Pr (dBm)	A (dBm)	P1 (dBm)	Pr (dBm)	B (dBm)	P2 (dBm)		
1								
2								
3								
4								
5								
6								
7								
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10								
11								
12								
13								
14								
15								
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17								
18								
19								
20								
21								
22								
23								
24								
Pr = P ref. for 1310 nm is_____ dBm.								

up to 48F

POWER METER TEST RESULT FOR SECTION:								
Fiber No.	1550 nm			1550 nm			P=(P1 + P2) /2 (dB)	P/Section Length
	Pr (dBm)	A (dBm)	P1 (dBm)	Pr (dBm)	B (dBm)	P2 (dBm)		
1								
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19								
20								
21								
22								
23								
up to 48F 24								
Pr = P ref. for 1550 nm is_____ dBm.								

No. GETCO/E-TS-Steel Drum/R1 Nov-18

Technical Specifications for Steel Drum for Conductor

The scope of specification is to manufacture, fabricate, test & supply of steel drums suitable for ACSR/AL59 conductors as per IS:15976 (2013) and parameters stated here in. Drum shall be manufactured from MS steel confirming to IS:2062 (amendment up to date).

1) Drum size shall be suitable for accommodation conductor length of 2000 meters +/- 5%.
2) Drum shall be suitable for use with tension stringing equipments.
3) Flanges shall be provided such that the projection of the flanges beyond the outermost layer of conductor shall be at least 75 mm. to achieve clearance between outer surface of outer layer of conductor and inner surface of protective lagging should be not less than 75 mm.
4) Flange shall have non-corrosive primer coat & two coat of oil paint shade 631 as per IS:5 (Asian/Berger/Nerolac make). "PROPERTY OF GETCO" shall be marked on both the flanges (on cross arms) & inner side of barrel with white shade.
5) Name plate shall contain details of (a) Name & address of the manufacturer/supplier (b) Order no. (c) Year of manufacture (d) Tare weight of drum (e) Gross weight of drum (f) Serial number (g) Size of conductor (h) Length of conductor (i) Arrow marking for rewinding
6) The barrel & inner surface of flange (drum surface in contact with conductor) shall be provided with min. 2 mm. HDPE sheet & the same shall be secured with similar material rivets without making protrusions so as to not to damage the conductor. This layer shall not have any sharp edges that may damage the conductor surface.
7) Minimum requirements for the components of steel drum –

Sr. No.	Description	Zebra/Moose/ AL59(61/3.50)	Dog/Panther
a.	Corrugated sheet thickness	1.6 mm.	1.2 mm.
b.	Barrel sheet thickness	2.0 mm.	1.6 mm.
c.	Cross arm min. 4 nos. each side thickness	5 mm.	4 mm.

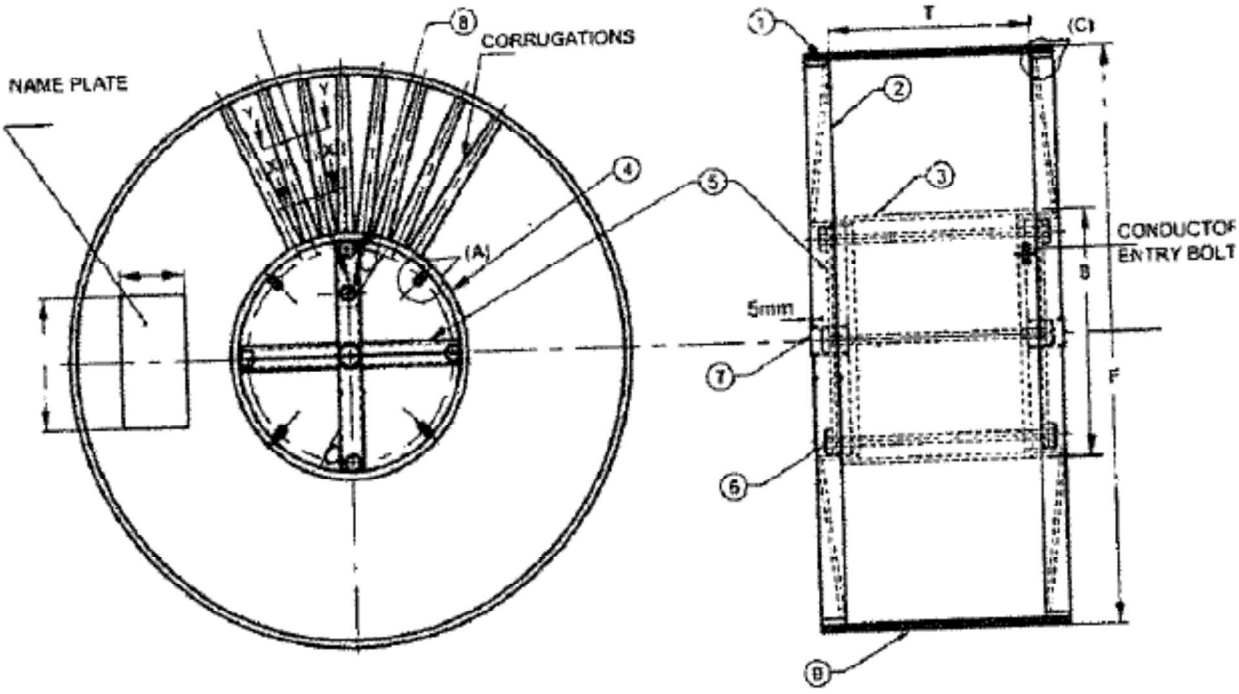
(d) Name plate size 450 mm.x200 mm.x1.6 mm. thick welded on one side of flange

(e) Center hole dia. 100 mm.

(f) Tie rods 8 nos.

(g) Drive pin hole 2 nos. on each side having dia. 65 mm.

8) Where a slot is cut in the flange to receive the inner end of the conductor, the entrance shall be in line with the periphery of the barrel. The edges of the slot shall be smooth to avoid any damage to conductor surface.
9) The outermost layer of conductor shall be covered with polypropylene sheet of appropriate thickness & secured using polymeric strap (min. 2 nos.) & sealed for full security. No wooden external laggings required. (This shall be applicable for drum supply with conductor)
10) Successful bidder have to submit detailed drawing of steel drum for approval.
11) Following Acceptance tests shall be performed
    a) Visual examination & verification of dimension – minimum 5% of drums offered.
    b) Drop test on drum – one drum – conductor loaded drum to be dropped from height of 1 meter. No damage to drum or to conductor shall be noticed & the same to be checked by rewinding of conductor. (This shall be applicable for drum supply with conductor).
    c) Drum strength - minimum 5% of drums offered – Roll down the drum three times from 1 meter height on an inclined plane of 45°. No damage/bend to flange shall be noticed.



Material and Components

Sl No.	Name of the Parts	Material Specification	Qty.
1	OUTER RING	M.S. PLATE	2
2	FLANGE	H.R. SHEET	2
3	BARREL	H.R. SHEET	
4	INNER RING	M.S. PLATE	2
5	CROSS ARM	ISMC.	4
6	TIE ROD	M.S. ROD	8
7	CENTRE BUSH	M.S. PIPE	2
8	DRIVE BUSH	M.S. PIPE	2
9	EXTERNAL LAGGING	WOODEN BATTEN	—

REFERENCE DRAWING FOR STEEL DRUM

Format-A	
Name of Line:	
Name of Circle:	
Total Location:	
Jurisdiction Wise location:	
Order Ref. No:	
OPGW and hardware accessories drawing and DRS Approval L.No.	

Sr. No.	Type of Tower Suspension-S, Tension-T, Gantry	Detail of OPGW hardware quantity to be recorded.									To be checked and verified that along with OPGW hardware, whether earth bond is connected or not from OPGW to respective tower as per approved drawing for make and type of hardware of OPGW at each tower location **(Observation to be recorded either as "Checked & provided as per approved Drg." OR "Not Provided" against respective tower location)**	Remarks
		Suspension Assembly	Single Tesnsion Assembly For Dead End Location	Double Tesnsion Assembly for Joint Box Location	Double Tesnion Assembly for Pass Through Location	Vibration damper with protection rod	Joint Box (OPGW - OPGW)	Joint Box (OPGW - Approach cable)	Surplus cable support	Downlead Clamp		

Along with above following points are also to be checked and confirmed.		**Yes/No**
1	At joint box location, where OPGW cable coming down from top, check that	
a.	Is Tension assembly properly provided ? **(Yes/No)**	
b.	Is Earth bond properly provided with one end connected with OPGW cable through PG clamp properly tightened and other end connected and tightened with tower ? **(Yes/No)**	
c.	At JB location, is the OPGW cable lay down to ground level from top of tower location, for splicing in JB, by providing down lead clamps properly and sufficient in numbers ? **(Yes/No)**	
d.	After splicing and testing, are the joint box and OPGW cable rings properly arranged in loop bracket/surplus cable supports and installed above bottom cross arm ? **(Yes/No)**	
2	Vibration Dampers, whether provided in required nos. and at place for each suspension & tension location as per approved drawing or not.	

Seal & Sign with Name & date
(Executing agency to whom order placed by GETCO)

Seal & Sign with Name & date
(Nodal Officer of respective Project, GETCO)

Seal & Sign with Name & date
(JE/DE TR/Const., GETCO)

Seal & Sign with Name & date
(SE (TR), Circle office, GETCO)