



# **FIJI ELECTRICITY AUTHORITY**

## **BIDDING DOCUMENT**

**TENDER NUMBER: MR88/2016**

**TENDER NAME: PREFERRED SUPPLIER OF OPTICAL GROUND  
WIRE (OPGW)**

## Section 1. Instructions to Bidders

1. **Scope of Bid** The Fiji Electricity Authority (hereinafter referred to as "the Employer"), wishes to receive bids for PREFERRED SUPPLIER OF OPTICAL GROUNG WIRE (OPGW), also known as Optical Fiber Composite Overhead Ground Wire, as specified in these bidding documents (hereinafter referred to as "the OPGW").
2. **Eligible Bidders** This Invitation to Bid is open to bidders who have sound technical and financial background and have relevant previous experience.  
  
Bidders shall provide such evidence of their continued eligibility satisfactory to the Employer as the Employer may reasonably request.  
  
Bidders shall not be under a declaration of ineligibility for corrupt or fraudulent practices.
3. **Eligible Materials, Equipment and Services** The OPGW to be supplied under the Contract shall have its origin from reputable companies and countries. At the Employer's request, bidders may be required to provide evidence of the origin of the raw materials and components of the OPGW.
4. **Qualification of the Bidder** To be qualified for award of Contract, bidders shall submit proposals regarding manufacturing methods, scheduling and resourcing which shall be provided in sufficient detail to confirm the bidder's capability to fulfil the supply contract.
5. **Cost of Bidding** The bidder shall bear all costs associated with the preparation and submission of its bid and the Employer will in no case be responsible or liable for those costs.
6. **Sealing, Marking and Submission of Bids** **Bidders are required to submit both Electronic copies of the Bid and hard copies of the Bid.**

### **Tender Submission - Instruction to bidders**

#### **Hard Copy Submission**

**Three (3) hard copies** of the tender bids in sealed envelope shall be deposited in the tender box located at the Supply Chain Office at the FEA Head Office, 2 Marlow Street, Suva, Fiji.

The bidder shall seal the original hardcopy of the bid comprising of both the technical proposal and the price proposal, in one envelope, and clearly mark the envelope as: "ORIGINAL - PROPOSAL". Bidders shall also provide 2 copies of the original bid and mark them as "COPY - PROPOSAL". Each copy proposal shall also be individually sealed within an envelope. The 3 envelopes comprising the Original and Copies shall be sealed within an outer envelope. All inner and outer envelopes shall bear the following marking / identification:

**Bid for Tender MR88/2016 - PREFERRED SUPPLIER OF OPTICAL GROUND WIRE (OPGW).**

**DO NOT OPEN BEFORE TENDER CLOSING DATE AND TIME.**

**All envelopes shall also indicate the name and address of the Bidder on the reverse of the**

**envelope.**

The inner and outer envelopes shall be addressed to the Employer as follows:

**TENDER MR88/2016 – PREFERRED SUPPLIER OF OPTICAL GROUND WIRE (OPGW)**

**The Secretary - Tender Committee,  
c/o Supply Chain Office,  
Fiji Electricity Authority,  
Private Mail Bag, 2 Marlow Street,  
Suva, Fiji Islands**

All postage or courier charges for delivery of Tender documents must be paid by the bidders. It is the responsibility of the bidder to pay courier charges and all other cost associated with the delivery of the hard copy of the Tender submission.

**This tender closes at 4:00pm, on Wednesday 12th of October, 2016.**

All late tenders, and inadequately marked envelopes shall be returned to the Tenderers unopened. (Bids via e-mail or fax will not be considered).

For further information or clarification on the submission of bids, please contact our Supply Chain Office on phone **(+679) 3224360** or **(+679) 9991587**

**Hard copies of the Tender bid will also be accepted after the closing date and time provided a soft copy is uploaded in the e-Tender Box and it is dispatched before the closing date and time.**

**Electronic Submission of Bids**

It is mandatory for Bidders to upload an electronic submission their bid in the **TENDER LINK** Electronic Tender Box no later than **4:00pm, on Wednesday 12<sup>th</sup> of October, 2016.**

To register your interest and tender a response, view 'Current Tenders' at: <https://www.tenderlink.com/fea>

For further information contact The Secretary Tender Committee, by e-mail [TDelairewa@fea.com.fj](mailto:TDelairewa@fea.com.fj)

Tenders received after the closing date shall not be considered.

- will not be considered.
- Lowest bid will not necessarily be accepted as successful bid.

7. **Deadline for Submission of Bids** Bids must be received by the Employer at the address specified above **4:00pm or 16:00hrs, on Wednesday 12<sup>th</sup> of October, 2016.**
- The Employer may, at its sole discretion, extend the deadline for submission of bids by issuing an addendum, in which case all rights and obligations of the Employer and the bidders previously subject to the original deadline will thereafter be subject to the deadlines extended.
8. **Late Bids** Any bid received by the Employer after the deadline for submission of bids prescribed will be rejected and returned unopened to the bidder.
9. **Modification and Withdrawal of Bids** The bidder may modify or withdraw its bid after bid submission, provided that written notice of the modification or withdrawal is received by the Employer prior to the deadline for submission of bids. The bidder's modification or withdrawal notice shall be prepared, sealed, marked and delivered, with the outer and inner envelopes additionally marked "MODIFICATION" or "WITHDRAWAL", as appropriate. A withdrawal notice may also be sent by fax but must be followed by a signed confirmation copy.
10. **Employer's Right to Accept any Bid and to Reject any or all Bids** No bid may be modified by the bidder after the deadline for submission of bids. The Employer reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids, at any time prior to award of Contract, without thereby incurring any liability to the affected bidder or bidders or any obligation to inform the affected bidder or bidders of the grounds for the Employer's action.
11. **Notification of Award** Prior to expiration of the period of bid validity prescribed by the Employer, the Employer will notify the successful bidder by fax/email, confirmed by registered letter, that its bid has been accepted. This letter (hereinafter and in the Conditions of Contract called the "Letter of Award") shall name the sum which the Employer will pay the Bidder in consideration of the execution, completion and maintenance of the Works by the Bidder as prescribed by the Contract (hereinafter and in the Conditions of Contract called "the Contract Price"). The notification of award will constitute the formation of the Contract.
- The Employer will promptly notify the other bidders that their bids have been unsuccessful.
12. **Corrupt or Fraudulent Practices** The Employer requires that the Bidder observe the highest standard of ethics during the procurement and execution of such contracts. In Pursuance of this policy, the Employer:
- (a) defines, for the purposes of this provision, the terms set forth below as follows:
- (i) "corrupt practice" means behavior on the part of officials in the public or private sectors by which they improperly and unlawfully enrich themselves and/or those close to them, or induce others to do so, by misusing the position in which they are placed, and it includes the offering, giving, receiving or

soliciting of anything of value to influence the action of any such official in the procurement process or in contract execution; and

- (ii) "fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Employer, and includes collusive practice among bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Employer of the benefits of free and open competition;
- (b) will reject a proposal for tender award if it is determined that the bidder has engaged in corrupt or fraudulent practices in competing for the contract in question.

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# Technical Specifications for Optical Ground Wire (OPGW)

## 1. Scope of Supply

**Background:** This tender is being called to establish a preferred supplier to supply the Fiji Electricity Authority with the required OPGW for the replacement of aging galvanized steel earth-wire with comparable OPGW.

**Quantity:** The initial lump sum quantity to be supplied is 50km. The minimum continuous length on each drum shall be 10km. Thereafter, the employer shall place orders for quantities as and when required as the need arises. The total anticipated quantity to be supplied is 150km.

**Duration of Supply:** The aged earth-wire replacement project duration shall span from 2016 thru 2018. It is anticipated that purchase orders for all required quantities shall be placed on or before 31<sup>st</sup> December, 2017. Consequently, the prices shall be firm and valid till 31<sup>st</sup> December, 2017. Bidders may quote prices in any reputable currency such as FJD, USD, NZD, AUD, GBP, EUR, CHF, JPY, etc. All prices shall be quoted on a CIF basis, as defined by the 8<sup>th</sup> version of INCOTERMS – 2010. All domestic customs duties and taxes shall be borne by the employer. The acceptable delivery ports shall be The Port of Lautoka or the Port of Suva in the Fiji Islands

## 2. Required OPGW Characteristics

The characteristics of optical fiber to be provided under this specification are as follows:

### 2.1 Physical Characteristics

Dual-Window Single mode (DWSM), G.652D telecommunication grade optical fibers shall be provided in the OPGW. DWSM optical fibers shall meet or exceed the performance requirements herein this document.

*Table 1 - Key Design Characteristics must meet or exceed the following performance requirements*

Nominal Cross Sectional Area	mm <sup>2</sup>	50
Nominal Overall Diameter	mm	9.75
Center – Stainless Steel Tube – No./Dia. (Nominal Outer Diameter)	mm	1/3.25
L1- Aluminum Clad Steel Wires (27%) – No./Dia.	Mm	6/3.25
Lay Direction-Outer Layer		RIGHT HAND
Ultimate Conductor Tensile Strength	kN	6000 OR MORE
Minimum Breaking Load	kN	6000 OR MORE
Electrical Resistance at 20 degrees Celsius	Ohm / km	1 ohm per km ± 2% or less
Modulus of Elasticity	kN/mm <sup>2</sup>	150 ± 5%
Coefficient of Linear Expansion	x10 <sup>-6</sup> /°C	13.2 ± 2%
Short Circuit Current Capacity (at 40 °C Ambient)	kA <sup>2</sup> s	> 16

Table 2 - Optical Data Characteristics

Optical Fiber Type	Single Mode G.652D	
Mode Field Diameter – 1310nm	μm	9.2±0.5
Mode Field Diameter – 1550nm	μm	10.4±0.8
Cladding Diameter	μm	125.0±1.0
Core-Clad Concentricity	μm	≤ 0.5
Cladding Non-Circularity	%	≤ 0.1
Coating Diameter	μm	235-250
Coating-Cladding Concentricity	μm	< 12
Attenuation Coefficient – 1310nm	dB/km	≤ 0.40
Attenuation Coefficient – 1550nm	dB/km	≤ 0.25
Cable Cut-Off Wavelength	nm	≤ 1260
Zero Dispersion Wavelength	nm	1300 – 1324
Zero Dispersion Slope	Ps/nm <sup>2</sup> .km	≤ 0.092
Minimum bending radius (without fiber damage)	mm	Bidder to Specify
Total number of Fibers required	count	36

## 2.2 OPGW Construction

The design of OPGW shall account for the varying operating and environmental conditions that the OPGW shall experience while in service. The OPGW shall meet and/or exceed all requirements of IEEE 1138-2009 Standard and all other performance requirements defined herein this document. A total of 36 fiber cores are required

## 2.3 Optical Fiber Identification

. Individual optical fibers within a fiber unit, and fiber units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme as stated below.

### Fiber 1 to Fiber 12:

Blue, Orange, Green, Brown, Slate, White, Red, Natural, Yellow, Violet, Pink, Aqua.

### Fiber 13 to Fiber 24:

Same as base color with ONE black ring mark at the regular interval of 150mm or 6 inches or less

### Fiber 25 to Fiber 36:

Same as base color with TWO black rings mark at regular interval 150mm or 6 inches or less

## 2.4 Buffer Tube

Loose tube construction shall be implemented. The individually coated optical fiber(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the OPGW. The fiber coating and buffer shall be strippable for splicing and termination. Buffer tubes shall be filled with a water-blocking gel.

## 2.5 Optical Fiber Strain

The fiber optic OPGW shall be designed such that the optical fibers experience no strain under all loading conditions. No fiber strain condition shall apply even after a 25 year OPGW creep.



The no fiber strain condition is defined as fiber strain of less than or equal to 0.05%, as determined by direct measurements through IEC/ ETSI (FOTP) specified optical reflectometry techniques.

The following information shall be provided by the bidder:

- **Maximum Working Tension (MWT)** - the maximum OPGW tension at which there is no fiber strain.
- **The OPGW strain margin** - the maximum OPGW strain at which there is no fiber strain.
- **The OPGW Maximum Allowable Tension (MAT)** - the maximum tension experienced by the OPGW under the worst case loading condition.
- **The OPGW maximum strain** - the maximum strain experienced by the OPGW under the worst case loading condition.
- **The OPGW Every Day Tension (EDT)** is defined as the maximum OPGW tension on any span under normal conditions 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 five (5) minutes at which the specimen shall not break.

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

- The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/ Strain margin of the OPGW.
- The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the OPGW strain at Max Allowable Tension (MAT) is less than or equal to the OPGW strain margin.

The Sag-tension chart indicating the maximum tension, OPGW strain and sag shall be calculated for the following conditions:

- 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

The above cases shall be considered for the spans from 100 m to maximum span length in the range of 500 m spans. The full wind load shall be considered as the design wind load and the sag-tension chart shall be submitted accordingly.

## **2.6 Filling Materials**

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

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 OPGW components it may come in contact with and shall inhibit the generation of hydrogen within the OPGW.

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 fiber coating, color coding, or encapsulate commonly used in splice enclosures, shall be dermatologically safe, non-staining and easily removable with a non-toxic cleaning solvent.

## **2.7 Marking, Packaging and Shipping**

**Drum Markings:** Each side of every reel of OPGW shall be permanently marked in a minimum of 5 cm or 2" high white lettering with the vendors' address, the Employer's destination address, OPGW part number and specification as to the type of OPGW, length, number of fibers, a unique drum number & segment no., factory inspection stamp and date.

**OPGW Drums:** All optical fiber 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 OPGW shall be sealed as to prevent the escape of filling compounds and dust & moisture ingress during shipment and handling. Spare OPGW caps shall be provided with each drum as required.

**There shall be no factory splices allowed within a continuous length of OPGW for the minimum length of 10km.** Only one continuous OPGW length shall be provided on each drum. The lengths of OPGW to be supplied on each drum shall not be less than 10km, same shall be discussed & finalized during the detailed engineering.

## **2.8 Optical Ground Wire (OPGW)**

OPGW construction shall comply with IEEE-1138. The OPGW provided shall meet both the construction and performance requirements such that the ground wire function, the optical fiber integrity and optical transmission characteristics are suitable for the intended purpose.

The composite fiber optic overhead ground wire shall be made up of buffered optical fiber units embedded in a water tight stainless steel protective central fiber optic unit surrounded by concentric-lay stranded metallic wires. The dual purpose of the composite OPGW is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fiber.

## **2.9 Central Fiber Optic Unit**

The central fiber optic unit shall be designed to house and protect multiple buffered optical fiber units from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central fiber optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibers from degradation due to vibration and galloping, wind loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen.

## **2.10 Basic Construction**

The OPGW construction shall conform to the applicable requirements of Technical Specification, applicable clauses of IEC 1089 related to stranded conductors and **Table 1, 2 and 3** OPGW Mechanical and Electrical Characteristics. In addition, the basic construction shall include bare concentric-lay-stranded metallic wires with the outer layer having left hand lay.

## **2.11 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 fiber optic unit shall not be considered a load bearing tension member when determining the total rated breaking strength of the composite conductor.

## **2.12 Electrical and Mechanical Requirements**

Table 3 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 power poles/pylons/structures. For the purposes of determining the appropriate Max Working Tension limit for the OPGW, appropriate clauses IEC/IEEE standard shall be applied and cited with the bid document. For the OPGW 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.

## **2.13 Operating Conditions**

Since OPGW shall be located at the top of the HV (132,000V or 33,000V) 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.

## **2.14 Specification Data Sheet and Type Testing Results**

The bidders are to submit with their bid a detailed data sheet of the OPGW they intend to supply.

### **3.0 Testing**

#### **3.1 Sample Test Reports**

A sample record of all factory routine tests carried out during manufacturing shall be submitted with the bid documents. Bidders shall provide all type testing details, documents and results in their bid, relevant to the product.

Following are the requirements of testing for supply of OPGW:

1. Type Testing
2. Factory Acceptance Testing

#### **3.2 Type Tests**

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

- (a) The Bidders shall submit copies of test reports and certificates for all of the Type Tests that that have previously been performed.
- (b) If no type tests have been carried out, then The Bidder shall provide a detailed schedule for performing all specified type tests. These tests shall be performed in the presence of an authorised representative of the Employer. All associated costs shall be borne by the bidder.
- (c) In case of failure during any type test, the Supplier is either required to manufacture a fresh sample lot and repeat all type tests successfully or repeat that particular type tests at least three times successfully on the samples selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

#### **3.3 Factory Acceptance Tests**

Factory acceptance tests shall be conducted on randomly selected samples of OPGW to be supplied.

OPGW shall not be shipped to the Fiji Electricity Authority until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the FEA, and the Employer has in writing agreed to the tests. Successful completion of the factory tests and the Employer approval to ship shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Employer's authorized representatives unless waived for witnessing by Employer. Factory Acceptance Testing shall be carried out to demonstrate all stipulated technical requirements in this document and those referred to in IEEE 1138-2009.

The factory acceptance test shall demonstrate the technical characteristics of the Fiber Optic in relation to this specifications and approved drawings and documents. List of factory acceptance tests for OPGW are given in Appendix A. This list of factory acceptance tests shall be supplemented by the Bidder's standard FAT testing program. The bidder prices shall factor all costs for the Factory Acceptance Testing, including all associated travel costs for two (2) engineers or representatives as nominated by the Employer.

## Appendix A

### Type testing/ Factory Acceptance Tests Requirements

Factory Acceptance Tests shall be carried out to meet and/or exceed IEEE1138-2009 and all other requirements detailed herein this document. 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 color photographed and copies of color photographs shall be included in type test report)

### Tests for Optical Fibers

S.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

### OPGW Earth Wire

Other Factory Acceptance tests to be conducted on the OPGW are listed below. 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.

S.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	IEEE 1138 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 Contractor 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 the tension/suspension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test.
5	Galloping test	IEEE 1138 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

S.NO.	Test Name	Test Description	Test Procedure	
				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 $\pm$ 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

S.NO.	Test Name	Test Description	Test Procedure
			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.



