

Insert OPGW in the passcable until OPGW touch the internal clamping or until the Central Tube (AL/Steel) is outside from the passcable of about 90 mm.
Lock the moving clamping with torque force of 12 NM, like a Figure 5.

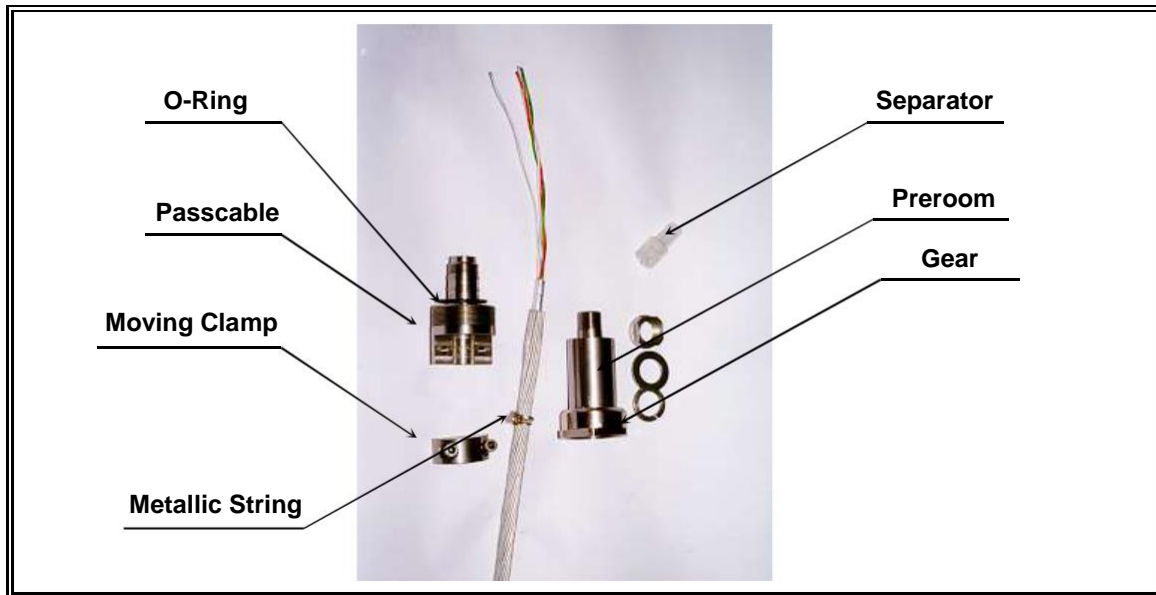


Fig. 4

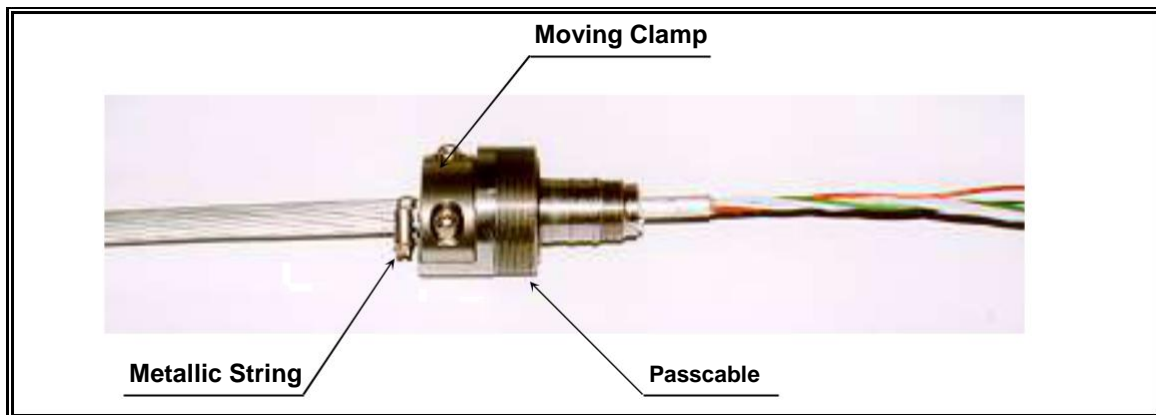


Fig. 5

d) Application of thermo-shrinkable tube

Cover the Central Tube (AL/Steel) with aluminium sheet and put the thermo-shrinkable tube with heating gun

or lamp, like a Figure 6.

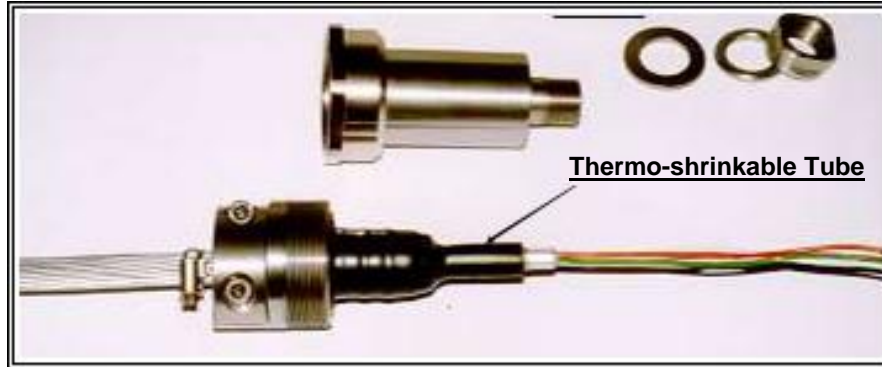


Fig. 6

e) Application of the preroom

Lock the passcable to the preroom.

Screw down the preroom to the passcable.

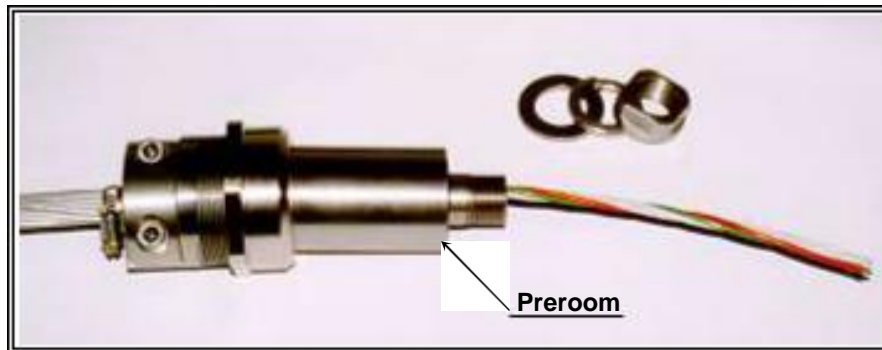


Fig. 7

f) Fixing of the preroom

Put the preroom in the hole of the splice enclosure base.

Give attention that the O-ring is in the right position and fix with the torque force of 50 NM

g) Taking out of optical units

Remove the PBT tube of optical units leaving a suitable distance (around 1m) from the edge of the AL tube.

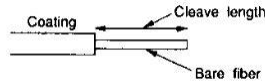
Make each optical unit into loops of about 5 to 10 cm diameter, and stick these optical unit loops at a suitable

position on the joint box with plastic adhesive tape in order to ensure that the optical unit is not damaged during splicing work.

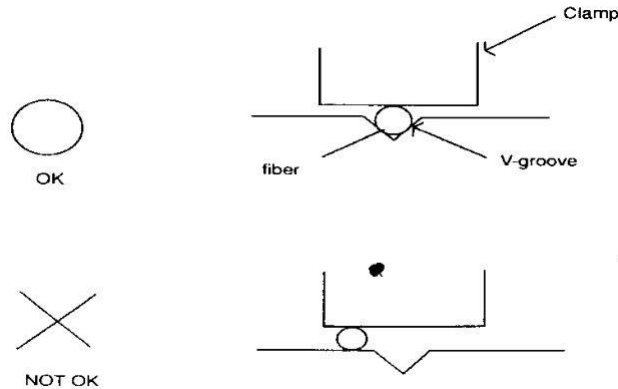
h) Splicing of optical fibers.

Cleave length

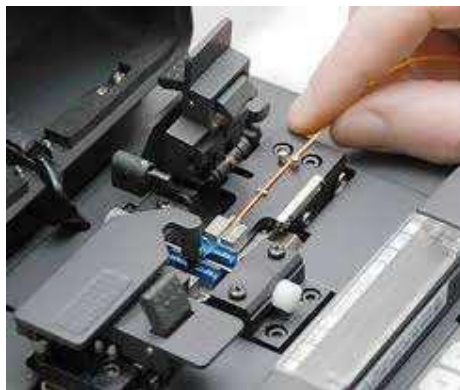
Bare fiber length should be $16\text{mm} \pm 5$ after cleaving.



Remove the fiber coating. Clean the fiber and then cleave the bare fiber to the predetermined length. Slip a protection sleeve over one of the two fibers for reinforcement after splicing. Set the prepared fiber in the v grooves as shown in the figure below.



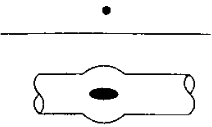

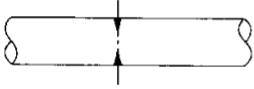
Clamp the prepared fiber exactly by pushing the clamp lever. After clamping the right and left fibers, close the hood. Make sure that the prepared fiber is not trapped by the hood, and not caught by any other part of the machine.



Evaluate the splice.

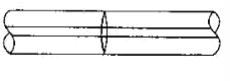
The evaluation of the splicing should be done by the splicing loss and the external appearance at the splice point.

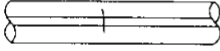


(1) Splicing having the following appearance shall be rejected.

<p>Bubble</p> 	<p>Be sure to remove this type of splice, because the splice loss can be extremely high.</p> <p>Caused by</p> <ol style="list-style-type: none"> 1. Dust on fiber end 2. Condensing 3. Bad cleaving 4. Pre-fusion time is too short. 5. Arc power is too strong.
<p>Thick black line</p> 	<p>In this case, make re-fusion by ARC Switch, and check it again. (*)</p>
<p>Black shadow</p> 	

(*) In the case where fluorine doped fiber is splicer, a black line will always appear at the splicing point, but does not cause any damage to the characteristics of the optical transmission.

(2) The following splices are acceptable, even if the external appearance at the splice point does not look good.

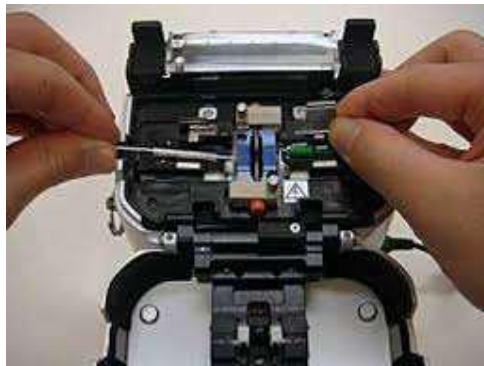
<p>White line</p> 	<p>It is all right if the estimated splice loss is within the specified value. This is due to optical causes upon observation, and there is no effect on the splice characteristics.</p>
--	--

<p>Blurred thin line</p> 	<p>Same as above</p>
	<p>Because of core alignment, this is possible for fiber with large core eccentricity.</p>
	<p>This appearance is due to differences in fiber diameter.</p>

When the spliced portion is required to be observed in detail, “FIELD CHANGE” and “FOCUS UP” and “FOCUS DOWN” SW on top mounted console panel are useful.

i) Reinforcing of spliced parts.

- (I) Open the heater cover, the left fiber clamp and right fiber clamp
- (II) Open the hood, take out the spliced portion, close the hood, and press the “RESET” SW.



- (III) Slide fiber protection sleeve over the spliced portion.

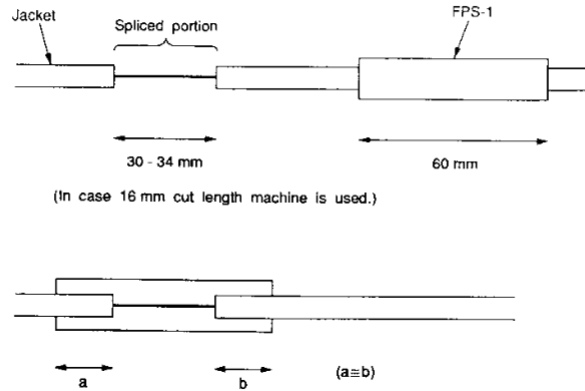


Fig. 5

Note

Make sure fiber coating is clean.

Put the sleeve over the splice as shown in Fig. 5. Don't twist the fiber.

Protection sleeve should be straight.

(IV) Apply a slight tension and place the splice in the heater, close the right hand heater clamp by pressing down with the right hand fiber.

(V) Next, close the left hand heater clamp while pulling the fiber slightly, and close the heater cover.

Note

Fiber should be straight.

Make sure that there is no dust, or jelly in the protection sleeve.

(VI) Press the "HEATER SET" SW, and the "working" indicator will light up.



Fig. 5

(VII) After the tensile proof test (a few seconds), it will take a few minutes until the fiber protection sleeve is shrunk. A buzzer will indicate the finishing of shrinking the sleeve. If the fiber breaks, or the fiber is loosely clamped or slips during the tensile proof test, the buzzer will beep intermittently. Correct the condition before proceeding.

Note 1

Both the splicer and heater can be operated simultaneously.

Note 2

The tensile proof strength can be set from 50 to 500 grams. This value is set to 200 grams normally.

(VIII) Open the heater cover and clamps.

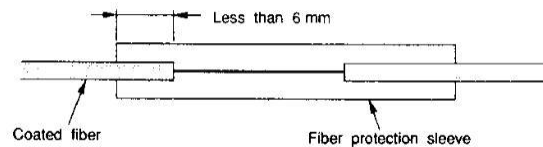
Take out the protected splice carefully while pulling the fiber slightly.

Cool the protection sleeve for a few minutes, as it is very hot just after reinforcement.

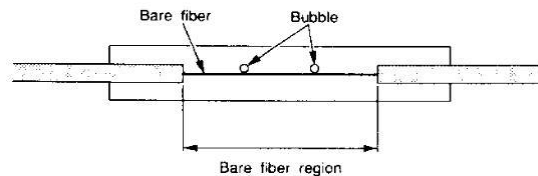
(IX) Check the appearance of the reinforced portion.

Bad protection examples

Short coverage of coated fiber.



Bubble on bare fiber.

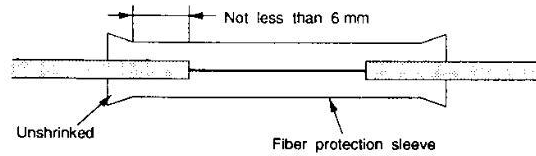


Bending bare fiber

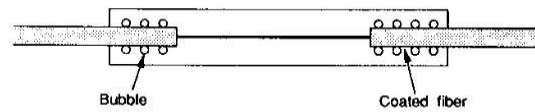


Good protection examples

Unshrink sleeve end



Bubble on coated fiber



5. Treatment of surplus length optical fibers.

Arrangement of loose tube

The loose tube should be dressed up while closing joint box so that it is protected against impact, corrosion and bend. The loop diameter of loose tube is more than 50mm.

Arrangement of optical fiber

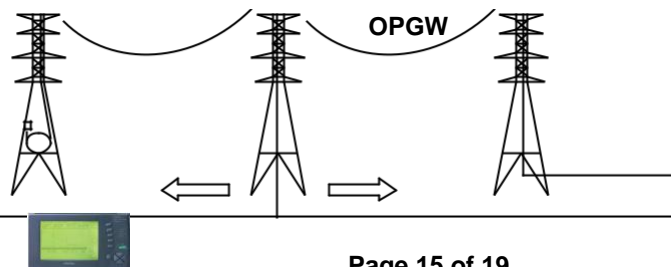
The spliced portion of optical fiber should be put in regular order in the fusion splice protector, and the extra length of optical fiber should be put on the splice tray.

The loop diameter of optical fiber is more than 50mm.

6. Measurement of splice loss: Splice loss shall be measured by

using OTDR. A. Test (Before splicing)

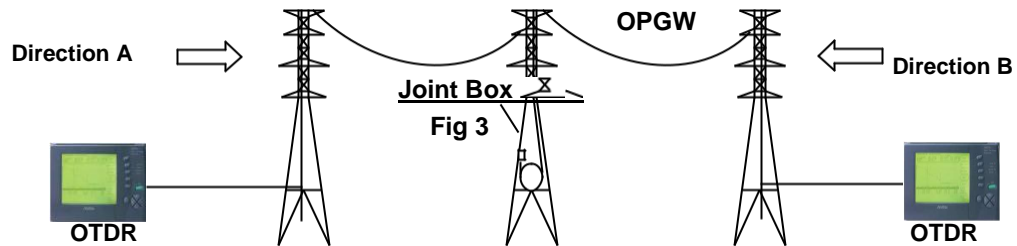
- After successfully completion of the installation, check for optical attenuation and discontinuity at every splicing points (Joint Box Locations).



- The attenuation of the fibres shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.1dB. The overall optical fibres attenuation should be less than 0.21dB/km at 1550nm and 0.35dB/km at 1310nm.

B. Splicing Test (After splicing)

- Before closing the splice enclosure, splice loss shall be measured for checking the splicing condition.



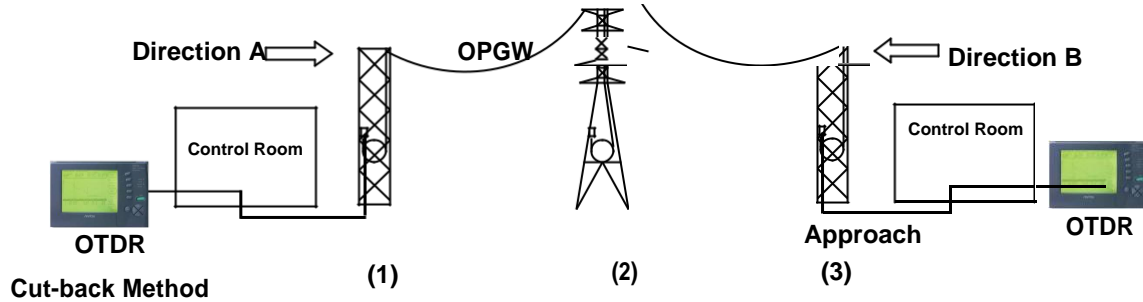
- Before closing the in-line splice enclosure, the splice test shall be executed at both sides (direction A & direction B) of jointing point.
- The average of bi-directional attenuation of fusion splices shall not be more than 0.05 dB and no single splice loss shall exceed 0.1 dB at 1550 nm.
- Appearance of splice enclosure shall have no defect,
- Splice enclosure shall have good sealing condition to prevent moisture and dust free environment, and render it waterproof.

***No point discontinuities in excess of 0.1dB**

Every effort shall be taken to minimize the splice loss during splicing so that every splice loss in the link shall lie within 0.05 dB. Maximum splice loss at any splice joint may be permitted up to 0.1 dB. However, such events shall be avoided to minimize the splice loss and total loss in the link.

C. Measurement of splicing loss.

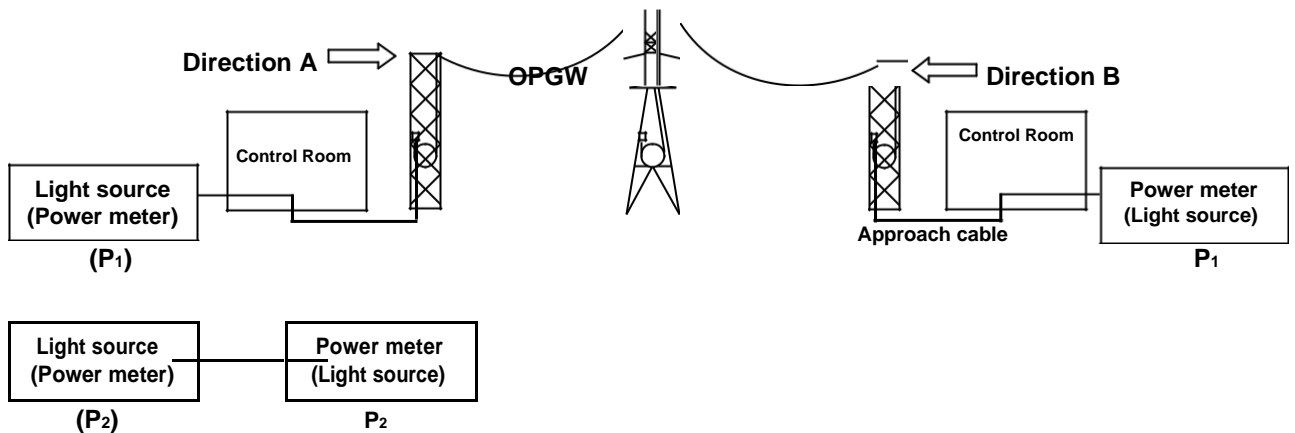
Measure the of splice loss by OTDR



$$\text{Transmission Loss (dB)} = P_2 - P_1$$

P₁ : Power measured when light source is connected to power meter with the OPGW fibre in between.

P₂ : Power measured when light source and power meter are connected to one another with reference fibre in between.



7. Fixing the joint box lid

Fix the cover to the joint box after having confirmed that nothing is left in the joint box such as tools and dusts. Lock the lid with the torque force of 10 NM.

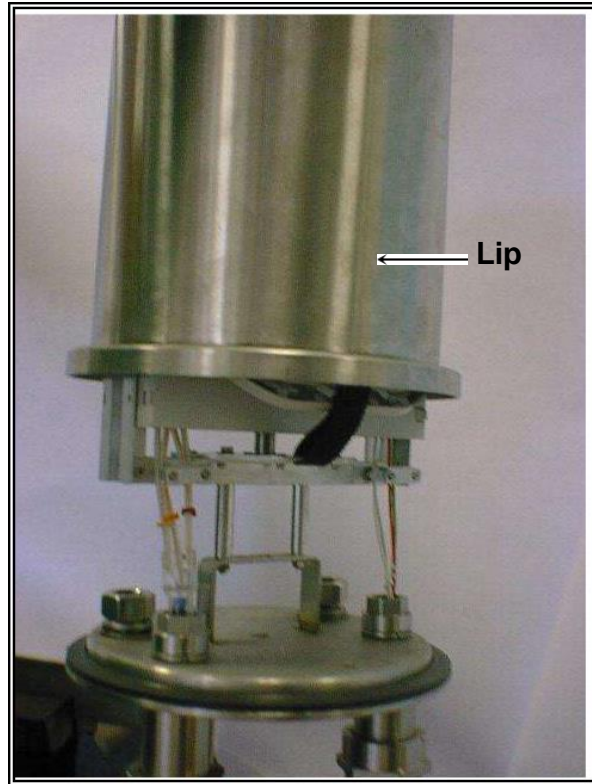
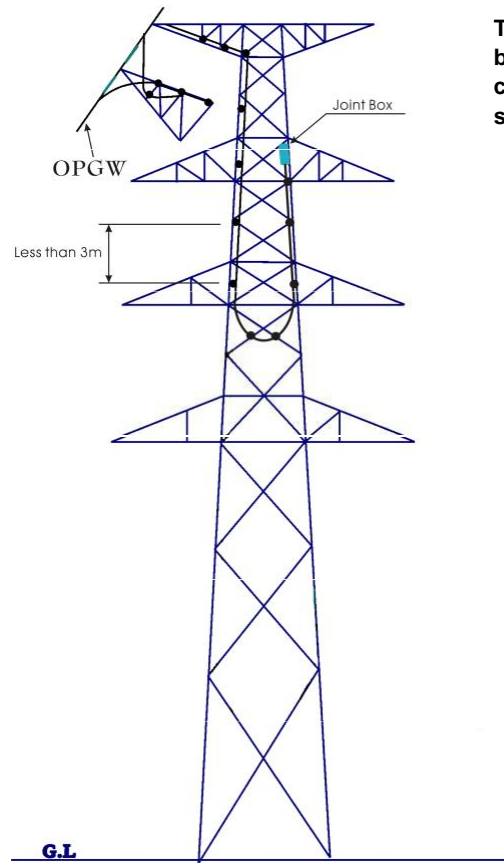


Fig. 6

8. Installation of a joint box.

SPLICING TOWER

The balanced length of OPGW should be coiled around a circle having a diameter of more than 1.5 meters after completion of jointing and firmly fixed to the tower as shown in figure.



The position of the joint box should be near the top cross-arm of the tower as shown in the figure.

Check Point

Check the status of water proof.

Fusion splice working is protection it against dirt, grit and moisture. Lift the joint box using the eye bolt of lid.

Fixing condition of joint box on the tower.

Coiling condition of sur-plus(balanced) length of OPGW

FAT Procedure for OPGW Cable

FACTORY ACCEPTANCE TEST PROCEDURE FOR OPTICAL FIBRE (ITU-T G.652D)

**APPLICABLE
STANDARD
RELEVANT STANDARDS OF
EIA/TIA 455**

Sl. No.	Test Name	Test Procedure	Acceptance Criteria
1	Attenuation Coefficient	EIA/TIA 455-78A	≤0.35dB/km (1310nm) ≤0.21dB/km (1550nm)
2	Point Discontinuities of Attenuation	EIA/TIA 455-59	≤0.1 dB
3	Attenuation at Water Peak	EIA/TIA-455-78A	≤0.34dB/km at 1383nm
4	Chromatic Dispersion	EIA/TIA 455 -168A/169A /175A	≤18 ps/(nm·km) at 1550nm
			≤3.5 ps/(nm·km) from 1288 nm to 1339nm
			≤5.3 ps/ (nm·km) from 1271nm to 1360nm
			Zero Dispersion wavelength: 1300nm – 1324nm; Zero Dispersion slope: ≤ 0.092 ps/nm ² .km
5	Core - Clad Concentricity Error	EIA/TIA 455- 176	≤0.5 μm
6	Cladding Diameter	EIA/TIA 455-176	125 ± 0.7 μm
7	Fibre Tensile Proof Testing	EIA/TIA 455-31B	≥1.0%, 1 sec. ≥ 0.69 Gpa (100kpsi)

Note: The test report of the above tests for the fibres are to be carried out by the Fibre Manufacturer and used in the OPGW shall be shown to the inspector during OPGW FAT and shall be submitted along with the OPGW FAT reports.

FAT Procedure for OPGW Cable

**FACTORY ACCEPTANCE TEST PROCEDURE FOR OPGW
CABLES APPLICABLE STANDARD
IEEE 1138 : 2021 / IEC 60794**

Sl. No	Factory Acceptance Test on Manufactured OPGW Cable	Sampling Plan
1	Attenuation Coefficient (1310nm, 1550nm)	10% of offered OPGW drums/Lot and 100% of fibres in selected OPGW Cable drums(Minimum 2 drums).
2	Point Discontinuities of attenuation	10% of offered OPGW drums/Lot and 100% of fibres in selected OPGW Cable drums(Minimum 2 drums).
3	Visual Material verification and dimensional checks as per approved drawings	Quantity Verification: 100% of offered material.
4	Ultimate Tensile Strength	1 Sample from the selected OPGW drums/Lot.
5	Lay Length Measurements	10% of offered OPGW drums/Lot(Minimum 2 drums).

FAT Procedure for OPGW Cable

1. Attenuation Coefficient (1310nm, 1550nm)
2. Point Discontinuities of attenuation

Test Standard : IEC 60793-1-40, EIA/TIA-455-59 & EIA/T1A-455-61 and ITU-T G.652 D

Test Location :

Test Objective : To measure the optical attenuation at wavelengths 1310 nm and 1550 nm & Point discontinuities at both wavelength of 1310 nm and 1550nm.

Test Set-ups:

Prepare the sample under test as per the figure showing below the test setup. The test bench is connected with Optical Time Domain Reflectometer (OTDR) to measure the value of attenuation coefficient and Point discontinuities

Test Procedure:

1. Connect the test sample either to the instrument or to one end of end dead-zone fiber (if used).
Connect the other end of the dead-zone fiber (if used) to the instrument.
2. If the accurate locations of point defects are to be recorded, the effective group delay index of the test sample is required. If this value is not known, use FOTP-60 (Method A) to determine it.
3. Enter OTDR parameters such as source wavelength, pulse duration, length range, and signal averaging into the instrument, along with the test sample effective group index. The values of some of these parameters may be present in the instrument.
4. Adjust the instrument to display a backscatter signal from the test sample. It may be advantageous to begin with coarse vertical and horizontal scaling to maximize the length displayed. An example is given in Figure.
5. Examine the OTDR signal along the test sample for point defects. If increased resolution is needed, adjust the graphical display, if possible, to expand the section of interest to larger scale (exercising care to assure that proper reading of the true signal can still be distinguished from the noise points).
6. To determine that a point defect (rather than an attenuation non-uniformity situation) exist observe the area in question using two different pulse durations. If the shape of the loss or gain changes with the pulse duration, the anomaly is a point defect. If the shape does not change, the anomaly shall be considered to be attenuation non-uniformity to be measured by **FOTP-61**.
7. Report any point defect deviations which exceed the values specified in the Detail Specification. Describe the nature of these faults (e.g. apparent loss or gain, reflection, duration, etc.) as required by the Detail Specification.
 - 7.1 Determine the defect location, if required, by placing a cursor at the beginning (or at another point specified by the OTDR manufacturer) of a power rise or drop, this may be difficult to do at a drop. Obtain the distance coordinate via the alphanumeric display.
 - 7.2 Obtain the apparent loss or gain of the defect, if required, by the method described by the OTDR manufacturer. Some instruments required placement of a pair of cursors on each

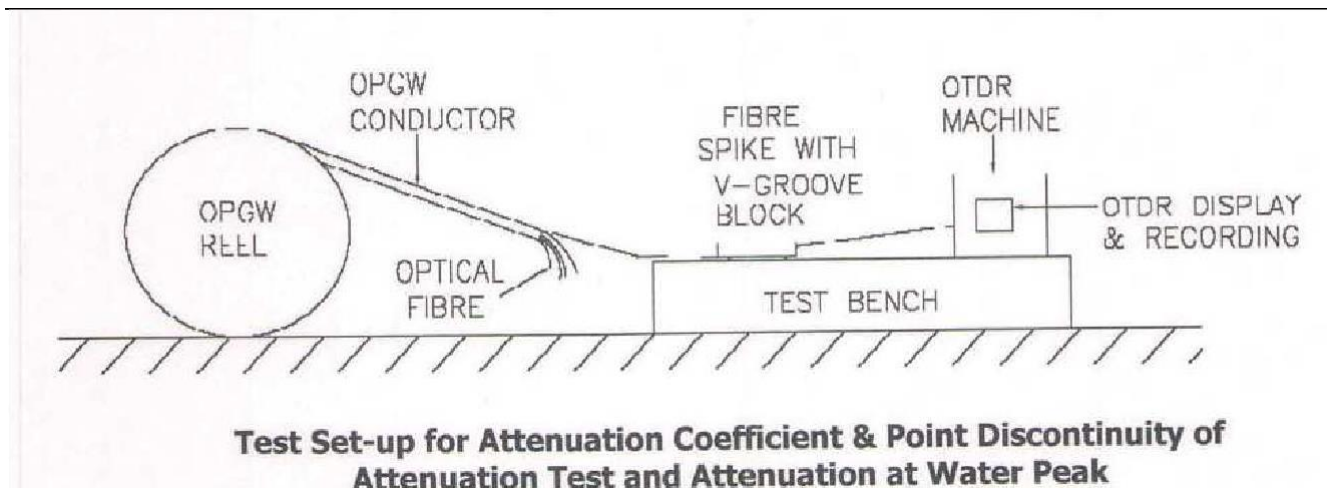
FAT Procedure for OPGW Cable

side of the defect. The two best-fit straight lines (from a two-point or least-squares fit for each) are extrapolated to the defect location. If available, the linear fit method should be chosen. The vertical separation of the lines gives the apparent loss or gain. Note any reflection peak.

7.3 When possible, repeat the test for a single launched into the test sample in the opposite direction. A more accurate loss estimate (and the elimination of apparent gain) is made by averaging

readings taken directionally at the same wavelength. This eliminates the effect of any backscatter different for the fiber sections on both side of the defect.

7.4 Repeat the test at another wavelength.



Acceptance Criteria:

For Attenuation

Wavelength	Attenuation
1310 nm	< 0.35 dB/Km
1550 nm	<0.21 dB/Km

For Point Discontinuity: Attenuation of fiber shall be uniform throughout its length such that there are no point discontinuity in excess of 0.1dB.

FAT Procedure for OPGW Cable

ATTENUATION AND POINT DISCONTINUITY

Ring Mark	Fiber id	At 1310 nm				Ring Mark	At 1550 nm				
		Optical Attenuation	Point Discontinuity	Pass or Fail	Remarks		Optical Attenuation	Point Discontinuity	Pass or Fail	Remarks	

Observations, if any:

Test Results:

The attenuation and point discontinuity measured have met/not met the acceptance criteria.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW Cable

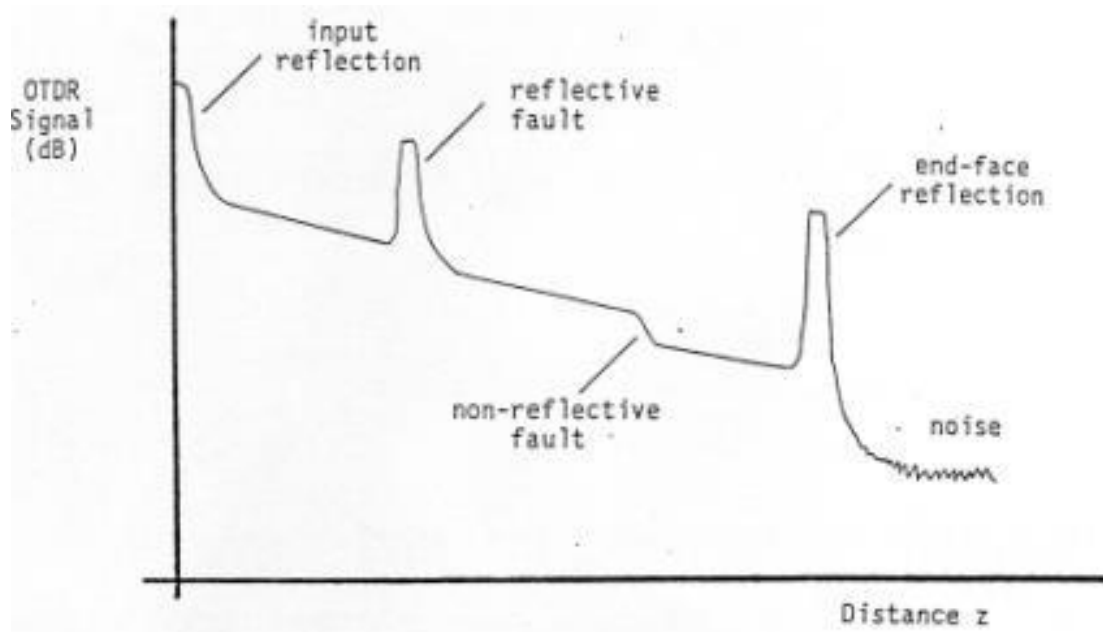


Figure 1. Schematic of an OTDR Trace. Point defects with apparent loss are shown, one reflective and one non-reflective.

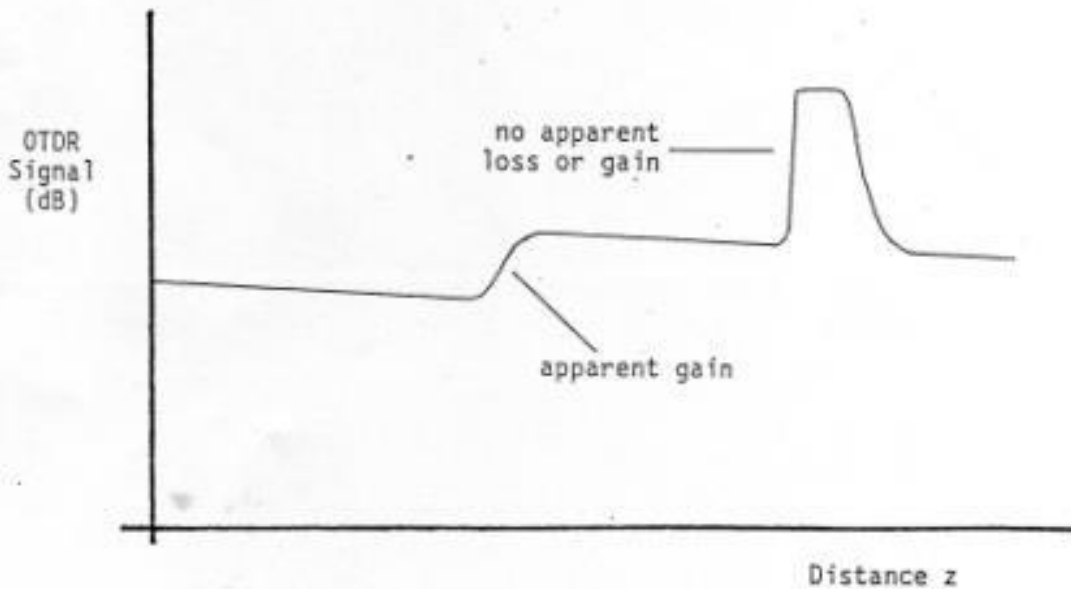


Figure 2. Schematic of an expanded OTDR trace. Two point defects are shown, one with apparent gain, and another with no apparent loss or gain.

FAT Procedure for OPGW Cable

3. VISUAL MATERIAL VERIFICATION AND DIMENSION CHECK & GENERAL TESTS

Standard: IEEE-1138:2021, IEC 61089, IEC 61232 & MFR's Technical Specification

Test Location:

Cable Type: OPGW

Reference Document Approved DRS & Drawings of OPGW.

Test Procedure:

1. Physical Verification for the 100% offered quantity of the offered reels/drums shall be carried out.
2. 100% physical verification of sealing of cable ends with end caps, check for provision of spare cable caps for each drum.
 3. 100% verification of Sealing/Pasting the drum details over the end cap with transparent tape.
4. Verification of drum details properly printed and pasted on each drum suitably as per approved document.
5. Measure the overall diameter at the outside end of the complete OPGW on 10% of offered reels/drums using Caliper/Micrometer of high accuracy.
6. The diameter recorded is the average of two readings, rounded to two decimals of millimeter, taken at right angles to each other at the same location.
7. The verification of the external aspect is made by checking appearance and finish of the completed OPGW. The sequence of the metallic wires/ACS strands and the Aluminium Tubes shall be in accordance with the approved DRS & Drawings.
8. The metallic wires are removed and the diameter of each wire is measured with a micrometer using the same method as referred at point no. 5.
9. The metallic wires are individually examined by eye. All the wires shall be free from imperfections such as fissures, roughness, grooves and inclusions.
10. The Aluminium Tubes are examined by eye. All Aluminium Tubes shall be free from corroding substances, pinholes, cracks, scratches, indentations and other surface imperfections. The inner & outer diameter of each Aluminium Tube is measured with a micrometer using the same method as referred at point no. 5.

Acceptance Criteria:

Acceptance criteria shall be as per Table Test No.5 for the offered OPGW cable.

FAT Procedure for OPGW Cable

Test Results: Visual Verification, Dimensional Checks & other requirements including physical parameters/values of complete OPGW cable, Metallic wires, ACS strands, Aluminium tube and complete optical unit measured/observed have met/not met the acceptance criteria.

Test Summary: The following tests are to be checked and verified under Visual Verification, Dimensional Check Tests and General tests on OPGW Cable.

Table Test-5

Visual Verification, Dimensional & General Tests	Acceptance Criteria
A. Aluminium Clad Steel Strands/Wires:	
1. Appearance	Circular
2. Diameter of each Strand	AS PER APPROVED Cat-1 DRS
3. Elongation at Fracture	AS PER APPROVED Cat-1 DRS
4. No. of ACS Strands	AS PER APPROVED Cat-1 DRS
5. Thickness of Al coating / % IACS	AS PER APPROVED Cat-1 DRS
6. Twist Test (for ACS Strand)	AS PER APPROVED Cat-1 DRS
7. Tensile Strength	AS PER APPROVED Cat-1 DRS
8. Resistance	AS PER APPROVED Cat-1 DRS
B. Complete OPGW Cable:	
1. Appearance	Circular
2. OPGW Cable Construction	AS PER APPROVED Cat-1 DRS
3. Overall cable diameter	AS PER APPROVED Cat-1 DRS
4. Pitch ratio (length (mm)/diameter (mm))	AS PER APPROVED Cat-1 DRS
5. Weight of OPGW Cable	AS PER APPROVED Cat-1 DRS
6. Attenuation Coefficient at 1310nm and 1550nm	AS PER APPROVED Cat-1 DRS
7. Rated Tensile Strength/UTS	AS PER APPROVED Cat-1 DRS
C. General Tests on Optical Unit:	
1. Total no. of fibres, No. of fibres per buffer tube & Color coding of optical fibres in each Tube	AS PER APPROVED Cat-1 DRS
2. No. of Buffer tubes, Color of Buffer tubes, Buffer tube Material	AS PER APPROVED Cat-1 DRS
3. Aluminium tube (Outer and Inner diameter)	AS PER APPROVED Cat-1 DRS
4. Binding Yarn/Tape (Thermal barrier)	AS PER APPROVED Cat-1 DRS
5. Filling Material	AS PER APPROVED Cat-1 DRS
6. Strengthening Member (FRP)	AS PER APPROVED Cat-1 DRS



FAT Procedure for OPGW Cable

Note: Elongation at Fracture, Thickness of Al coating; Twist Test will be carried out only once.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW Cable

4. ULTIMATE TENSILE STRENGTH TEST

Test Standard	:	IEEE 1138:2021
Test Location	:	
Cable Type	:	OPGW
Objective	:	To verify the actual (ultimate) tensile strength of the OPGW meets or exceeds the UTS of the OPGW.

Test Set-up:

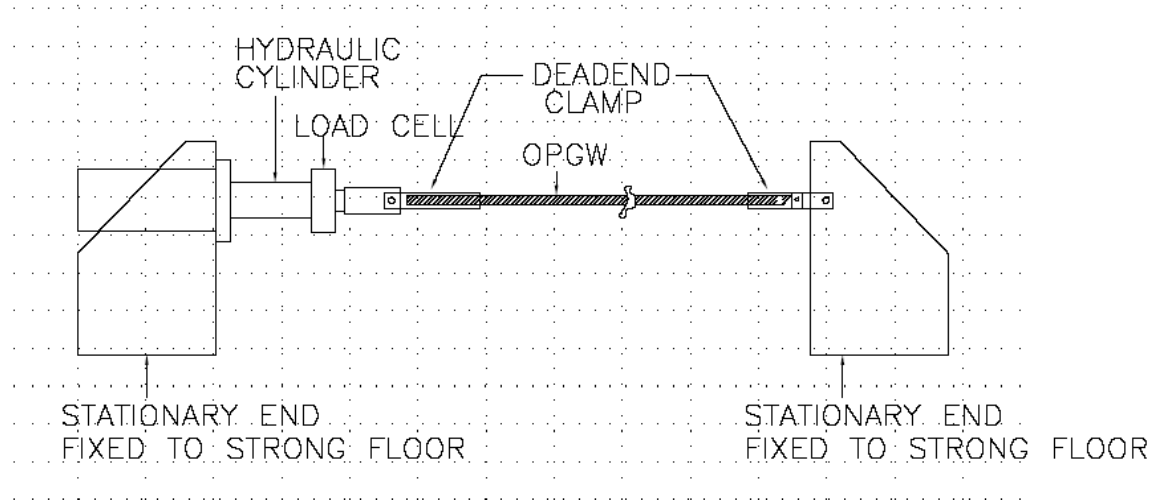
The OPGW sample shall be installed in a suitable tensile test machine. The length of the cable between the loading points of the tensile machine to be minimum 10m. Pre-tension at 2% UTS a suitable transducer

such as a load cell or dynamometer shall be used to measure the tension in the cable as per figure.

Test Procedure:

1. A tension is applied to the OPGW conductor until failure of the conductor occurs. The sample cable length is 10 mtrs minimum between the dead end clamps. Pre-tension the sample to 2% UTS of OPGW.
2. The load shall be applied at a uniform rate such that the time to reach UTS of the cable is at least 5 minutes and then hold for one(1) minute at 100% UTS. Record the continue plot/graph for applied force vs elongation/displacement/time. The observations of UTS test should meet or exceed the 100% UTS of the OPGW mentioned in DRS.
3. The ultimate tensile strength of the cable shall be defined as the maximum load the cable can withstand before failure. Individual strand failures do not necessarily constitute cable failure. However, no outer layer strands shall fail below 100% of the cable UTS. This is to ensure that the outer strands will not unravel below the maximum design loading conditions

FAT Procedure for OPGW Cable



Acceptance Criteria:

The OPGW should with stand not less than 100% of the UTS without failure of any outer strands or any component of OPGW for a period of at least one minute holdup at 100% UTS.

Observations, if any:

Test Results:

The OPGW withstood/did not with stand not less than 100% of the ultimate tensile strength without failure of any outer strands or any components of OPGW for a period of at least one minute holdup at 100% UTS.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW Cable

5. LAY LENGTH MEASUREMENT

Test Standard : TEC/GR/TX/OFC-021/01/SEP-11
Test Location :
Cable Type : OPGW

Test Set-up: See figure- 3.

Lay length measurement shall be made on a Straight length of OPGW cable while under tension load.

Test Procedure:

1. Measurements are taken at stranding operations between the closing die and capstan reel.
2. Take a piece of paper (onion skin quality) which is a length greater than three times the maximum lay length specified for the OPGW under measurement.
3. Lay the paper over the OPGW and run a lead pencil over the length of the paper to obtain strand marks on the tracing paper.
4. The lay length is determined by measuring the strand marks for N strands of the OPGW cable (N number of strands in layer).
5. Repeat for total of three measurements and average the measurements to determine lay length.

Acceptance Criteria:

Cable Type	Lay Length
OPGW	10 to 16 * OPGW outside Diameter

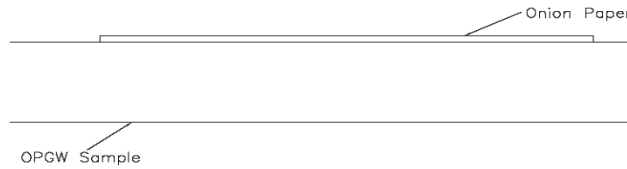


Figure 3 – TEST SET-UP for Lay Length Measurement Test

Test Results:

The lay length measurement for OPGW cable shall be between 10 to 16 times OPGW outside diameter.



FAT Procedure for OPGW Cable

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

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- Reference Documents:**
- 1) Approved DRS & Drawings in Category-I
 - 2) Applicable Standards - IEC 61284, 1997

SAMPLE SIZE AND CRITERIA FOR CONFORMITY as per IS:2486

1. SAMPLING

1.1 LOT

All fittings of same type and design manufactured under similar conditions of production, offered for acceptance. A Lot may consist of the whole or part of the quantity offered for FAT.

1.2

The number of fittings to be selected at random from the lot shall be in accordance with column I and col II of Table 1. If required {Point no. 2 Conformity) additional fittings as given in col III of Table 1 shall also be selected at random. In order to ensure the randomness of selection, random number tables shall be used (see IS 4905 : 1968).

2. CONFORMITY

Each of the fittings selected in the first stage in accordance with column I and column II of Table 1 shall be subjected to all acceptance tests. A fitting shall be declared defective if it fails in any of these tests. The lot shall be, considered as conforming to the requirements of acceptance tests if the number of defectives, in the sample is less than or equal to corresponding acceptance number (see column IV). The lot shall be rejected if the number of defectives is equal to or greater than first rejection, 'R1' (see column V). If the number of defective fittings are in between 'A' and 'R1', a second sample of same size (see column III) shall be selected from the lot at random and subjected to the tests. If the number of defectives in the two samples combined is less than 'R2' (see column VI), the lot shall be considered as conforming to the requirements of acceptance tests, otherwise the lot shall be rejected.

Table 1: Sampling Procedure (IS 2486)

S.No.	Lot Size	Sample Size		A	R1	R2
		I – Stage	II - Stage			
	(I)	(II)	(III)	(IV)	(V)	(VI)
1.	101 to 500	5	5	0	2	2
2.	501 to 1000	8	8	0	2	2
3.	1001 to 3000	13	13	0	2	2
4.	3001 to 10000	20	20	0	3	4
5.	10001 to 35000	32	32	1	4	5
6.	35001 and above	50	50	2	5	7

**VISUAL MATERIAL VERIFICATION AND DIMENSIONAL CHECKS
FOR HARDWARE FITTINGS OF OPGW CABLE
(Suspension Assembly, All types of Tension Assemblies & Downlead Assembly)**

Document : IEC 61284:1997, Approved DRS & Drawings

Manufacturer :

Test Location :

Test Sample : 100% of Quantity

- Suspension Assembly
- All types of Tension Assemblies- Dead End; Pass through; Splicing Location & Tension Assembly for Suspension Tower
- Parallel Groove clamp & Earth Lead Assembly/Grounding wire
- Vibration Dampers
- Downlead clamp Assembly

Objective : This test determines the factory acceptance of the batch quantity of fittings that they confirm to the relevant drawings and where appropriate/ have a sufficient galvanized coating.

Test Procedure:

1. Physical/Visual Verification for the part no. of all the materials as per approved DRS& drawings.
2. It shall be verified that the sample are in accordance with their relevant drawings, particularly as regards any dimensions to which special tolerance apply and indicated in the corresponding approved DRS/Drawings.
3. The following tolerance shall be allowed/on all dimensions to which special tolerance do not apply.

Appearance: To check all and ascertain to be appropriate as per DRS & Drawings.

Dimensions: (A) Forgings:

- i) Dimensions up to and including 30mm ± 1.5 mm.
- ii) Dimensions greater than 30 mm..... $\pm 5\%$ upto max. of ± 5 mm.

(B) Helical Fittings:

- i) Dimensions up to and including 30mm ± 1.5 mm.
- ii) Dimensions greater than 30 mm..... $\pm 5\%$ upto max. of ± 5 mm.

Galvanizing: i) Galvanized coatings shall be tested in accordance with as appropriate.

ii) All measurements shall be made after galvanizing where galvanizing is the normal finish. Galvanized coatings shall be tested and galvanized coating shall be minimum 85 μ m.

Acceptance Criteria:

Fittings shall be accordance with their relevant drawings within the tolerance Specified.
Galvanized coatings on general articles shall be minimum thickness of 85 μ m.

Observation, if any;

Test Results: The Hardware fittings, as tested met / did not meet the requirement as per approved DRS & Drawings.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

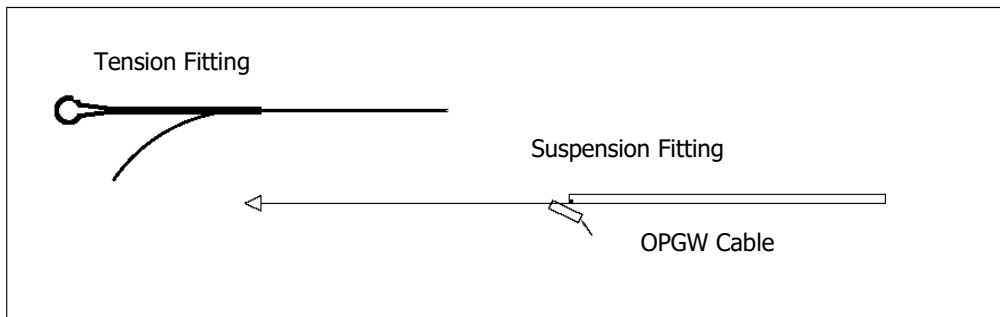
CLAMP SLIP STRENGTH TEST FOR SUSPENSION ASSEMBLY

Test location	:	
Manufacturer	:	
Test Standard	:	Overhead lines. Requirements and Test for fittings, IEC 61284 11.4.2 (method A) Slip Test on standard dampers with a specified minimum and maximum slip load and Manufacturer's Technical Specification.
Test Sample	:	OPGW Cable Suspension Assembly

} As per approved DRS/Drawings

Objective: To simulate a differential load on the Suspension clamp assembly and prove that the load at which the cable slips through, is within the specified minimum and maximum slip load.

Test Set-up: The below figure shows the schematic of the test configuration. The OPGW used for this test shall be type approved by Power Grid.



Paint/Red marking should be applied to the assembly to assist in the visual inspection of relative movement.

The OPGW is assembled between the extremities of the hydraulic ram and subject to a tension load of 20% of the Ultimate Tensile Strength.

All Suspension Clamp and their associated components shall be identified against the relevant drawing and be uniquely marked for any future identification.

All results shall be automatically recorded on a plotter using 200mm horizontal Position scale and a 20kN vertical Load scale.

The following dimensions shall be recorded before the start of each test using a diameter tape or other suitable means:

- a. Cable diameter at the center position of initial Clamp placement.
- b. Protection Splice diameter at the center position of initial Clamp placement.

Assemble the Suspension Clamp on the OPGW using the Installation Instructions as a strict guide to ensure that the assembly is correctly fitted and is the same that will be carried out during actual installation.

Reduce the load applied to the OPGW to zero and detach the OPGW from the fixed end of the tension machine. Attach the Clamp to the fixed extremity mounting and secure with the approved bolt and nut, which must run down finger tight only to clear the split pin hole.

Test procedure:

1. A graph of Load (kN) and position(mm) shall be plotted.
2. The OPGW is loaded 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 Reinforcement rods, Armour rods and Suspension clamp were marked. The relative positions of the helical armour rods and associated reinforcing rods at each end were marked and also 2mm relative position between clamp body and armour rods was marked on one side.
3. The load is increased to the minimum slip window of 12 KN(Check for Minimum Slip Strength value for fitting in DRS) at a rate of 3 KN per minute and held constant for 60 seconds. At the end of this one minute, the relative displacement between clamp body and the armour rods will be observed. If the slippage is 2mm or above, the test shall be terminated . Otherwise at the end of the position of the clamp body and 2mm relative position between clamp body and armour rods are marked on the other side.
4. After 1 minute, pause, the load is further increased at a rate of 3 KN per minute until either the relative position between clamp body and armour rods reaches more than 2mm or the load reaches the maximum slip load of 17 KN(Check for Maximum Slip Strength value for fitting in DRS). Visual examination of all paint marks is recorded, and a measurement of any displacement recorded in the table of results.

On completion of the test, a graph of 'Load' (KN) against 'Position' (mm) shall be produced. This graph shall forms the test record and will be examined to ascertain the point that slip has occurred.

Acceptance Criteria:

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

1. No slippage* shall occur at or below the specified slip load of 12 KN(check Minimum Slip Strength value for fitting in DRS).
2. Slippage shall occur between the specified min. and maximum slip load of 12-17 KN (or as per Minimum & Maximum Slip strength value in DRS).
3. There shall be no slippage of the reinforcing rods over the cable, and no slippage of the armour rods over the reinforcing rods.

4. The relative movement (i.e. more than 2 mm between armour rods and clamp body) between minimum slip strength (as per DRS), 12 KN and maximum slip strength (as per DRS), 17 KN shall be considered as slip.

5. The armour rods shall not be displaced from their original lay or damaged ** .

*Definition of no slippage as defined in IEC 61284: 1997. Any relative movement less than 2mm is accepted. The possible couplings or elongations produced by the cable as the result of the test itself are not regarded as slippage.

** 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 shall constitute a failure.

For each sample tested there shall be Graphical records of Slip Load against Position Displacement Identification List of all components against relevant drawings Measurement of OPGW diameter.

Observation, if any;

Test Results: The Suspension Assembly, as tested, met / did not meet the requirement specified in technical specification.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)



Mechanical Strength Test for Suspension Assembly

Manufacturer :

Test Location :

Test Standard : MFR's Technical Specification, IEC61284:1997

Test Sample : OPGW Cable
Suspension Assembly } As per approved DRS/Drawings

Objective: To determine the mechanical strength performance of the suspension assembly fitting for the OPGW.

Test Set-up:

The Items to be tested are installed into the hydraulic test machine and secured. The components being tested will be labeled to be exactly the same as the corresponding drawing in order to make identification clear.

The general arrangement for the Test Set-up is shown in Figure 1.

The Armour Rods and Protection Splice are assembled on to the approved OPGW using the Installation instructions as a strict guide to ensure that the assembly is correctly fitted and is the same that will be carried out during actual installation. The assembly shall be mounted in the hydraulic tensile test machine, with the Suspension Assembly suspended by the associated Clevis Eye in their normal working position. Suitable facilities to avoid bird-caging (twist) of the OPGW when tensioned shall also be provided.

Note: Care shall be taken to ensure that during the installation of the test fitting that the OPGW strands remain tight.

Test Procedure:

Part 1:

1. The suspension assembly shall be increased at a constant rate up to a load equal to 50% of the specified Minimum Failure Load as per DRS (MFL) increased and held for one minute for the test rig to stabilize.
2. The load shall then be increased at a steady rate 67% of minimum failure load and held for 5 minutes. The angle between the cable, the suspension assembly and the horizontal shall not exceed 16°.
3. This load shall then be removed in a controlled manner and the protection splice disassembled.

4. Examination of all the components shall be made and any evidence of visual deformation shall be documented.

Part 2:

1. The suspension clamp shall then be placed in the testing machine. The tensile load shall gradually be increased up to 50% of the specified minimum failure load of the suspension assembly and held for one minute for the Test Rig to stabilize.
2. The load shall be further increased at a steady rate until the specified minimum failure load is reached and held for one minute.
3. The applied load shall then be increased until the failing load is reached and value shall be documented.

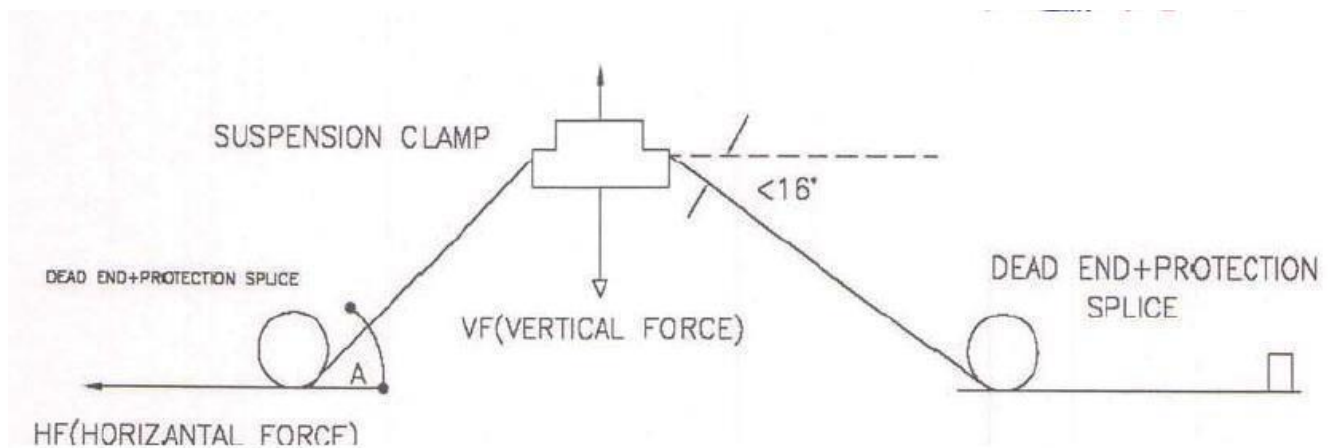


Figure 1: Test set up for mechanical strength test for suspension assembly

Acceptance Criteria:

The Suspension assembly has passed the Test if the following conditions are met:

- i) No evidence of Binding of the Nuts or Deformation of components at the end of Part 1 of test.
- ii) No evidence of Fracture up to 1 minute at Minimum Failure Load during Part 2 of the Test.
- iii) Any result outside these parameters shall constitute a failure.

Suspension clamp Shackle: Ultimate Strength (minimum) of fitting: as per approved DRS.

For each sample tested there shall be:-

Part 1:

Identification list of all components against relevant drawings and confirmation that the components meet the declared dimensions. Record of physical examination, specifically commenting on evidence of Binding of the Nuts, and deformation of the Suspension assembly components.



Part 2:

Confirmation record that the Clamp sustained a MFL load for one minute without fracture.
Recorded value of breaking load.

Identification of components against relevant drawing numbers:

Drawing Number	Issue	Description

Table of Suspension Assembly examination:

Sample Number	Part 1		Part 2	
	Possible to disassemble Assbly (Yes/No)	Comment on condition of components	Ass. sustained MFL for 1 minute (Yes/No)	Breaking Load (KN)
1				
2				
3				
4				
5				

Observations, if any:

Test Results: The Suspension Assembly, as tested, met/did not meet the requirement specified in the technical specification.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)



**MECHANICAL STRENGTH TEST ON EACH COMPONENT OF SUSPENSION
ASSEMBLY**

&

**MECHANICAL STRENGTH TEST ON ALL TYPES OF TENSION ASSEMBLIES i.e.
Dead End or Pass through or Splicing Location or Tension fitting for Suspension Tower
(Yoke plate)**

Manufacturer :

Test Location :

Test Standard : IEC 61284: 1997

Test Sample : OPGW

Tension Assembly
or each component of Suspension Assembly



As per approved DRS
& Drawings

Objective: To assess the Mechanical strength (Failing Load) test on each component of All types of Tension Assemblies.

TEST SET-UP

The Tension assembly is correctly fitted and is the same that will be carried out during installation.

TEST PROCEDURE

Each component of the Tension/Suspension assembly shall be fixed with suitable fixing arrangement with-the test machine. The load shall be increased steadily up to their specified tensile strength and held for one minute. The load shall then be increased up to the breaking of the component.

Acceptance Criteria:

1. No evidence of the fracture after one minute at nominated rated load.
2. The Mechanical strength (failing load) shall not be less than the specified rated requirement of load for all components.
3. Any result outside these parameters shall constitute a failure.

In case of Tension fitting on Suspension Tower(Yoke Plate Type), the mechanical strength test is performed upto Failure Load/ breaking strength of Yoke Plate (as per value mentioned in DRS for Yoke Plate) during this Test. Additionally, the breaking strength of Yoke Plate should be more than the UTS of OPGW. Any evidence of fracture or deformation at the end of one minute at the minimum failure load/ breaking strength of



Yoke Plate shall be considered as failure. Any result outside these parameters shall also constitute a failure.

Observation, if any;

Test Results: Each component of tension assembly, as tested, met/did not meet the requirement specified in technical specification.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

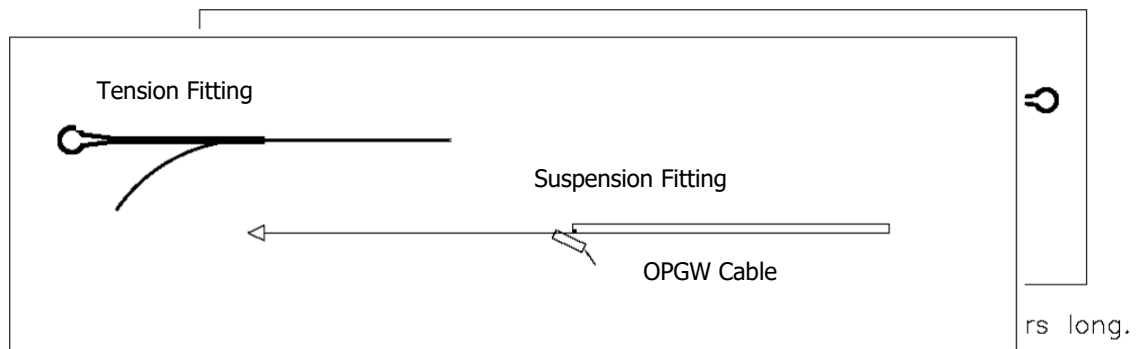
CLAMP SLIP STRENGTH TEST ON ALL TYPES OF TENSION ASSEMBLIES

**i.e. Dead End or Pass through or Splicing Location or
Tension fitting for Suspension Tower (Yoke plate)**

Manufacturer :
Test location :
Test Standard : IEC 61284-1997
Test Sample OPGW Cable }
 Tension Assembly } As per approved DRS/Drawings

Objective : To determine the clamp slip strength for the various types of tension assemblies proposed for the OPGW cable.

Test Set-up: The general arrangement for the Slip Strength Test of the Tension Assemblies is shown below



The Tension Assembly and associated components shall be identified against the relevant drawing and be uniquely marked for any future identification

The set-up for the slip strength for tension clamp is shown in Figure-2.

The tension assembly shall be fitted on a more than 8 m length of fibre optic cable on both ends. The assembly shall be mounted on a tensile machine and anchored in a manner similar to the arrangement to be used in service.

The Reinforcing Rods and Tension Assembly fitting is assembled on the OPGW using the Installation Instruction as a strict guide to ensure that the assembly is correctly fitted and is the same that will be carried out during actual installation. The assembly shall be mounted in the hydraulic tensile test machine, with suitable facilities to avoid bird caging (twist) of the OPGW when tensioned.

Note: Care shall be taken to ensure that during the installation of the test fittings the OPGW strands remain tight.

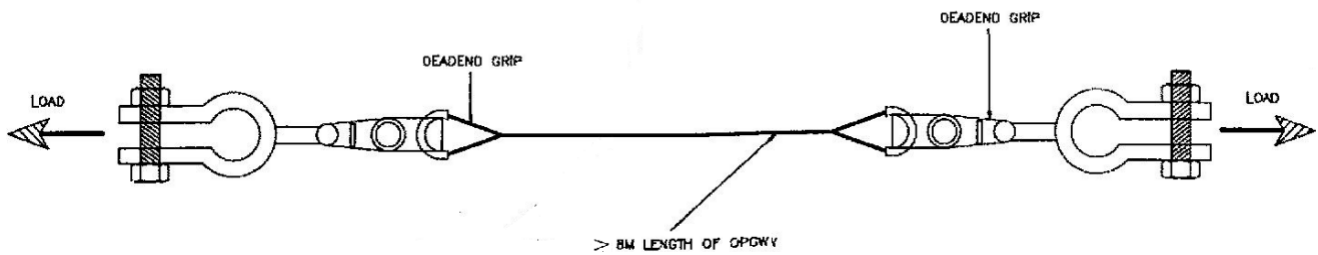


Figure 2: Schematic of slip strength test for tension assembly

Test Procedure:

A tension load shall gradually be applied up to 20% of the Ultimate Tensile Strength of the OPGW Cable.

1. Displacement transducers shall be installed to measure the relative movement between the OPGW relative to the reinforcing rods and the tension Dead-End relative to the reinforcing rods. In addition, suitable marking shall be made on the OPGW and Dead-End to confirm grip.
2. The load shall gradually be increased at a rate of 6 KN per minute until it reaches 50% of the specified UTS and the Position scale of the recorder is 'zeroed'.
3. The load shall gradually be increased at a rate of 6 KN per minute until it reaches 95% of the specified UTS and maintained for one minute.
4. After 1 minute pause, the load shall slowly be released to zero and the makings examined and measured for any relative movement.
5. On completion of the test a graph of Load (KN) against Position' (mm) shall be produced for each of the two measurements. This graph shall forms the test record and will be examined to ascertain the degree of any movement.

Acceptance Criteria:

The Tension Clamp has passed the Test if the following conditions are met:

No movement* shall, occur between the OPGW and the Reinforcing Rods, or between the Reinforcing Rods and the Tension assembly.

No failure or damage or disturbance to the lay of the Tension Clamp, 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 OPGW as a result of the test itself are not regarded as slippage.

Any result outside these parameters shall constitute a failure.



Test Results:

The Tension Assembly, as-tested, met / did not meet the requirement specified in technical specification.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

STRUCTURE MOUNTING CLAMP STRENGTH TEST

(For Downlead Assembly)

- Lab Location** :
- Manufacturer** :
- Test Standard** : Technical Specification
- Test Sample** : OPGW Cable }
Down lead clamp } As per approved DRS & Drawings

Objective: To demonstrate the ability of the down lead bracket assembly to withstand a specified load.

Test Set-up:

The clamp and mounting assembly shall be assembled on a vertical 200mm x 200mm angle and a short length of fiber optic cable installed as shown in Figure 3.

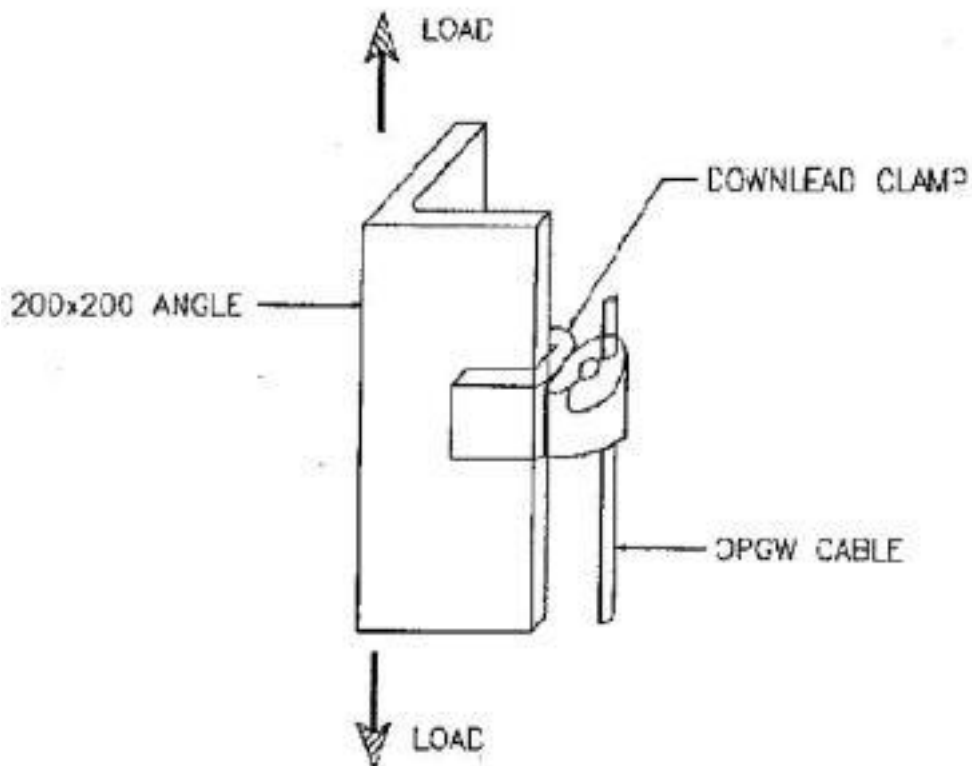


Figure 3: Schematic of structure mounting clamp strength test

Test Procedure:

1. A vertical load of 200 kg shall be applied at the end of the mounting clamp and held for 5 minutes.
2. The markings on the structure Down Lead Clamp and OPGW are examined for any signs of visible distortion, slipping or breaking of any components.
3. The load shall be increased to 400 kg and held for 30 seconds.
4. The load is then removed and the markings on the structure, Down Lead Clamp and OPGW are examined for any signs of visible distortion, slipping or breaking of any components.

Acceptance Criteria:

The down lead clamp has passed the test if the following conditions are met.
No visible evidence of distortion / slipping or breaking of any components.
Any result outside these parameters shall constitute a failure.

Observation, if any:**Test Results:**

S/N	Load (kg)	Description	Comment
1	400		
2	400		
3	400		
4	400		
5	400		

The Structure mounting Clamps for OPGW tested, met / did not meet the requirement specified in technical specification.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

STRUCTURE MOUNTING CLAMP FIT TEST

Lab Location :

Manufacturer :

Test Standard : Technical Specification

Test Sample : OPGW

Down lead clamp

} As per approved DRS & Drawings

Objective: To demonstrate the ability of the down lead assembly to withstand a specified load.

Test Set-up:

For structure mounting clamp, fit test shall be conducted with two OPGW cables installed.

Test Procedure:

Structure mounting clamp shall be installed including clamping compound as required on the OPGW cable. The nut shall be tightened on to the bolt by using torque wrench with a torque of 40Nm or supplier's recommended torque and the tightened clamp shall be held for 10 minutes. After the test remove the OPGW cable and examine all its components for distortion, crushing or breaking. Also the OPGW cable shall be checked to ensure free movement within the core to measure the diameter of the core tube.

Acceptance Criteria:

1. If any visible distortion, crushing, cracking or breaking of the core tube is observed, the test will be defined as a failed.
2. 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, the test will be defined as a failed.

Observations, if any

Test Results: The Structure mounting Clamps Fit tested, met/did not meet the requirement specified in technical specification.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

VISUAL/PHYSICAL VERIFICATION OF QUANTITIES AND SPECIFIC COMPONENT NUMBER FOR EACH COMPONENT OF SPLICE ENCLOSURES (JOINT BOX) & FODP AND DIMENSIONAL CHECKS AGAINST THE APPROVED DRAWINGS

Test location:

Manufacturer:

Test Sample: SPLICE ENCLOSURES (Joint Box)

FODP

} (As per approved DRS & Drawings)

Objective: This test confirms the appearance, Quantity and Dimension for Splice Enclosures & FODP for conformance to the relevant DRS/Drawings.

Test set-up:

It shall be verified that the sample are in accordance with their relevant drawings.

The following tolerance shall be allowed on all dimensions to which special tolerance do not apply.

SAMPLING: 100% of Items in the Lot

Dimensions:

The following tolerance shall be allowed on all dimensions to which special tolerances do not apply (i.e.) where tolerances are not indicated in the approved DRS/Drawings. Dimensions greater than 30 mm±5% up to a max. of ± 5 mm.

Visual & Quantity: To check the items in Lot & all found to be ok as per approved DRS & Drawings and the following.

No. of splice Trays

No. of holes for cable entry/ diameter of holes

IP Protection Class

Color shade

Specific Component Number

Acceptance Criteria:

Appearance should have no defect. All quantities should be correct.

Specific component number of each component shall be as per approved DRS/Drawings.

Dimensions shall be in accordance with their drawings with the tolerances specified.

Observations, if any:

Test Results : The Splice enclosure/FODP as tested met / did not meet the requirement specified.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW -Vibration Dampers

VISUAL MATERIAL VERIFICATION AND DIMENSIONAL CHECKS FOR VIBRATION DAMPER

Test Location:

Manufacturer:

Test Standard: IEC61284:1997, Approved DRS/Drawings in cat-I

Test Sample: Vibration Damper & associated hardware fittings

Objective : This test determines the factory acceptance of the batch quantity of fittings that they confirm to the relevant drawings and where appropriate/ have a sufficient galvanized coating.

Test Procedure:

1. Physical/Visual Verification for the part no. of all the materials as per approved DRS & drawings.
2. It shall be verified that the sample are in accordance with their relevant drawings, particularly as regards any dimensions to which special tolerance apply and indicated in the corresponding approved DRS/Drawings.
3. The following tolerance shall be allowed/on all dimensions to which special tolerance do not apply.

Appearance: To check all and ascertain to be appropriate as per DRS & Drawings.

Dimensions:

(A) Forgings:

- i) Dimensions up to and including 30mm.... ± 1.5 mm.
- ii) Dimensions greater than 30 mm..... $\pm 5\%$ upto max. of ± 5 mm.

(B) Helical Fittings:

- i) Dimensions up to and including 30mm..... ± 1.5 mm.
- ii) Dimensions greater than 30 mm..... $\pm 5\%$ upto max. of ± 5 mm.

FAT Procedure for OPGW -Vibration Dampers

Galvanizing (Vibration dampers, all nuts & bolts components as per approved DRS & Drawings):

- i) Galvanized coatings shall be tested in accordance with as appropriate.
- ii) All measurements shall be made after galvanizing where galvanizing is the normal finish. Galvanized coatings shall be tested and galvanized coating shall be minimum 85µm.

Acceptance Criteria:

Fittings shall be accordance with their relevant drawings within the tolerance Specified. Galvanized coatings on general articles shall be minimum thickness of 85µm.

Observation, if any;

Test Results: The Hardware fittings, as tested met / did not meet the requirement as per approved DRS & Drawings.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW -Vibration Dampers

CLAMP SLIP TEST OF THE VIBRATION DAMPER

Test Location:

Manufacturer:

Test Standard: Technical Specification, IEC61897:1999

Test Sample: Vibration Damper
OPGW Cable

} As per approved DRS/Drawings

Objective: To demonstrate the ability of the vibration damper grip the conductor .

Test set up:

The test shall be performed using the conductor for which the clamp is intended. The conductor shall be “as new” (free of deterioration or damage). The minimum free length of test conductor between its terminating fittings shall be 2 meters. The conductor can be tensioned to 20% of its Ultimate tensile strength (the conductor is free that is accepted). Precautions shall be taken to avoid bird caging of the conductor.

The clamp shall be installed in accordance with their recommended instructions on a different portion of the conductor for each test.

Test Procedure:

The load shall be gradually increased (no faster than 100 N/s) until it reaches 2.5kN (specified minimum slip load). This load shall be kept constant for 60 seconds. Then the load value shall be gradually increased until slippage of the clamp occurs. The value of slip load shall be recorded. Clamp slip shall be considered as having occurred when a slip distance of 1mm is measured.

Acceptance Criteria:

- 1) No movement of the clamp relative to the conductor greater than 1mm shall occur at or before the end of application of 2.5kN for 60 seconds.
- 2) Surface flattening of the outer strands of the conductor is acceptable.

Observation, if any;

FAT Procedure for OPGW -Vibration Dampers

Test Results: The vibration damper tested, met / did not meet the requirement specified in technical specification.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW -Vibration Dampers

VIBRATION DAMPER RESPONSE (RESONANT FREQUENCIES) TEST AND DYNAMIC CHARACTERISTIC TEST

Test Location:

Manufacturer:

Test Sample: Vibration Damper (As per approved DRS/Drawings)

Objective: To analyze the vibration damper response at Resonant frequencies

Test procedure

The damper was mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for Critical Aeolian Vibration frequency band ranging from $0.18/d$ to $1.4/d$ - where d is the OPGW cable diameter in meters. The damper assembly was 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

Acceptance criteria:

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies were 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.

- I. The above dynamic characteristics test on five damper shall be conducted.
- II. The mean reactance and phase angle vs frequency curves shall be drawn with the criteria of best fit method.
- III. The above mean reactance response curve should lie within following limits:
 $V.D$ for OPGW - $0.060 f$ to $0.357 f$ kgf/mm*
Where f is frequency in Hz.
- IV. The above mean phase angle response curve shall be between 25 to 130 within the frequency range of interest.

FAT Procedure for OPGW -Vibration Dampers

- V. If the above curve lies within the envelope, the damper design shall be considered to have successfully met the requirement.
- VI. Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values. A tolerance of ± 1 hz at a frequency lower than 15 Hz and ± 2 hz at a frequency higher than 15 Hz only shall be allowed.

Observations, if any:

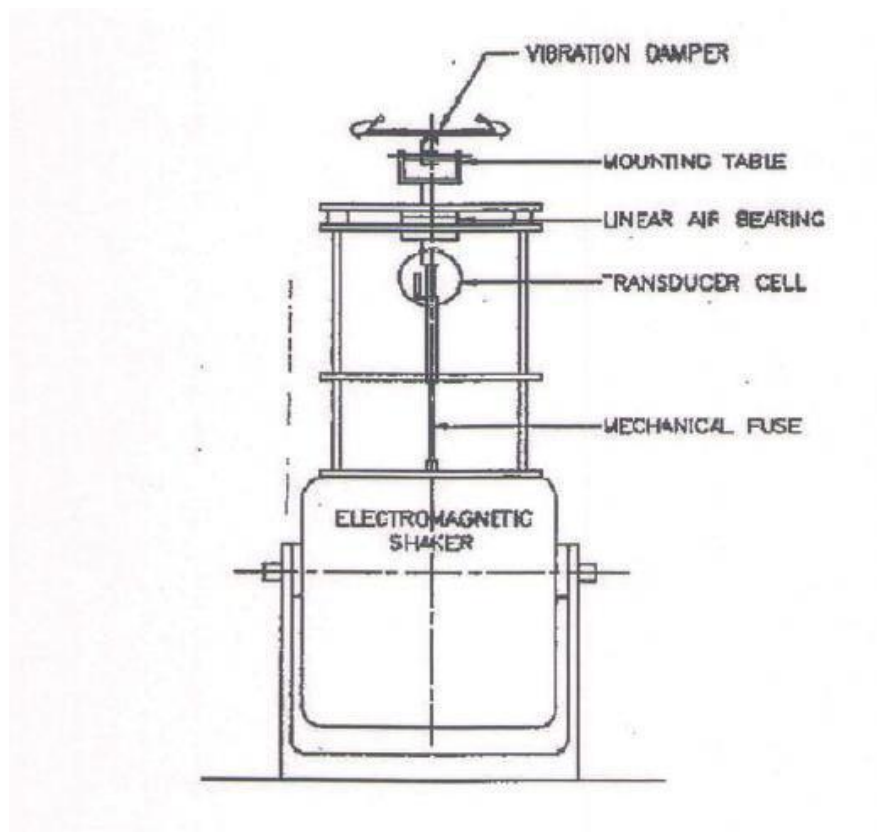


Fig.1 Schematic of Vibration Damper Characteristics

Test Results: The Vibration Damper has met/ did not meet the acceptance criteria for Vibration Damper response at resonant frequencies.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW -Vibration Dampers

STRENGTH OF MESSENGER WIRE TEST FOR VIBRATION DAMPER

Test Location:

Manufacturer:

Test Sample : Messenger Cable (As per approved DRS & Drawings)

Objective: To determine the strength of the damper messenger wire.

Test Procedure:

The messenger cable shall be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. Alternatively, each strand of messenger cable may be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. In such a case, the 95% of yield strength of each wire shall be added to get the total strength of the cable. The load shall be not less than the value guaranteed by the contractor.

Acceptance Criteria: The minimum tensile stress of the messenger cable shall be 42

KN Test Results:

Sampler No.	Tested up to Rated Strength /UTS (KN)	Acceptance Criteria	Pass/Fail
		No Deformation/Breakage	
		No Deformation/Breakage	
		No Deformation/Breakage	

The above as tested met / did not meet the requirement specified in technical specification.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW -Vibration Dampers

ATTACHMENTS OF WEIGHTS TO MESSENGER CABLE

Test Location:

Manufacturer:

Test Standard: Technical Specification, IEC61897:1999

Test Sample: Vibration Damper (As per approved DRS/Drawings)

Objective: To demonstrate the ability of the weight grips the messenger.

Test Procedure:

On an assembled damper a tensile load shall be applied between the weights coaxial with the messenger cable. The load shall be gradually increased (100N/s maximum) until it reaches 5kN (or specified minimum slip load as per DRS). This load shall be constant for 60 seconds.

The load shall be increased slowly until one weight has been pulled free of the messenger cable. The maximum load obtained during this process shall be recorded, for information purposes only.

Acceptance Criteria:

No relative movement greater than 1 mm between each weight and the messenger cable shall occur at or before the end of the application of 5kN(or specified minimum slip load as per DRS) for 60 seconds.

Observation, if any;

Test Results:

Damper No.	Tensile Strength (KN)	Breaking Stress (KN/mm ²)

FAT Procedure for OPGW -Vibration Dampers

The vibration damper tested, met / did not meet the requirement specified in technical specification.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW -Vibration Dampers

ATTACHMENTS OF CLAMP TO MESSENGER CABLE

Test Location:

Manufacturer:

Test Standard : Technical Specification, IEC61897:1999

Test Sample : Vibration Damper As per approved DRS/Drawings

Objective : To demonstrate the ability of the clamp grips the messenger.

Test Procedure:

On an assembled damper a tensile load shall be applied between messenger cable and the clamp body, coaxial with the messenger cable. The load shall be gradually increased (100N/s maximum) until it reaches 1.5kN (or specified minimum slip load as per DRS). This load shall be constant for 60 seconds.

The load shall be increased slowly until the clamp has been pulled free of the messenger cable. The maximum load obtained during this process shall be recorded, for information purposes only.

Acceptance Criteria:

No relative movement greater than 1 mm between the clamp relative to the messenger cable shall occur at or before the end of the application of 1.5kN(or specified minimum slip load as per DRS) for 60 seconds.

Observation, if any;

Test Results:

Damper No.	Tensile Strength (KN)	Breaking Stress (KN/mm ²)

FAT Procedure for OPGW -Vibration Dampers

The vibration damper tested, met / did not meet the requirement specified in technical specification.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW -Vibration Dampers

CLAMP BOLT TIGHTENING AND TORQUE TEST

Test Location:

Manufacturer:

Test Standard: Technical Specification, IEC61897:1999

Test Sample : Vibration Damper (As per approved DRS/Drawings)

Objective : To demonstrate the ability of the tighten bolt.

Test set up:

The test shall be performed by installing the clamp on a length of conductor for which the damper is intended.

Test procedure:

The bolts or nuts shall be tightened to a torque 10% above the specified installation torque.

Lastly, the torque should be increased to either twice the specified installation value or the maximum torque value recommended by the bolt supplier whichever is lower.

Acceptance Criteria:

- 1) The threaded connection shall remain serviceable for any number of subsequent installations or removals and components of the clamp shall be undamaged.
- 2) No unacceptable damage shall occur to the conductor inside the clamp. (Unacceptable damage shall be agreed between the purchaser and supplier)
- 3) The increase to either twice should not result in any breakage of threaded parts or other components.

Observation, if any;

Test Results:

Damper No.	1.1 times torque Comment on condition of components	2 times torque Comment on condition of components

FAT Procedure for OPGW -Vibration Dampers

The vibration damper tested, met / did not meet the requirement specified in technical specification.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FACTORY ACCEPTANCE TEST PROCEDURE FOR OPTICAL FIBRE (ITU-T G.652D) APPLICABLE STANDARD EIA/TIA 455

Sl. No.	Test Name	Test Procedure	Acceptance Criteria
1	Attenuation Coefficient	EIA/TIA 455-78A	≤0.35dB/km (1310nm) ≤0.21dB/km (1550nm)
2	Point Discontinuities of Attenuation	EIA/TIA 455-59	≤0.1 dB
3	Attenuation at Water Peak	EIA/TIA-455-78A	≤0.34dB/km at 1383nm
4	Chromatic Dispersion	EIA/TIA 455 -168A/169A /175A	≤18 ps/(nm·km) at 1550nm
			≤3.5 ps/(nm·km) from 1288 nm to 1339nm
			≤5.3 ps/ (nm·km) from 1271nm to 1360nm
			Zero Dispersion wavelength: 1300nm – 1324nm; Zero Dispersion slope: ≤ 0.092 ps/nm ² .km
5	Core - Clad Concentricity Error	EIA/TIA 455- 176	≤0.5 μm
6	Cladding Diameter	EIA/TIA 455-176	125 ± 0.7 μm
7	Fibre Tensile Proof Testing	EIA/TIA 455-31B	≥1.0%, 1 sec. ≥ 0.69 Gpa (100kpsi)

Note: The test report of the above tests for the fibres are to be carried out by the Fibre Manufacturer and used in the Approach cable shall be shown to the inspector during Approach cable FAT and shall be submitted along with the Approach cable FAT reports.

**FACTORY ACCEPTANCE TEST PROCEDURE
FOR APPROACH CABLES**

Sl. No.	Factory Acceptance Test	Sampling plan
1	Attenuation Coefficient at 1310nm,1550nm	10% of offered FO approach cable drums/lot and 100% of fibers in selected FO approach cable drums.(Minimum 2)
2	Point discontinuities	10% of offered FO approach cable drums/lot and 100% of fibers in selected FO approach cable drums. (Minimum 2)
3	Visual material verification and dimensional checks as per approved DRS & drawings	Quantity verification: 100% of offered material.

IEC 60793-1-40, EIA/TIA-455-59 & EIA/T1A-455-61 and ITU-T G.652 D

Test Location :

Manufacturer :

Test Objective : To measure the optical attenuation at wavelengths 1310 nm and 1550 nm & Point discontinuities at both wavelength of 1310 nm and 1550nm.

Test Set-ups:

Prepare the sample under test as per the figure showing below the test setup. The test bench is connected with Optical Time Domain Reflectometer (OTDR) to measure the value of attenuation coefficient and Point discontinuities

Test Procedure:

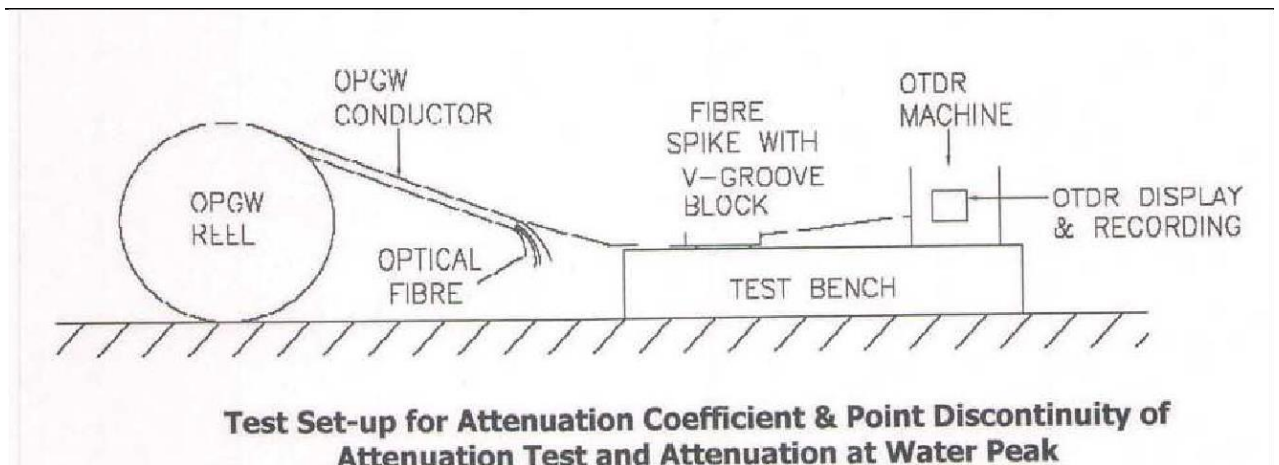
1. Connect the test sample either to the instrument or to one end of end dead-zone fiber (if used).
Connect the other end of the dead-zone fiber (if used) to the instrument.
2. If the accurate locations of point defects are to be recorded, the effective group delay index of the test sample is required. If this value is not known, use FOTP-60 (Method A) to determine it.
3. Enter OTDR parameters such as source wavelength, pulse duration, length range, and signal averaging into the instrument, along with the test sample effective group index. The values of some of these parameters may be present in the instrument.
4. Adjust the instrument to display a backscatter signal from the test sample. It may be advantageous to begin with coarse vertical and horizontal scaling to maximize the length displayed. An example is given in Figure.
5. Examine the OTDR signal along the test sample for point defects. If increased resolution is needed, adjust the graphical display, if possible, to expand the section of interest to larger scale (exercising care to assure that proper reading of the true signal can still be distinguished from the noise points).
6. To determine that a point defect (rather than an attenuation non-uniformity situation) exist observe the area in question using two different pulse durations. If the shape of the loss or gain changes with the pulse duration, the anomaly is a point defect. If the shape does not change, the anomaly shall be considered to be attenuation non-uniformity to be measured by FOTP-61.
7. Report any point defect deviations which exceed the values specified in the Detail Specification. Describe the nature of these faults (e.g. apparent loss or gain, reflection, duration, etc.) as required by the Detail Specification.
 - 7.1 Determine the defect location, if required, by placing a cursor at the beginning (or at another point specified by the OTDR manufacturer) of a power rise or drop, this may be difficult to do at a drop. Obtain the distance coordinate via the alphanumeric display.
 - 7.2 Obtain the apparent loss or gain of the defect, if required, by the method described by the OTDR manufacturer. Some instruments required placement of a pair of cursors on each side of the defect. The two best-fit straight lines (from a two-point or least-squares fit for each) are extrapolated to the defect location. If available, the linear fit method should be

FAT Procedure for Fibre Optic Approach Cable

chosen. The vertical separation of the lines gives the apparent loss or gain .Note any reflection peak.

7.3 When possible, repeat the test for a single launched into the test sample in the opposite direction. A more accurate loss estimate (and the elimination of apparent gain) is made by averaging readings taken directionally at the same wavelength .This eliminates the effect of any backscatter different for the fiber sections on both side of the defect.

7.4 Repeat the test at another wavelength.



Acceptance Criteria:

For Attenuation

Wavelength	Attenuation
1310 nm	< 0.35 dB/Km
1550 nm	<0.21 dB/Km

For Point Discontinuity: Attenuation of fiber shall be uniform throughout its length such that there are no point discontinuity in excess of 0.1dB.

ATTENUATION AND POINT DISCONTINUITY

Ring Mark	Fiber id	At 1310 nm				Ring Mark	At 1550 nm			
		Optical Attenuation	Point Discontinuity	Pass or Fail	Remarks		Optical Attenuation	Point Discontinuity	Pass or Fail	Remarks

Observations, if any:

Test Results:

The attenuation and point discontinuity measured have met/not met the acceptance criteria.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

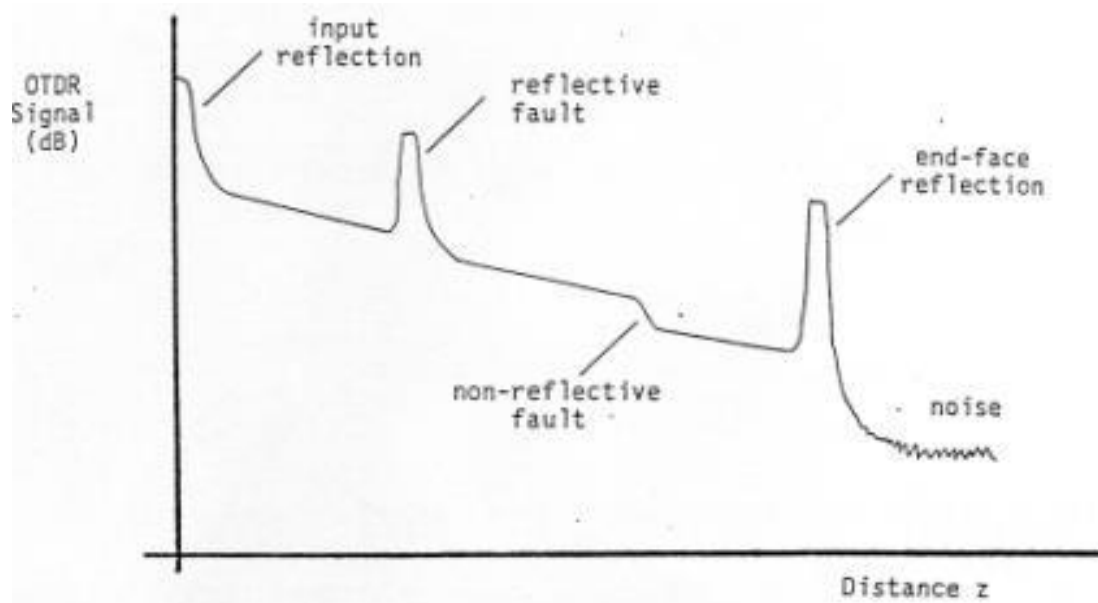


Figure 1. Schematic of an OTDR Trace. Point defects with apparent loss are shown, one reflective and one non-reflective.

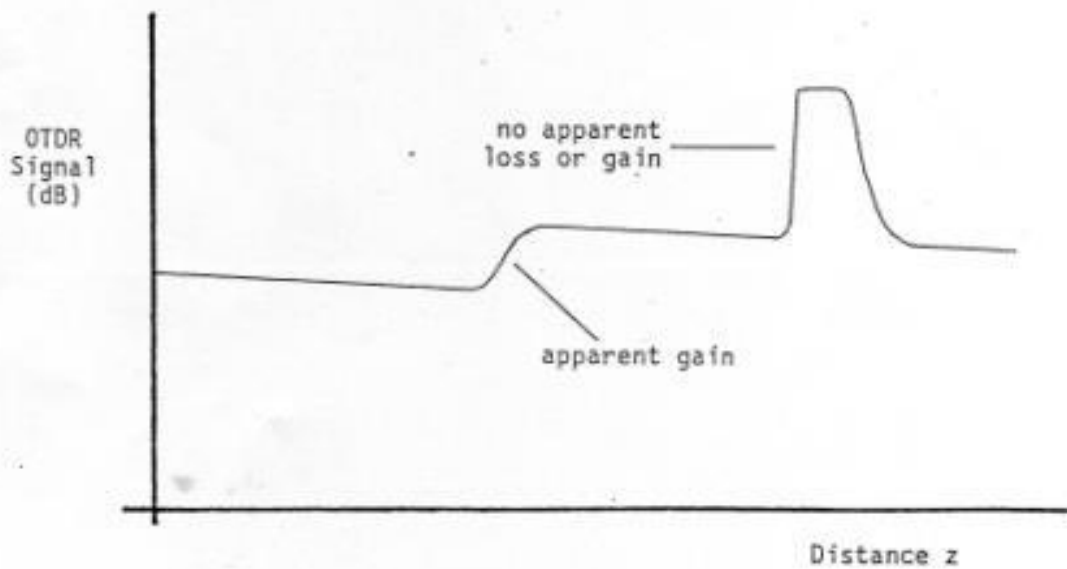


Figure 2. Schematic of an expanded OTDR trace. Two point defects are shown, one with apparent gain, and another with no apparent loss or gain.

2. VISUAL MATERIAL VERIFICATION, CABLE CONSTRUCTION AND DIMENSIONAL CHECKS

Test Standard: IEC 60793 & 60794, EIA/TIA-598

Test Location:

Manufacturer:

Cable Type: Approach Cable.

Reference Doc: Approved DRS & Drawings of Fiber Optical Approach Cable.

Objective: To measure the Visual material verification, Cable construction and dimensional checks for Fiber Optical Approach Cable.

Test Procedure:

The physical/dimensional measurements of the individual parts of the cable shall be taken with suitable measuring device and verified against the approved DRS/Drawings

Drum Checks:

Physical Verification for the 100% offered quantity of the offered reels/drums shall be carried out. 1.

2. 100% physical verification of sealing of cable ends with end caps, check for provision of spare cable caps for each drum.
3. 100% verification of Sealing/Pasting the drum details over the end cap with transparent tape.
4. Verification of drum details properly printed and pasted on each drum suitably as per approved document **Checks**

on Approach cable: The below to be verified as per approved DRS/Drawings for both Fiber Optical Approach Cable.

S.NO.	Description	Acceptance Criteria
1.	No. of Fiber	AS per approved DRS& drawings
2.	Buffer Tube Quantity(Nos.)/Diameter	AS per approved DRS& drawings
3.	No. of Fibers per tube(Nos.)	AS per approved DRS& drawings
4.	Filling Material	AS per approved DRS& drawings
5.	Strengthening Member	AS per approved DRS& drawings
6.	Outside Jacket Coating	AS per approved DRS& drawings
7.	Outside Jacket Thickness	AS per approved DRS& drawings
8.	Armoring Tape provided	AS per approved DRS& drawings
9.	Weight(kg/km)	AS per approved DRS& drawings
10.	Overall Diameter	AS per approved DRS& drawings
11.	Identification of colors of fibers/tube	AS per approved DRS& drawings
12.	Other physical/Technical parameters	AS per approved DRS& drawings

Acceptance Criteria: Visual material verification, Cable construction and dimensional checks shall be as per approved DRS /drawings.

Observations, if any:

Test Results: The Fiber Optic Approach cables as tests met tested met the requirement as approved DRS & Drawings.

Test by:
(sign with date)

Witnessed by:
(sign with date)

Appendix-J

List of items, goods, services or works from Class-I Local supplier meeting the Minimum Local Content notified in Annexure-1 of Ministry of Power (MoP) order on 'Pubic Procurement (Preference to Make In India) to provide for purchase preference (linked with local content) in respect of Power Sector'dated 16.11.2021

Sl. No.	Electrical Equipment for Generation, Transmission and Distribution sectors with sufficient local capacity and competition	Class-I Local Supplier (Minimum Local Content (%))
(A) Common items for Transmission, Distribution and Generation Sector		
1	Power Transformers (up to 765 kV, including Generator transformers)	60
2	Instrument Transformer (up to 765 kV)	60
3	Transformer Oil Dry Out System (TODOS)	60
4	Reactors up to 765 kV	60
5	Oil Impregnated Bushing (up to 400 kV)	60
6	Resin Insulated Paper (RIP) bushings (up to 145 kV)	50
7	Circuit Breakers (up to 765 kV AC - Alternating Current)	60
8	Disconnectors/Isolators (up to 765 kV AC)	60
9	Wave trap (up to 765 kV AC)	60
10	Oil Filled Distribution Transformers up to & Including 33 kV [Cold Rolled Grain Oriented (CRGO)/Amorphous, Aluminium/Copper wound]	60
11	Dry Type Distribution Transformer upto and including 33 kV (CRGO/Amorphous, Aluminium/Copper wound)	60
12	Conventional Conductor	60
13	Accessories for Conventional conductors	60
14	High Temperature/High Temperature Low Sag (HTLS) conductors (such as Composite core, GAP, ACSS, INVAR, AL59) and Accessories	60
15	Optical ground wire (OPGW) – all designs	60
16	Fiber Optic Terminal Equipment (FOTE) for OPGW	50
17	OPGW related Hardware and Accessories	60
18	Remote Terminal Unit (RTU)	50
19	Power Cables and accessories up to 33 kV	60
20	Control cables including accessories	60
21	XLPE Cables up to 220 kV	60
22	Substation Structures	60
23	Transmission Line Towers	60
24	Porcelain (Disc/Long Rod) Insulators	60
25	Bus Post Insulators (Porcelain)	60
26	Porcelain Disc Insulators with Room Temperature Vulcanisation (RTV) coating	50
27	Porcelain Longrod Insulators with Room Temperature Vulcanisation (RTV) coating	50
28	Hardware Fittings for Porcelain Insulators	60
29	Composite/Polymeric Long Rod Insulators	60
30	Hardware Fittings for Polymer Insulators	60
31	Bird Flight Diverter (BFD)	60
32	Power Line Carrier Communication (PLCC) System (up to 800 kV)	60
33	Gas Insulated Switchgear (up to 400 kV AC)	60
34	Gas Insulated Switchgear (above 400 kV AC)	50
35	Surge/Lightning Arrester (up to 765 kV AC)	60
36	Power Capacitors	60
37	Packaged Sub-station (6.6 kV to 33 kV)	60
38	Ring Main Unit (RMU) (up to 33 kV)	60
39	Medium Voltage (MV) GIS Panels (up to 33 kV)	60
40	Automation and Control System/Supervisory Control and data Acquisition (SCADA) System in Power System	50
41	Control and Relay Panel (including Digital/Numerical Relays)	50
42	Electrical Motors 0.37 kW to 1 MW	60
43	Energy Meters excluding smart meters	50
44	Control & power cables and Accessories (up to 1.1 kV)	60
45	Diesel Generating (DG) set	60

Sl. No.	Electrical Equipment for Generation, Transmission and Distribution sectors with sufficient local capacity and competition	Class-I Local Supplier (Minimum Local Content (%))
46	DC system (DC Battery & Battery Charger)	60
47	AC & DC Distribution Board	60
48	Indoor Air Insulated Switchgear (AIS) upto 33 kV	60
49	Poles (PCC, PSCC, Rolled Steel Joist, Rail Pole, Spun, Steel Tubular)	60
50	Material for Grounding/earthing system	60
51	Illumination system	60
52	Overhead Fault Sensing Indicator (FSI)	50
53	Power Quality Meters	50
54	Auxilliary Relays	50
55	Load Break Switch	50
	(B) Hydro Sector	
56	Hydro Turbine & Associated equipment	
	a) Francis Turbine	60
	b) Kaplan Turbine	60
	c) Pelton Turbine	50
57	Main Inlet Valve & Associated Equipment	60
58	Penstock Protection Valve and Associated Equipment	60
59	Governing system & Accessories	60
60	Generator for Hydro Project & Associated Equipment	60
61	Static Excitation System	60
62	Workshop Equipment	60
63	Cooling Water System	60
64	Compressed Air System	60
65	Drainage/Dewatering System	60
66	Fire Protection System	60
67	Heating, Ventilation & Air Conditioning System (HVAC)	60
68	Oil Handling System	60
69	Mechanical Balance of Plant (BOP) Items	60
	(C) Thermal Sector	
	Boiler Auxiliaries	
70	Air Pre-Heater	60
71	Steam Coil Air Pre Heater (SCAPH)	60
72	Steam soot blowers [wall blowers & Long Retractable Soot Blower (LRSB)]	60
73	Auxiliary Steam Pressure Reducing & Desuperheating (PRDS)	60
74	Fuel oil system	60
75	Seal air Fan	60
76	Ducts and dampers	60
77	Duct expansion joints	60
78	Blowdown tanks	60
79	Coal burners and oil burners	60
80	Coal mills	60
81	Gear Box of Coal Mill	50
82	Coal feeders	60
83	Primary Air Fans	60
84	Forced Draft Fans	60
85	Induced Draft Fans	60
86	Forced Draft (FD)/Induced Draft (ID)/ Primary Air (PA) Fan Servo Motor Assembly	50
87	Tubes (Carbon Steel)	50
88	Steam pipes (Carbon Steel)	50
89	Steam drum	50
90	Separator	50
91	Selective Catalytic Reduction (SCR)	50

Sl. No.	Electrical Equipment for Generation, Transmission and Distribution sectors with sufficient local capacity and competition	Class-I Local Supplier (Minimum Local Content (%))
	Electro-Static Precipitators (ESPs)	
92	Casing	60
93	Electrodes	60
94	Rapping System	60
95	Hopper Heaters	60
96	Transformer Rectifiers	60
97	Insulators	60
	Turbine & Auxiliaries	
98	Turbine (High Pressure/Intermediate Pressure/Low Pressure)	50
99	Condensate Extraction Pumps	60
100	Condenser On line Tube Cleaning System (COLTC)	60
101	Debris filters	60
102	Deaerator	60
103	Drain Cooler and Flash Tank	60
104	ECW Pump	50
105	Plate Heat Exchanger	50
106	Self- cleaning filters	50
107	Condensate Polishing Units (CPUs)	60
108	Chemical Dosing System	60
109	Oil Filter	60
110	Gland Steam Condenser	60
111	Oil Purifying Centrifuge	50
112	Water Cooled Condenser	50
113	Boiler Feed Pumps (BFPs)	50
	Generator and Auxilleries	
114	Generator (including Seal Oil System, Hydrogen Cooling System, Stator water cooling system)	60
	Electrical Works	
115	Control and metering equipment	60
	Control & Instrumentation System (C&I System)	
116	Thermocouples	50
117	Measuring instruments [Resistance Temperature Detectors (RTDs)], Local gauges	50
118	Actuators (Pneumatic and conventional electric)	50
119	Interplant Communication/ Public Address (PA) system except IP based	50
	Coal Handling Plant	
120	Conveyors	60
121	Wagon Tippler	60
122	Side Arm Charger	60
123	Paddle feeder	60
124	Crushers & Screens	60
125	Dust suppression (dry fog & plain water) system	60
126	Air Compressors	50
127	Magnetic separators & metal detectors	60
128	Coal Sampling System	60
129	Stacker cum reclaimer	60
130	Belt weighing & monitoring system.	60
131	Wheel & axle assembly (without bearings) for Bottom Opening Bottom Release (BOBR) Wagons	60
	Ash Handling System	
132	Clinker grinder	60
133	Water jet ejectors	60
134	Scraper chain conveyor	60
135	Dry fly ash vacuum extraction system	60
136	Pressure pneumatic conveying system	60

Sl. No.	Electrical Equipment for Generation, Transmission and Distribution sectors with sufficient local capacity and competition	Class-I Local Supplier (Minimum Local Content (%))
137	Ash water & ash slurry pumps	60
138	Compressors, air dryers & air receivers	50
139	Ash water recovery system	60
	Raw Water Intake & Supply System	
140	Travelling water screens	60
141	Raw water supply pumps	60
142	Valves, RE joints etc.	60
	Water Treatment System and Effluent Treatment System	
143	Clarification plant	60
144	Filtration plant	60
145	Ultra filtration plant	50
146	Reverse Osmosis (RO) plant and its membrane	55
147	De-Mineralised water plant (DM Plant)	60
148	Chlorination plant	60
149	Chemical dosing system	60
150	Effluent Treatment Plant	60
	Circulating Water (CW) & Auxiliary Circulating Water (ACW) System	
151	CW & ACW Pumps	60
152	Butter Fly (BF) valves, Non-return Valves (NRVs) etc.	60
153	Rubber Expansion (RE) joints	60
154	Air release valves	60
	Cooling Towers (NDCT/ IDCT)-Natural-Draft and Induced Draft Cooling Tower	
155	Water Distribution System	60
156	Spray nozzles	60
157	Packing	60
158	Drift eliminators	60
159	Cooling Tower (CT) Fans (for Induced Draft Cooling Towers IDCT)	60
160	Gear boxes, shafts & motors (for IDCT)	60
	Air Conditioning & Ventilation System	
161	Split & window air conditioners	60
162	Chilling/ condensing unit [upto 500 ton of refrigeration(TR)]	55
163	Air Handling Unit (AHU) and Fresh air unit	60
164	Cooling Towers	60
165	Air Washing Units (AWUs), axial fans, roof extractors	60
166	Ducts, louvers & dampers	60
	Flue Gas Desulphurization (FGD)	
167	Spray Nozzles,	50
168	Spray header	50
169	Oxidation Blowers	50
170	Limestone wet Ball Mill	50
171	Slurry Handling Pumps for FGD system	50
172	Booster Fans for FGD system	50
173	Carbon Steel Ducts and Dampers for FGD	60
174	Storage Tanks and Silos	60
175	Process Water Pump for FGD system	50
	(D) Other Common Items	
	Fire protection and detection system	
176	Motor driven fire water pumps	60
177	Diesel engine driven fire water pumps	60
178	Hydrant system for the power plant.	60
179	High velocity water spray system	60
180	Medium velocity water spray system	60
181	Foam protection system	60
182	Inert gas flooding system	60

Sl. No.	Electrical Equipment for Generation, Transmission and Distribution sectors with sufficient local capacity and competition	Class-I Local Supplier (Minimum Local Content (%))
183	Fire tenders	60
184	Portable fire-extinguishers	60
185	Cranes, EOT cranes, gantry crane & chain pulley blocks etc.	60
186	Elevator	60

(E) Minimum Local Content percentages in Engineering, Procurement & Construction (EPC) / Turnkey project

In case the contract is awarded through the EPC route, the contractor should comply with the requirement of MLC for individual items as listed in Annexure-I and should purchase these items only from Class-I Local supplier. In addition, MLC for complete EPC project may also be prescribed as below:

	(1) Package Based Works	Minimum Local Content (%)
1	Boiler	60
2	TG System (Water Cooled Condenser)	60
3	Ash Handling Plant	60
4	Coal Handling Plant	60
5	Electro-static Precipitator (ESP)	60
6	Circulating Water (CW) System	60
7	Cooling Tower	60
8	Water Treatment System	60
9	Air Conditioning System (below 500TR)	60
10	Flue Gas Desusphurisation (FGD) System	60
11	Station Control & Instrumentation (C&I)	50
12	Hydro Power Projects (Electro-Mechanical Works)	60
	Gas based generation	
	Overall Gas Turbine Package (on finished Product basis)	
13	< 44 MW	60
14	44 –145 MW	50
	Overall Combined Cycle Gas Turbine (CCGT) Package (on finished Product basis)	
15	< 44 MW	60
16	44 – 145 MW	60
17	> 150 MW	60
	(2) Project as a whole	
1	Works and service contracts in Power Sector	60
2	Transmission Line with Conventional conductors (ACSR, AAAC, AL-59 etc.)	60
3	Transmission Line with High temperature Low Sag (HTLS) conductors	60
4	HVAC Substation Air Insulated (AIS)	60
5	HVAC Substation Gas Insulated (GIS)	60
6	HVDC Substation	60
7	Distribution Sector	60

Appendix-K

Local supplier meeting the Minimum Local Content notified in Table-A, B & C of Department of Telecommunications(DoT), Ministry of Communications order dated 29.08.2018 on 'Public Procurement (Preference to Make In India) Order 2017 –Notification of Telecom products, Services or Wors – regarding “

Table-A

List of Telecom Products, Services and Works with PMI and LC

Sl. No.	Telecom Products, Services and Works	Year		Year	
		2018-19		2019-20 onwards	
		PMI	LC	PMI	LC
1.	Encryption/UTM platforms (TDM and IP)	100	65	100	65
2.	IP/MPLS Core routers/ Edge/ Enterprise Router	50	55	50	60
3.	Managed Leased line Network equipment	50	55	50	60
4.	Ethernet Switches (L2 and L3), Hubs	50	55	50	60
5.	IP based Soft Switches, IMS, Unified Communication Systems	100	55	100	60
6.	Wireless/Wireline PABXs / IP PBX & / Media Gateways	100	65	100	65
7.	CPE (including Wi-Fi Access points and Routers, Media Converters), 2G/3G/4G/LTE Modems, Leased-line Modems, NFV/SDN CPE	100	45	100	50
8.	Set-Top Boxes	50	50	50	55
9.	SDH/Carrier-Ethernet/MPLS- TP/ Packet Optical Transport equipment/ PTN/ OTN systems	100	65	100	65
10.	DWDM/CWDM systems	50	55	50	60
11.	GPON / XGS-PON, NG-PON2 equipment (including ONT and OLT)	100	55	100	60
12.	Optical/SDH/PDH Cross Connects/ OTN Cross-connects and optical MUX,OADM	100	55	100	60
13.	Small size 2 G/3 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH	100	55	100	60
14.	2 G/3 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH	50	55	50	60
15.	Small Size LTE/LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNodeB, Small Cells, EPC, NIB C-RAN BBU and RRH ,LTE/LTE-R/4.5 G/ 5 G based broadband wireless access systems (eNodeB, gNB, EPC, etc.)	50	55	50	60
16.	LTE/LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNode B, Small Cells, EPC, NIB C-RAN BBU and RRH ,LTE/LTE-R/4.5 G/ 5 G based broadband wireless access systems (eNodeB, gNB, EPC, etc.)	50	45	50	50
17.	Wi-Fi based broadband wireless access systems (Including Access Point, Aggregation Block, Core Block), Integrated Broadband system	50	50	50	55

18.	Microwave Radio systems (IP/Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI)	100	50	100	55
19.	Software Defined Radio, Cognitive Radio systems	50	50	50	55
20.	Repeaters (RF/RF-over-Optical), IBS, and Distributed Antenna system	100	55	100	60
21.	Satellite based systems –Hubs, VSAT Disaster Communication Systems etc.	50	35	50	40
22.	Copper access systems (DSL/DSLAM), high-speed xDSL (G.fast)	50	50	50	55
23.	Network Management systems (NMS) with its various derivatives	100	65	100	65
24.	Security and Surveillance Communication Systems (video and sensors based) including Perimeter Security Systems	100	35	100	40
25.	Optical Fiber	50	50	50	50
26.	Optical Fiber Cable	75	50	75	55
27.	Telecom Power System (Including Solar Power)	50	50	50	55
28.	Telecom Batteries (Lead Acid & Li-ion)	50	50	50	55
29.	IP audio phones / IP video Phones / Analog adaptor	50	35	50	40
30.	SDN Software Controllers, NVF and CNF software	50	50	50	55
31.	Telecom Cloud infrastructure, Telecom Data centers	50	35	50	40
32.	2 way Analog/Digital radio including Walkie-Talkie & Mobile Radio	50	50	50	55
33.	Batteries of 2 way Analog/Digital radio including Walkie-Talkie	50	40	50	45
34.	Fiber Monitoring System	50	50	50	55
35.	M2M/IOT Subsystems	50	50	50	55
36.	Telecom Services/Works	100	70	100	70

PMI =Minimum preference in % (of total quantity being procured) for Make in India Telecom Products, Services or Works as indicated against each financial year

LC = Minimum Local Content as a percentage of total Bill of Material (cost of production) to qualify as Make in India Telecom Products, Services or Works as indicated against each financial year

-----END OF TABLE-A-----

Table-B

Main Inputs /stages for manufacture of telecom products & conditions for the inputs to be qualified as Local Content	
Main Inputs /stages for manufacture of telecom products *	Conditions for the inputs to be qualified as Local Content
1) Design (a) Hardware design (b) Software Design & Development	The maximum Local Content (LC) percentage for Design which can be claimed by a Local manufacturer for the telecom products based on in-house/in country R&D costs incurred/amortized to create IPR in India are as per Table-C subject to the condition that: (a) The Intellectual Property Right (IPR) resides in India for Hardware Design, (b) The Copyright is in India for the software Design & Development.
2) Components (a) Integrated chips (ICs) – Processor, Memory etc. (b) Active components – Transistors, Diodes etc. (c) Passive Components – Resistors, Capacitors, Inductors etc.	Manufactured in India
3) PCBs (a) PCB Fabrication (b) PCB population using components	Manufactured in India
4) Cables/Chassis etc. (a) Chassis (b) Cables (c) Racks (d) Heat sinks (e) Enclosures	Manufactured in India
5) RF Components/Subsystem (a) Duplexers/Filters (b) Antenna	Manufactured in India
6) Assembly/Integration/Testing [#]	The upper ceiling limit of Domestic Local Content (LC) for Assembly/ Integration/ Testing in respect of the telecom products listed in Table-C would be 10% of the total product Bill of Material (except S. No. 25,26 and 36)
* The product may include some/all of the input/stage as mentioned above. While calculating only those inputs/stages will be calculated which are involved in the manufacturing of these telecom products.	
# In case a system of its subsystem is merely assembled / integrated / tested, then actual Local Content shall be taken as up to 10% only of the cost of system / subsystem.	

-----END OF TABLE-B-----

Table-C

Maximum ceiling for Design as Local Content out of total LC for Telecom Equipment		
Sl. No.	Telecom equipment Description	Maximum ceiling for Design as Local Content out of total LC
1	Encryption/UTM platforms (TDM and IP)	55
2	IP/MPLS Core routers/ Edge/ Enterprise Router	40
3	Managed Leased line Network equipment	40
4	Ethernet Switches (L2 and L3), Hubs	40
5	IP based Soft Switches, IMS, Unified Communication Systems	40
6	Wireless/Wireline PABXs / IP PBX & / Media Gateways	45
7	CPE (including Wi-Fi Access points and Routers, Media Converters), 2G/3G/4G/LTE Modems, Leased-line Modems, NFV/SDN CPE	30
8	Set-Top Boxes	35
9	SDH/Carrier-Ethernet/MPLS- TP/ Packet Optical Transport equipment/ PTN/ OTN systems	45
10	DWDM/CWDM systems	40
11	GPON / XGS-PON, NG-PON2 equipment (including ONT and OLT)	40
12	Optical/SDH/PDH Cross Connects/ OTN Cross-connects and optical MUX,OADM	40
13	Small size 2 G/3 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH	40
14	2 G/3 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH	40
15	Small Size LTE/LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNode B, Small Cells, EPC, NIB C-RAN BBU and RRH ,LTE/LTE-R/4.5 G/ 5 G based broadband wireless access systems (eNodeB, gNB, EPC, etc.)	40
16	LTE/LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNode B, Small Cells, EPC, NIB C-RAN BBU and RRH ,LTE/LTE-R/4.5 G/ 5 G based broadband wireless access systems (eNodeB, gNB, EPC, etc.)	35
17	Wi-Fi based broadband wireless access systems (Including Access Point, Aggregation Block, Core Block), Integrated Broadband system	35
18	Microwave Radio systems (IP/Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI)	35
19	Software Defined Radio, Cognitive Radio systems	35
20	Repeaters (RF/RF-over-Optical), IBS, and Distributed Antenna system	40
21	Satellite based systems –Hubs, VSAT Disaster Communication Systems etc.	25

22	Copper access systems (DSL/DSLAM), high-speed xDSL (G.fast)	35
23	Network Management systems (NMS) with its various derivatives	50
24	Security and Surveillance Communication Systems (video and sensors based) including Perimeter Security Systems	30
25	Optical Fiber	NIL
26	Optical Fiber Cable	NIL
27	Telecom Power System (Including Solar Power)	30
28	Telecom Batteries (Lead Acid & Li-ion)	30
29	IP audio phones / IP video Phones / Analog adaptor	15
30	SDN Software Controllers, NVF and CNF software	15
31	Cloud infrastructure, Data centers	20
32	2 way Analog/Digital radio including Walkie-Talkie & Mobile Radio	30
33	Batteries of 2 way Analog/Digital radio including Walkie-Talkie	30
34	Fiber Monitoring System	35
35	M2M/IOT Subsystems	35
36	Telecom Services/Works	NIL

-----END OF TABLE-C-----

-----END OF APPENDIX-K-----

Section-1

Introduction, General Information and General Requirement

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Section 1

Introduction, General Information and General Requirement

1.1 Introduction and General Information

This Volume II of the Tender Document describes the technical specifications for OPGW Packages under Communication System Projects which includes overhead fiber optic cabling and associated items. This specification describes the functional and performance requirements of OPGW packages. The intent of this Package is to implement a communication system network based on OPGW in India. The execution of the aforesaid project has been entrusted to POWERGRID, a Govt. of India Enterprise, (herein referred as 'Employer').

The purpose of this section of the specification is to provide scope of work, general information about the existing systems and the proposed system under this project, requirements, responsibilities & obligations of contractor, Employer & Owner and general bidding requirements for the project.

1.2 Proposed Communication System

The proposed communication system shall be fibre optic based and shall consist of overhead fibre optic links with a bit rate of Synchronous Transport Module-4 (STM-4)/ Synchronous Transport Module-16 (STM-16).

1.3 Scope and General Requirements under the OPGW Package

The scope of this package is described in following:

1.3.1 Fibre Optic Cabling and associated items

The broad scope of the procurement of this part include the survey, planning, design, engineering, manufacturing, supply, transportation, insurance, delivery at site, unloading, handling, storage, Supervision of erection/installation , installation, splicing, termination, testing, training, and demonstration for acceptance, commissioning and documentation for:

- a) OPGW including all associated hardware accessories & fittings
- b) Fibre Optic Approach Cable including installation hardware
- c) Underground Fiber Optic cable(UGFO)/All Dielectric Self Supporting(ADSS) cable including installation material, accessories and fixtures
- d) Fibre Optic Distribution Panels (FODP) & Joint Box
- e) Supply of spares
- g) All other associated work/items described in the technical specifications.

“The existing earthwire/OPGW alongwith its hardware & fittings shall be dismantled & taken away by the contractor on installation of OPGW. The contractor shall quote the

buyback price for the dismantled earth wire / OPGW(along with hardware fittings & accessories).”

Standard OPGW designs are to be used for various voltage levels & wind zones of transmission lines that are mentioned at Section-02 of Technical Specifications . In case of constraints in adopting standard design for any of the transmission line(s) or for any specific sections such as higher spans (>600m), Valley crossings, snow covered sections or for other voltage levels & wind zones etc., the Contractor may propose customized design(s) during detailed engineering to meet the requirement.

Mostly, the OPGW Cable under this specification shall be installed under live line conditions, i.e. with all circuits of the transmission line charged to their voltage. Installation The bill of quantities for the same is specified in the appendices accordingly. However, the actual quantities for the requirement may vary during implementation which shall be finalised after detailed survey. The Contractor has to carry out the detailed survey and collect the required data for preparation of OPGW BoQ. Aviation Globules are to be removed and reinstalled from earth wire to OPGW wherever applicable during OPGW installation.

The various sections of these specifications defines the survey, design, performance, installation, testing & implementation for the fibre optic cable system.

1.4 General Technical Requirements

List of items, goods, services or works from Class-I Local supplier meeting the Minimum Local Content notified in Annexure-1 of Ministry of Power (MoP) order on ‘Pubic Procurement (Preference to Make In India) to provide for purchase preference (linked with local content) in respect of Power Sector’ dated 16.11.2021 is enclosed at **Appendix-J** to this Technical Specifications.

List of items, goods, services or works from Local supplier meeting the Minimum Local Content notified in Table-A, B & C of Department of Telecommunications(DoT), Ministry of Communications order dated 29.08.2018 on ‘Public Procurement (Preference to Make In India) Order 2017 –Notification of Telecom products, Services or Works – regarding’ is enclosed at **Appendix-K** to this Technical Specifications.

1.4.1 Fibre Optic Cable

Fibre Optic Approach Cable and Under Ground Fibre Optic Cable shall be offered from a manufacturer(s) **who is a “Local Supplier” as per latest DPIIT and DoT notification.**

1.4.2 Aerial Fibre Optic (ADSS) Cable manufacturer

The Aerial Fibre Optic cable shall be offered from a manufacturer(s) who is a “Local Supplier” as per latest DPIIT and DoT notification and has been manufacturing Aerial Fibre Optic cable for the last three (3) years and at least 100 Km of Aerial Fibre Optic cable manufactured by such manufacturer(s) shall have been in satisfactory operation for at least two (2) years as on the date of bid opening.

1.5 General Requirements

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

It should be noted that preliminary design information and in this specifications are indicative only. The Contractor shall verify the design data during the site surveys & detail engineering and finalise the BoQ as required for ultimate design & system performance. The Employer reserves the right of execution of works within the stipulated quantity variation provision at places (anywhere inside Northern Region) other than those indicated in the appendices at the same rates, terms and conditions.

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 surveys, design, and engineering may lead the Contractor to conclude that additional items are required that are not specifically mentioned in this specification. The Contractor shall be responsible for providing at no added cost to the Employer, all such additional items such that a viable and fully functional Communication System is implemented that meets or exceeds the capacity, and performance requirements specified. 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 in their proposal.

All communication equipments provided shall be designed to interface with existing communication equipments and shall be capable of supporting all present requirements and spare capacity requirement identified in this specification.

The communication equipments shall be designed and provisioned for expansions and reconfigurations without impairing normal operation, including adding and removing circuits. The offered items 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 Contractor shall demonstrate a specified level of performance of the offered items during well structured factory and field tests.

The Bidders are advised to visit sites (at their own expense), prior to the submission of a proposal, and make surveys and assessments as deemed necessary for proposal submission. The successful bidder (Contractor) is required to visit all sites. The site visits after contract award shall include all necessary surveys to allow the contractor to perform the design and implementation functions.

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

- a) Suitability of transmission line for live line OPGW cable installation on the present infrastructure, towers, earth wire, etc.
- b) Identification of higher spans exceeding 600 m and submission of earth wire/conductor sag details for checking suitability of OPGW for such span.
- c) Details of power line crossing using diamond configuration.
- d) Proposed routing of the approach FO 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.
- e) The positions of fibre optic distribution panel (FODP) to be finalised during survey and the same shall be indicated in the survey report.
- f) Identification of facility modifications, if required.
- g) Identify all additional items required for integration for each site/location.

1.6 General Responsibilities and Obligations

This section describes the general responsibilities and obligations of the Contractor and the Employer.

1.6.1 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 this specification. The implementation plan shall be modelled such that it provides fibre optic cabling and communication system support for the activation of this Project. The Implementation plan shall include the activities of the Contractor, the Owner and the Employer, showing all key milestones such as facilities readiness and clearly identifying the nature of all information and project support expected from the Employer. The Employer and Contractor shall finalise the detailed Implementation plan following award of the contract.

1.6.2 Contractor's Responsibilities and Obligations

The Contractor shall be responsible for the implementation of the Fibre Optic Cable system and communication system under the package . The Contractor shall be responsible for all cabling and wiring associated with the equipment provided, both inside and outside buildings in accordance with technical specifications. The Contractor shall also be responsible for determining the adequacy of the local power source for the equipment and for wiring to it, with adequate circuit protective breakers. In addition, the Contractor shall be responsible for shielding equipment and cabling to eliminate potential interference to or from the equipment, and for earthing all cabinets and shields.

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

- (1) Provide a working system 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) Inputs for finalisation of installation and safety guidelines and procedures for the stringing, mechanical installation
- (4) Obtaining statutory clearances from regulatory bodies, statutory bodies such as municipality, highway authority, electrical utilities, forest department, gas authorities etc.
- (5) Development of installation and safety guidelines and procedures for the complete system.
- (6) Development of procedure for splicing of all fibre optic cable, including testing and documentation.
- (7) Project management, project scheduling, including monthly progress reports documenting progress during the contract period.
- (8) Coordination with other Project Contractors for phased implementation and system integration & commissioning of the overall communications network
- (9) Engineering and technical assistance during the contract and warranty period and annual maintenance contract (AMC) period.
- (10) Site visits, surveys, and studies necessary to identify and provide all equipment needed to implement the FO Cable installation and communication network.
- (11) For any renovation, expansion or construction of facilities required to be carried out by Employer, the Contractor shall provide in the survey report the details necessary to enable such work to be carried out.
- (12) Assessment of suitability for live line installation of overhead FO cable on the present infrastructure, tower etc.
- (13) Design and Installation of the mechanical assemblies and accessories, including vibration dampers required for installation of all overhead fibre cable. To conduct structural analysis and to carry out tower strengthening if required, any or all additional steel work or modifications required to attach the overhead fibre cables shall also be carried out by the Contractor. Design data of towers shall be provided by the Employer.
- (14) Supply, installation and termination of cables and cabling for all interconnection.
- (15) Intimate source power requirements within 30 days after receipt of the order for each cabinet/ rack of equipment provided at each location.
- (16) Factory and site acceptance testing of all items including hardware, software & firmware provided.

- (17) Conduct type tests or provide documented evidence of satisfactory Type Test performance to the Employer.
- (18) Provide a Quality Assurance Plan ensuring the Employer access to the manufacturing process.
- (19) Providing earthing system and extension of earthing system
- (20) Shipment of all equipment and documentation to the Employer designated locations and/or staging areas.
- (21) Storing, Staging, maintenance and security of the staging area up to the operational acceptance including the full responsibility for protection from fire and theft of the supplied equipment.
- (22) Connectivity with the FODP.
- (23) All Fibre Optic Distribution frame patch facilities.
- (24) Implement all minor civil works as per Technical Specification.
- (25) All documentation and drawings as specified.
- (26) All required spare parts, maintenance aids, etc.
- (27) Training of Employer personnel
- (28) Maintenance and support of the items through final acceptance, and maintenance throughout the warranty period.
- (29) Due diligence in properly planning and executing the work so as to minimise any physical damage.
- (30) The Contractor shall appoint key personnel for the project such as Project Manager, Site Manager, Design Engineer, Installation Engineer and Commissioning Engineer only after approval of the experience data by the Employer. Approval of the Employer shall be obtained, whenever the Contractor wants to change key personnel.
- (31) Mandatory Testing and Certification of Telecom Equipments (MTCTE) under Indian Telegraph (Amendment) Act, 2017 : Mandatory Testing and Certification of Telecom Equipment (MTCTE)' under the provision of Indian Telegraph (Amendment) Rules 2007 shall apply on all equipment to be supplied under subject Package. Contractor has to supply only certified equipment as per MTCTE. Please refer the weblink <https://www.mtcte.tec.gov.in> for more details.
- (32) Provision to be complied as per latest guidelines of GOI/ MOP/DPIIT/DOT.

The Contractor shall ensure following things and at their own cost,:-

- (i) *Any imported equipment/material/item/parts/component to be supplied under the contract shall be tested in the certified laboratories to check for any kind of embedded malware/trojans/cyber threats and for adherence to Indian Standards as per the directions issued by Ministry of Power/Govt. of India from time to time. In case of such import from specified "prior reference" countries, the requirement of prior permission from the Govt. of India including protocol for testing in certified and designated laboratories by Ministry of Power/Govt. of India shall also be complied with by the contractor.*
 - (ii) *The equipment offered by the contractor shall at least conform to the requirements specified under relevant IS standard. In case of discrepancy between IS and other international standard, provisions of IS shall prevail. The Contractor shall also note that the list of standards presented in this specification is not complete. Whenever necessary, the list of standards shall be considered in conjunction with specific IS. If the IS standard is not available for an equipment/material, then other applicable International standard (IEC/Equivalent), as per the specification, shall be accepted."*
 - (iii) *The bidder/contractor shall list out the products and components producing Toxic e-waste under the contract and shall furnish to the Employer the procedure of safe disposal at the time of closing of the contract.*
 - (iv) *The Bidder shall have to furnish a certificate regarding cyber security/safety of the equipment/ process to be supplied/services to be rendered as safe to connect.*
- (33) The contractor shall take measures to avoid trippings during Live Line OPGW installation. In case of tripping of EHV lines (132kV & above) observed on account of poor workmanship following provisions shall be applicable :

An amount equal to Rs 30,000/-plus applicable taxes per incident shall be recovered from contractor. In case of consecutive incidents in any of the line under the said package within a period of 90 days from last such incident), an additional amount of Rs 30,000/-plus applicable taxes mentioned above for every incidental tripping over the last recovered amount. After 03 consecutive trippings, a fixed rate of Rs 1,00,000 per tripping shall be recovered from contractor bills.

Detailed descriptions of the Contractor's obligations, in relation to individual items and services offered, are delineated in other sections of this specification.

FACILITIES TO BE INCORPORATED FOR LABOUR.

The Contractor shall, on his/their own cost, provide his/their labour with sufficient number of the following facilities with the indicated specifications:-

Tents:

- i. Tent should be with double layer canvas, outer layer being water-proof. The size / number

- should be sufficient to accommodate required number of people comfortably.
- ii. The preferred size of tent should be 20ft x 20ft with Centre height of 7 ft and side height of 2.5 ft.
 - iii. Tent windows should have arrangement for mosquito net with waterproof outer covering.
 - iv. Doors of the tents shall have Velcro or any other closing system.
 - v. The site selected for the camp shall be on high ground, removed from Jungle.
 - vi. Efficient arrangement for draining away stagnant water should be provided so as to keep the camp neat and tidy.
 - vii. The tents should have illumination at night by providing battery operated LED lanterns or equivalent lighting system.

Portable (Tyre- mounted) Bio toilet

- i. The toilet seats should be 'Indian'
- ii. The number of Toilets should be not less than 2 per 50 laborers with separate toilets for female laborers.
- iii. Bio-tank should be of sufficient capacity to allow bacteria present to decompose the excreta and only waste water (odourless and harmless) gets discharged out of the toilet through a sewerage channel away from the tent areas and working areas.
- iv. Water tank of adequate capacity should be installed with the Portable Toilet.

1.6.3 The Employer Responsibilities and Obligations

The Employer will provide the following items and services as part of this Project:

- 1) Review and approval of the Contractor's designs, drawings, survey reports and recommendations.
- 2) Participation in and approval of "Type", factory and site acceptance tests.
- 3) Review and approval of training plans.
- 4) Assistance in obtaining statutory clearances from regulatory bodies.
- 5) Approval of key personnel for the project.
- 6) Overall project management of the project
- 7) Provide to the extent possible the details of the survey carried out by the Transmission Line Contractor along with tower spotting data, snow load details and other mechanical loads etc.

1.7 General Bidding Requirements

The Bidder shall be responsive to the technical requirements as set forth in this specification. 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 Employer's specified objectives. The plan shall include the activities of both the Contractor and Employer, show all key milestones, and clearly identify the nature of all information and project support to be provided by Employer.
- (3) The bidder shall submit with their proposal, performance certificates for all the offered equipments (other than QR items and the items for which General Technical Requirements has been specified in this section) from at least one customer. The performance certificates shall provide evidence of successful operation of the proposed equipment for at least one year as on date of NOA.
- (4) A commitment and a clearly defined plan to develop a system support organization, based in India and capable of providing a full range of local services (including software and hardware maintenance and upgrade support) for the life of the delivered telecommunications systems.
- (5) The bidder may offer the bought-out items from more than one manufacturer. In case of QR items and the items for which General Technical Requirements has been specified in this section, the bidder shall provide supporting qualification document also.
- (6) The General Technical Requirements data of the Manufacturer (in support of meeting the requirements at clause 1.5 of this section) shall be furnished in the bid.

**Table 1-1;
Bid Documents Checklist**

S. No.	Description:	Enclosure Reference	
1	Completed Data Requirement Sheets (As per Appendix of Technical Spec Volume II)	Page no. Ref no.	
2	Performance certificate	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.	
5	General Technical Requirements data of the Manufacturer. (As per relevant Sections of Technical Spec Volume II)	Page no. Ref no.	

1.8 Organization of the Technical Specification Document

Sections 2 through 7 and Appendices provide the project requirements of the fibre optic cabling system to be provided.

Section 2 contains specifications and functional description of OPGW cabling & associated hardware & fittings

Section 3 contains the requirement for Inspection & Testing

Section 4 contains the requirement for Training and Support Services

Section 5 contains the documentation and deliverables requirements

Section 6 describes project management, schedule and implementation plan

Section 7 contains specifications for Aerial cabling (ADSS) and associated hardware & fittings

TS for UGFO also provided.

The following is a list of the Volume II Appendices:

- Appendix A - General Information
- Appendix B - Data Requirement Sheets (DRS)
- Appendix C - Guidelines for Live Line Installation
- Appendix D - Guidelines for Off Line Installation
- Appendix E - Splicing Guide Lines
- Appendix F - Type Test Procedure
- Appendix G - FAT Procedure
- Appendix H - SAT Procedure
- Appendix I - Guidelines for Approach Cable Installation

- Appendix J - Annexure-1 of Ministry of Power (MoP) order on 'Public Procurement (Preference to Make In India)
- Appendix K - Table-A, B & C of Department of Telecommunications(DoT), Ministry of Communications order dated 29.08.2018 on 'Public Procurement (Preference to Make In India)

1.9 Applicable Standards

The applicable standards are mentioned in the respective technical section. The offered equipment shall conform to the standards mentioned in the specification except to the extent modified by this specification. In case of any discrepancy between the description given in the specification and the standards, the provisions of the technical specification shall be followed. The parameters not specifically mentioned in this specification shall conform to the standard mentioned in this specification.

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 Contractor shall attempt to comply with such, provided that no additional expenses are charged to the Employer without Employer's written consent.

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

In case values indicated for certain parameters in the specifications are more stringent than those specified by the standards, the specification shall override the standards.

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

- (i) IEEE 802.3, 1138-2021
- (ii) ITU-T/CCITT Recommendations, G.652, G.701, G.702, G.703, G.711/ 12/ 14/ 35/ 36, G.721, G.742, G.811 and G.823
- (iii) ITU-T/CCITT Recommendations, G.801, G.821, G.822, G.823, G.826.
- (iv) ITU-T/CCITT Recommendations of the V Series
- (v) ITU-T/CCITT Recommendations R35, R37, and R38A (or R38B)
- (vi) ITU-T/CCITT Recommendations M3010, G771
- (vii) Internet Activities Board, RFC-1157 (SNMP)
- (viii) International Electrotechnical Commission standards, IEC 60801-2/3/4/5, IEC-60255-4, IEC-60255-5, IEC-60870-2-1, IEC-60721-3-3, IEC-60529.
- (ix) International Electrotechnical Commission standards, IEC 1000-4-xx series.
- (x) IEC publication 60068, 60068-2-2, 60068-2-3, 60068-2-14, 60068-2-27, 60068-2-32.
- (xi) ITU-T/CCITT Recommendations K.11, K.17, K.20.
- (xii) International CISPR standards

1.10 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

----- **End of this Section** -----

**Section-02
Specification for Fibre Optic cabling & associated items**

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Section-02
Specification for OPGW cabling and associated hardware & fittings

This section of the technical specification describes the functional and technical specifications of Fibre Optic cabling and associated items.

2.1 Fibre Optic Cabling

In this section of the technical specification, the functional & technical specifications of OPGW cable, Fibre Optic Approach Cable, Joint Box and associated hardware & fittings for the requirements for G.652D Dual-window Single mode (DWSM) telecommunications grade optical fibre is specified. Bidders shall furnish with their bids, detailed descriptions of the fibres & cable(s) proposed.

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

2.1.1 Required Optical Fibre Characteristics

The optical fibre to be provided should have following characteristics :

2.1.1.1 Physical Characteristic

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

2.1.1.2 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.

**Table 2-1(a)
DWSM Optical Fibre Characteristics**

Fibre Description:	Dual-Window Single-Mode
Mode Field Diameter @ 1310nm:	8.6 to 9.5 μm ($\pm 0.6\mu\text{m}$)
Cladding Diameter:	125.0 $\mu\text{m} \pm 1 \mu\text{m}$
Mode field concentricity error	$\leq 0.6\mu\text{m}$
Cladding non-circularity	$\leq 1\%$
Cable Cut-off Wavelength λ_{cc}	$\leq 1260 \text{ nm}$

Table 2-1(a)
DWSM Optical Fibre Characteristics

1550 nm loss performance	As per G.652 D
Proof Test Level	≥ 0.69 Gpa
Attenuation Coefficient:	@ 1310 nm ≤ 0.35 dB / km @ 1550 nm ≤ 0.21 dB / km
Chromatic Dispersion; Maximum:	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 ² xkm) maximum
Polarization mode dispersion coefficient	≤ 0.2 ps/km ^{1/2}
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60°C to +85°C)
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

2.1.2 Fibre Optic Cable Construction

The OPGW (Optical Ground Wire) cable is to be installed on the transmission lines in place of Earth wire for 765/400/220/132kV lines. 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 meeting the design parameters specified in Technical Specifications.

2.1.2.1 Optical Fibre Cable Lengths in Customised or Standard drums

The estimated optical fibre cable length for F.O. link(s) are provided in BPS considering 5% for plain and 7% for hilly areas over and above route length of the transmission line. The permissible extra consumption is inclusive of cable length required to meet OPGW sag which is not more than 1% of the route length. Other such as splicing lengths (upto 10m per OPGW drum), loop length (upto 10m per OPGW drum), tower heights/down lead length (as per actuals), wastages (if any), etc are included in the permissible extra consumption limit mentioned above.

(a) Supply in Customised Drums:

Contractor shall supply the OPGW cable in customised drum lengths preferably as mentioned below:

- (i) 3km to 3.5km drum size for 765kV voltage lines.
- (ii) 4km to 5km drum size for upto 400kV and below voltage lines.

Contractor to preplan termination/splicing of OPGW on tension towers based on approved tower schedule provided by POWERGRID during detailed engineering. In case of constraints, termination/splicing of OPGW at Suspension towers may be accepted in consultation with Project Manager.

(b) Supply in Standard Drums:

Alternatively, the contractor shall supply the OPGW cable in standard drum length mostly in 5 km (with $\pm 5\%$ tolerance) for plain terrain & 3 km (with $\pm 5\%$ tolerance) for hilly terrain in consultation with Project Manager.

For 765kV voltage lines, Standard Drum size of 3km(with $\pm 5\%$ tolerance) may be preferred for Standard Drum BoQ.

BoQ for Supply of OPGW & its associated items (i.e. Hardware fittings, vibration dampers, Joint box, Approach cable & its installation hardware, FODP etc.) along with mandatory spares shall be released by Project Manager for purpose of supply in consultation with contracting agency.

2.1.2.2 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 Bellcore GR-20 colour-coding scheme.

Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogenous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing.

Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibres is included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibres shall be suitably bundled, tagged and identified at the factory by the vendor.

2.1.2.3 Optical Fibre Strain& Sag-Tension chart

The OPGW cable the optical fibres shall experience no strain under all loading conditions defined in IS 802. Zero fibre strain condition shall apply even after a 25 year cable creep. For the purpose of this specification, 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
- 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.
- The cable *max strain* is defined as the maximum strain experienced by the Cable under the worst case loading condition.
- The cable *Every Day Tension (EDT)* is defined as the maximum cable tension on any span under normal conditions.
- The *Ultimate Tensile Strength (UTS/ 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:

- The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/ Strain margin of the cable.
- The sag shall not exceed the earth wire sag in all conditions.
- The Max Allowable Tension shall also be less than or equal to 0.45 times the UTS.
- 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.
- The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable.

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

1. 53° C , no wind and no ice
2. 32° C, no wind and no ice
3. 0°C, no wind and no ice
4. 32° C, full wind and no ice
5. 32° C, 75% full wind and no ice
6. 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 600 m or higher span length in the range of 50 m spans. Max. Vertical sag, max. tension and max sag at 0° C & no wind shall be considered in line with the design parameter of transmission line. The full wind load shall be considered as the design wind load for all the specified transmission lines as per relevant IS 802 version and the sag-tension chart shall be submitted considering the transmission lines.

2.1.2.4 Cable Materials

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

2.1.2.4.1 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 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.

2.1.2.4.2 Metallic Members

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

2.1.2.5 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 white lettering with the vendors' address, the Purchaser's destination address, cable part number and specification as to the type of cable, length, number of fibres, a unique drum number including the name of the transmission line & segment no., factory inspection stamp and date.
- (b) Cable Drums and Packing: The OPGW shall be supplied in returnable steel drums for main supply & non-returnable steel drums for spare supply. These painted steel drums shall be corrosion free, shall be of adequate strength, and constructed to protect the OPGW against all damage and displacement during transit, storage ,subsequent handling & stringing operations in the field. The supplier shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The ownership of the empty OPGW drums shall lie with the OPGW supplier who shall ultimately take back the empty OPGW drums 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 on standard drum length.

2.1.3 Optical Ground Wire (OPGW) construction

OPGW cable construction shall comply with IEEE-1138, 2021. 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.

2.1.3.1 OPGW design

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. The fibre coating and buffer shall be strippable for splicing and termination. Each fibre unit shall be individually identifiable utilizing colour coding. Buffer tubes shall be filled with a water-blocking gel. The individually coated optical fibre(s) shall be provided directly in stainless steel tube in case stainless steel tube design.

(a) Central Aluminium tube type

The composite fibre optic overhead ground wire shall be made up of multiple buffer tubes embedded in a water tight aluminium/aluminium alloy protective central fibre optic unit surrounded by concentric-lay stranded metallic wires in single or multiple layers. Each buffer tube shall have maximum 12 no. of fibres. All fibres in single buffer tube or directly in central fibre optic unit is not acceptable. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre.

(b) Central Stainless Steel tube type

The composite fibre optic overhead ground wire shall consist of a central fibre optic unit made up of stainless steel with aluminium coating/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

Central Fibre Optic Unit

(a) Central Aluminium tube type

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

The OPGW design of dissimilar materials for stranded wires and tubes are not allowed. Central fibre optic unit may be of aluminium / aluminium alloy tube. There shall be no exposed areas of tubing that can make electrical contact either directly or indirectly through moisture, contamination, protrusions, etc with the

surrounding stranded wires. The tube may be fabricated as a seamless tube, seam welded, or a tube without a welded seam.

(b) Central Stainless Steel tube type

The central fibre optic unit shall be designed to house and protect optical fibres provided in single buffered tube of stainless steel tube from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central fibre optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibres from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen.

The OPGW design of dissimilar materials for stranded wires and tubes are not allowed. Central fibre optic unit shall be of stainless steel tube with aluminium protective coating or stainless steel tube with Al protecting outer tube. In case of aluminium protective coating, the coating must completely cover the tubes leaving no exposed areas of tubing that can make electrical contact either directly or indirectly through moisture, contamination, protrusions, etc with the surrounding stranded wires. The tube may be fabricated as a seamless tube, seam welded, or a tube without a welded seam.

2.1.3.2 OPGW Parameters to be considered for different line voltage and wind zones

Transmission Line Voltage and wind zone	OPGW Cable Parameters						
	UTS (Kg)	Area (sqmm)	Wt. (Kg/m)	Dia. (mm)	Modulus of Elasticity (Kg/sqmm)	Coeff. Of linear Expansion (per deg C)	Central Fibre optic unit design
765 kV S/C & D/C WZ 1-4 765kV S/C & D/C WZ 5 400kV M/C WZ 1-5 400kV S/C & D/C WZ 1-5	9350± 150	56.5± 2.5	0.45± 0.01	12 ± 0.2	14290±110	0.0000138± 0.0000003	Al tube*
765 kV WZ 5	9098± 150	57.5±2.5	0.49 ± 0.01	11.5 ± 0.2	14114 ± 110	0.0000136 ± 0.0000003	Stainless Steel Tube
220 kV S/C & D/C WZ 1-4 132kV S/C & D/C WZ 1-5	7376±50	51±2	0.355±.01	11.4±.02	12344±100	0.0000149± 0.0000003	Al Tube*
River Crossing Section	20059±100	118±5	0.884±0.01	14.7±0.2	16355±100	0.0000127± 0.0000003	Stainless Steel Tube
800kV	10369.0112	72.66	0.5719	13.5	13788.99	0.00001404	Al tube*

Transmission Line Voltage and wind zone	OPGW Cable Parameters						
	UTS (Kg)	Area (sqmm)	Wt. (Kg/m)	Dia. (mm)	Modulus of Elasticity (Kg/sqmm)	Coeff. Of linear Expansion (per deg C)	Central Fibre optic unit design
	Or suitable to tower design				Or suitable to tower design		
Special cable (For Ladakh WZ-6 with snow, 25mm snow in Arunachal Pradesh, high UTS special applications, etc)	15316 to 15300.72	90.50 to 107	0.715 to 0.750 (Mass tolerance of 2%)	13.6 (tolerance of 3%)	15973.4 to 15989	0.0000125	Stainless Steel Tube

*-Note: In case of 96Fiber OPGW, Stainless Steel tube is also acceptable.

For Al tube & Stainless steel tube design details refer clause 2.1.3.1 above.

Basic Construction

The OPGW cable construction shall conform to the applicable requirements of this 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 hand lay. 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. The finished wires shall contain no joints or splices unless otherwise agreed to by the Employer and shall conform to all applicable clauses of IEC 61089 as they pertain to stranded conductors.

The wires shall be so stranded that when the complete OPGW is cut, the individual wires can be readily regrouped and then held in place by one hand.

Breaking Strength

The rated breaking strength of the completed OPGW shall be taken as 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.