TYPE TEST PROCEDURE FOR OPGW CABLE

(15) Test Name: Ultimate Tensile Strength Test
Final Customer: Power Grid Corporation of India Limited, India.
Project Name:
Manufacturer:
Cable Type:
Standard: IEEE 1138-2021 Method 6.5.1.4

Classification: Cable characteristic/mechanical/mandatory

Intent

The intent of the Ultimate Tensile Strength Test is to determine the actual measured breaking strength of the cable.

Objective

a) To verify that the actual (ultimate) tensile strength of the OPGW cable meets or exceeds the UTS of the OPGW cable specified by the supplier.

b) Monitoring the optical performance of the OPGW cable is not required during this test unless specified by the cable purchaser.

Set-up

The OPGW cable sample shall be installed in a suitable tensile test machine. The length of the cable between the loading points of the dead-end assemblies shall be a minimum of 10 m. A suitable transducer such as a load cell or dynamometer shall be used to measure the tension in the cable.

Procedure

The load shall be applied at a uniform rate to reach the UTS of the cable in at least 5 min. The ultimate tensile strength of the cable shall be defined as the maximum measured load of the cable at failure. Individual strand failures above UTS do not necessarily constitute an ultimate cable failure. However, there shall be no mechanical failures in the cable below 100% UTS. This is to reduce the chances that the outer strands will unravel below the maximum design loading conditions.

This test may be performed separately or on the same cable sample as the stress-strain test or the MRDT Test. In this case, the ultimate tensile strength test would be performed immediatelyfollowing the stress-strain test or the strain margin test.

Acceptance criteria

The ultimate tensile strength (UTS) of the OPGW cable shall meet or exceed 100% of the UTS of the cable.In addition, there shall be no outer layer strand failure in the cable below 100% UTS.

However, if the maximum load does not meet 100% of the UTS of the cable, and if either of the following
occurs the test shall be repeated with an alternative gripping mechanism:

a) The break occurs inside or within 50 mm (2 in) of a dead-end fitting.

b) The OPGW cable slips in a dead-end fitting.

NOTE—If this is a systems test, the above exceptions would not apply.

OBSERVATIONS, IF ANY:

TEST RESULT: The OPGW cable met/not met the acceptance criteria for Ultimate Tensile Strength Test .

(TESTED BY) **(WITNESSED BY)**

Sign & Date Sign & Date

TYPE TEST PROCEDURE FOR OPGW CABLE

(16) Test Name: Lightning Arc Test
Final Customer: Power Grid Corporation of India Limited, India.
Project Name:
Manufacturer:
Cable Type:
Standard: IEEE 1138- 2021 Method 6.5.3.4

Classification: In-service/electrical, mechanical, environmental/mandatory

Intent

The intent of the lightning arc test is to subject the OPGW cable to an electrical arc that is intended to simulate the damaging portion of the lighting arc strike that represents possible filed condition.

Objective

a) To verify the mechanical performance of the OPGW cable when subjected to the simulated lightning conditions for the specified class as per table 5.

b) To verify the optical performance of the OPGW cable when subjected to the simulated lightning conditions for the specified class as per Table 5.

Set-up

The general arrangement for the lightning arc test is shown in Fig 16.1, unless otherwise specified by the cable purchaser.

Test apparatus

The sample shall be of sufficient length to perform up to six simulated lightning arc strikes in six separate sections followed by tension tests. The location of the lightning arc strike shall be applied in the center of each section. Each section of the OPGW sample shall be installed between two fixed abutments. The length of the cable section between the load points of the dead-end assembly shall be greater than 10 m.

A suitable instrument, such as load cell or dynamometer shall measure the tension in the cable.

The OPGW shall be grounded. Suitable equipment to apply the specified simulated arc shall be used to generate a dc current compatible with the values in Table 5.

An electrode with a plane surface shall be used to apply the simulated lightning arc. The electrode should be a material that is not damaged by repeated arcs, such as tungsten. The location of the electrode and returning current points should be symmetrical to balance the electromagnetic forces and stabilize the current arc applied to the cable. A thin filament may be used to initiate the simulated lightning arc strike to the cable. The intent of the filament is to initiate the arc so it should be of minimum diameter and conductivity to maximize the current transfer on the cable. The current waveform shall be measured versus time with a suitable device capable of sampling to at least 1000 Hz. The charge transference shall be calculated from the current trace (area under the curve).

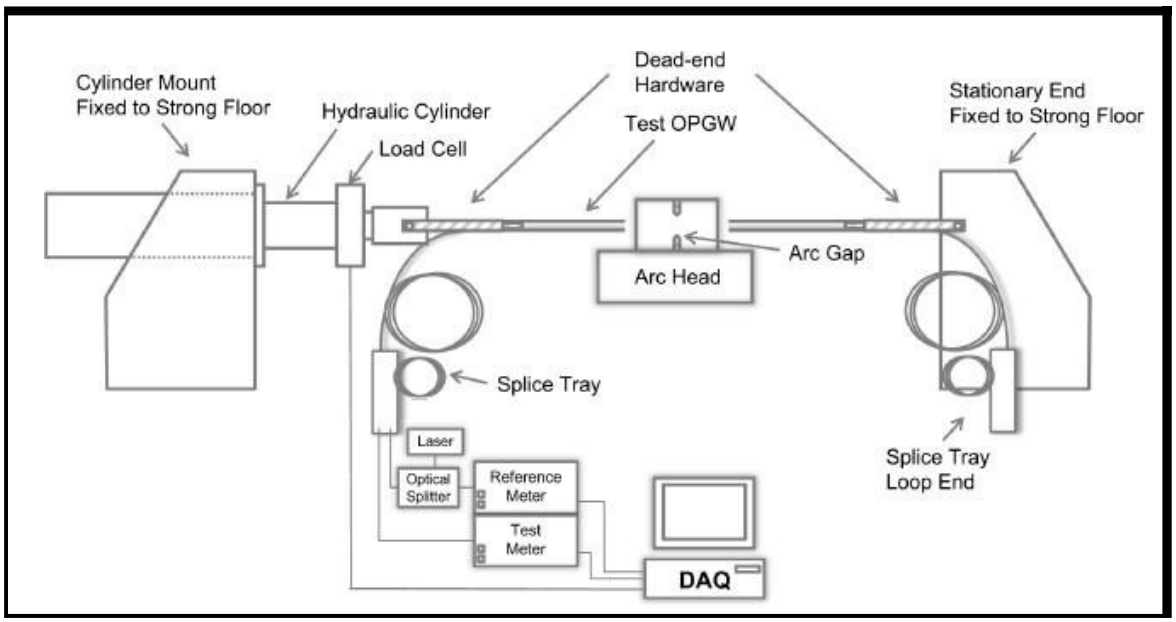

Figure 11—General arrangement for lightning arc test

Optical network

For optical attenuation measurements, the sample shall be prepared according to 6.3. The optical attenuation shall be monitored during each simulated lighting arc strike and recorded by a digital data logging system at a suitable samplingrate. The tension may be recorded manually. Optical attenuation measurement are not required during the tension tests.

Procedure

The cable sample shall be tested to a class rating according to Table 5. Simulated lighting strikes shall be applied in up to six separate locations in the center of each section. To validate the class rating, the cable shall withstand the respectively charge transfer in Table 5. The test class of the OPGW cable shall be specified by the purchaser or manufacturer.

Table 5—Charge transfer class rating Arc exposure:

	Class 0	Class 1	Class 2	Class 3
Current (A)	100	200	300	400
Duration (s)	0.5	0.5	0.5	0.5
Charge transfer (C = A x s)	50	100	150	200

Each of the cable sections shall be tensioned to 15% to 20% of the cable UTS at a temperature of 22°C ±3 °C. An arc current with negative polarity on the electrode shall be applied to the cable through a 5 cm ±1 cm long thin filament. The charge transference to the cable shall be as specified by the purchaser or manufacturer. The tolerance on the charge transference for each individual strike is±10%. A charge exceeding 110% of the target value may also be acceptable, if agreed between the purchaser and manufacturer. A total of five sections shall be successfully exposed to the specified charge transference, with the average of the five charge transfers to exceed 95% of the target. Up to six sections may be tested, to collect at least five qualifying strikes with an average that exceeds 95% of the target.

NOTE—It is not required to perform six hits if the average of the first five hits exceeds 95% of target.

The cable and its components shall be inspected with the unaided eye, and material changes, including the metallic tube, shall be documented. If there are broken wires, the numbers and types (aluminum, ACS) of the broken wires shall be reported.

Tension test after arc: Upon completion of the five simulated lightning arc strikes, one at a time, each section of OPGW shall be tension tested to MRDT. The sections shall be positioned with the strike location approximately in the center of each section. If requested, a breaking strength test can be performed for information only.

To recognize the practical issues of performing this test, re-testing should be discussed and agreed upon between purchaser and manufacturer.

Acceptance criteria

a) After the lightning strike application, the cable sample shall experience no permanent increase in optical attenuation greater than 0. 10 dB for the concatenated loop at nominally 1550 n m ± 20 nm for single-mode fibers.

b) In all five qualifying lightning strike locations, visually, there shall be no damage (holes, cracks, etc.) to the integrity of the metallic tube.

c) During the tension test, at least four out of the five qualifying strike locations shall withstand the MRDT for typical applications, or up to a maximum of 70% RTS for special applications. The metallic tube shall maintain integrity after the tension test to MRDT for typical applications, or 70% RTS for special applications.

NOTE—Special applications are considered when MRDT is higher than 70% RTS.

OBSERVATIONS, IF ANY:

TEST RESULT: The OPGW cable met/not met the acceptance criteria for Lightning Arc test.

(TESTED BY) **(WITNESSED BY)**

Sign & Date Sign & Date

TYPE TEST PROCEDURE FOR OPGW CABLE

(17) Test Name: DC Resistance Test
Final Customer: Power Grid Corporation of India Limited, India.
Project Name:
Manufacturer:
Cable Type:
Standard: IEEE 1138-2021 Method 6.5.1.5

Classification: Cable characteristic/electrical/mandatory

Intent

The intent of the DC Resistance Test is to determine the actual dc resistance of the cable.

Objective

a) To verify that the actual dc resistance of the OPGW cable does not exceed the dc resistance stated by the supplier.

Set-up and procedure

Copper connectors shall be crimped or secured to a cable sample approximately 10 m in length, to achieve 5 m gauge lengths. Alligator-type clips, or other suitable connectors, shall be used to connect a calibrated current source of 10 A to the cable.

Optical measurements are not required for this test.

The potential drop between the two points shall be measured by a micro-ohmmeter and displayed directly as micro-ohms. Resistance measurements shall be taken five times in five locations along the 10 m sample length. The dc resistance per meter of the cable shall be calculated by averaging the five individual measurements and dividing by the gauge length. To reduce error due to heating, the current shall be injected through the cable for only a few seconds to obtain a reading. The temperature at the time of testing shall be recorded.If the temperature of the cable at the time of measurement is lower than that specified by the cable manufacturer, then the resistance measurements shall be corrected to the specified temperature.

For shorter cable length samples, alternative set-ups for resistivity measurements that reduces resistivity error such as 4-wire measurement may also be employed, if agreed between the supplier and the purchaser.

Acceptance criteria

The actual dc resistance of the OPGW cable shall not exceed the dc resistance stated by the manufacturer at the specified temperature.

OBSERVATIONS, IF ANY:

TEST RESULT: The OPGW cable met/not met the acceptance criteria for DC Resistance test.

(TESTED BY)

Sign & Date

(WITNESSED BY)

Sign & Date

Space for Observations

IEEE-1138:2021 Clause 6.3

Procedure for optical measurements and fiber preparation:

To increase the sensitivity to changes in attenuation, a number of fibers in each test sample are spliced together, or concatenated, to form one long, continuous optical path. The minimum number of fibers to be spliced and monitored for applicable tests is shown in Table-1. Whenever possible, an equal number of fibers shall be selected from each optical fiber unit.

Table-4 Minimum Fibers for Tests

Cable fiber Count	Minimum number of fibers to be spliced and monitored
1 to 24	All
25 to 48	24
49 to 96	36
97 to 192	48
193 to 384	60
385 to 768	72

A laser source with the appropriate wavelength is injected to an optical splitter. The splitter divides the source signal into two signals. During the test, the optical measuring system (source, splitter, and receiver) shall remain stable in a temperature and humidity-controlled environment. One of the split signals is sent directly to an optical power meter and serves as the reference signal. The other split signal is splicedinto one of the free ends of the concatenated test fibers. A second power meter is connected to the returning end of the test fibers. This measurement is the test signal. During the tests, the readings from the reference and test optical power meters are monitored and recorded periodically in a suitable manner for future analysis. Any changes from the initial difference between the reference and test signals indicate a change in the attenuation in the fibers due to the test. A net increase in attenuation indicates a loss in the optical signal strength. A net decrease in attenuation indicates a gain in the signal strength.

For tests where the OPGW is subjected to tension, the samples shall be terminated in a manner such thatthe movements of the end of the optical fibers are restricted relative to the elongation of OPGW cable. Although other arrangements may be used, an example of an arrangement for preparing loops between the test sample and the fiber splice tray is shown in Figure 1. Three loops of cable with a typical diameter of 1 m are formed and secured as close as possible to the dead-end tension clamps. Another three loops of the optical fiber unit only are formed just in front of the splice tray. This configuration is suitable for stranded optical fiber unit cables and will restrain metallic, non-metallic and

fiber components from movement during the test. Other configurations, such as central optical fiber unit cable, may requires a different arrangement.

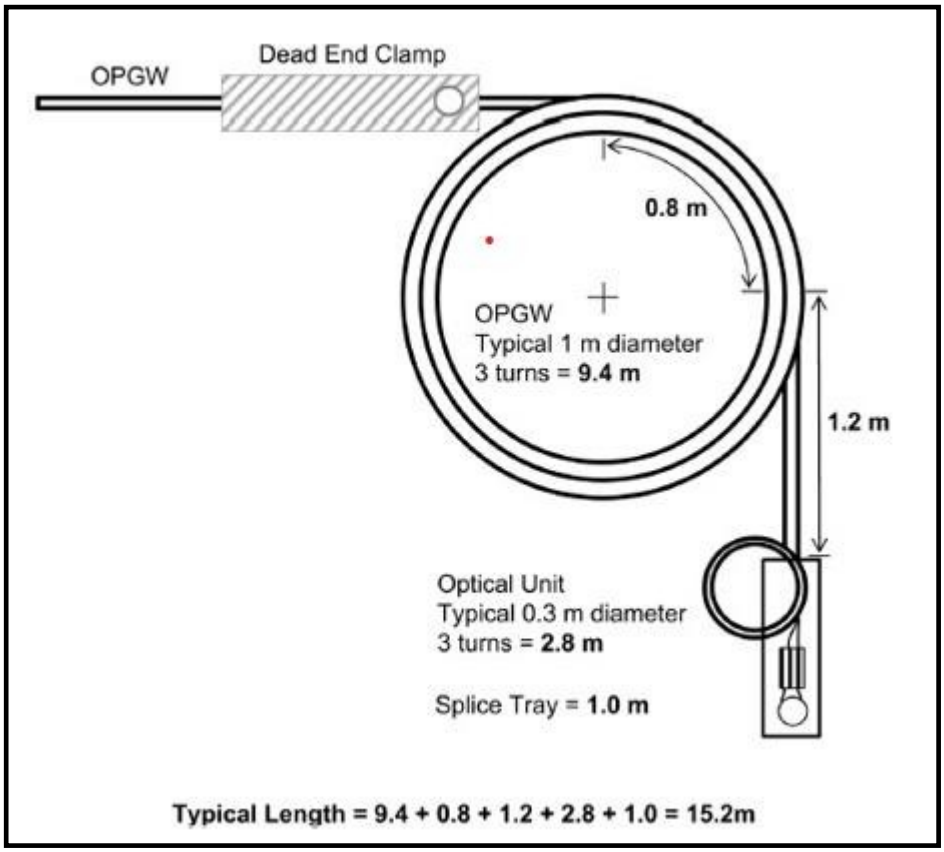

Figure 7 : Test Sample Termination Arrangement

The type test procedures on the OPGW Cable fittings and accessories are listed in below table:

No.	TEST NAME	APPLICABLE STANDARD	TEST RESULT PASS/FAIL
1	Visual examination, dimensional & material verification test	ISO 1461-2009/IEC:61284-1997	
2	Mechanical Strength Test for Suspension assembly	IS 2486/IEC:61284-1997	
3	Mechanical Strength Test for Tension assembly	IS 2486/IEC:61284-1997	
4	Clamp Slip Strength Test for Suspension assembly	IS 2486/IEC:61284-1997	
5	Slip Strength Test for Tension Clamp	IS 2486/IEC:61284-1997	
6	Grounding clamp and structure mounting clamp fit test	IS 2486/IEC:61284-1997	
7	Structure mounting clamp strength test	As per Vol. B Technical specification	

Reference Document:

1)Approved DRS & Drawings of OPGW Hardware & Fittings.

2)Applicable for OPGW installation hardware & fittings.

3)Applicable standard.(ISO 1461 IS 2486/IEC:61284)

4)Contract-Technical Specifications

Sampling Procedure: For OPGW installation hardware and fittings, at least ten (10) samples shall be offered for selection.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

1.TYPE TEST PROCEDURE OF VISUAL EXAMINATION, DIMENSIONAL & MATERIAL VERIFICATION TEST

Test Name: Visual Examination, Dimensional & Material Verification Test
Manufacturer:
Standard: ISO 1461-2009 / IEC 61284-1997
Objective: It shall be verified that the samples are in accordance with the relevant drawings, particularly as regards any dimensions to which special tolerance apply and have a sufficient galvanized coating.

Test Procedure:
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 ±1.5mm.
ii) Dimensions greater than 30 mm……±5% upto max. of ±5 mm.
(B) Helical Fittings:
i) Dimensions up to and including 30mm ±1.5mm.
ii) Dimensions greater than 30 mm……±5% upto max. of ±5 mm.

Galvanizing (Tension assembly fittings, Suspension assembly fittings, Earth lead Assembly Down-lead/fastening Clamps, 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, except 43µm of bolts & nuts.

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, except 43µm of bolts & nuts.

OBSERVATIONS, IF ANY:

TEST RESULT: The Hardware Fittings as tested met/did not meet the requirements as preapproved DRS & Drawings.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

2. TYPE TEST PROCEDURE OF MECHANICAL STRENGTH TEST FOR SUSPENSION ASSEMBLY

Test Name: Mechanical Strength Test for Suspension Assembly
Manufacturer:
Standard: IS 2486 / IEC 61284-1997

Objective:To verify the mechanical strength test for suspension Assembly.

TEST SET-UP

The amour rods /reinforcement rods are assembled onto the approved OPGW by the installation instructions to check the assembly is correctly fitted and is the same that will be carried out during installation.

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 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 five (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 shall be 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. No fracture shall occur during this period.
3. The applied load shall then be increased until the failing load is reached and value shall be documented.

ACCEPTANCE CRITERIA

1. No evidence of binding of the nuts or deformation of components at end of Part 1 of test.
2. No evidence of fracture at the end of one minute at the minimum failure load during Part 2 of the test.
3. Any results outside the above parameters shall constitute a failure.

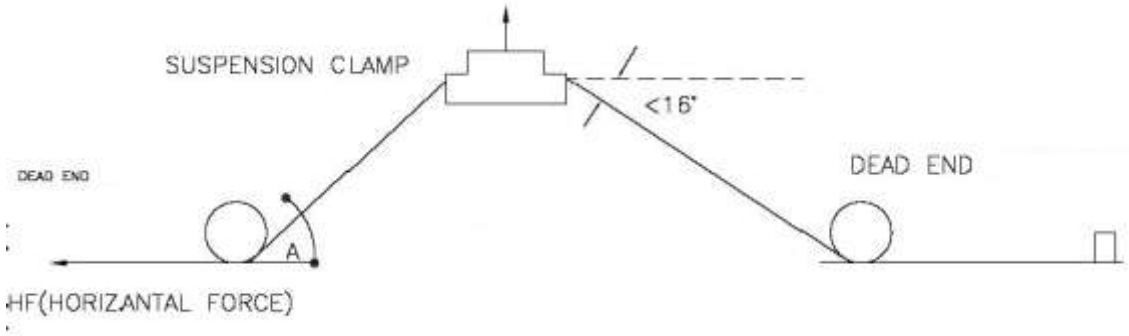

Figure 1: Test set up for mechanical strength test for suspension assembly

OBSERVATIONS, IF ANY:

TEST RESULT: The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Mechanical Strength Test for suspension assembly.

(Tested by)	**(Witnessed by)**
Sign & date	Sign & date

3.TYPE TEST PROCEDURE OF MECHANICAL STRENGTH TEST FOR TENSION ASSEMBLY

Test Name: Mechanical strength for Tension assembly

Manufacturer:

Standard: IS 2486 / IEC 61284-1997

Objective: To verify the mechanical strength test for the tension assembly.

TEST SET-UP

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

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TEST PROCEDURE

Part 1:

1. The tension assembly (excluding tension clamp) of cable section shall be increased at a constant rate up to a load equal to 50% of the specified minimum failure load increased at a constant rate and held for one (1) minute for the test rig to stabilize.
2. The load shall then be increased at a steady rate to 67% of the minimum failure load and held for five minutes.
3. This load shall then be removed in a controlled manner and the tension assembly shall be disassembled, Examination of the Tension Dead—End and associated components shall be made and any evidence of visual deformation shall be documented.

Part 2:

1.The Tension Dead-End and associated components shall then be reassembled and bolts tightened as before.

2.The tensile load shall gradually be increased up to 50% of the specified minimum failure load of the tension assembly and held for one minute for the test rig to stabilize and the load shall be further increased at a steady rate until the specified minimum failure load is reached and held for one minute.

3.The applied load shall then be increased until the failing load is reached and the value shall be documented.

ACCEPTANCE CRITERIA

1.No evidence of binding of the nuts or deformation of components at end of part 1 of test.

2.No evidence of fracture at the end of one minute at the minimum failure load during part 2 of the test.

3.Any results outside the parameters shall constitute a failure.

4.Failure load shall meet or exceed value as per approved DRS.

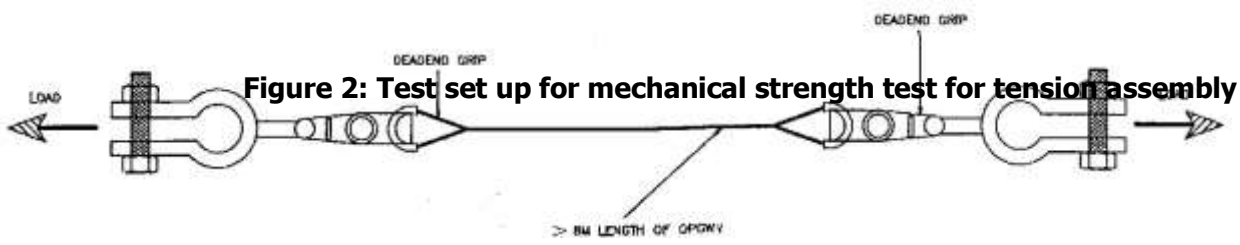


Figure 2: Test set up for mechanical strength test for tension assembly

OBSERVATIONS, IF ANY:

TEST RESULT: The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Mechanical Strength Test for Tension assembly.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

4.TYPE TEST PROCEDURE OF SLIP STRENGTH TEST FOR SUSPENSION ASSEMBLY

Test Name: Clamp slip strength test of suspension assembly
Manufacturer:
Standard: IS 2486 / IEC 61284-1997
Objective: To verify the clamp slip strength test for suspension assembly proposed for the OPGW cable.

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.

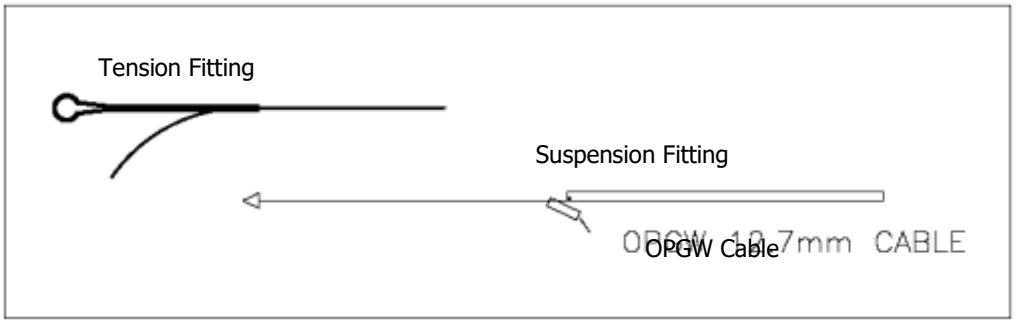


Figure 3: Test set up for slip strength test for suspension assembly

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

Test procedure:

1. After the suspension clamp has been assembled, the test rig is tensioned to 1 KN and the position scale on the recorder 'Zeroed'. The test rig is then tensioned to 2.5 KN and the relative positions of the Reinforcing rods, Armour rods and Suspension clamp were marked by suitable means to confirm any slippage after the test has been completed. The relative positions of the helical armour rods and associated reinforcing rods at each end shall be marked and also 2mm relative position between clamp body and the armour rods shall be marked on one side.

2. The load shall be increased to 12 KN at a loading rate of 3 KN/min and held for one minute. At the end of this one minute, 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 one minute the position of the clamp body and 2mm relative position between clamp body and armour rods shall be marked on the other side.

3. After the one minute pause, the load shall be further increased at a loading rate of 3 KN/min, and recording of load and displacement shall continue until either the relative position displacement between clamp body and armour rods reaches more than 2mm or the load reaches the maximum slip

load of 17 KN. On reaching either of the above values the test is terminated. Visual examination of all paint marks shall be recorded, and a measurement of any displacement recorded in the table of results.

Acceptance Criteria:

The Suspension Clamp has passed the Slip Test if the following conditions are met:
1. No slippage* shall occur at or below the specified minimum slip load of 12 KN.
2. Slippage shall occur between the specified minimum and maximum slip load of 12-17 KN. 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 12 KN and maximum slip 17 KN shall be considered as slip.
5. The armour rods shall not be displaced from their original lay or damaged **.
6. Any result outside the above parameters is a failure.

*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

OBSERVATIONS, IF ANY:

Test Results: The hardware fittings, as tested, met/ not met the acceptance criteria for the Clamp Slip strength Test for suspension assembly.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

5.TYPE TEST PROCEDURE OF SLIP STRENGTH TEST FOR TENSION CLAMP

Test Name: Slip strength test of tension clamp
Manufacturer:
Standard: IS 2486 / IEC 61284-1997
Objective: To verify the slip strength test for tension clamp proposed for the OPGW cable.

TEST SET-UP

The set-up for the slip strength for tension clamp is shown in Figure-4.

The tension clamps shall be fitted on both ends of a 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.

TEST PROCEDURE

1. A tensile load shall gradually be applied up to 20% of the Rated Tensile Strength of the OPGW. 2. Displacement transducers shall be installed to measure the relative movement between the OPGW relative to the reinforcing rods and Tension Dead-End relative to the reinforcing rods. In addition, suitable marking shall be made on the OPGW and Dead-End to confirm grip.
3. The load shall be gradually increased at a constant rate until it reaches 50% of the specified UTS and the Position scale of the recorder is 'zeroed'.
4. The load shall then gradually be increased at a constant rate until it reaches 95% of the specified UTS and maintained for one minute.
5. After 1 minute pause, the load is slowly released to zero and the markings examined and measured for any relative movement.
6. On completion of the test a graph of load against position is produces for each of the two measurements.

ACCEPTANCE CRITERIA:

No movement***** shall, occur between the OPGW and the Reinforcing Rods, or between the Reinforcing Rods and the Dead-End assembly.

No failure or damage or disturbance to the lay of the Tension Dead-end Clamp, Reinforcing Rods or OPGW.

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

Any results outside these parameters shall constitute a failure.

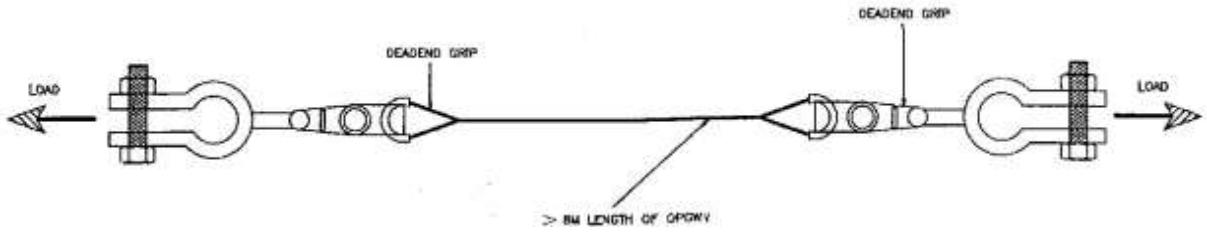


Figure 4: Test set up for slip strength test of tension clamp

OBSERVATIONS, IF ANY:

TEST RESULT: The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Slip strength Test for Tension clamp.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

6.TYPE TEST PROCEDURE FOR
GROUNDING AND STRUCTURE MOUNTING CLAMP FIT TEST FOR SUSPENSION SET AND TENSION SET

Test Item: Fit Test of Grounding Clamp
Manufacturer:
Standard: IEC 61284-1997
Objective: To determine the Fit test for Grounding clamp and structure mounting (downlead clamp) clamp fit test proposed for the OPGW cable.

TEST PROCEDURE

For structural mounting clamp, one series of tests shall be conducted with two fibre optic cables installed, one series of tests with one fibre optic cable installed in one groove, and one series of tests with one fibre optic cable in the other groove.

For grounding clamp, one series of tests shall be conducted with one fibre optic cable with structural reinforcing rods installed in one side, the grounding wire into other side, for both Suspension and Tension assemblies, separately.

The clamp shall be installed including clamping compound as required on the fibre optic cable and the grounding wire. The nut shall be tightened on to the bolt by using torque wrench with supplier's recommended torque and the tightened clamp shall be held for 10 minutes. After the completion of the test, the fibre optic cable and the grounding wire components shall be examined for distortion, crushing or breaking. Also the fibre optic cable shall be checked to ensure free movement within the core using dial calipers to measure the diameter of the core tube.

ACCEPTANCE CRITERIA

There shall be no visible distortion, crushing, cracking or breaking of the core tube and the fibre optic cable within the core tube shall be free to move. The diameter of the core tube as measured at any location in the clamped area shall be not more than 0.5 mm larger or smaller of the core diameter of the core tube as measured outside the clamped area.

There shall be no visible distortion crushing or cracking of the grounding wire. Any result outside these parameters is a failure.

OBSERVATIONS, IF ANY:

TEST RESULTS:

Fitting No.	Torque applied for 10 mins (Nm)	Free Movement of core (Yes/No)	Visual distortion, crushing, cracking or breaking	Average core diameter in clamped area (mm)	Average core diameter in unclamped area (mm)	Difference (mm)
1						
2						
3						

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Fit Test for Grounding clamp.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

7.TYPE TEST PROCEDURE OF STRUCTURE MOUNTING CLAMP STRENGTH TEST

Test Name: Structure Mounting Clamp Strength Test
Manufacturer:
Standard: Technical Specification
Objective: To demonstrate the ability of the down lead bracket assembly to withstand a specified load.

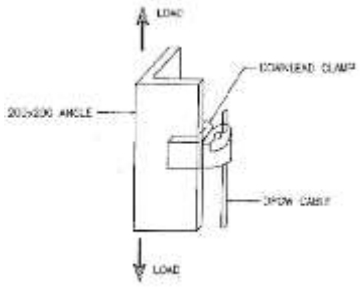


Figure 2: Schematic of structure mounting clamp strength test

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 2

Test Procedure:

1. A vertical load of 200 kg is 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 is 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:

Any visible distortion, slipping or breaking of any component of the mounting clamp shall constitute failure.

Test Results:

The Structure mounting Clamps tested, met the requirement specified in technical specification, and results are shown as follows.

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

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Structure Mounting Clamp Strength Test。

(Tested by)
Sign & date

(Witnessed by)
Sign & date

Type Test Procedure of Vibration Damper

Project Name:
LOA No.:

Type test items on vibration damper are listed in below table:

No.	TEST NAME	APPLICABLE STANDARD	TEST RESULT PASS/FAIL
1	Visual examination, dimensional & material verification test	IEC 61284-1997	
2	Dynamic characteristic test (Damper response test)	As per Vol. B Technical specification	
3	Vibration analysis test (Damping efficiency test)		
4	Clamp slip test	IEC:61897-1998	
5	Fatigue test	As per Vol. B Technical specification	
6	Attachment Of Weights To Messenger Cable Test	IEC:61897-1998	
7	Attachments of clamp to messenger cable test	IEC:61897-1998	
8	Clamp bolt tightening test	IEC:61897-1998	
9	Damper effectiveness evaluation test	IEC:61897-1998	

Reference Document:

1)Approved DRS & Drawings of OPGW Hardware & Fittings.

2)Applicable for OPGW installation hardware & fittings.

3)Vol B Contract Technical specification.

Sampling Procedure: For vibration damper, at least ten (10) samples shall be offered for selection.

1 TYPE TEST PROCEDURE OF VISUAL EXAMINATION, DIMENSIONAL & MATERIAL VERIFICATION TEST

Test Name: Visual Examination, Dimensional & Material Verification Test
Customer: Power Grid Corporation of India Limited, India
Manufacturer:
Standard: ISO 1461-2009 / IEC 61284-1997
Objective: It shall be verified that the samples are in accordance with the relevant drawings, particularly as regards any dimensions to which special tolerance apply and have a sufficient galvanized coating.

Test Procedure:
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 ±1.5mm.
ii) Dimensions greater than 30 mm ±5% upto max. of ±5 mm.
(B) Helical Fittings:
i) Dimensions up to and including 30mm ±1.5mm.
ii) Dimensions greater than 30 mm ±5% upto max. of ±5 mm.

Galvanizing (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, except 43µm of bolts & nuts.

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, except 43µm of bolts & nuts.

OBSERVATIONS, IF ANY:

TEST RESULT: The Hardware Fittings as tested met/did not meet the requirements as preapproved DRS & Drawings.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

2 TYPE TEST PROCEDURE OF VIBRATION DAMPER DYNAMIC CHARACTERISTIC TEST (DAMPER RESPONSE TEST)

Test Name: Dynamic Characteristic Test of Vibration Damper (Damper response test)
Customer: Power Grid Corporation of India Limited, India
Manufacturer:
Standard: As per Vol. B Technical specification

Test Procedure:

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

(i) Force Vs frequency
(ii) Phase angle Vs frequency
(iii) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies 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. The above dynamic characteristics test on five dampers shall be conducted. The variation below the samples tested shall confirm to the sample test limits. The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.

Acceptance criteria:

(i)The Force Vs frequency curve showing steep speaks at resonance frequencies and deep troughs between the resonance frequencies shall constitute failure.
(ii)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.
(iii)The above mean phase angle response curve shall be between 25º to 130º within the frequency range of interest.
(iv)Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values.

OBSERVATIONS, IF ANY:

TEST RESULTS:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for Dynamic Characteristic Test of Vibration Damper.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

3 TYPE TEST PROCEDURE OF VIBRATION ANALYSIS TEST (DAMPING EFFICIENCY TEST)

Test Name: Vibration Analysis Test (Damping efficiency test) for vibration damper
Customer: Power Grid Corporation of India Limited, India
Manufacturer:
Standard: As per Vol. B Technical specification

TEST PROCEDURE

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

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

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

(c)The power dissipation curve obtained from Damper Characteristic test shall be used for analysis with damper.

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

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

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

ACCEPTANCE CRITERIA

The dynamic strain levels at damper attachment point, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits. The dynamic strain levels at damper attachment point is not more than 150 micro-strains (single peak)

OBSERVATIONS, IF ANY:

TEST RESULT:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Damper Analysis test of Vibration Damper.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

4 TYPE TEST PROCEDURE OF VIBRATION DAMPER CLAMP SLIP TEST

Test Name: Clamp slip test of vibration damper
Customer: Power Grid Corporation of India Limited, India
Manufacturer:
Standard: IEC 61897-1998

TEST SET-UP

The Vibration damper clamp slip shall be conducted on a laboratory set up with a minimum effective span length of 30m. The fibre optic cable shall be tensioned at 15 kN and shall not be equipped with protective armour rods at any point.

Constant tension shall be maintained within the span by means of lever arm arrangement. After the fibre optic cable has been tensioned, clamps shall be installed to support the fibre optic cable at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the fibre optic cable. There shall be no loose parts, such as suspension clamps, U bolts, on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

TEST PROCEDURE

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

Clamp slip shall be considered as having occurred when a slip distance of 1 mm is measured.

ACCEPTANCE CRITERIA

No movement of the Vibration damper clamp relative to the conductor greater than 1 mm shall occur at or before the end of application of 2.5 KN for 60 s. If both a minimum and a maximum slip load are stated, the slip shall occur between those values. Surface flattening of the outer strands of the conductor is acceptable.

OBSERVATIONS, IF ANY:

TEST RESULT: The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Clamp Slip test of Vibration Damper.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

5 TYPE TEST PROCEDURES FOR VIBRATION DAMPER FATIGUE TEST

Test Name: Fatigue test of vibration damper
Customer: Power Grid Corporation of India Limited, India
Manufacturer:
Standard: As per Vol. B Technical specification
Objective: To determine the fatigue of vibration damper.

TEST SET-UP

The Vibration damper fatigue test shall be conducted on a laboratory set up with a minimum effective span length of 30m. The fibre optic cable shall be tensioned at 25% UTS of OPGW and shall not be equipped with protective armour rods at any point.

Constant tension shall be maintained within the span by means of lever arm arrangement. After the fibre optic cable has been tensioned, clamps shall be installed to support the fibre optic cable at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the fibre optic cable. There shall be no loose parts, such as suspension clamps, U bolts, on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

TEST PROCEDURE

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

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

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

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

After the above tests, the damper shall be removed from fibre optic cable and subjected to dynamic characteristics test, the Graphs showing results for:

a)Force Vs Frequency
b)Phase angle Vs Frequency
c)Power dissipation Vs Frequency
Shall be recorded as per test procedure of Dynamic characteristic test

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

ACCEPTANCE CRITERIA

1. There shall not be any resonant frequency shift before and after the test by more than ± 20%.
2. The power dissipation of the damper before and after test at the individual resonant frequencies do not differ by more than ± 20%.

OBSERVATIONS, IF ANY:

TEST RESULT:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Fatigue test of Vibration Damper.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

6 TYPE TEST PROCEDURE FOR ATTACHMENT OF WEIGHTS TO MESSENGER CABLE TEST

Test Name: Attachment Of Weights To Messenger Cable Test Of Vibration Damper
Customer: Power Grid Corporation of India Limited, India
Manufacturer:
Standard: IEC 61897-1998

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 (100 N/s maximum) until it reaches 5.0 kN (specified minimum slip load). This load shall be kept constant for 60 s.

The load shall then 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 1mm between each weight and the messenger cable shall occur at or before the end of the application of 5.0 kN for 60s.

OBSERVATIONS, IF ANY:

Test Results:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Attachment Of Weights To Messenger Cable Of Vibration Damper.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

7 TYPE TEST PROCEDURE FOR ATTACHMENTS OF CLAMP TO MESSENGER CABLE TEST

Test Name: Attachments Of Clamp To Messenger Cable Test Of Vibration Damper
Customer: Power Grid Corporation of India Limited, India
Manufacturer:
Standard: IEC 61897-1998

Test Procedure:

A tensile load shall be applied between the messenger cable and the clamp body, coaxial with the messenger cable. The load shall be gradually increased (100 N/s maximum) until it reaches 1.5 kN (specified minimum slip load). This load shall be kept constant for 60 s.

The load shall then 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 movement of the clamp relative to the messenger cable greater than 1mm shall occur at or before the end of the application of 1.5 kN for 60s.

OBSERVATIONS, IF ANY:

Test Results:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for Attachments Of Clamp To Messenger Cable Test.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

8 TYPE TEST PROCEDURE FOR CLAMP BOLT TIGHTENING TEST OF VIBRATION DAMPER

Test Name: Clamp Bolt Tightening Test Of Vibration Damper
Customer: Power Grid Corporation of India Limited, India
Manufacturer:
Standard: IEC 61897-1998

Test Procedure:

The test shall be performed using the conductor for which the clamp is intended to be used. The bolt(s) or nut(s) shall be tightened to a torque 10 % above the specified installation torque.
Lastly, the torque shall be increased to twice the specified installation torque. This increase shall not result in any breakage of threaded parts or other components.

Acceptance criteria:

Regarding 1.1 times torque, the test is passed if the threaded connection remains serviceable for any number of subsequent installation or removals, and all components comprising the clamp are undamaged.
Regarding 2 times, the test is passed if any breakage either to threaded parts or to the components connected to them does not occur.

OBSERVATIONS, IF ANY:

Test Results:

Damper No.	1.1 times torque Comment on condition of components	2 times torque Comment on condition of components
1		
2		
3		

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for Clamp Bolt Tightening Test of Vibration Damper.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

9 TYPE TEST PROCEDURE FOR DAMPER EFFECTIVENESS EVALUATION TEST OF VIBRATION DAMPER

Test Name: Damper effectiveness Evaluation Test of Vibration Damper
Customer: Power Grid Corporation of India Limited, India
Manufacturer:
Standard: IEC 61897-1998

Test Procedures

The damping efficiency test shall be conducted on a laboratory set up with a minimum free span length of 30m.
Install the OPGW on the test span, and the OPGW shall be tensioned at Every Day Stress (20% of UTS).
A rigid clamp shall be installed to support rigidly (but not to tension) the OPGW at both ends of the span and the damper and shaker shall be positioned in figure 1. The shaker shall be installed in such a way that its connection to the OPGW cable is located in the first loop for all frequencies to be employed.
The damper or dampers shall be installed in accordance with manufacturer recommendations, unless specified.
OPGW bending strain shall be monitored adjacent to the rigid clamp at the span end with the damper(s) and to both sides of the clamp of each damper. Two strain gauges shall be attached to the OPGW at each of the three positions; one each on the two uppermost strands and as close as practicable to, but not more than 2 mm from the last point of contact of the rigid clamp with strands and 5 mm from the last point of contact of the damper clamp with strands. The test span shall be excited to achieve stable cbale motion at the frequencies for which resonance occurs within the range 0.18/d~1.4/d, where d is the OPGW diameter in metre. A maximum of 20 tuneable frequency span resonances shall be tested, they shall be reasonably spaced over the frequency range indicated above.
Adjust the input power at each tuneable frequency until the highest of the strain readings corresponds to 150 micro-strain (single peak).
At each of these test frequencies the following shall be recorded:

a)Frequency;
b)OPGW Bending strain;
c)Power Input Pj from the shaker;
d)OPGW antinode peak-to-peak amplitude Yj in one of the loops near the damper.

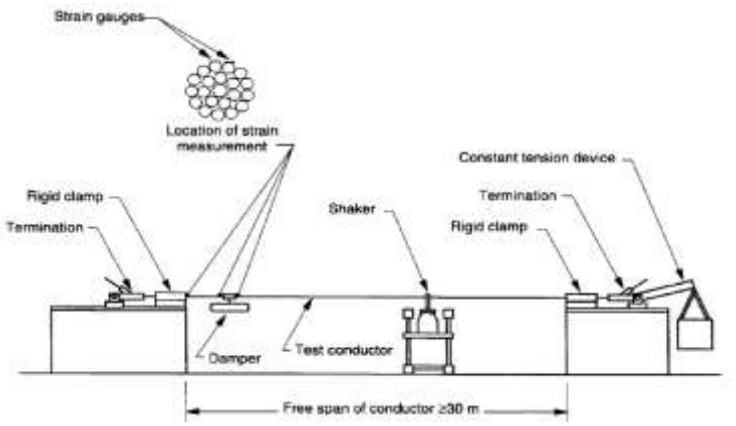


Figure 1-Test for laboratory test of damper effectiveness

Acceptance Criteria

For each test frequency the power input Pj during the test shall exceed the assumed wind power input Pw,j which shall b calculated from the equation:

$P_{w,j} = L*d_4 + f_{j3}*f_n(Y_j/d)$

Where,

L is the maximum protectable conductor span length for the damper arrangement under test as agreed between purchaser and supplier (m);

d is the OPGW diameter (m);

f_j is the frequency (Hz);

Y_j the conductor antinodes peak-to-peak amplitude (m);

$fn(Y_j/d)$ is the wind power input function;

OBSERVATIONS, IF ANY:

Test Results:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for Attachments of Clamp To Messenger Cable Test.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

Type Test Procedure for Joint Box

Project Name-
LOA No.-

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

List of test items

S.No.	TEST NAME	APPLICABLE STANDARD	TEST RESULT (PASS / FAIL)
1	Temperature cycling Test	EIA 445-20/IEC 60794-1-C 10	
2	Humid Heat Test	IEC 60794-1 or EIA/TLA 455	
3	Water Immersion Test	IEC 60060 or EIA/TLA 455	
4	Vibration Test	IEC 60794-1 or EIA/TLA 455	
5	Bending and Torsion Test	IEC 60794-1 or EIA/TLA 455	
6	Tensile Test	IEC 60794-1 or EIA/TLA 455	
7	Drop Test	IEC 60068-2-32	

Project Name-
LOA No.-

Type Test procedure for Temperature Cycling Test

Test Name	: **Temperature Cycling Test**
Final Customer	: Power Grid Corporation of India Limited, India.
Project Name	:
Manufacturer	:
Box Type	:
Standard	: (EIA 455-20/IEC 60794-1-C 10).

TEST SET-UP

Fiber Optical cable is installed in the splice enclosure and optical fiber spliced and looped.

TEST PROCEDURE

The Joint box must be subjected to 5 cycles of temperature variations of -40°C to +65°C with a dwell time of at least 2 hours on each extreme.

Fibre loop attenuation shall be measured in accordance with EIA 455-20 / IEC 60794-1-C10.

The variation in attenuation will be recorded in the form of plots/graphs.

ACCEPTANCE CRITERIA

Variation in attenuation shall be less than ±0.05dB.The final humidity level, inside the box, shall not exceed the initial level, at the closing of the box.

Conclusion

The joint box meets the acceptance criteria of temperature cycling test

(TESTED BY)
Sign & Date

(WITNESSED BY)
Sign & Date

Project Name-
LOA No.-

Type Test procedure for Humid Heat Test

Test Name : **Humid Heat Test**

Final Customer : Power Grid Corporation of India Limited, India.
Project Name :
Manufacturer :
: Box Type
Standard : (IEC 60794-1 or EIA/TLA -455).

TEST SET-UP

Fiber Optical cable is installed in the splice enclosure and optical fiber spliced and looped.

TEST PROCEDURE

The sealed Joint box , with fibres spliced and looped inside, must be subjected to a temperature of +55°C ±2°C with a relative humidity rate of between 90% and 95% for 5 days.
The variation attenuation of the fibres will be recorded through graphs.

ACCEPTANCE CRITERIA

The attenuation variation of the fibres during the duration of the test shall be less than ±0.05dB, and the Internal humidity rate measured, less than 2%.

Conclusion

The joint box meets the acceptance criteria of Humid Heat Test.

(TESTED BY)
Sign & Date

(WITNESSED BY)
Sign & Date

Project Name-
LOA No.-

Type Test procedure for Rain Withstand Test/Water Immersion Test

Test Name : **Water Immersion Test.**

Final Customer : Power Grid Corporation of India Limited, India.
Project Name :
Manufacturer :
: Box Type
Standard : IEC 60060 or EIA/TLA 455

TEST SET-UP

Fiber Optical cable is installed in the splice enclosure and optical fiber spliced and looped.

TEST PROCEDURE

The Joint Box with optical fibres cable installed and fibres spliced fixed, is subjected to 24 hours of Water immersion in accordance with IEC 60060 testing requirements

ACCEPTANCE CRITERIA

1. No water seepage or moisture was detected in the joint box.
2. The attenuation variation of the fibres after the test shall be less than ±0.05dB.

Conclusion

The joint box meets the acceptance criteria of Rain withstand Test/Water Immersion Test.

(TESTED BY)
Sign & Date

(WITNESSED BY)
Sign & Date

Project Name-
LOA No.-

Type Test procedure for Vibration Test

Test Name : **Vibration Test**

Final Customer	: Power Grid Corporation of India Limited, India.
Project Name	:
Manufacturer	:
	: Box Type
Standard	: (IEC 60794-1 or EIA/TLA 455).

TEST SET-UP

The Joint box, with fiber united inside, is installed on vibration in the horizontal vertical direction separately with a frequency scanning of 5 to 50HZ.

TEST PROCEDURE

The amplitude of the vibrations shall be constant at 0.450mm, peak to peak, for 2 hours, for each of the Vibrations direction. Variation in attenuation shall be recorded.

ACCEPTANCE CRITERIA

1. The Variation in attenuation, of the fibres, shall be less than ±0.05dB.
2. The joint box shall be examined for any defects or deformation. There shall be no loosening or Visible damage of the OPGW cable at the entry point.

Conclusion

The joint box meets the acceptance criteria of Vibration Test.

(TESTED BY)
Sign & Date

(WITNESSED BY)
Sign & Date

Project Name-
LOA No.-

Type Test procedure for Bending and Torsion Test

Test Name : **Bending and Torsion Test**
Final Customer : Power Grid Corporation of India Limited, India.
Project Name :
Manufacturer :
: Box Type
Standard : (IEC 60794-1 or EIA/TLA 455).

TEST SET-UP
OPGW is installed in the joint box and optical fiber are spliced and looped inside.

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

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

b) 3 bending cycles of ±180° shall be exercise on the cable. Each cycle shall be less than one minute.

ACCEPTANCE CRITERIA

1. The Variation in attenuation, of the fibres, shall be less than ±0.05dB.
2. The cables connection ring shall remain securely fixed to the box with the connection Maintained Firmly.
3. No defects and fissures shall be noted on the joint ring or on the joint box.

Conclusion
The joint box meets the acceptance criteria of Bending And Torsion Test.

(TESTED BY)
Sign & Date

(WITNESSED BY)
Sign & Date

Project Name-
LOA No.-

Type Test Procedure for Tensile Test

Test Name : **Tensile Test.**

Final Customer : Power Grid Corporation of India Limited, India.
Project Name :
Manufacturer :
Box Type :
Standard : (IEC 60794-1 or EIA/TLA 455).

TEST PROCEDURE

The joint box with cable fixed to the boxes is subjected to a minimum tension of 448 N for a period of two minutes.

ACCEPTANCE CRITERIA

No fissure shall be noted in the connections or on the box.

Conclusion

The joint box meets the acceptance criteria of Tensile Test.

(TESTED BY)
Sign & Date

(WITNESSED BY)
Sign & Date

Project Name-
LOA No.-

Type Test Procedure For Drop Test

Test Name : **Drop Test**

Final Customer	: Power Grid Corporation of India Limited, India.
Project Name	:
Manufacturer	:
Box Type	:
Standard	: (IEC 60068-2-32).

TEST PROCEDURE

With 2 lengths of 11 meters of cable fixed to the box, it has to be dropped five times from a height of 10 meters.

ACCEPTANCE CRITERIA

There shall be no fissure, at all, of the box, and the connections shall remain tight.

Conclusion

The joint box meets the acceptance criteria of Drop Test.

(TESTED BY)
Sign & Date

(WITNESSED BY)
Sign & Date

SITE ACCEPTACE TEST PROCEDURES AND PLAN FOR OPTICAL FIBRE CABLES

1. Introduction

The Site Acceptance Test Plan must stimulate the quality during the site work from the storage of materials to the complement of installation.

In addition to stimulating of quality control, it assists in keeping the record of test and remembering the major point of the site work,

2. List of Site Acceptance Test

1) Pre-Installation Test (Drum Test)
    a. Physical Inspection of the cable assembly for damage
    b. Optical fibre continuity and fibre attenuation with OTDR at 1550 nm
    c. Fibre Optic Cable length measurement using OTDR
2) Post-Installation Test
    a. Optical fibre continuity and fibre attenuation with OTDR at 1550 nm
    b. Fibre Optic Cable length measurement using OTDR
3) Splice Test
    a. Per splice bi-directional average attenuation with OTDR
    b. Physical inspection of splice box/enclosure for proper fibre / cable routing techniques
    c. Physical inspection of sealing techniques, weatherproofing, etc.
4) Commissioning Test
    a. End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by OTDR.
    b. End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by Power meter
    c. Bi-directional average splice loss by OTDR of each splice as well as for all splices in the link (including at FODP also).
    d. Proper termination and labelling of fibres & fibre optic cables at FODP as per approved labelling plan.

Reference Documents:

1) DRS of OPGW/Optical fiber.
2) Sag-Tension Chart.
3) OPGW Live-Line Installation Procedure.
4) Splicing/Jointing Manual.

PRE-INSTALLATION TEST (DRUM TEST)

Title of Test : Pre-Installation Test (Drum Test)

Application : All FO Cables

Purpose of the Test : For precluding cable that may be damaged duringshipment and transportation, every spooled FO cable segment shall be tested prior to installation.

Test Equipment : OTDR & physical inspection

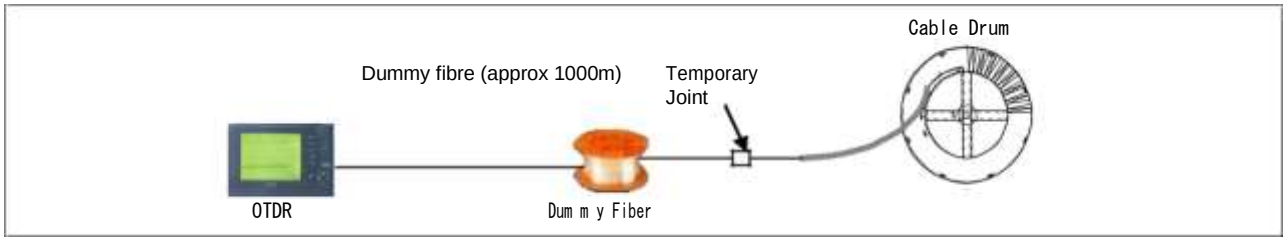
Test Set-up & Procedure : First of all, check the appearance and marking of the Drums.

SHIPPING TAG

Package Name			
Employer 's Name	**Power Grid Corporation of India Limited** **(A Government of India Enterprise)**		
Employer 's Address			
Destination Address			
Vendor's Name			
Vendor's address			
Year of Manufacture	**Xxxx**	**Batch No.**	**Xxxx**
Drum No.	**(As per the Drum Schedule)**		
Type of Cable			
Type of Fibres	**DWSM**		
No. of Fibres	**24F/48F**		
Total Cable Length	**Xxx Mtrs**		
Weight of the Drum	**Xxx kg**		
Year of Production	**Day-Month-Year**	**Factory Inspection Date**	**Day-Month-Year**
Factory Seal			

Xxxx – To be furnished by Sterlite Power Transmission Ltd Shall furnished before FAT.

- Check the sealing of the cable ends and spare cable caps
- Carry out the physical inspection of the cable assembly and then check the Fibre Length, continuity and attenuation of optical fibers by OTDR. Compare the observed attenuation data with respect to the pre-shipment / FAT data.



Acceptance Criteria:

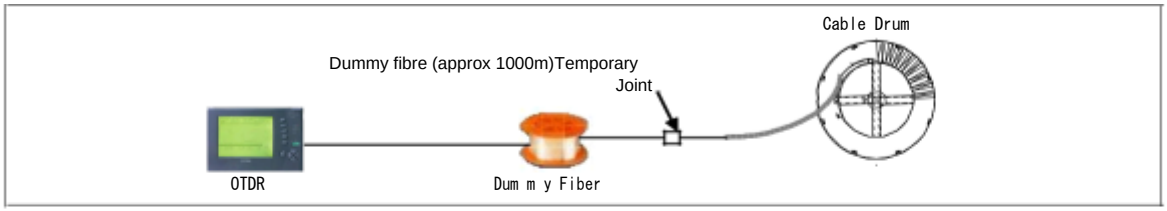
- Appearance shall have no defect and drum marking shall be correct.
- The attenuation of the fibers shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.1dB. The overall optical fibers attenuation should be less than 0.21dB/km at 1550nm and 0.35dB/km at 1310nm.
- Cable ends and spare cable caps shall be properly sealed.
- Every drum, OPGW cable shall be tested for compliance of fibre Length, Continuity & attenuation with the Pre-Shipment data received from manufacturer.

Result/Conclusion:

- Test result shall be filled in the respective test formats as enclosed for Pre -Installation test.
- If there is any excess of attenuation compared with the standard attenuation norms, then the test shall be re-conducted. If the result of retest does not meet the norm, proper action shall be taken promptly in accordance with the flow of trouble slip.

SAT-01-A (24 F)
PRE-INSTALLATION TEST REPORT FOR OPGW CABLE (DRUM TEST)

Date:	Section:		
	Drum No:		
	Drum Length:		(As per Pre-shipment date)
	Drum Length:		(Actual at site)
Type of OTDR:	WAVELENGTH	REFRACTION INDEX	MAX ATTENUATION
Testing Date:	1310nm	1.4670	0.35 dB/km
	1550nm	1.4675	0.21 dB/km



S.No:	Description	Result (Yes / No)	Remarks
1	Physical Appearance check		
2	Drum Marking check		
3	Sealing of Cable ends & provision of spare cable caps		

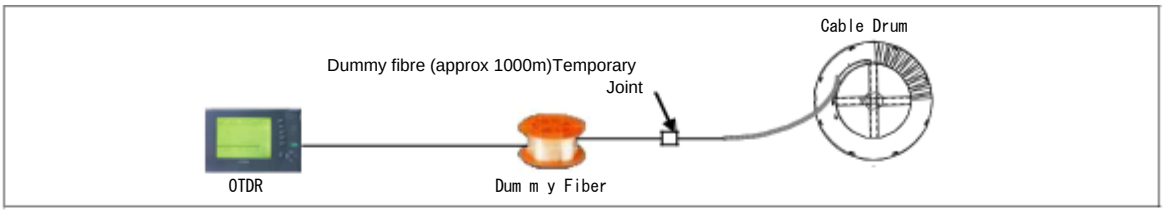
Tube Color	Fiber No	Fiber Color	Length (km)	Attenuation		Remarks
				1310nm dB/km	1550nm dB/km	
BLUE	1	Blue				
	2	Orange				
	3	Green				
	4	Brown				
	5	Slate				
	6	White				
ORANGE	7	Blue				
	8	Orange				
	9	Green				
	10	Brown				
	11	Slate				
	12	White				
GREEN	13	Blue				
	14	Orange				
	15	Green				
	16	Brown				
	17	Slate				
	18	White				
BROWN	19	Blue				
	20	Orange				
	21	Green				
	22	Brown				
	23	Slate				
	24	White				

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

Tested By Witnessed By Approved By

SAT-01-A (48 F)
PRE-INSTALLATION TEST REPORT FOR OPGW CABLE (DRUM TEST)

Date:	Section:		
	Drum No:		
	Drum Length:		(As per Pre-shipment date)
	Drum Length:		(Actual at site)
Type of OTDR:	WAVELENGTH	REFRACTION INDEX	MAX ATTENUATION
Testing Date:	1310nm	1.4670	0.35 dB/km
	1550nm	1.4675	0.21 dB/km



S.No:	Description	Result (Yes / No)	Remarks
1	Physical Appearance check		
2	Drum Marking check		
3	Sealing of Cable ends & provision of spare cable caps		

Tube Color	Fiber No	Fiber Color	Length (km)	Attenuation		Remarks
				1310nm dB/km	1550nm dB/km	
BLUE	1	Blue				
	2	Orange				
	3	Green				
	4	Brown				
	5	Slate				
	6	White				
	7	Red				
	8	Black				
	9	Yellow				
	10	Violet				
	11	Pink				
	12	Aqua				
ORANGE	13	Blue				
	14	Orange				
	15	Green				
	16	Brown				
	17	Slate				
	18	White				
	19	Red				
	20	Black				
	21	Yellow				
	22	Violet				
	23	Pink				
	24	Aqua				

Tube Color	Fiber No	Fiber Color	Length (km)	Attenuation		Remarks
				1310nm dB/km	1550nm dB/km	
GREEN	25	Blue				
	26	Orange				
	27	Green				
	28	Brown				
	29	Slate				
	30	White				
	31	Red				
	32	Black				
	33	Yellow				
	34	Violet				
	35	Pink				
	36	Aqua				
BROWN	37	Blue				
	38	Orange				
	39	Green				
	40	Brown				
	41	Slate				
	42	White				
	43	Red				
	44	Black				
	45	Yellow				
	46	Violet				
	47	Pink				
	48	Aqua				

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

Tested By
(Sign with date)

Witnessed By
(Sign with date)

Approved By
(Sign with date)

POST-INSTALLATION TEST

Title of Test : Post-Installation Test (After Stringing)

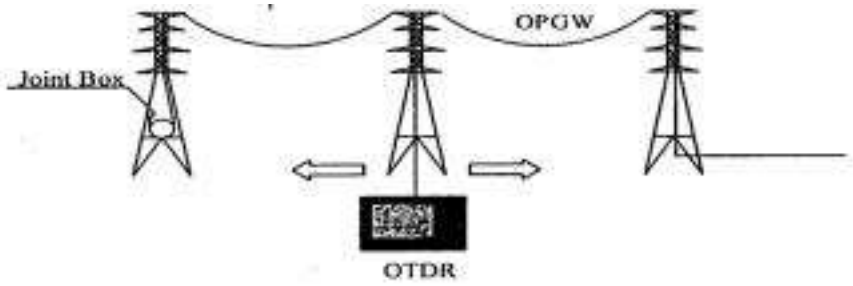
Application : All splicing points

Purpose of the Test : Before splicing work, check for any increase or step Discontinuity in attenuation that may have occurred during Transportation and installation.

Test Equipment : OTDR

Test Set-up & Procedure :

- After successfully completion of the installation work.
- Check for optical attenuation and discontinuity at every splicing point.



Acceptance Criteria:

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

Result/Conclusion:

- Test result shall be filled in the respective test formats as enclosed for Post Installation Test.

Tested By	**Witnessed By**	**Approved By**
(Sign with date)	(Sign with date)	(Sign with date)

SPLICE TEST

Title of Test : Splice Test

Application : All splicing positions

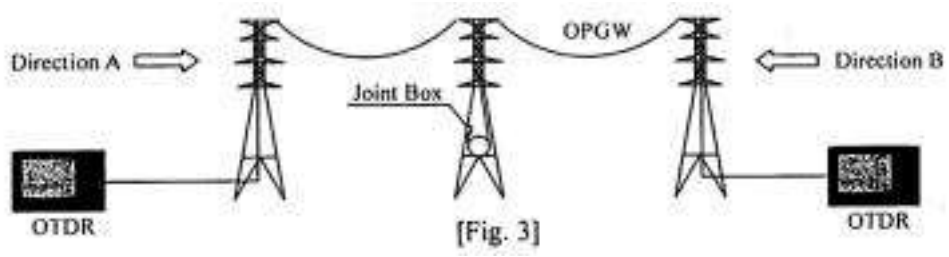
Purpose of the Test:

- Splicing as per approved splicing plan.
- Before closing the splice enclosure, splice loss shall be measured for checking the splicing condition.
- The treatment of surplus fibers on the splice tray and sealing condition shall be checked.

Test Equipment : OTDR & physical inspection

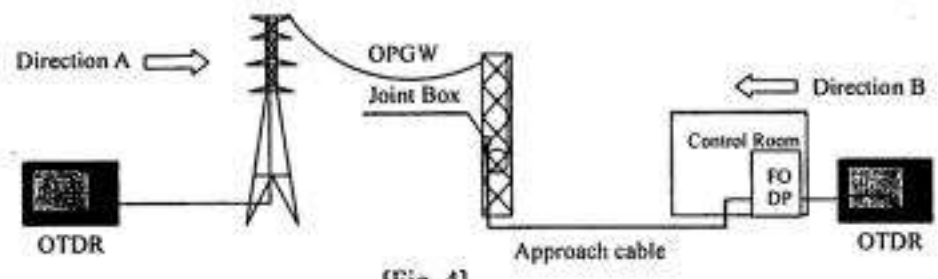
Test Set-up & Procedure:

- All in-line splices shall be encased in splice enclosures with a protective moisture and dust free environment and suitable for outdoor use. All fibers shall be accomplished through the fusion splicing, and then protected by heating shrinkable tube. All splices shall be neatly installed in covered splice trays with 0.5 meter of bare fiber service loop and 1 meter of fiber unit service loop. Before closing the in-line splice enclosure, the splice test shall be executed at both sides (direction A & direction B) of jointing point. The splicing shall be as per approved splicing plan.



[Fig. 3]

- the splice test in the sub-station is the same as that of the in-line splice. In this case, in-line splice enclosure shall be installed on the gantry tower and splicing is between OPGW and approach cable.



[Fig. 4]

- When closing the splice enclosure, the treatment of surplus fibers on the splice tray, sealing conditions and weather proofing shall be checked by physical inspection.

Acceptance Criteria:

- The average of bi-directional attenuation of each fusion splice shall not be more than 0.1 dB at 1550nm & 1310nm. Adequate care shall be taken to minimize the splice loss so as to achieve the required bi-directional average attenuation of splice in the link less than 0.05 dB per splice.
- Appearance of splice enclosure shall have no defect.
- The fibers routing is proper inside the splice enclosure and FODP.
- Splice enclosure shall have good sealing condition to prevent moisture and dust free environment and render it waterproof.
- Splicing is as per approved splicing plan.
- The connector loss shall be less than or equal to 0.5 dB per connector.

- The warning sheet is properly fixed on the splice enclosure.

Result/Conclusion:

- Test result shall be filled in the respective test formats as enclosed for splice test.

Tested By	**Witnessed By**	**Approved By**
(Sign with date)	(Sign with date)	(Sign with date)

COMMISSIONING TEST (LINK TEST)

Title of Test : Link Commissioning Test

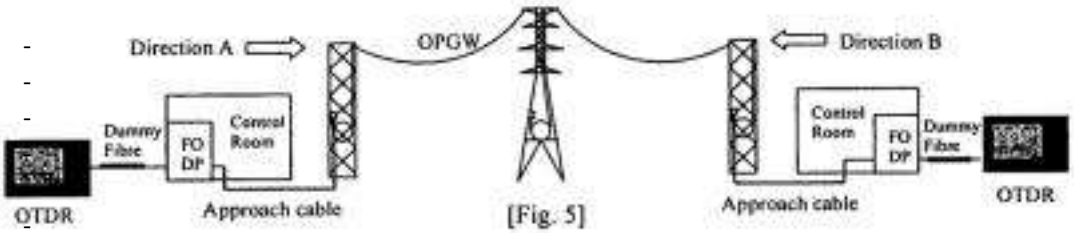
Application : All Links (FODP to FODP)

Purpose of the Test: After completion of splicing of installed section and termination at both ends, the optical fiber path attenuation shall be checked to ensure that the optical fiber shall be in operation satisfactorily.

Test Equipment : OTDR, Power Meter & Light Source

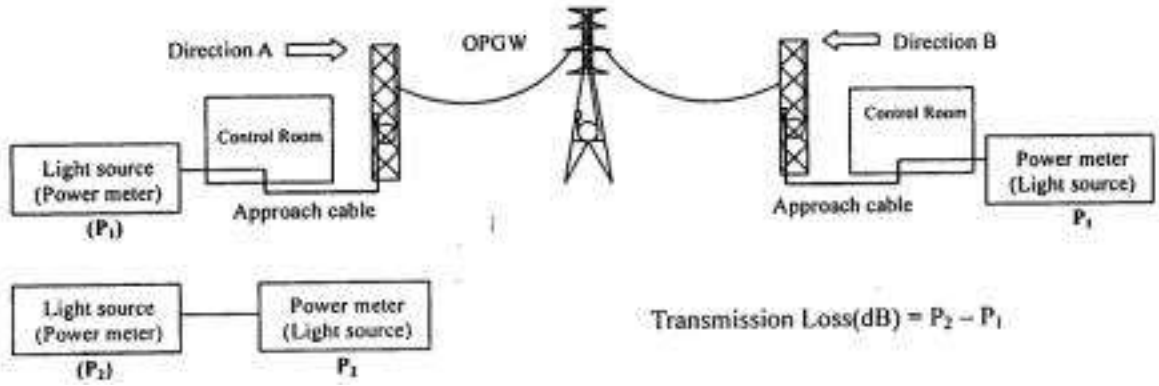
Test Set-up & Procedure:

- The numbering and labeling plan shall be checked at each FODP.
- The optical fiber path attenuation shall be measured at both ends of link by OTDR as well as Power meter and laser light at 1310nm and 1550 nm. The bi-directional average attenuation by both methods shall be calculated.



[Fig. 5]

- The measurement using the power meter is as below;



NOTE: The FODP to FODP link distance should be restricted to 70 Kms for the bidirectional test as the attenuation measurement using OTDR for the wavelength 1310nm may not be accurate for the link distances more than 70 Kms.

Acceptance Criteria:

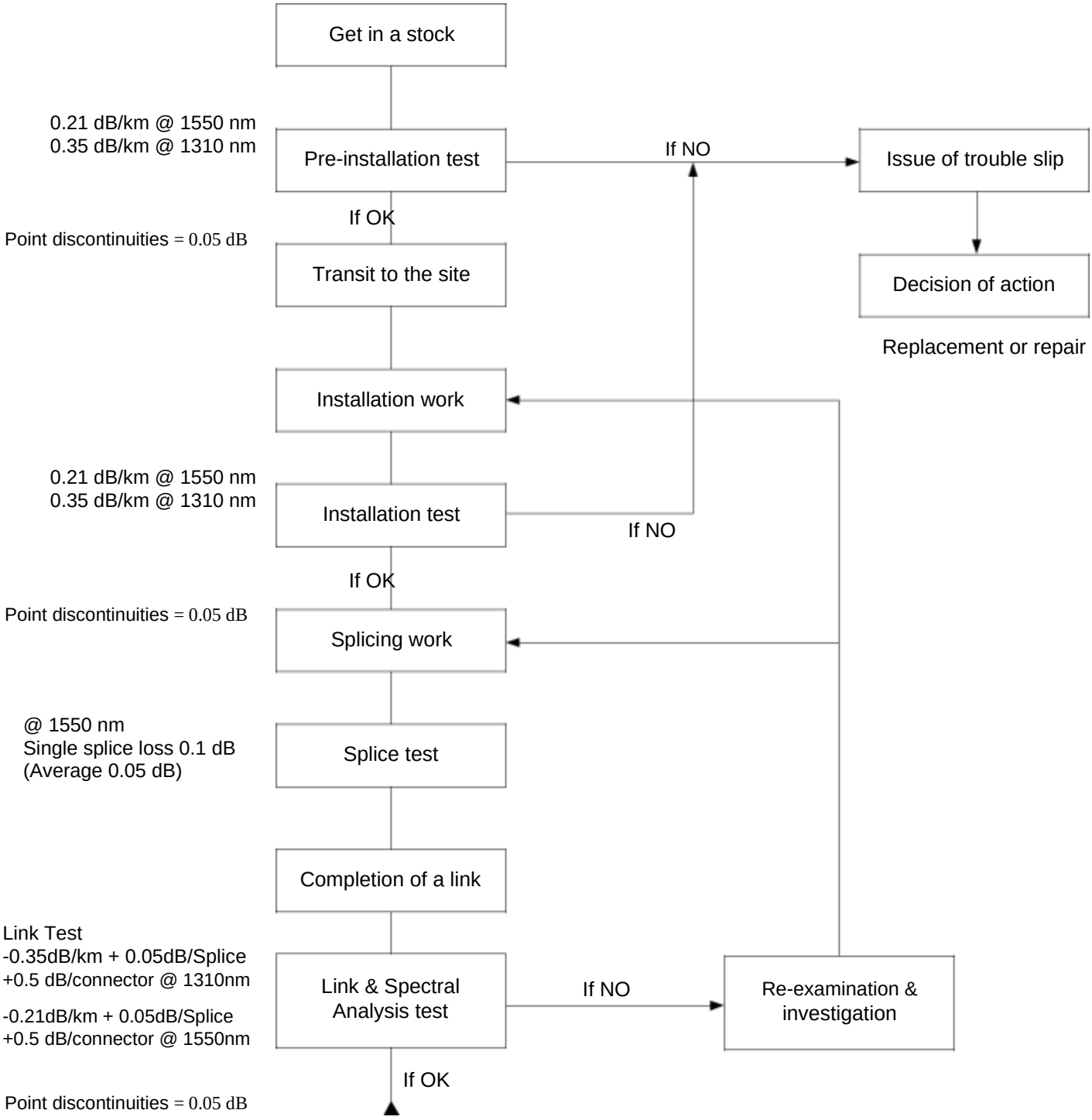
- The numbering and labeling plan at each FODP shall be as per approved plan.
- The overall optical fiber path attenuation at 1550 nm shall be 0.21 dB/km + 0.05 dB/splice + 0.5 dB/connector.
- The overall optical fiber path attenuation at 1310 nm shall be 0.35 dB/km + 0.05 dB/splice + 0.5 dB/connector.
- There are no point discontinuities in excess of 0.1 dB

Result/ Conclusion:

- Test result shall be filled in the respective test formats as enclosed for link commissioning test.
- Bidirectional averages splice loss by OTDR of each splice as well as for all splices in the link (including FODP also).
- Proper termination and labeling of fibers and fiber optic cables at FODP as per approved labeling plan.

Tested By	**Witnessed By**	**Approved By**
(Sign with date)	(Sign with date)	(Sign with date)

PROCEDURE CHART



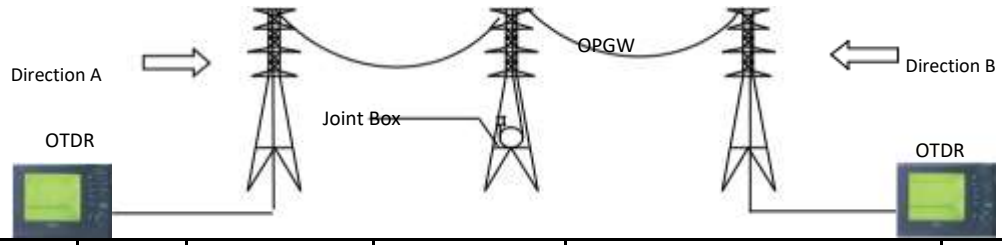
PLAN FOR SAT

Test Title	Function/Parameter	Test Equipment	Criteria	Remarks
llation Test est)	The point is whether the cable shall be used for the installation or not. Appearance of drum and cable; Optical fiber continuity end-to-end and attenuation	OTDR	Attenuation: ≤0.21dB/km@1550nm ≤0.35dB/km@1310 nm Discontinuity: ≤0.1 dB	
Installation Test	After completion of installation, check for any increase or step discontinuity in attenuation that may have occurred during transportation and installation.	OTDR	Attenuation: ≤0.21dB/km@1550 nm ≤0.35dB/km@1310 nm Discontinuity: ≤0.1 dB	
Splice Test	Before closing splice enclosure, splice loss shall be measured from both directions. OTDR Shall be located at the one side of splicing point, loop for measurement of bi-directional splice loss shall be constituted at the other side. $S1=0 \leq \frac{A+B}{2} \leq 0.1dB$ Where, A is splice loss from 'A' direction. B is splice loss from 'B' direction.	OTDR	@ 1550 nm, Single splice loss 0.1 dB Average 0.05 dB.	
Commissioning Test (Link Test)	After installation and splicing of each link, path attenuation shall be measured with the help of OTDR & power meter. Splice loss shall be measured with OTDR and average splice loss shall be calculated	OTDR & Power Meter, Laser Source	<Link Test> **Path attenuation**: ≤0.21dB/km +0.05dB/splice +0.5db/connector @1550nm ≤0.35db/km +0.05dB/splice +0.5db/connector @1310 nm **Discontinuity**:≤0.05dB **Average splice loss** $=(S_1+S_2+---Sn)/N$ Where S_1, S_2,---S_n is average splice loss at joint 1,2,----n etc.	

SAT-02-A (24 F)

POST-INSTALLATION TEST REPORT FOR OPGW

Report No:	Sector:		
Date:	Section:		
	Drum No:		
	Drum Length:		(As per Pre-shipment date)
	Drum Length:		(Actual at site)
Type of OTDR:	WAVELENGTH	REFRACTION INDEX	MAX ATTENUATION
Testing Date:	1310nm	1.4670	0.35 dB/km
	1550nm	1.4675	0.21 dB/km



Tube Color	Fiber No	Fiber Color	Length (km)	Attenuation dB/km		Remarks
				1550nm	1310nm	
BLUE	1	Blue				
	2	Orange				
	3	Green				
	4	Brown				
	5	Slate				
	6	White				
ORANGE	7	Blue				
	8	Orange				
	9	Green				
	10	Brown				
	11	Slate				
	12	White				
GREEN	13	Blue				
	14	Orange				
	15	Green				
	16	Brown				
	17	Slate				
	18	White				
BROWN	19	Blue				
	20	Orange				
	21	Green				
	22	Brown				
	23	Slate				
	24	White				

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

Tested By
(Sign with date)

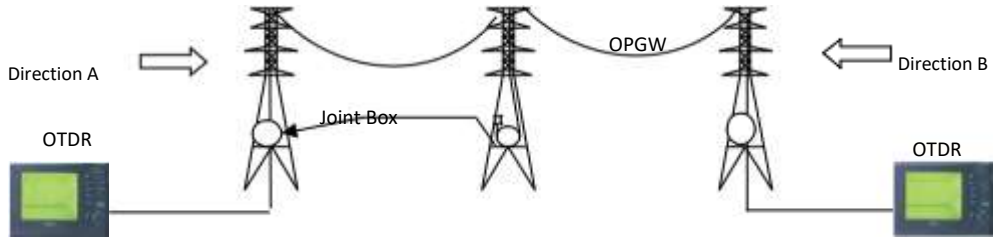
Witnessed By
(Sign with date)

Approved By
(Sign with date)

SAT-03-B (24 F)

SPLICE LOSS TEST REPORT FOR OPGW @ 1550nm

Report No:	Sector:		
Date:	Section:		
	TOWER No:		
			Acceptance criteria
			Max.Splice Loss
Type of OTDR:	WAVELENGTH	REFRACTION INDEX	0.10dB(Individual splice)
Testing Date:			Average Splice loss in link
	1550nm	1.4675	0.05 dB/Splice



Joint Box	Appearance	Fiber Routing	Sealing	Tower No.

Tube Color	Fiber No	Fiber Color	Length (km)	SPLICE LOSS (dB)		Actual Loss (dB)=(A+B)/2
				Direction A	Direction B	
BLUE	1	Blue				
	2	Orange				
	3	Green				
	4	Brown				
	5	Slate				
	6	White				
ORANGE	7	Blue				
	8	Orange				
	9	Green				
	10	Brown				
	11	Slate				
	12	White				
GREEN	13	Blue				
	14	Orange				
	15	Green				
	16	Brown				
	17	Slate				
	18	White				
BROWN	19	Blue				
	20	Orange				
	21	Green				
	22	Brown				
	23	Slate				
	24	White				

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

Tested By
(Sign with date)

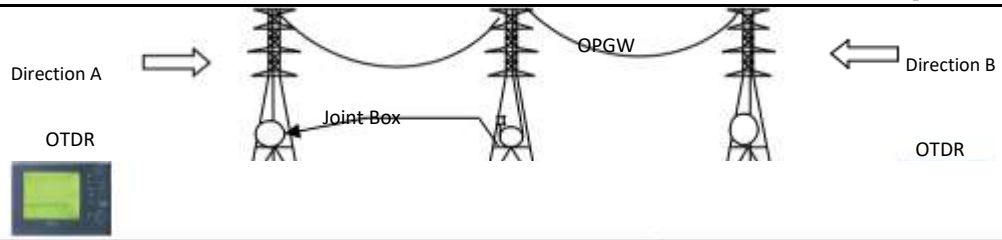
Witnessed By
(Sign with date)

Approved By
(Sign with date)

SAT-03-A (24 F)

SPLICE LOSS TEST REPORT FOR OPGW @ 1310nm

Report No:	Sector:		
Date:	Section:		
	TOWER No:		
			Acceptance criteria
			Max.Splice Loss
Type of OTDR:	WAVELENGTH	REFRACTION INDEX	0.10dB(Individual splice)
Testing Date:			Average Splice loss in link
	1310nm	1.4670	0.05 dB/Splice



Joint Box	Appearance	Fiber Routing	Sealing	Tower No.

Tube Color	Fiber No	Fiber Color	Length (km)	SPLICE LOSS (dB)		Actual Loss (dB)=(A+B)/2
				Direction A	Direction B	
BLUE	1	Blue				
	2	Orange				
	3	Green				
	4	Brown				
	5	Slate				
	6	White				
ORANGE	7	Blue				
	8	Orange				
	9	Green				
	10	Brown				
	11	Slate				
	12	White				
GREEN	13	Blue				
	14	Orange				
	15	Green				
	16	Brown				
	17	Slate				
	18	White				
BROWN	19	Blue				
	20	Orange				
	21	Green				
	22	Brown				
	23	Slate				
	24	White				

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

Tested By
(Sign with date)

Witnessed By
(Sign with date)

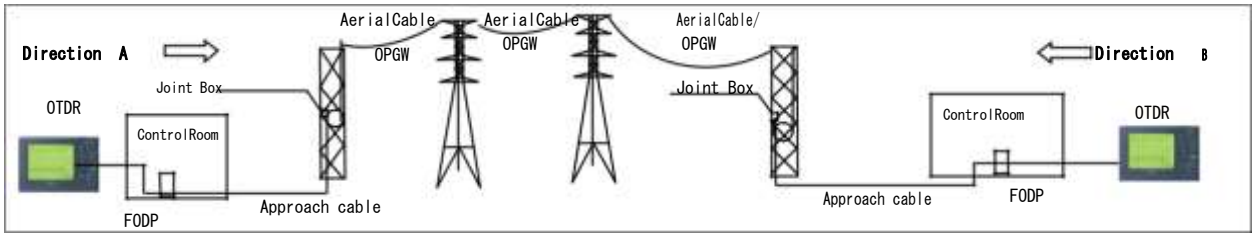
Approved By
(Sign with date)

SAT-04-A (24 F)

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

Report No: Date:

SECTOR				
LINE LINK				
FODP to FODP				
Type of OTDR	Testing Date	Wave Length	Max Attenuation of Fiber	Specified Loss
		1310 nm	0.35 dB/km	∑ 0.35dB/km **x** Total FO length + 0.05dB/splice **x** Total No. of splice + 0.5dB/connector **x** No. of connectors



Tube Color	Fiber No	Fiber Color	Length (km)	Total LOSS (dB)		Actual Loss (dB)=(A+B)/2
				Direction A	Direction B	
BLUE	1	Blue				
	2	Orange				
	3	Green				
	4	Brown				
	5	Slate				
	6	White				
ORANGE	7	Blue				
	8	Orange				
	9	Green				
	10	Brown				
	11	Slate				
	12	White				
GREEN	13	Blue				
	14	Orange				
	15	Green				
	16	Brown				
	17	Slate				
	18	White				
BROWN	19	Blue				
	20	Orange				
	21	Green				
	22	Brown				
	23	Slate				
	24	White				

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

Tested By
(Sign with date)

Witnessed By
(Sign with date)

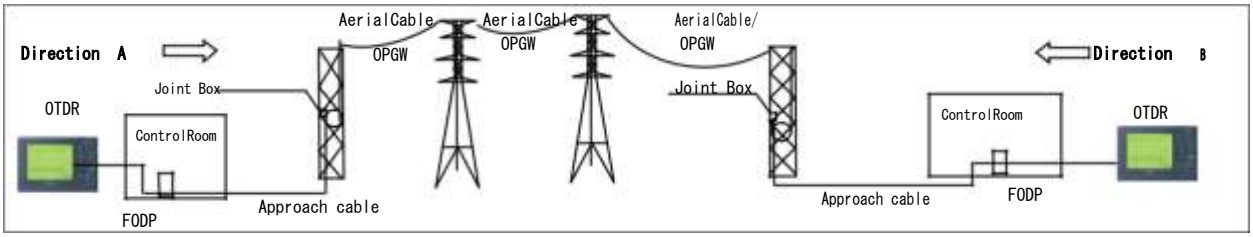
Approved By
(Sign with date)

SAT-04-B (24 F)

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

Report No: Date:

SECTOR				
LINE LINK				
FODP to FODP				
Type of OTDR	Testing Date	Wave Length	Max Attenuation of Fiber	Specified Loss
		1550 nm	0.21 dB/km	∑ 0.21dB/km **x** Total FO length + 0.05dB/splice **x** Total No. of splice + 0.5dB/connector **x** No. of connectors



Tube ColorFiber No	Fiber Color	Length (Km)	Total LOSS (dB)		Actual Loss (dB)=(A+B)/2
			Direction A	Direction B	
BLUE 1	Blue				
2	Orange				
3	Green				
4	Brown				
5	Slate				
6	White				
ORANGE 7	Blue				
8	Orange				
9	Green				
10	Brown				
11	Slate				
12	White				
GREEN 13	Blue				
14	Orange				
15	Green				
16	Brown				
17	Slate				
18	White				
BROWN 19	Blue				
20	Orange				
21	Green				
22	Brown				
23	Slate				
24	White				

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

Tested By
(Sign with date)

Witnessed By
(Sign with date)

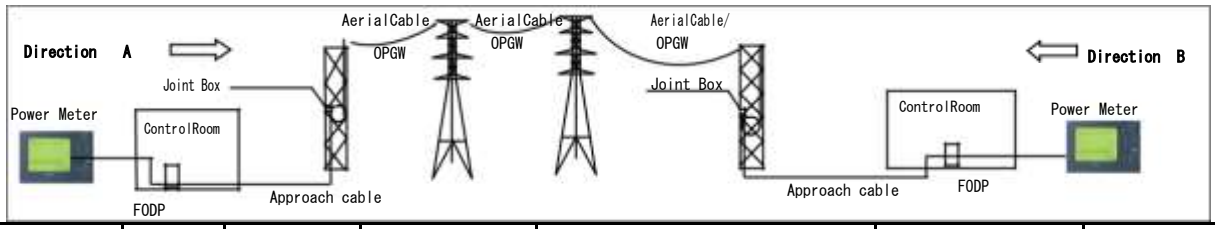
Approved By
(Sign with date)

SAT-05-A (24 F)

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

Report No: Date:

SECTOR	FODP to FODP			
LINE LINK				
REFERENCE POWER : Pr dBm				
A- Power measuring from A Direction dBm			P1: Pr - A dBm	
B- Power measuring from B Direction dBm			P2: Pr - B dBm	
Type of Power Meter	Testing Date	Wave Length	Max Attenuation of Fiber	Specified Loss
		1550 nm	0.21 db/km	∑ 0.21dB/km **x** Total FO length + 0.05dB/splice **x** Total No. of splice + 0.5dB/connector **x** No. of connectors



Tube Color	Fiber No	Fiber Color	Length (Km)	Received Power (dB)		Actual Loss (dB) P=(P1+P2)/2	Average Loss (dB/km) P/Section length
				Direction-A (P1)	Direction-B (P2)		
BLUE	1	Blue					
	2	Orange					
	3	Green					
	4	Brown					
	5	Slate					
	6	White					
ORANGE	7	Blue					
	8	Orange					
	9	Green					
	10	Brown					
	11	Slate					
	12	White					
GREEN	13	Blue					
	14	Orange					
	15	Green					
	16	Brown					
	17	Slate					
	18	White					
BROWN	19	Blue					
	20	Orange					
	21	Green					
	22	Brown					
	23	Slate					
	24	White					

Tested By
(Sign with date)

Witnessed By
(Sign with date)

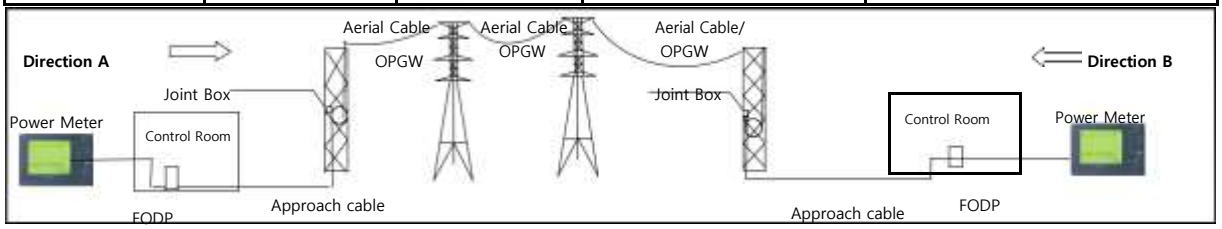
Approved By
(Sign with date)

SAT-05-B (24 F)

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

Report No: Date:

SECTOR	FODP TO FODP			
LINE LINK				
REFERENCE POWER : Pr dBm				
A- Power measuring from A Direction dBm			P1: Pr - A dBm	
B- Power measuring from B Direction dBm			P2: Pr - B dBm	
Type of Power Meter	Testing Date	Wave Length	Max Attenuation of Fiber	Specified Loss
		1310 nm	0.35 db/km	∑ 0.35dB/km **x** Total FO length + 0.05dB/splice **x** Total No. of splice + 0.5dB/connector **x** No. of connectors



Tube Color	**Fiber No**	**Fiber Color**	**Length (Km)**	**Received Power (dB)**		**Actual Loss (dB) P=(P1+P2)/2**	**Average Loss (dB/km) P/Section length**
				Direction-A (P1)	**Direction-B (P2)**		
BLUE	1	Blue					
	2	Orange					
	3	Green					
	4	Brown					
	5	Slate					
	6	White					
ORANGE	7	Blue					
	8	Orange					
	9	Green					
	10	Brown					
	11	Slate					
	12	White					
GREEN	13	Blue					
	14	Orange					
	15	Green					
	16	Brown					
	17	Slate					
	18	White					
BROWN	19	Blue					
	20	Orange					
	21	Green					
	22	Brown					
	23	Slate					
	24	White					

Tested By
(Sign with date)

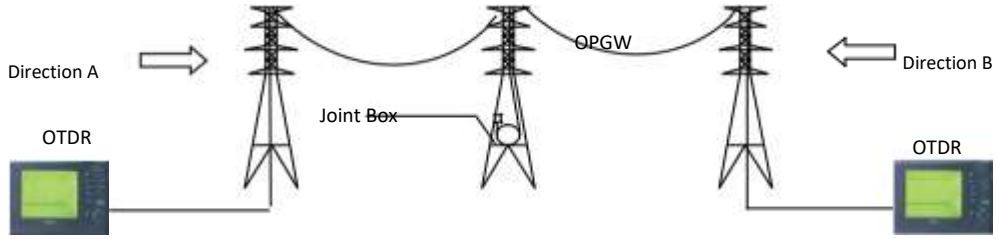
Witnessed By
(Sign with date)

Approved By
(Sign with date)

SAT-02-A (48 F)

POST-INSTALLATION TEST REPORT FOR OPGW

Report No:	Sector:		
Date:	Section:		
	Drum No:		
	Drum Length:		(As per Pre-shipment date)
	Drum Length:		(Actual at site)
Type of OTDR:	WAVELENGTH	REFRACTION INDEX	MAX ATTENUATION
Testing Date:	1310nm	1.4670	0.35 dB/km
	1550nm	1.4675	0.21 dB/km



S.No:	Description	Result (Yes / No)	Remarks
1	Physical Appearance check		
2	Drum Marking check		
3	Sealing of Cable ends & provision of spare cable caps		

Tube Color	Fiber No	Fiber Color	Length (km)	Attenuation		Remarks
				1310nm dB/km	1550nm dB/km	
BLUE	1	Blue				
	2	Orange				
	3	Green				
	4	Brown				
	5	Slate				
	6	White				
	7	Red				
	8	Black				
	9	Yellow				
	10	Violet				
	11	Pink				
	12	Aqua				
ORANGE	13	Blue				
	14	Orange				
	15	Green				
	16	Brown				
	17	Slate				
	18	White				
	19	Red				
	20	Black				
	21	Yellow				
	22	Violet				
	23	Pink				
	24	Aqua				

Tube Color	Fiber No	Fiber Color	Length (km)	Attenuation		Remarks
				1310nm dB/km	1550nm dB/km	
GREEN	25	Blue				
	26	Orange				
	27	Green				
	28	Brown				
	29	Slate				
	30	White				
	31	Red				
	32	Black				
	33	Yellow				
	34	Violet				
	35	Pink				
	36	Aqua				
BROWN	37	Blue				
	38	Orange				
	39	Green				
	40	Brown				
	41	Slate				
	42	White				
	43	Red				
	44	Black				
	45	Yellow				
	46	Violet				
	47	Pink				
	48	Aqua				

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

Tested By
(Sign with date)

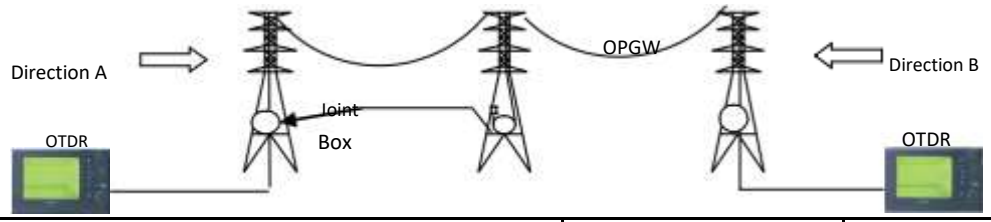
Witnessed By
(Sign with date)

Approved By
(Sign with date)

SAT-03-B (48 F)

SPLICE LOSS TEST REPORT FOR OPGW @ 1550nm

Report No:	Sector:		
Date:	Section:		
	TOWER No:		
			Acceptance criteria
			Max.Splice Loss
Type of OTDR:	WAVELENGTH	REFRACTION INDEX	0.10dB(Individual splice)
Testing Date:			Average Splice loss in link
	1550nm	1.4675	0.05 dB/Splice



S.No:	Description	Result (Yes / No)	Remarks
1	Physical Appearance check		
2	Drum Marking check		
3	Sealing of Cable ends & provision of spare cable caps		

Tube Color	Fiber No	Fiber Color	Length (km)	SPLICE LOSS (dB)		Actual Loss (dB)=(A+B)/2
				Direction A	Direction B	
BLUE	1	Blue				
	2	Orange				
	3	Green				
	4	Brown				
	5	Slate				
	6	White				
	7	Red				
	8	Black				
	9	Yellow				
	10	Violet				
	11	Pink				
	12	Aqua				
ORANGE	13	Blue				
	14	Orange				
	15	Green				
	16	Brown				
	17	Slate				
	18	White				
	19	Red				
	20	Black				
	21	Yellow				
	22	Violet				
	23	Pink				
	24	Aqua				

Tube Color	Fiber No	Fiber Color	Length (km)	SPLICE LOSS (dB)		Actual Loss (dB)=(A+B)/2
				Direction A	Direction B	
GREEN	25	Blue				
	26	Orange				
	27	Green				
	28	Brown				
	29	Slate				
	30	White				
	31	Red				
	32	Black				
	33	Yellow				
	34	Violet				
	35	Pink				
	36	Aqua				
BROWN	37	Blue				
	38	Orange				
	39	Green				
	40	Brown				
	41	Slate				
	42	White				
	43	Red				
	44	Black				
	45	Yellow				
	46	Violet				
	47	Pink				
	48	Aqua				

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

Tested By
(Sign with date)

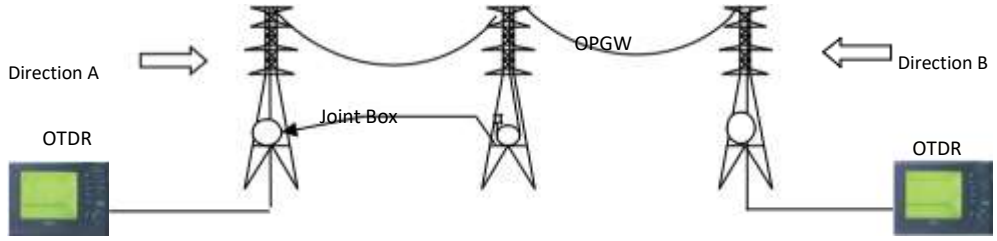
Witnessed By
(Sign with date)

Approved By
(Sign with date)

SAT-03-A (48 F)

SPLICE LOSS TEST REPORT FOR OPGW @ 1310nm

Report No:	Sector:		
Date:	Section:		
	TOWER No:		
			Acceptance criteria
			Max.Splice Loss
Type of OTDR:	WAVELENGTH	REFRACTION INDEX	0.10dB(Individual splice)
Testing Date:			Average Splice loss in link
	1310nm	1.4670	0.05 dB/Splice



S.No:	Description	Result (Yes / No)	Remarks
1	Physical Appearance Check		
2	Drum Marking Check		
3	Sealing of Cable Ends & Provision of Spare Cable Caps		

Tube Color	Fiber No	Fiber Color	Length (km)	SPLICE LOSS (dB)		Actual Loss (dB)=(A+B)/2
				Direction A	Direction B	
BLUE	1	Blue				
	2	Orange				
	3	Green				
	4	Brown				
	5	Slate				
	6	White				
	7	Red				
	8	Black				
	9	Yellow				
	10	Violet				
	11	Pink				
	12	Aqua				
ORANGE	13	Blue				
	14	Orange				
	15	Green				
	16	Brown				
	17	Slate				
	18	White				
	19	Red				
	20	Black				
	21	Yellow				
	22	Violet				
	23	Pink				
	24	Aqua				

Tube Color	Fiber No	Fiber Color	Length (km)	SPLICE LOSS (dB)		Actual Loss (dB)=(A+B)/2
				Direction A	Direction B	
GREEN	25	Blue				
	26	Orange				
	27	Green				
	28	Brown				
	29	Slate				
	30	White				
	31	Red				
	32	Black				
	33	Yellow				
	34	Violet				
	35	Pink				
	36	Aqua				
BROWN	37	Blue				
	38	Orange				
	39	Green				
	40	Brown				
	41	Slate				
	42	White				
	43	Red				
	44	Black				
	45	Yellow				
	46	Violet				
	47	Pink				
	48	Aqua				

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

Tested By
(Sign with date)

Witnessed By
(Sign with date)

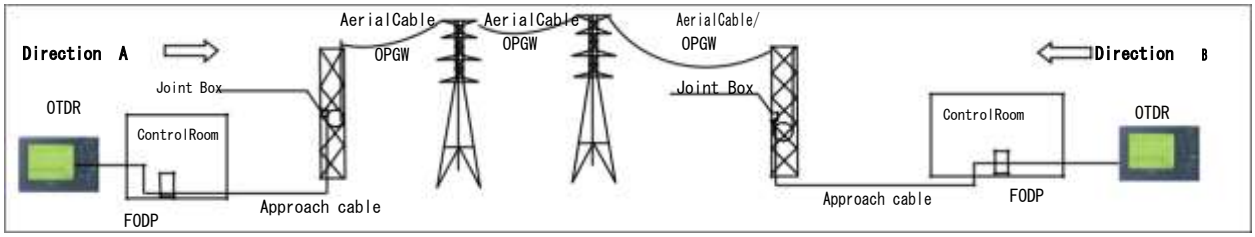
Approved By
(Sign with date)

SAT-04-A (48 F)

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

Report No: Date:

SECTOR				
LINE LINK				
FODP to FODP				
Type of OTDR	Testing Date	Wave Length	Max Attenuation of Fiber	Specified Loss
		1310 nm	0.35 db/km	∑ 0.35dB/km **x** Total FO length + 0.05dB/splice **x** Total No. of splice + 0.5dB/connector **x** No. of connectors



Tube Color	Fiber No	Fiber Color	Length (km)	Total Loss (dB)		Actual Loss (dB)=(A+B)/2
				Direction A	Direction B	
BLUE	1	Blue				
	2	Orange				
	3	Green				
	4	Brown				
	5	Slate				
	6	White				
	7	Red				
	8	Black				
	9	Yellow				
	10	Violet				
	11	Pink				
	12	Aqua				
ORANGE	13	Blue				
	14	Orange				
	15	Green				
	16	Brown				
	17	Slate				
	18	White				
	19	Red				
	20	Black				
	21	Yellow				
	22	Violet				
	23	Pink				
	24	Aqua				

Tube Color	Fiber No	Fiber Color	Length (km)	Total Loss (dB)		Actual Loss (dB)=(A+B)/2
				1310nm dB/km	1550nm dB/km	
GREEN	25	Blue				
	26	Orange				
	27	Green				
	28	Brown				
	29	Slate				
	30	White				
	31	Red				
	32	Black				
	33	Yellow				
	34	Violet				
	35	Pink				
	36	Aqua				
BROWN	37	Blue				
	38	Orange				
	39	Green				
	40	Brown				
	41	Slate				
	42	White				
	43	Red				
	44	Black				
	45	Yellow				
	46	Violet				
	47	Pink				
	48	Aqua				

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

Tested By
(Sign with date)

Witnessed By
(Sign with date)

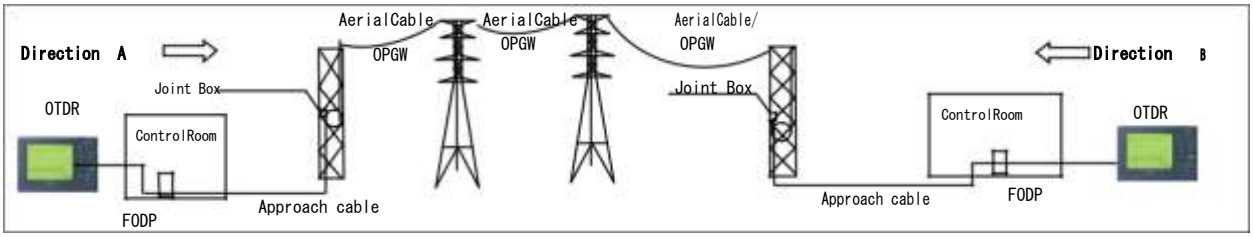
Approved By
(Sign with date)

SAT-04-B (48 F)

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

Report No: Date:

SECTOR				
LINE LINK				
FODP to FODP				
Type of OTDR	Testing Date	Wave Length	Max Attenuation of Fiber	Specified Loss
		1550 nm	0.21 db/km	∑ 0.21dB/km **x** Total FO length + 0.05dB/splice **x** Total No. of splice + 0.5dB/connector **x** No. of connectors



Tube Color	Fiber No	Fiber Color	Length (km)	Total Loss (dB)		Actual Loss (dB)=(A+B)/2
				Direction A	Direction B	
BLUE	1	Blue				
	2	Orange				
	3	Green				
	4	Brown				
	5	Slate				
	6	White				
	7	Red				
	8	Black				
	9	Yellow				
	10	Violet				
	11	Pink				
	12	Aqua				
ORANGE	13	Blue				
	14	Orange				
	15	Green				
	16	Brown				
	17	Slate				
	18	White				
	19	Red				
	20	Black				
	21	Yellow				
	22	Violet				
	23	Pink				
	24	Aqua				

Tube Color	Fiber No	Fiber Color	Length (km)	Attenuation		Remarks
				1310nm dB/km	1550nm dB/km	
GREEN	25	Blue				
	26	Orange				
	27	Green				
	28	Brown				
	29	Slate				
	30	White				
	31	Red				
	32	Black				
	33	Yellow				
	34	Violet				
	35	Pink				
	36	Aqua				
BROWN	37	Blue				
	38	Orange				
	39	Green				
	40	Brown				
	41	Slate				
	42	White				
	43	Red				
	44	Black				
	45	Yellow				
	46	Violet				
	47	Pink				
	48	Aqua				

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

Tested By
(Sign with date)

Witnessed By
(Sign with date)

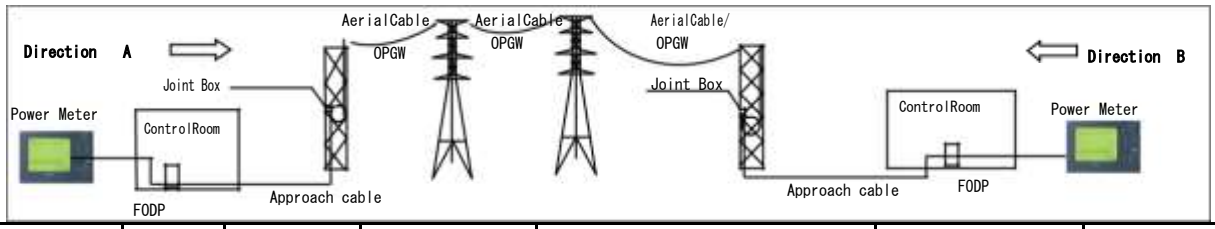
Approved By
(Sign with date)

SAT-05-A (48 F)

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

Report No: Date:

SECTOR	FODP to FODP			
LINE LINK				
REFERENCE POWER : Pr dBm				
A- Power measuring from A Direction dBm			P1: Pr - A dBm	
B- Power measuring from B Direction dBm			P2: Pr - B dBm	
Type of Power Meter	Testing Date	Wave Length	Max Attenuation of Fiber	Specified Loss
		1550 nm	0.21 db/km	∑ 0.21dB/km **x** Total FO length + 0.05dB/splice **x** Total No. of splice + 0.5dB/connector **x** No. of connectors



Tube Color	Fiber No	Fiber Color	Length (Km)	Received Power (dB)		Actual Loss (dB) P=(P1+P2)/2	Average Loss (dB/km) P/Section length
				Direction-A (P1)	Direction-B (P2)		
BLUE	1	Blue					
	2	Orange					
	3	Green					
	4	Brown					
	5	Slate					
	6	White					
	7	Red					
	8	Black					
	9	Yellow					
	10	Violet					
	11	Pink					
	12	Aqua					
ORANGE	13	Blue					
	14	Orange					
	15	Green					
	16	Brown					
	17	Slate					
	18	White					
	19	Red					
	20	Black					
	21	Yellow					
	22	Violet					
	23	Pink					
	24	Aqua					

Tube Color	Fiber No	Fiber Color	Length (Km)	Received Power (dB)		Actual Loss (dB) P=(P1+P2)/2	Average Loss (dB/km) P/Section length
				Direction-A (P1)	Direction-B (P2)		
GREEN	25	Blue					
	26	Orange					
	27	Green					
	28	Brown					
	29	Slate					
	30	White					
	31	Red					
	32	Black					
	33	Yellow					
	34	Violet					
	35	Pink					
	36	Aqua					
BROWN	37	Blue					
	38	Orange					
	39	Green					
	40	Brown					
	41	Slate					
	42	White					
	43	Red					
	44	Black					
	45	Yellow					
	46	Violet					
	47	Pink					
	48	Aqua					

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

Tested By
(Sign with date)

Witnessed By
(Sign with date)

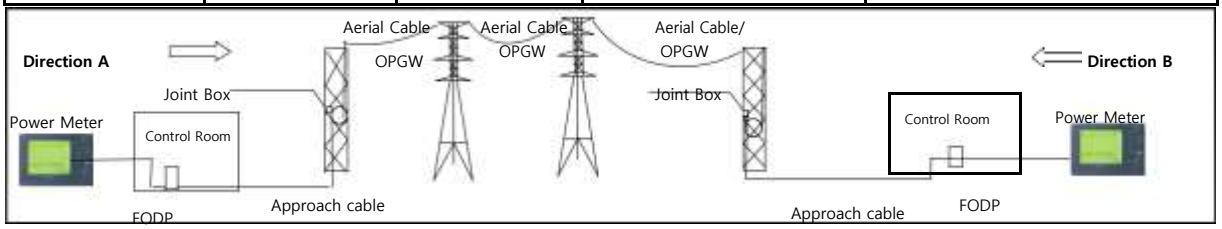
Approved By
(Sign with date)

SAT-05-B (48 F)

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

Report No: Date:

SECTOR	FODP TO FODP			
LINE LINK				
REFERENCE POWER : Pr dBm				
A- Power measuring from A Direction dBm			P1: Pr - A dBm	
B- Power measuring from B Direction dBm			P2: Pr - B dBm	
Type of Power Meter	Testing Date	Wave Length	Max Attenuation of Fiber	Specified Loss
		1310 nm	0.35 db/km	∑ 0.35dB/km **x** Total FO length + 0.05dB/splice **x** Total No. of splice + 0.5dB/connector **x** No. of connectors



Tube Color	Fiber No	Fiber Color	Length (Km)	Received Power (dB)		Actual Loss (dB) P=(P1+P2)/2	Average Loss (dB/km) P/Section length
				Direction-A (P1)	Direction-B (P2)		
BLUE	1	Blue					
	2	Orange					
	3	Green					
	4	Brown					
	5	Slate					
	6	White					
	7	Red					
	8	Black					
	9	Yellow					
	10	Violet					
	11	Pink					
	12	Aqua					
ORANGE	13	Blue					
	14	Orange					
	15	Green					
	16	Brown					
	17	Slate					
	18	White					
	19	Red					
	20	Black					
	21	Yellow					
	22	Violet					
	23	Pink					
	24	Aqua					

Tube Color	Fiber No	Fiber Color	Length (Km)	Received Power (dB)		Actual Loss (dB) P=(P1+P2)/2	Average Loss (dB/km) P/Section length
				Direction-A (P1)	Direction-B (P2)		
GREEN	25	Blue					
	26	Orange					
	27	Green					
	28	Brown					
	29	Slate					
	30	White					
	31	Red					
	32	Black					
	33	Yellow					
	34	Violet					
	35	Pink					
	36	Aqua					
BROWN	37	Blue					
	38	Orange					
	39	Green					
	40	Brown					
	41	Slate					
	42	White					
	43	Red					
	44	Black					
	45	Yellow					
	46	Violet					
	47	Pink					
	48	Aqua					

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

Tested By
(Sign with date)

Witnessed By
(Sign with date)

Approved By
(Sign with date)

Appendix-B

Data Requirement Sheets

Appendix-B

Data Requirement Sheets

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

DRS Form 1(a)

DATA REQUIREMENTS SHEETS for OVERHEAD FIBRE OPTIC CABLE

OPTICAL GROUND WIRE (OPGW) – 24/48 Fibre:

Manufacturer: _____

Part #: _____

Configuration: _____

CABLE CONSTRUCTION			
Seq	**Parameter:**	**As per Technical Specification**	**As per Bidder Offering**
1.	No. of Fibres Dual Window Single-Mode:	24/48	
2.	Buffer Type:	As applicable	
3.	Buffer Tube material	As applicable	
4.	No. of Buffer Tubes:	As applicable	
5.	No. of Fibers per bufferTube:	As applicable	
6.	Expected Cable Life:	25 Year	
7.	**Parameters of OPGW**		
(i)	UTS	In Kgf	
(ii)	Effective area	In mm^2	
(iii)	Weight	In kg/m	
(iv)	Diameter	In mm	
(v)	Modulus of elasticity	In kg/ mm^2	
(vi)	Coeff. Of linear expansion	In /℃	
(vii	Central tube design	Al or Steel	

DRS Form 2

DATA REQUIREMENTS SHEETS for OPTICAL FIBRE

DUAL-WINDOW SINGLE MODE (DW-SM)

OPTICAL PARAMETERS			
Seq	**Parameter:**	**As per Technical Specification**	**As per Bidder offering**
1.	Fiber manufacturer(s)/Type:		
2.	Attenuation Coefficient@ 1310 nm: @ 1550 nm:	≤ 0.35 dB/km ≤ 0.21 dB/km	
3.	Point discontinuity @ 1310nm: @ 1550nm:	≤ 0.05 dB ≤ 0.05 dB	
4.	Nominal Mode Field Diameter @ 1310 nm:	8.6 to 9.5 µm (± 0.6 µm)	
5.	Chromatic Dispersion Coefficient @ 1310 (1288-1339) nm: @ 1310 (1271-1360) nm: @ 1550 nm:	 3.5 ps/(nmxkm) 5.3 ps/(nmxkm) 18 ps/(nmxkm)	
6.	Zero dispersion wavelength:	1300 to 1324 nm	
7.	Cutoff wavelength:	≤ 1260 nm	
Physical and Mechanical Properties			
8.	Bend Performance: (37.5 mm radius, 100 turns) @1310 nm (30 mm radius, 100 turn) @1550 nm (16mm radius, 1 turn) @ 1550nm	≤ 0.05 dB ≤ 0.05 dB ≤ 0.50 dB	
9.	Cladding Diameter (nominal ± deviation):	125.0 µm ± 1 µm	
10.	Polarisation mode dispersion coefficient	≤ 0.2 ps/km$^{1/2}$	
11.	Proof test level	≥ 0.69 Gpa	

DRS Form-3

DATA REQUIREMENTS SHEETS for OPTICAL LINE TERMINATION EQUIPMENT (OLTE)

Manufacturer:_____

Model #: _____

Seq	Parameter:	As per Technical Specification	As per Technical Specification	As per Bidder Offering	As per Bidder Offering
		STM-4 Equipment	STM-16 Equipment	STM-4 Equipment	STM-16 Equipment
1.	SDH hierarchy level: Capacity Aggregate Bit-rate: CEPT E-1 Ports:	STM-4 620 Mbps 252 x E1	STM-16 2480 Mbps 1008 x E1		
2.	Minimum No. of protected (MSP) directions	Three	Three		
3.	No. of E1 Interfaces per card	minimum 16	minimum 16		
4.	No. of 10/100Mbps Ethernet Interfaces per card with layer 2 switching	minimum 8	minimum 8		
5.	Service Channel provision a) Voice Channel b) Data Channel	Yes Minimum 1 Minimum 1	Yes Minimum 1 Minimum 1		
6.	Cross Connection Capacity (Non-Blocking & bi-directional) High Order: Low Order	 64 STM-1 64 STM-1	 256 STM-1 128 STM-1		
7.	Power Supply cards of SDH equipment Common Control* Card of SDH equipment	1:1 APS or distributed power supply 1:1 APS	1:1 APS or distributed power supply 1:1 APS		

* = Common Control Cards which are essentially required for the operation of the equipment

DRS Form-4

DATA REQUIREMENTS SHEETS for

Primary Multiplexer/Drop & Insert Multiplexer

Manufacturer:

_____

Model #:

_____

Configuration:

Seq.	**Parameter**	**As per Technical Specification**	**As per Bidder Offering**
1.	Output Aggregate Rate	2.048 Mbps +/- 50 ppm	
2.	Interface Code	HDB3	
3.	Impedance	75 ohm unbalanced	
4.	Maximum Insertion Loss	6 dB	
5.	Power Supply card of multiplexer	1:1 APS or distributed power supply	

The detailed DRS for all equipments/items are required to be submitted along with brochures during detailed engineering.

----------End of the Appendix----------

Appendix-D

GUIDELINES FOR OPGW CABLE OFF-LINE INSTALLATION

1.General

Installation procedure for OPGW is basically similar to that for conventional overhead ground wires in overhead transmission line construction, however particular care required to be taken for protection of optical fibers in OPGW cable from damage by handling the same properly during transportation , unloading and installation at site. Off line installation to be carried out using power operated winch machines and pulley blocks on each tower using experienced installation team comprising of minimum 25 persons. The installation team shall have one team leader/crew in-charge along with 15 skilled and 10 unskilled persons minimum in one installation crew.

List of Tools and Plants to be used are as per enclosed Annexure.

Following aspects are to be kept in mind before taking up live-line installation:

a)Tools and Plant suitability
b)Working conditions, specially following:

- Strong winds more than 7 m/sec
- Rain or snow
- Foggy
- Lightening

2. Safety measures

All site workers must follow the Electricity Rules and Employer specified safety procedures. They must use safety belts, safety shoe, safety helmet and other safety items required.

Assign foremen/Crew In-charge for each erection crew for enforcing installation guidelines. It may be ensured that only authorized person is climbing the tower during live-line installation of OPGW. Fix the warning red flag on the tower, in order to keep the workers from encroaching into unsafe zones.

2.1 Permission to Work (PTW) :

Permit to work to be obtained by the representative of installation agency from concerned sub-station staff in coordination with employer project manager prior to commencement of installation in case of power line crossings and the same is to be returned after completion of the work in all respect within the specified time duly following the PTW conditions.

2.2 Preparedness to tackle untoward incidents:

a) Safety Engineer has to make sure the availability of First Aid Box with each team. b) Maintain a record of the details of list of all nearby hospitals/clinics in each area, with contact details and Emergency contact nos. of Ambulances.

c) In case of any untoward situation, Safety engineer/crew incharge must act fast and provide the necessary first aid to the affected person(s). Ambulance to be arranged immediately from the nearby area and coordinate with hospital for immediate medical assistance as required.

3. Off-line Installation Process

3.1 Installation plan:

Following measures are to be taken in advance for smooth completion of the installation.

- Coordination with employer project manager
- Erection crew mobilization along with T&Ps
- Safety aspects
- Field quality aspects
- Transportation arrangement

3.2 Materials handling:

Check the material with respect to the approved documentation. All materials shall be visually examined for any physical damage. Any material, which is not as per documentation or is damaged, shall not be used.

OPGW Drums checks:

- Packing condition
- Packing list (Object, Type, Length, OPGW Weight, Drum No. etc)
- Attenuation results of OPGW

Hardware Fittings Checks:

- Bolts, Nuts Pitch
- Type & Quantity

Handling of OPGW:

OPGW contains optical fibers which are very delicate and to be handled with due care. For the safety of optical fibers, it is very important to avoid the bending at sharp angle. Manufacturer guidelines are to be followed strictly while handling the same.

In order to avoid undue tension on OPGW, it is not recommended to pay off OPGW together with phase conductors or other wires tied in parallel. The tension during stringing works should be well managed within permissible limits.

Adequate length of OPGW shall be ensured as loop at each joint location after stringing so that it is possible to bring OPGW up to the ground level for carrying out jointing work.

4. OPGW Stringing

- Hang the pulley blocks on one of the earth wire peaks for the whole section (Section is a consecutive group of towers needed to support the installation of scheduled length of OPGW Drum)
- Carry out paying of pilot wire for entire section and connect the same with OPGW on drum side and winch machine on other side suitably.
  - Pull the Pilot Wire with the use of winch machine to pay out the OPGW.
  - Maintain proper tension while pulling OPGW so as to avoid damage to fibers inside the OPGW. In no case pulling tension should exceed 15 % of UTS of OPGW.
- **Set the Come-along and Lever Block to the OPGW.**With this OPGW paying fora section gets completed.

5. OPGW sagging

Use the pre-calculated Sag & Tension Table as sag reference. Avoid fixing the sag if the wind is strong.

5.1 Sagging:

1) Methods and procedures for sagging of OPGW are the same as those of normal overhead ground wire.

After stringing the OPGW shall be sagged using information furnished on the sag and tension chart. The sag of the OPGW should not exceed the existing

ground-wire sag.

3) Sagging thermometers shall be used to determine accurate temperature and OPGW sag of each sag section. Sagging thermometer shall be used sufficiently prior to the actual sagging operation to represent the temperature of the OPGW.

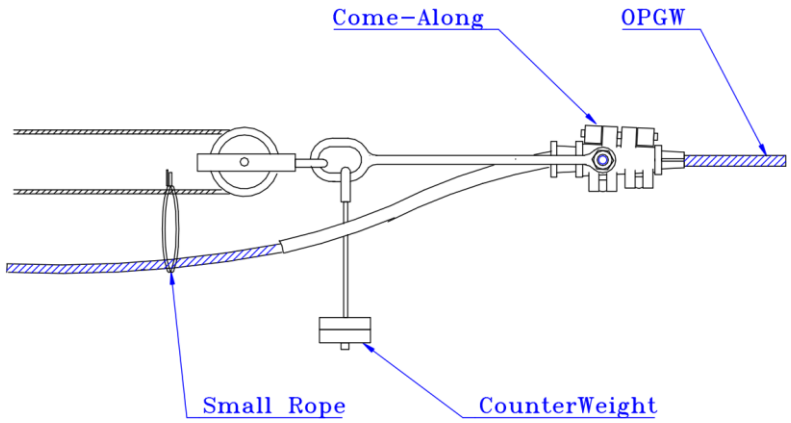
5) At the time of sagging OPGW, the sag should be within 6 inches of the theoretical value for existing temperature condition.

7) OPGW tension between each sag section shall be equalized and this shall be determined by the vertical position of the suspension clamps on the last clipped structure of the preceding sag section.

8) For pulling the OPGW with tension, the device of come-along is to be recommended.

9) Personnel should be specifically deployed for keeping watch on sag at a different section of the line during stringing.

10) Waterproof caps shall be fixed at both ends of the OPGW cable after installation.

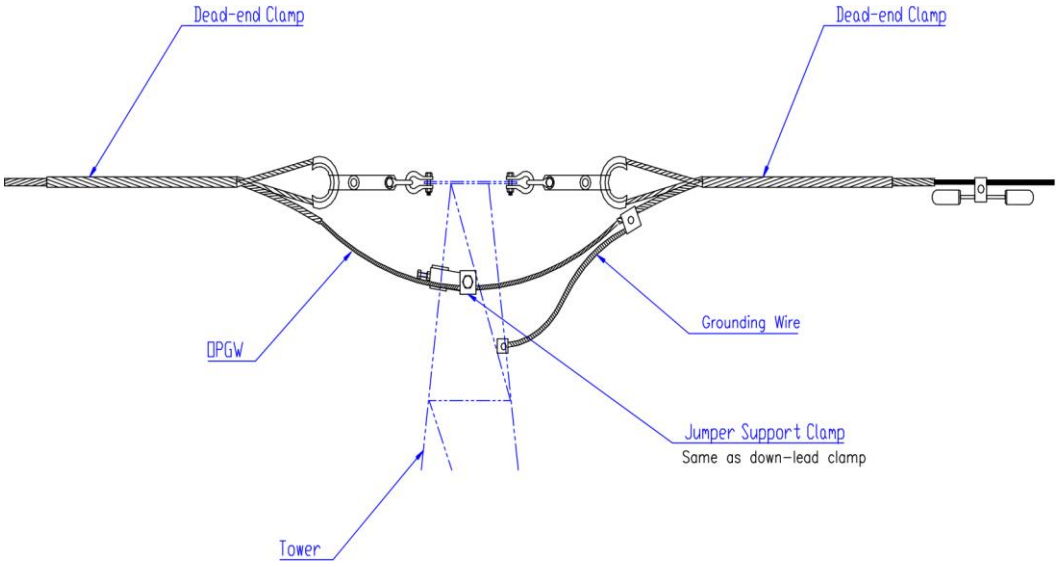


6. OPGW Clamping

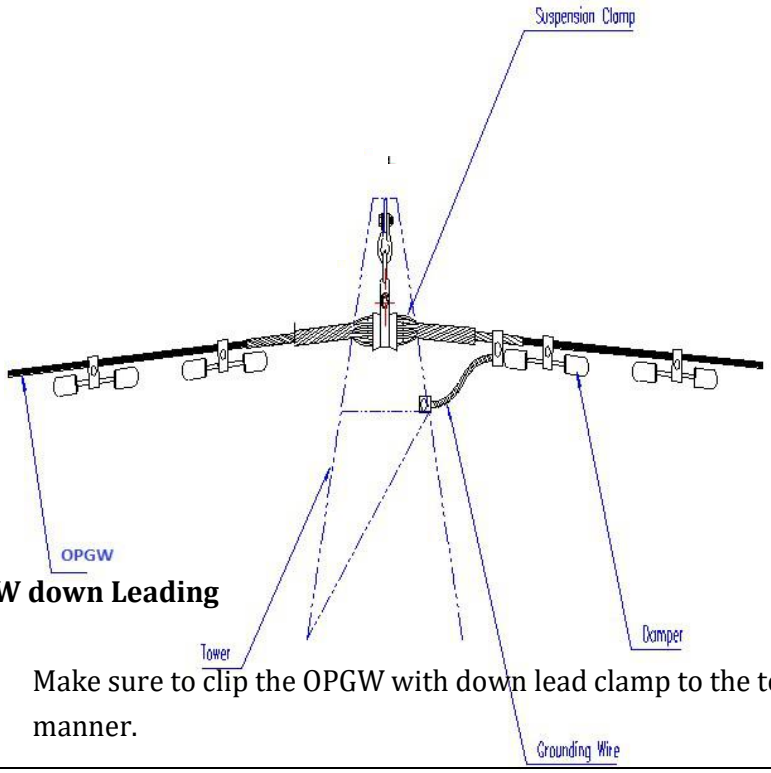
6.1 Make sure to install and tighten the bolt of clamp properly.

6.2 Tightening must be made sequentially from the support point.

TENSION TOWER



SUSPENSION TOWER



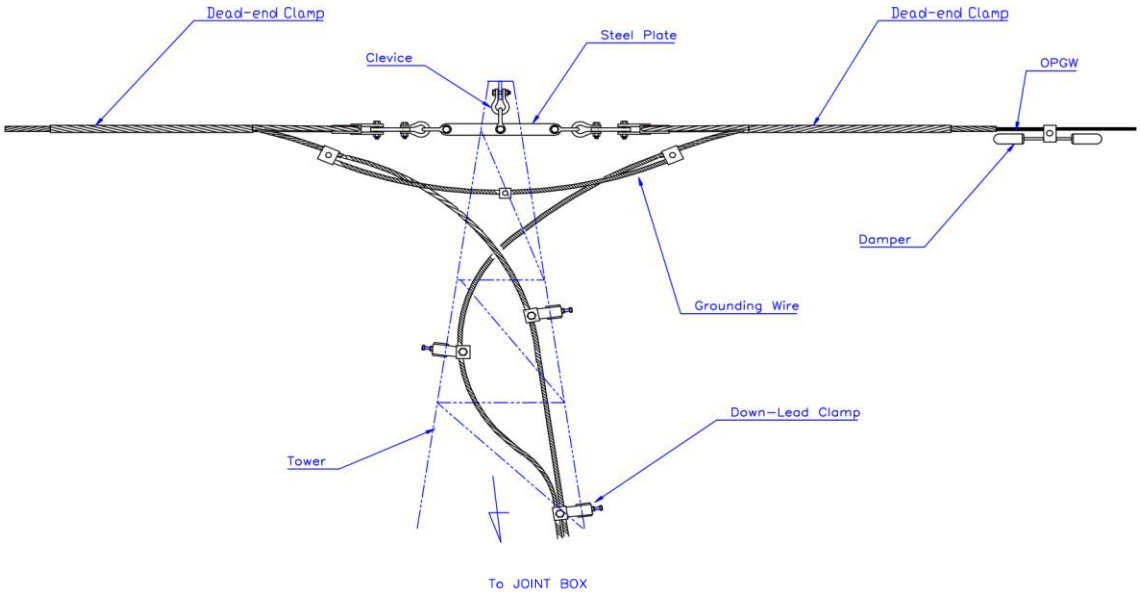
7. OPGW down Leading

7.1 Make sure to clip the OPGW with down lead clamp to the tower in a careful manner.

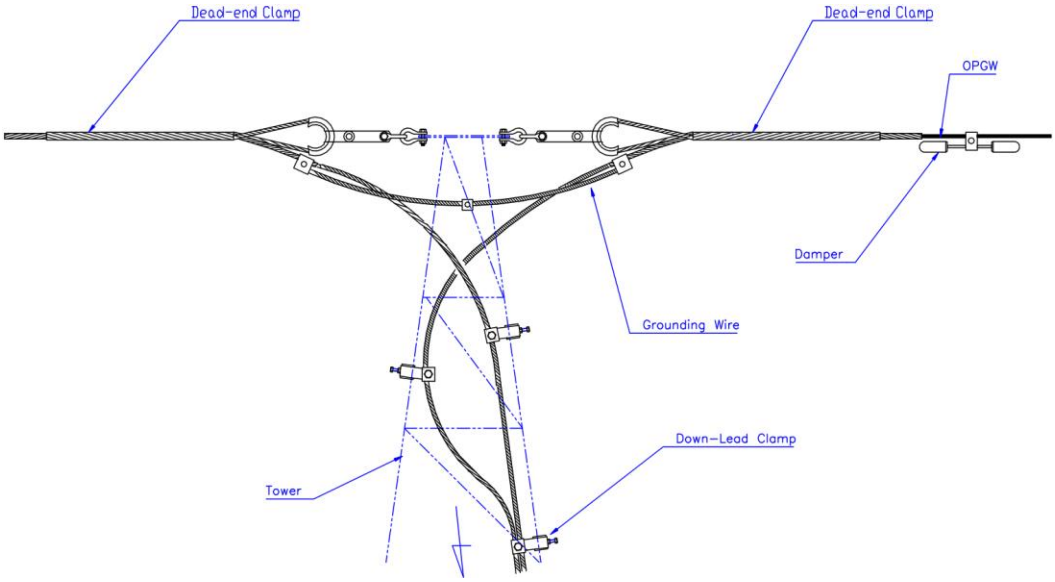
7.2 Make sure to tighten the bolt of down-lead clamp properly.

7.3 Install the down-lead clamp at appropriate interval .

SUSPENSION TOWER FOR JOINTING TOWER



TENSION TOWER OF JOINTING TOWER



Annexure-1

List of Tools:

S. No	Description	Specifications
01	Pulley block(Aluminum roller) 300 mm	20 Nos
02	Pulley block(Aluminum roller) 450 mm	20 Nos
03	Pulley block(Aluminum roller) 600 mm	6 Nos
04	Pilot Wire (14 mm)	1000 M
05	Pilot Wire (16 mm)	7000 M
06	Pilot Rope 12 mm Nylon Rope	600 M
07	Earthing roller	3-way roller
08	Winch machine (3 Tons)	2 Nos
09	Drum stand	2 sets
10	Reel winder	6 Nos
11	Come along clamp	8 Nos
12	Torque Wrench (1 Ton)	2 Nos
13	Running Board (20 Kg)	4 Nos
14	D-shackle	30 Nos
15	Snatch Block (1 way 2 ton)	8 Nos
16	Snatch Block (2 way 2 ton)	4 Nos
17	Chain Block (3 Ton)	4 Nos
18	Wire Connector	20 Nos
19	Braid Clamp	6 Nos
20	Wire Clamp	20 Nos
21	Swivel (3 ton)	10 Nos

Appendix - E

Guidelines for Splicing of Fibre Optic Cable

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1. General

OPGW based Fibre Optic network being established by Power Utilities for catering data & voice communication requirements. OPGW is being supplied in number of drums for a link and required splicing for completing of a fibre optic link. Generally fusion method is being used for splicing of fibres in cable. For carrying out splicing work, experienced personnel is essential for handling splicing kit and necessary instruments such as OTDR etc.

a) Jointing of OPGW is usually carried out on the ground. For ease of jointing with accuracy, adequate space (with tent) to be ensured on the ground for jointer and equipment. This floor space should be protected against the heavy wind, strong sunshine, high temperature, rain and dusty atmosphere.

b) Attention must be paid so as not to damage OPGW including its optical components during handling, cutting, un-stranding of component wires and jointing.

c) Attenuation of optical fibers to be measured just before splicing and after splicing.

d) Typical organization chart for jointing work is given below:

A. Jointing In charge

-1 A.1For Testing :

(i) Lineman – 1

(ii) Jointer & Tester – 1

(iii) Unskilled labor -1

A.2 For Jointing :

(i) Lineman- 1

(ii) Jointer & Tester – 1

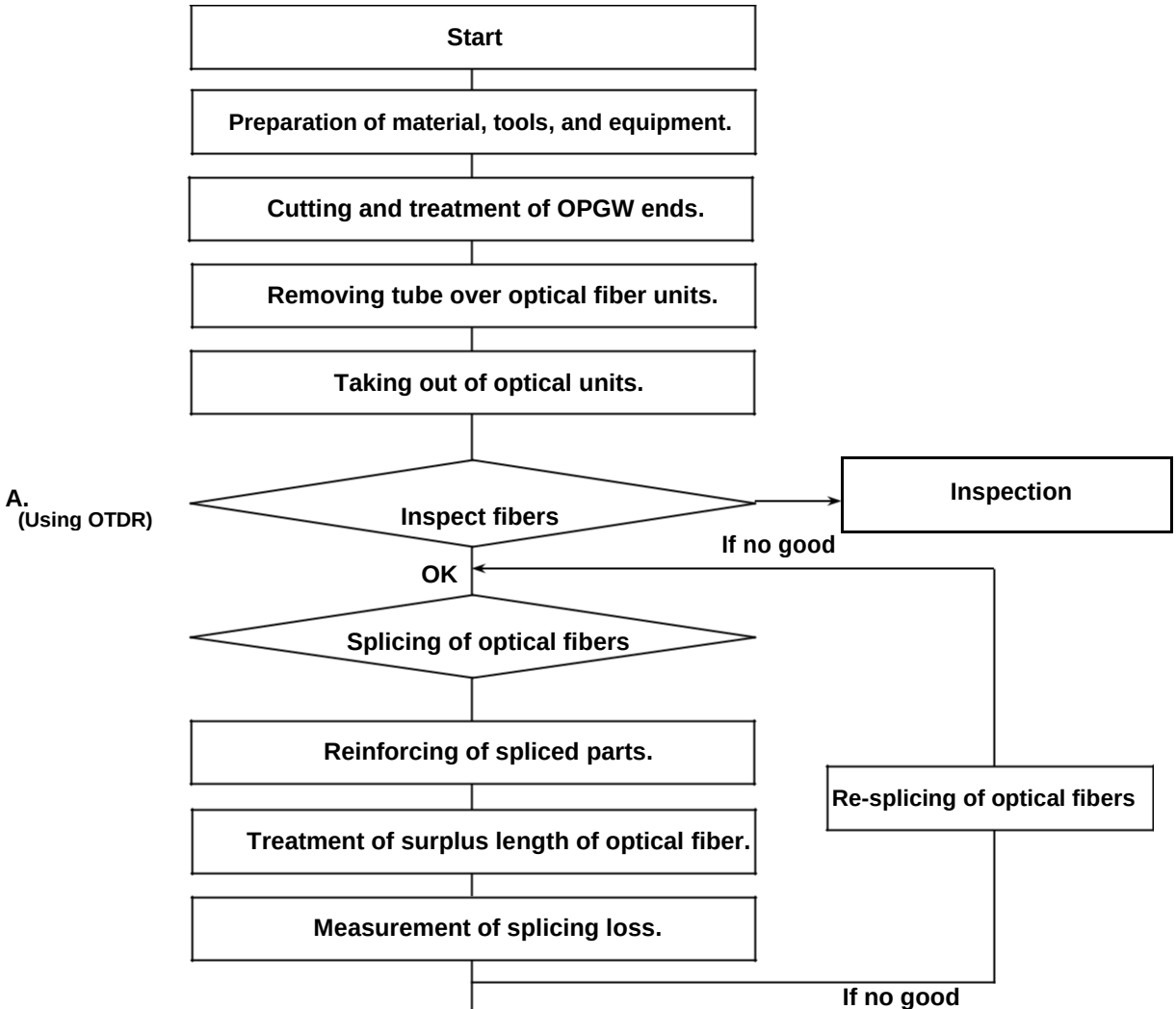
(iii) Unskilled labor -1

2. Jointing of optical fibre

Optical fibre are joined by using Fusion splicing. It is the process of fusing or welding two fibers together usually by an electric arc. Fusion splicing is the most widely used method of splicing as it provides for the lowest loss and least reflectance, as well as providing the strongest and most reliable joint between two fibers.

3. Flowchart of jointing procedure.

Process flow chart of OPGW jointing works is summarized briefly, as below:



Sealing and closing of the joint box

Installation of the joint box

End

4. Jointing works

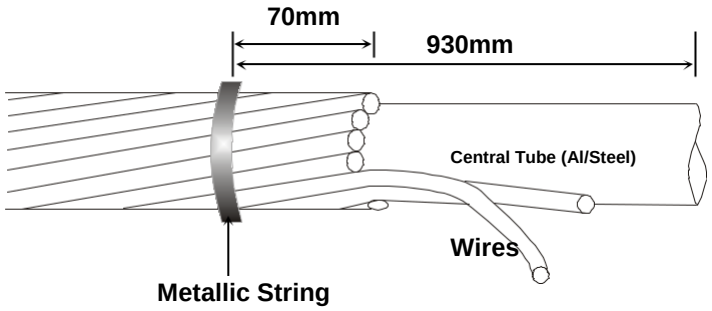
a) Preparation of materials, tools and equipment

It may be ensured that all the materials, tools and equipment listed in the Table-1 are available. The Table-1 shows tentative list of required tools & material.

b) Cutting and treatment of OPGW ends

Coiled OPGW to be brought down and cut-off unnecessary lengths of the OPGW with a cable cutter.

Put marks on OPGW at positions where OPGW is to be fixed to the glands of the joint box. Carryout mounting of OPGW at a position about 70mm below the cutting mark with a metallic string to prevent the stranded wires from becoming loose after cutting off the OPGW.



Notch the Strand wires of the OPGW with a hacksaw to the depth of 1/3 or 1/2 of the Strand wire diameter. In this case, take care not to damage the inside Central Tube (AL/Steel) of the OPGW. Loose the Strand wires from the OPGW ends one by one and snap them off at the notched position. Cut the Central Tube (AL/Steel).

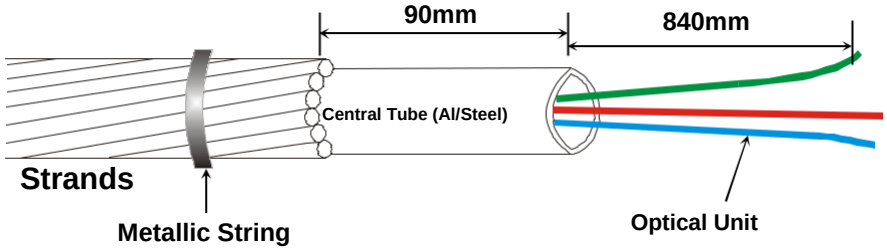


Table-1: Tools & Material

Description	Qt'y	Purpose
Stabilized light source	1	Measure loss
Optical power meter	1	Measure loss
Dummy fiber	1	Measure loss
Fusion splicer	1	Splicing fiber
Fiber cutter	2	Cutting fiber
Jacket stripper	2	Remove fiber jacket
Washing agent	2	Cleaning fiber
Ethyl alcohol	2	Cleaning fiber
Gauze	1 Set	Cleaning fiber
Dust remove	1	Cleaning splicer
Cable cutter	1	Cutting OPGW
Hacksaw	1	Cutting AW wire
Pipe cutter	1	Cutting al tube
Knife	1	
Screw driver set(+,-)	1	
Pliers	2	
Light stand	1	Lighting
Hexagon wrench	1	
Portable telephone set	2	
Engine generator(If need)	1	Power supply
OTDR	1	
Electric reel	1	
Optical telephone set	2	
Electric cord	1	

c) Fixing OPGW in the Passcable (see the Figure 4. for main assembling particulars)