

FAT Procedure for OPGW -Vibration Dampers

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

Test Location:

Manufacturer:

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

Objective: To analyze the vibration damper response at Resonant frequencies

Test procedure

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

- (a) Force Vs frequency
- (b) Phase angle Vs frequency
- (c) Power dissipation Vs frequency

Acceptance criteria:

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

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

FAT Procedure for OPGW -Vibration Dampers

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

Observations, if any:

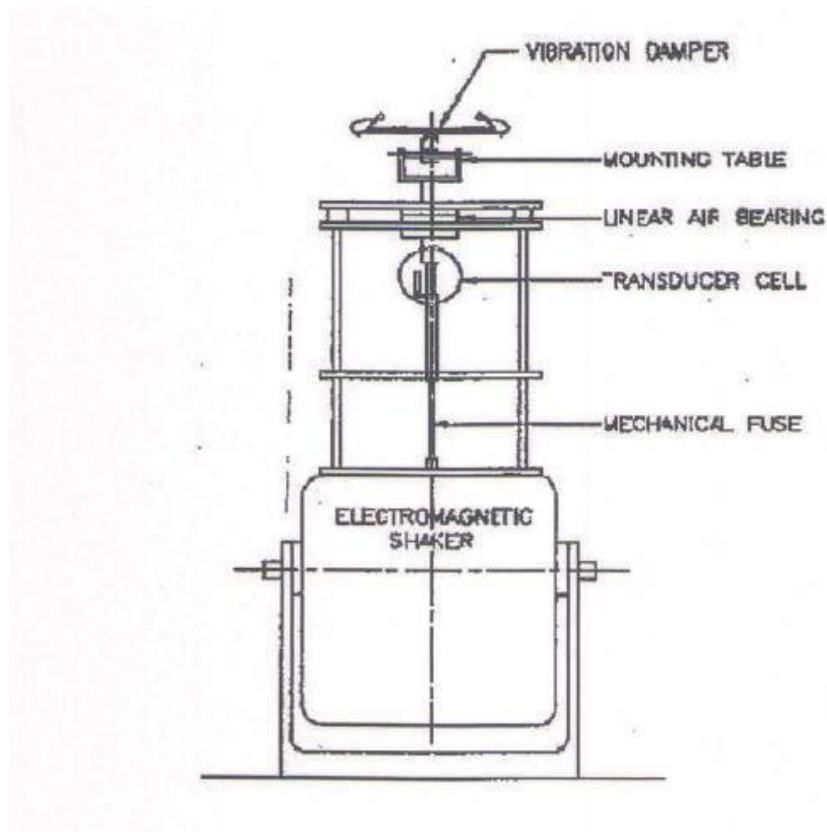


Fig.1 Schematic of Vibration Damper Characteristics

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

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW -Vibration Dampers

STRENGTH OF MESSENGER WIRE TEST FOR VIBRATION DAMPER

Test Location:

Manufacturer:

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

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

Test Procedure:

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

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

KN Test Results:

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

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

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW -Vibration Dampers

ATTACHMENTS OF WEIGHTS TO MESSENGER CABLE

Test Location:

Manufacturer:

Test Standard: Technical Specification, IEC61897:1999

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

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

Test Procedure:

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

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

Acceptance Criteria:

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

Observation, if any;

Test Results:

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

FAT Procedure for OPGW -Vibration Dampers

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

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW -Vibration Dampers

ATTACHMENTS OF CLAMP TO MESSENGER CABLE

Test Location:

Manufacturer:

Test Standard : Technical Specification, IEC61897:1999

Test Sample : Vibration Damper As per approved DRS/Drawings

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

Test Procedure:

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

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

Acceptance Criteria:

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

Observation, if any;

Test Results:

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

FAT Procedure for OPGW -Vibration Dampers

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

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

FAT Procedure for OPGW -Vibration Dampers

CLAMP BOLT TIGHTENING AND TORQUE TEST

Test Location:

Manufacturer:

Test Standard: Technical Specification, IEC61897:1999

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

Objective : To demonstrate the ability of the tighten bolt.

Test set up:

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

Test procedure:

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

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

Acceptance Criteria:

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

Observation, if any;

Test Results:

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

FAT Procedure for OPGW -Vibration Dampers

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

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

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

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

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

**FACTORY ACCEPTANCE TEST PROCEDURE
FOR APPROACH CABLES**

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

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

Test Location :

Manufacturer :

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

Test Set-ups:

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

Test Procedure:

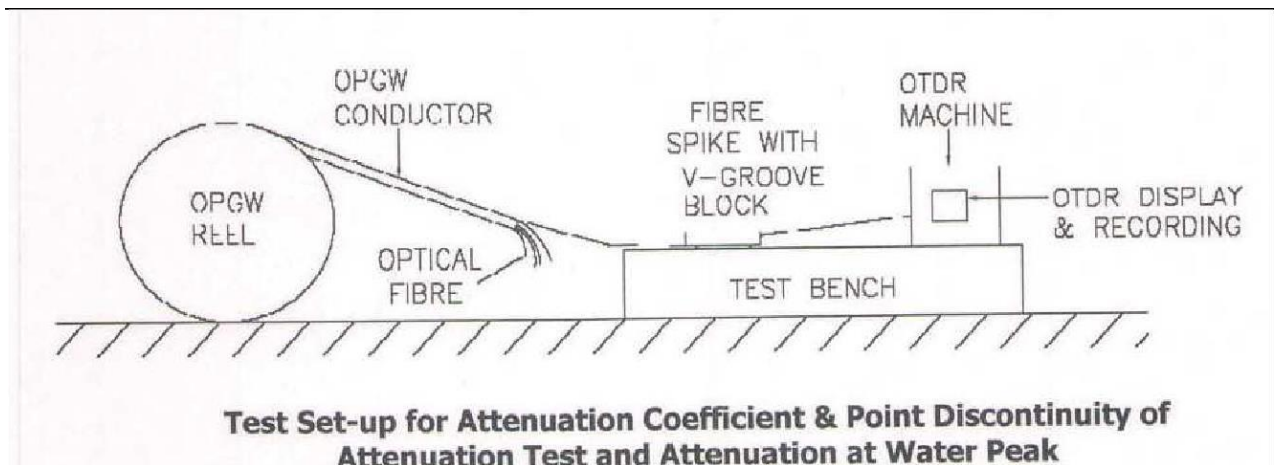
1. Connect the test sample either to the instrument or to one end of end dead-zone fiber (if used).
Connect the other end of the dead-zone fiber (if used) to the instrument.
2. If the accurate locations of point defects are to be recorded, the effective group delay index of the test sample is required.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

FAT Procedure for Fibre Optic Approach Cable

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

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

7.4 Repeat the test at another wavelength.



Acceptance Criteria:

For Attenuation

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

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

ATTENUATION AND POINT DISCONTINUITY

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

Observations, if any:

Test Results:

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

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

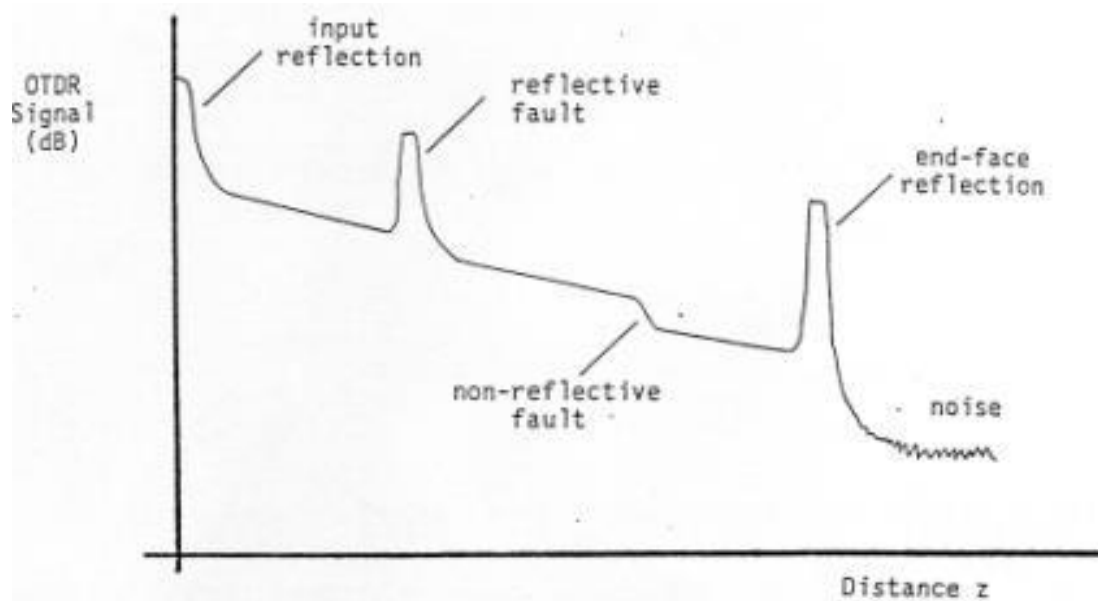


Figure 1. Schematic of an OTDR Trace. Point defects with apparent loss are shown, one reflective and one non-reflective.

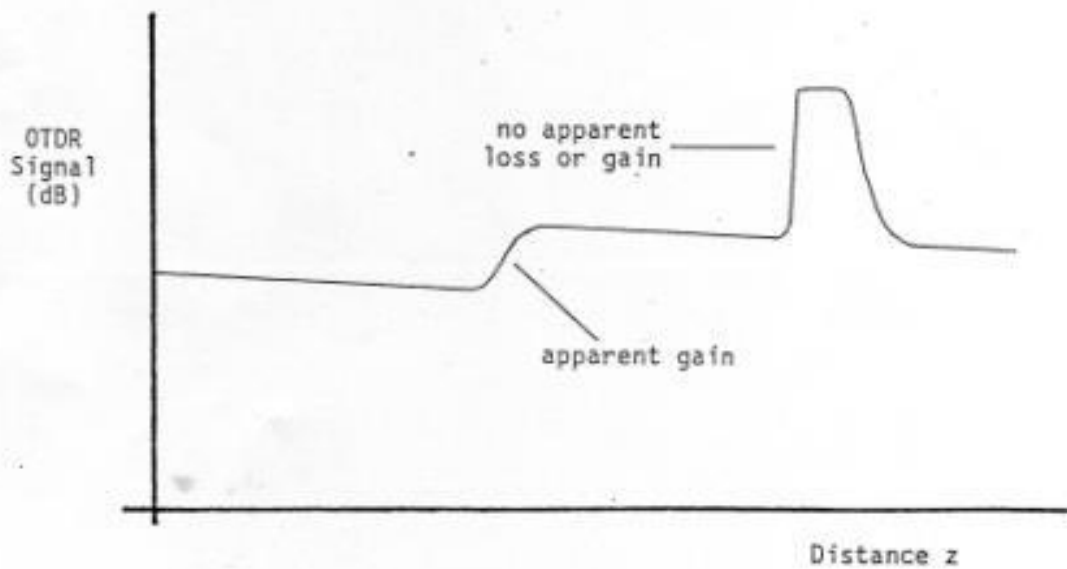


Figure 2. Schematic of an expanded OTDR trace. Two point defects are shown, one with apparent gain, and another with no apparent loss or gain.

2. VISUAL MATERIAL VERIFICATION, CABLE CONSTRUCTION AND DIMENSIONAL CHECKS

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

Test Location:

Manufacturer:

Cable Type: Approach Cable.

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

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

Test Procedure:

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

Drum Checks:

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

2. 100% physical verification of sealing of cable ends with end caps, check for provision of spare cable caps for each drum.

3. 100% verification of Sealing/Pasting the drum details over the end cap with transparent tape.

4. Verification of drum details properly printed and pasted on each drum suitably as per approved document **Checks**

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

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

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

Observations, if any:

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

Test by:
(sign with date)

Witnessed by:
(sign with date)

Appendix-J

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

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

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

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

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

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

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

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

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

Appendix-K

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

Table-A

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

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

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

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

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

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

Table-B

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

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

Table-C

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

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

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

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

Section-1

Introduction, General Information and General Requirement

1.1	Introduction and General Information	2
1.2	Proposed Communication System	2
1.3	Scope and General Requirements under the OPGW Package	2
1.4	General Technical Requirements	3
1.4.1	Fibre Optic Cable	3
1.4.2	Aerial Fibre Optic (ADSS) Cable manufacturer	3
1.5	General Requirements	4
1.6	General Responsibilities and Obligations	5
1.6.1	Responsibilities for the Implementation Plan	5
1.6.2	Contractor's Responsibilities and Obligations	5
1.6.3	The Employer Responsibilities and Obligations	9
1.7	General Bidding Requirements	9
1.8	Organization of the Technical Specification Document	11
1.9	Applicable Standards	12
1.10	References	13

Section 1

Introduction, General Information and General Requirement

1.1 Introduction and General Information

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

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

1.2 Proposed Communication System

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

1.3 Scope and General Requirements under the OPGW Package

The scope of this package is described in following:

1.3.1 Fibre Optic Cabling and associated items

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

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

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

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

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

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

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

1.4 General Technical Requirements

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

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

1.4.1 Fibre Optic Cable

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

1.4.2 Aerial Fibre Optic (ADSS) Cable manufacturer

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

1.5 General Requirements

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

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

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

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

An analysis of the functional and performance requirements of this specification and/or site surveys, design, and engineering may lead the Contractor to conclude that additional items are required that are not specifically mentioned in this specification. The Contractor shall be responsible for providing at no added cost to the Employer, all such additional items such that a viable and fully functional Communication System is implemented that meets or exceeds the capacity, and performance requirements specified. Such materials shall be considered to be within the scope of the contract. To the extent possible, the Bidders shall identify and include all such additional items in their proposal.

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

The communication equipments shall be designed and provisioned for expansions and reconfigurations without impairing normal operation, including adding and removing circuits. The offered items shall be designed to operate in varying environments. Adequate measures shall be taken to provide protection against rodents, contaminants, pollutants, water & moisture, lightning & short circuit, vibration and electro-magnetic interference etc.

The Contractor shall demonstrate a specified level of performance of the offered items during well structured factory and field tests.

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

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

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

1.6 General Responsibilities and Obligations

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

1.6.1 Responsibilities for the Implementation Plan

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

1.6.2 Contractor's Responsibilities and Obligations

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

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

- (1) Provide a working system that meets the functional and performance requirements of this specification.
- (2) Engineering and design specific to each location including review of, and

conformance with local environmental and earthing requirements.

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

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

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

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

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

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

FACILITIES TO BE INCORPORATED FOR LABOUR.

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

Tents:

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

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

Portable (Tyre- mounted) Bio toilet

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

1.6.3 The Employer Responsibilities and Obligations

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

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

1.7 General Bidding Requirements

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

- (1) The Technical Proposal including the documents listed in the table 1-1: Bid Documents Checklist shall be provided in the bid.
- (2) A detailed project implementation plan and schedule that is consistent with the scope of the project and Employer's specified objectives. The plan shall include the activities of both the Contractor and Employer, show all key milestones, and clearly identify the nature of all information and project support to be provided by Employer.
- (3) The bidder shall submit with their proposal, performance certificates for all the offered equipments (other than QR items and the items for which General Technical Requirements has been specified in this section) from at least one customer. The performance certificates shall provide evidence of successful operation of the proposed equipment for at least one year as on date of NOA.
- (4) A commitment and a clearly defined plan to develop a system support organization, based in India and capable of providing a full range of local services (including software and hardware maintenance and upgrade support) for the life of the delivered telecommunications systems.
- (5) The bidder may offer the bought-out items from more than one manufacturer. In case of QR items and the items for which General Technical Requirements has been specified in this section, the bidder shall provide supporting qualification document also.
- (6) The General Technical Requirements data of the Manufacturer (in support of meeting the requirements at clause 1.5 of this section) shall be furnished in the bid.

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

S. No.	Description:	Enclosure Reference	
1	Completed Data Requirement Sheets (As per Appendix of Technical Spec Volume II)	Page no. Ref no.	
2	Performance certificate	Page no. Ref no.	
3	Quality Assurance Program (As per relevant Sections of Technical Specs Volume II)	Page no. Ref no.	
4	Detailed Project Implementation Plan (As per relevant Sections of Technical Specs Volume II)	Page no. Ref no.	
5	General Technical Requirements data of the Manufacturer. (As per relevant Sections of Technical Spec Volume II)	Page no. Ref no.	

1.8 Organization of the Technical Specification Document

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

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

Section 3 contains the requirement for Inspection & Testing

Section 4 contains the requirement for Training and Support Services

Section 5 contains the documentation and deliverables requirements

Section 6 describes project management, schedule and implementation plan

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

TS for UGFO also provided.

The following is a list of the Volume II Appendices:

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

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

1.9 Applicable Standards

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

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

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

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

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

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

1.10 References

- (1) CIGRE Guide for Planning of Power Utility Digital Communications Networks
- (2) CIGRE Optical Fibre Planning Guide for Power Utilities
- (3) CIGRE New Opportunities for Optical Fibre Technology in Electricity Utilities

- (4) CIGRE guide to fittings for Optical Cables on Transmission Lines

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

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

2.1	FIBRE OPTIC CABLING	3
2.1.1	REQUIRED OPTICAL FIBRE CHARACTERISTICS.....	3
2.1.1.1	PHYSICAL CHARACTERISTIC	3
2.1.1.2	ATTENUATION.....	3
2.1.2	FIBRE OPTIC CABLE CONSTRUCTION	4
2.1.2.1	OPTICAL FIBRE CABLE LENGTHS IN CUSTOMISED OR STANDARD DRUMS	4
2.1.2.2	OPTICAL FIBRE IDENTIFICATION	5
2.1.2.3	OPTICAL FIBRE STRAIN& SAG-TENSION CHART	5
2.1.2.4	CABLE MATERIALS.....	6
2.1.2.4.1	FILLING MATERIALS.....	6
2.1.2.4.2	METALLIC MEMBERS	7
2.1.2.5	MARKING, PACKAGING AND SHIPPING.....	7
2.1.3	OPTICAL GROUND WIRE (OPGW) CONSTRUCTION.....	7
2.1.3.1	OPGW DESIGN.....	8
2.1.3.2	OPGW PARAMETERS TO BE CONSIDERED FOR DIFFERENT LINE VOLTAGE AND WIND ZONES	9
2.1.4	INSTALLATION HARDWARE.....	11
2.1.5	FIBRE OPTIC SPLICE ENCLOSURES (JOINT BOX).....	14
2.1.5.1	OPTICAL FIBRE SPLICES.....	14
2.1.6	Fibre Optic Approach Cables.....	15
2.1.6.1	BASIC CONSTRUCTION.....	15

2.1.6.2	JACKET CONSTRUCTION & MATERIAL.....	15
2.1.6.3	OPTICAL, ELECTRICAL AND MECHANICAL REQUIREMENTS	15
2.1.6.4	FIBRE OPTIC APPROACH CABLE INSTALLATION HARDWARE.....	15
2.1.7	Fibre Optic Distribution Panel.....	15
2.1.8	Optical Fibre Connectors.....	16
2.1.9	Check points to be insured during OPGW installation in sections having crossing of transmission lines	16

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

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

2.1 Fibre Optic Cabling

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

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

2.1.1 Required Optical Fibre Characteristics

The optical fibre to be provided should have following characteristics :

2.1.1.1 Physical Characteristic

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

2.1.1.2 Attenuation

The attenuation coefficient for wavelengths between 1525 nm and 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.05 dB/km. The attenuation coefficient between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.05 dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.10 dB. The fibre attenuation characteristics specified in table 2-1 (a) shall be “guaranteed” fibre attenuation of any & every fibre reel.

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

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

Table 2-1(a)
DWSM Optical Fibre Characteristics

1550 nm loss performance	As per G.652 D
Proof Test Level	≥ 0.69 Gpa
Attenuation Coefficient:	@ 1310 nm ≤ 0.35 dB / km @ 1550 nm ≤ 0.21 dB / km
Chromatic Dispersion; Maximum:	18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm
Zero Dispersion Wavelength: Zero Dispersion Slope:	1300 to 1324nm 0.092 ps/(nm ² xkm) maximum
Polarization mode dispersion coefficient	≤ 0.2 ps/km ^{1/2}
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60°C to +85°C)
Bend Performance:	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB/km @ 1550 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.10 dB/km @ 1550 nm (32±0.5 mm dia Mandrel), 1 turn; Attenuation Rise ≤ 0.50 dB/km

2.1.2 Fibre Optic Cable Construction

The OPGW (Optical Ground Wire) cable is to be installed on the transmission lines in place of Earth wire for 765/400/220/132kV lines. The design of cable shall account for the varying operating and environmental conditions that the cable shall experience while in service. The OPGW cable to be supplied shall be meeting the design parameters specified in Technical Specifications.

2.1.2.1 Optical Fibre Cable Lengths in Customised or Standard drums

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

(a) Supply in Customised Drums:

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

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

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

(b) Supply in Standard Drums:

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

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

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

2.1.2.2 Optical Fibre Identification

Individual optical fibres within a fibre unit and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme.

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

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

2.1.2.3 Optical Fibre Strain & Sag-Tension chart

The OPGW cable the optical fibres shall experience no strain under all loading conditions defined in IS 802. Zero fibre strain condition shall apply even after a 25 year cable creep. For the purpose of this specification, the following definitions shall apply:

- Maximum Working Tension (MWT) is defined as the maximum cable tension at which there is *no fibre strain*.
- The no fibre strain condition is defined as fibre strain of less than or equal to 0.05%, as determined by direct measurements through IEC/ ETSI (FOTP) specified optical reflectometry
- The Cable strain margin is defined as the maximum cable strain at which there is no fibre strain.

- The cable *Maximum Allowable Tension (MAT)* is defined as the maximum tension experienced by the Cable under the worst case loading condition.
- The cable *max strain* is defined as the maximum strain experienced by the Cable under the worst case loading condition.
- The cable *Every Day Tension (EDT)* is defined as the maximum cable tension on any span under normal conditions.
- The *Ultimate Tensile Strength (UTS/ breaking strength)* is defined as the maximum tensile load applied and held constant for one minute at which the specimen shall not break.

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

- The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/ Strain margin of the cable.
- The sag shall not exceed the earth wire sag in all conditions.
- The Max Allowable Tension shall also be less than or equal to 0.45 times the UTS.
- The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the cable strain at Max Allowable Tension (MAT) is less than or equal to the cable strain margin.
- The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable.

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

1. 53° C , no wind and no ice
2. 32° C, no wind and no ice
3. 0°C, no wind and no ice
4. 32° C, full wind and no ice
5. 32° C, 75% full wind and no ice
6. 0° C, 2/3rd / 36% of full wind (IS 802:1977 / 1995)

The above cases shall be considered for the spans from 100 m to 600 m or higher span length in the range of 50 m spans. Max. Vertical sag, max. tension and max sag at 0° C & no wind shall be considered in line with the design parameter of transmission line. The full wind load shall be considered as the design wind load for all the specified transmission lines as per relevant IS 802 version and the sag-tension chart shall be submitted considering the transmission lines.

2.1.2.4 Cable Materials

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

2.1.2.4.1 Filling Materials

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

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

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

2.1.2.4.2 Metallic Members

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

2.1.2.5 Marking, Packaging and Shipping

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

- (a) Drum Markings: Each side of every reel of cable shall be permanently marked in white lettering with the vendors' address, the Purchaser's destination address, cable part number and specification as to the type of cable, length, number of fibres, a unique drum number including the name of the transmission line & segment no., factory inspection stamp and date.
- (b) Cable Drums and Packing: The OPGW shall be supplied in returnable steel drums for main supply & non-returnable steel drums for spare supply. These painted steel drums shall be corrosion free, shall be of adequate strength, and constructed to protect the OPGW against all damage and displacement during transit, storage ,subsequent handling & stringing operations in the field. The supplier shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The ownership of the empty OPGW drums shall lie with the OPGW supplier who shall ultimately take back the empty OPGW drums Both ends of the cable shall be sealed as to prevent the escape of filling compounds and dust & moisture ingress during shipment and handling. Spare cable caps shall be provided with each drum as required.

There shall be no factory splices allowed within a continuous length of cable. Only one continuous cable length shall be provided on each drum. The lengths of cable to be supplied on standard drum length.

2.1.3 Optical Ground Wire (OPGW) construction

OPGW cable construction shall comply with IEEE-1138, 2021. The cable provided shall meet both the construction and performance requirements such that the ground wire function, the optical fibre integrity and optical transmission characteristics are suitable for the intended purpose.

2.1.3.1 OPGW design

Buffer Tube

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

(a) Central Aluminium tube type

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

(b) Central Stainless Steel tube type

The composite fibre optic overhead ground wire shall consist of a central fibre optic unit made up of stainless steel with aluminium coating/tube surrounded by concentric-lay stranded metallic wires in single or multiple layers. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre

Central Fibre Optic Unit

(a) Central Aluminium tube type

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

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

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

(b) Central Stainless Steel tube type

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

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

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

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

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

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

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

Basic Construction

The OPGW cable construction shall conform to the applicable requirements of this specification, applicable clauses of IEC 61089 related to stranded conductors and Table 2.2(a) OPGW Mechanical and Electrical Characteristics. In addition, the basic construction shall include bare concentric-lay-stranded metallic wires with the outer layer having left hand lay. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed. The finished wires shall contain no joints or splices unless otherwise agreed to by the Employer and shall conform to all applicable clauses of IEC 61089 as they pertain to stranded conductors.

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

Breaking Strength

The rated breaking strength of the completed OPGW shall be taken as 90 percent of the sum of the rated breaking strengths of the individual wires, calculated from their nominal diameter and the specified minimum tensile strength.

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

Electrical and Mechanical Requirements

Table 2-2(a) provides OPGW Electrical and Mechanical Requirements for the minimum performance characteristics.

Table 2.2(a)

OPGW Electrical and Mechanical Requirements

(1)	Everyday Tension	$\leq 20\%$ of UTS of OPGW
(2)	D.C. Resistance at 20°C:	< 1.0 ohm/Km
(3)	Short Circuit Current	≥ 6.32 kA for 1.0 second (for 220 kV & above lines) ≥ 5.6 kA for 1.0 second (for 132 KV & 66KV lines) Short Circuit shall be applicable as per the Voltage level of the lines

2.1.4 Installation Hardware

Installation Hardware includes all required fittings and hardware such as Tension assembly, Suspension assembly, Vibration dampers, Reinforcing rods, Earthing clamps, Downlead clamps, splice enclosure etc. The estimated quantity for hardware fittings are provided in BPS. Initially 70% of total hardware shall be supplied based on quantities in BPS or as directed by Project Manager and balance 30% shall be supplied as directed by Project Manager.

The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in clause 4.0 of EN 61284: 1997 (IEC 61284). The shear strength of all bolts shall be at least 1.5 times the maximum installation torque. The OPGW hardware & accessories drawing & Data Requirement Sheets (DRS) document shall consist of three parts: (1) A technical particulars sheet (2) An assembly drawing i.e. level 1 drawing and (3) Component level drawings i.e. level 2 & lower drawings. All component reference numbers, dimensions and tolerances, bolt tightening torques & shear strength and ratings such as UTS, slip strength etc shall be marked on the drawings.

The fittings and accessories described herein are indicative of installation hardware typically used for OPGW installations and shall not necessarily be limited to the following:

- (a) **Suspension Assemblies:** Preformed armour grip suspension clamps and aluminium alloy armour rods/ reinforcing rods shall be used. The suspension clamps shall be designed to carry a vertical load of not less than 25 KN. The suspension clamps slippage shall occur between 12kN and 17 kN as measured. For river crossing and special transmission lines (where heavier earthwire used e.g. 7/4.5) OPGW installation hardware design slippage shall occur between 9% and 14% of UTS of OPGW.

The Contractor shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pins, etc. The total drop of the suspension assembly

shall not exceed 150 mm (measured from the centre point of attachment to the centre point of the OPGW). The design of the assembly shall be such that the direction of run of the OPGW shall be the same as that of the conductor.

- (b) Dead End Clamp Assemblies: All dead end clamp assemblies shall preferably be of performed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates. Dead end clamps shall allow the OPGW to pass through continuously without cable cutting. The slip strength shall be rated not less than 95% of the Ultimate tensile strength of the OPGW.
- (c) Clamp Assembly Earthing Wire: Earthing wire consisting of a 1500 mm length of aluminium or aluminium alloy conductor equivalent in size to the OPGW shall be used to earth suspension and dead end clamp assemblies to the tower structure. The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.
- (d) Structure Attachment Clamp Assemblies: Clamp assemblies used to attach the OPGW to the structures, shall have two parallel grooves for the OPGW, one on either side of the connecting bolt. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. The tower attachment plates shall locate the OPGW on the inside of the tower and shall be attached directly to the tower legs/cross-members without drilling or any other structural modifications.
- (e) Tension Fitting for Suspension Tower: The OPGW cable sections shall also be terminated & spliced or pass through (as an interim arrangement) on suspension towers as per requirement. For this, a special fitting namely Yoke plate along with tension fittings shall be provided for termination/jointing of OPGW on Suspension tower. Typical drawing of suspension fitting where cable may be terminated on suspension tower is given in Appendices.
- (f) Vibration Dampers: Vibration dampers type 4R Stockbridge or equivalent, having four (4) different frequencies spread within the Aeolian frequency bandwidth corresponding to wind speed of 1m/s to 7 m/s, shall be used for suspension and tension points in each span. The Contractor shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis.

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

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

Clamping bolts shall be provided with self locking nuts and designed to prevent corrosion of threads or loosening in service.

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

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

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

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

The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed in Technical Specification, shall have to be submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

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

Sl. No.	Description	Technical Particulars
		rods/AGS
5	Maximum permissible dynamic strain:	+/- 150 micro strains

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

The damper placement charts shall include the following

- (1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per OPGW cable per span.
- (2) Placement distances clearly identifying the extremities between which the distances are to be measured.
- (3) Placement recommendation depending upon type of suspension clamps (viz Free center type/Armour grip type etc.)

2.1.5 Fibre Optic Splice Enclosures (Joint Box)

All splices shall be encased in Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. Splice enclosures shall comply with ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of required number of optical fibre splices and equipped with sufficient number of splice trays for splicing all fibres in the cable. No more than 12 fibres shall be terminated in a single splice tray. Minimum number of 04 splice trays shall be provided in a Joint Box. They shall be filled with suitable encapsulate that is easily removable should re-entry be required into the enclosures.

Splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on transmission line towers above anti-climb guard levels at about 10 metres from top of the tower and shall accommodate pass-through splicing. The actual mounting height and location shall be finalised after Survey

2.1.5.1 Optical Fibre Splices

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

- (a) All fibre splices shall be accomplished through fusion splicing.
- (b) Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.
- (c) All splices and bare fibre shall be neatly installed in covered splice trays.

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

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

2.1.6 Fibre Optic Approach Cables

For purposes of this specification, a fibre optic approach cable is defined as the Armoured underground fibre optic cable required to connect Overhead Fibre Optic Cable (OPGW) between the final in line splice enclosure on the gantry / tower forming the termination of the fibre cable on the power line and the Fibre Optic Distribution Panel (FODP) installed within the building. The estimated fibre optic approach cabling length requirements are indicated in the BoQ. Actual supply to be done as per directives of Project Manager.

2.1.6.1 Basic Construction

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

2.1.6.2 Jacket Construction & Material

The Approach Cable shall be a UV resistant, rodent proof, armoured cable with metallic type of armouring. The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall conform to ASTM D1248 for density.

2.1.6.3 Optical, Electrical and Mechanical Requirements

Approach cable shall contain fibres with identical optical/ physical characteristics as those in the OPGW cables. The cable core shall comprise of tensile strength member(s), fibre support/bedding structure, core wrap/bedding, and an overall impervious jacket.

2.1.6.4 Fibre Optic Approach cable Installation hardware

The required GI pipe (light grade) of suitable size (minimum 32mm), conforming to IS 1239 or BS 1378, along with required bends, joints, conduit etc. required for laying and installation of approach cable shall be supplied and installed by the Contractor.

2.1.7 Fibre Optic Distribution Panel

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

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

- (b) FODPs shall be suitable for use with each of the cable types provided as part of this contract. FODPs shall accommodate pass-through splicing and fibre terminations. No more than 12 fibres shall be terminated in a single splice tray.
- (c) FODPs shall be supplied in suitable cabinets/racks with locking arrangement. The dimension of FODP cabinet shall be minimum 2200mm x 600mm x 600mm (HxWxD) and shall meet or exceed ingress protection class IP55 specifications.
- (d) All FODPs shall be of corrosion resistant, robust construction and shall allow both top or bottom entry for access to the splice trays. Ground lugs shall be provided on all FODPs and the Contractor shall ensure that all FODPs are properly grounded.
- (e) Flexible protection shall be provided to the patch cord bunches going out from FODP to other equipment.

2.1.8 Optical Fibre Connectors

Optical fibres shall be connectorised with FC-PC type connectors preferably. Alternatively connector with matching patch cord shall also be acceptable. Fibre optic couplings supplied with FODPs shall be appropriate for the fibre connectors to be supported. There shall be no adapters.

2.1.9 Check points to be insured during OPGW installation in sections having crossing of transmission lines

In case of crossing locations of power transmission lines (over/under/ diamond configuration), prior measurement of clearances such as between existing earth wire of lower transmission line with bottom conductor of upper transmission line, etc. is to be surveyed by contractor. Post survey, contractor to submit the proposal to employer's project manager for approval before OPGW installation. In case diamond crossing is required, contractor with prior permission of project manager shall set up the same while maintaining clearances at such location(s) in liveline/offline condition without any additional cost to employer to avoid trippings during or post installation. This provision will also be applicable during of installation of OPGW for repeater links. Minimum clearances are specified in the Live Line OPGW installation guidelines.

.....**End of this Section**.....

Section - 03
Inspection & Testing
Index

3.1.	Inspection.....	2
3.2.	Test Plans and Procedures.....	3
3.2.1.	<i>Factory and Site Test Plans</i>	4
3.2.2.	<i>Test Procedures</i>	4
3.2.3.	<i>Test Records</i>	4
3.2.4.	<i>Rejection of Elements</i>	5
3.2.5.	<i>Test Periods Defined</i>	5
3.3.	Type Testing	5
3.3.1.	<i>Type Test Samples</i>	8
3.3.2.	<i>List of Type Tests</i>	8
3.3.2.1.	Type Tests for Optical Fibres.....	8
3.3.2.2.	Type Tests for OPGW Cables	9
3.3.2.3.	Type Test on OPGW Cable Fittings	11
3.3.2.4.	Type Test on Vibration Damper	15
3.3.2.5.	Type Tests for Splice Enclosures (Joint Box)	18
3.3.2.6.	Type Tests for Fibre Optic Approach Cable.....	19
3.3.2.6.1.	Impact Test	19
3.3.2.7.	Type Testing on Aerial Optical Fibre Cable	20
3.3.2.8.	Type Tests on Aerial FO cable Accessories & fixtures.....	28
3.4.	Factory Acceptance Tests.....	31
3.4.1.	<i>Sampling for FAT</i>	32
3.4.2.	<i>Production Testing</i>	34
3.4.3.	<i>Factory Acceptance Tests on Optical Fibre to be supplied with OPGW</i>	34
3.4.4.	<i>Factory Acceptance Test on OPGW Cable</i>	34
3.4.5.	<i>Factory Acceptance Test on OPGW Fittings</i>	35
3.4.6.	<i>Factory Acceptance Test on Approach Cable</i>	36
3.4.7.	<i>Factory Acceptance Test on Splice Enclosure (Joint Box) /FODP</i>	37
3.4.8.	<i>Factory Acceptance Test on Test Equipment, Pigtail & other items</i>	37
3.4.9.	<i>Factory Acceptance Tests on Self-supporting metal free Aerial optical fibre cable</i>	37
3.4.10.	<i>Factory Acceptance Tests on Aerial FO cable accessories & fixtures</i>	38
3.5.	Site Acceptance Tests.....	38
3.5.1.	<i>Minimum Site Acceptance Testing Requirement for FO Cabling</i>	39
3.5.1.1.	Phases of Site Acceptance Testing	39
3.6.	QUALITY ASSURANCE PROGRAMME.....	40
3.7.	INSPECTION, TESTING & INSPECTION CERTIFICATE	42

Section - 03 INSPECTION & TESTING

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

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

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

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

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

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

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

All **Cyber tests** shall be **carried out** during FAT , SAT **in compliance to latest cyber security guidelines issued by CEA/MoP or any other govt department.**

3.1. Inspection

Access to the Contractor's facilities during system manufacturing and testing and to any facility where systems/ equipment are being produced/ tested/ integrated for the fibre optic communication network, shall be available to the Employer. At all times the Employer shall have full facilities for unrestricted inspection of such materials or equipment. To facilitate this, the Contractor shall submit for the Employer approval, a comprehensive Quality Assurance Plan using ISO 9000 as a general guideline. In addition, the Quality Assurance

Plan shall satisfy the following:

- (a) Sufficient office facilities, equipment, and documentation necessary to complete all inspections and to verify that the equipment is being fabricated and maintained in accordance with the Specification shall be provided by the Contractor to the Employer.
- (b) Inspections to be performed by the Employer will include visual examination of hardware, cable dressings and labeling. Contractor's documentation will also be examined to verify that it adequately identifies and describes all offered items and spare parts.
- (c) Access to inspect the Contractor's standards, procedures, and records that are applicable to the supplied equipment shall be provided to the Employer. Documents will be inspected to verify that the Contractor has performed the required quality assurance activities.
- (d) The inspection rights described above shall also apply to sub Contractors who are responsible for supplying major components described in this Specification. These items shall be inspected and tested at the sub Contractor's factory by the Employer's representatives prior to shipping this equipment to the Contractor's facility or directly to the Employer.
- (e) The above inspection rights shall also apply to sub Contractors supplying assemblies, subassemblies and components. However, such items will normally be inspected and tested by the Employer's representatives at the Contractor's site before acceptance.

3.2. Test Plans and Procedures

Test plans for both factory and site acceptance tests shall be provided by the Contractor. Test plans shall be modular to allow individual test segments to be repeated upon request.

Procedures for type test, factory acceptance test, and site acceptance test for OPGW (including hardware accessories) and communication equipment (wherever applicable) have been provided in Appendix F, G & H respectively.

The Contractor shall submit a Test Schedule for the Employer's approval within one (1) week after the award of contract for Type Tests and three (3) months after the award of contract for all other tests. The test schedule shall list the tests to be carried out, and the approximate test duration. The test periods shall also be indicated in the PERT chart or equivalent for the work.

The Contractor shall give the Employer twenty one (21) days written notice of any material being ready for testing. Fifteen days prior to the scheduled testing, the Employer shall provide written notice to the Contractor of any drawings, equipment, material, or workmanship which, in the Employer's opinion, are not compliant to the specification. The

Contractor shall give due consideration to such objections, if valid, effecting the corrections as necessary or shall prove, in writing, that said modifications are unnecessary for contract compliance.

3.2.1. Factory and Site Test Plans

A test plan for factory and site acceptance tests shall be submitted for approval, at least four (4) weeks before the start of testing. The test plan shall be a single overview document that defines the overall schedule and individual responsibilities associated with conducting the tests, documenting the test results, and successfully completing the test criteria. Test Plans shall include, at a minimum, the information contained in Table 3-1.

Table 3-1
Factory & field Test Plan Requirements

Item:	Description:
1.	Test schedule
2.	Record-keeping assignments, procedures and forms
3.	Procedures for monitoring, correcting and retesting variances
4.	Procedures for controlling and documenting all changes made to the communications equipment after the start of testing

3.2.2. Test Procedures

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

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

3.2.3. Test Records

Complete and indexed records of all factory and site acceptance tests results shall be maintained and provided to the Employer by the Contractor in hardcopy. The records shall be keyed to the steps enumerated in the test procedures. The minimal items required in test records are described in Table 3-2.

Table 3-2
Test Record Requirements

Item:	Description:
1.	Test Title and Revision Level, if applicable; contract references
2.	Date and time for test start and test completed
3.	Test title and reference to the appropriate section of the test procedures
4.	Description of any special test conditions or special actions taken (Includes test-case data).

Table 3-2
Test Record Requirements

Item:	Description:
5.	Test results for each test segment including an indication of Passed, Conditional Pass, Incomplete or Failed.
6.	Test procedure modifications made during testing.
7.	Variance Report(s) tracking information and copies (if variance(s) was detected).
8.	Contractor's test engineer(s) identification, signature and remarks
9.	Employer's test witness identification, signature and remarks
10.	List of all attachments
11.	Attachments (including system logs, printouts, variances, hard copies of visual test result displays, etc.)

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

3.2.4. Rejection of Elements

Any item or component which fails to comply with the requirements of this Specification in any respect, at any stage of manufacture, test, erection or on completion at site may be rejected by the Employer either in whole or part as considered necessary.

Material or components with defects of such a nature that do not meet the requirements of the Specification by adjustment or modification shall be replaced by the Contractor at his own expense. After adjustment or modification, the Contractor shall submit the items to the Employer for further inspection and/or tests.

3.2.5. Test Periods Defined

The terminology used in Volume I, General Conditions of Contract and their correlation with the tests requirements described within this section is as follows:

Pre-Commissioning & Commissioning Period - The Site Acceptance Test (SAT)

Operational Acceptance - Successful completion of SAT

3.3. Type Testing

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

- (a) OPGW, Fiber optic cable(ADSS/Approach Cable/UGFO) & and its Hardware fittings & accessories equipment being supplied shall conform to type tests as per technical specification.
- (b) Validity period of type tests conducted on the OPGW, Fiber optic cable(ADSS/Approach Cable/UGFO) & and its Hardware fittings & accessories)- i.e. the period for which Type Test Reports shall remain valid and acceptable to employer provided no major change has been introduced in the basic design/technology/material/mechanical construction/functionalities / performance characteristic/manufacturing process, is as mentioned below :-

S.No.	Name of Equipment	Periodicity (in years)
1	OPGW	10
2	Fiber Optic cable (ADSS/ Approach Cable/UGFO)	10
3	Hardware fittings & accessories for OPGW & fiber optic cable	10

Note:- For all other equipment's validity of type test shall be 10 years from the originally scheduled last date of bid submission (Soft Copy)

Validity of test type reports shall be void in case of change in test procedure/method/criteria/test levels in case of revision/amendments to relevant standards.

In case of OPGW, the type tests conducted on OPGW design with 96fibers can be accepted for same OPGW design with 48 & 24fibers in line with IEEE 1138-2021 clause 6.3.

Further, the validity of Type Test reports shall be considered from Completion date of type testing up to the originally scheduled last date of bid submission (Soft Copy). The type tests of the equipment shall be repeated during its validity period, if there is change in technology, basic design, construction, electrical/ thermal/ mechanical stress, performance characteristics or materials employed or changes in manufacturing process, setup or combination of any of above. In case the type Test reports are not valid as per the conditions stipulated in this specification, the Contractor shall repeat the type tests at no extra cost to the employer/purchaser.

- (c) Type tests shall not be required to be carried out if supplier has conducted these tests earlier on the same type of equipment and valid type test certificates are available. The test certificate shall be considered valid if,
- i) Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/IEC 17025 by the National Accreditation body of the country where laboratory is located) or witnessed by POWERGRID/representative authorized by POWERGRID/representative of Utility /representative of accredited test lab/ representative of The National Accreditation Board for Certification Bodies (NABCB) certified agency.
 - ii) Type test reports contain valid Calibration reports/certificates of the relevant testing equipment, information pertaining to ratings, the relevant drawings, model number, test circuit, calculations (if any), photos, acceptance criteria/values specified in Technical Specification/ relevant standards (IS/ IEC) and compliance to the same.
and
 - iii) The Equipment shall be supplied from the same manufacturing works, where from the sample was manufactured and successfully type tested as per relevant standard or at the works of Parent organization in case of technology transfer/ Joint

Venture (JV) for the initial period of 03 years from the date of establishment of manufacturing plant.

In case of own manufacturing plant at different location within India, the type test of the original manufacturing works shall also be acceptable for the equipment manufactured and supplied from the different location subject to the following conditions:

- a) the relevant standard does not bar the same,
 - b) the equipment being manufactured at different locations shall be identical in design, drawings, specifications, ratings to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),
 - c) the equipment being manufactured at different locations shall be identical in material & critical components, manufacturing process/practices, and quality control to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),
 - d) Also, while submitting the Type Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking for above conditions (a), (b) and (c).
- d)** While submitting the Type Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking with it declaring that there is:
- i) No change in the Design
 - ii) No change in the material,
 - iii) No change in manufacturing process, and
 - iv) No amendment/ revision in the relevant standard as regard to type test conditions, since the type test.
- e)** In case the tests have been conducted earlier than the above stipulated period or carried out on samples manufactured from any other manufacturing works or in case of revision/ amendment in the provisions/ test procedure of the IS/IEC as referred in the TS or in the event of any discrepancy in the test report (i.e., due to non-inclusion of validity details of calibration certificate, desired information etc. or any test not applicable due to any design/ material/ manufacturing process change including substitution of components or due to non-compliance with the requirement stipulated in the Technical Specifications), the tests shall be conducted by the supplier at no extra cost to the Purchaser

The type test reports of hardware fittings and vibration dampers approved with a particular make of OPGW Cable, shall be accepted with OPGW designs of other manufacturers also (where both are Standard OPGW designs having similar parameters such as diameter, UTS, etc.).

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

The Contractor shall provide a detailed schedule for performing all specified type tests at least two (2) weeks in advance.

- f)** The Contractor shall ensure that all type tests can be completed within the time schedule offered in his Technical Proposal.
- g)** In case of failure in any type test, the supplier is either required to manufacture fresh sample lot and repeat the entire tests successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expense. In case a fresh lot is manufactured for testing then the lot already

manufactured shall be rejected.

If repeat type tests are required to be conducted, then all the expenses for deputation of inspector/purchaser's representative shall be to the supplier's account. Also, on receipt of the supplier's notice of testing, the purchaser's representative does not find the test samples or testing facilities/equipment ready for testing, the expenses incurred by the purchaser for re-deputation shall be to the supplier's account.

3.3.1. Type Test Samples

The Contractor shall supply equipment/material for sample selection only after the Quality Assurance Plan has been approved by the Employer. The sample material shall be manufactured strictly in accordance with the approved Quality Assurance Plan. The Contractor shall submit for Employer approval, the type test sample selection procedure. The selection process for conducting the type tests shall ensure that samples are selected at random. At least three samples of each of the proposed equipment/item/cable drum except FO cable installation hardware & fittings shall be offered for selection. For FO cable installation hardware & fittings at least ten (10) samples shall be offered for selection.

3.3.2. List of Type Tests

The type testing shall be conducted on the following equipment/items

- (a) Optical fibres
- (b) OPGW Cable
- (c) OPGW Cable fittings
- (d) Vibration Damper
- (e) Splice Enclosure (Joint Box)
- (f) Approach Cable
- (g) ADSS & its hardware fittings
- (h) UGFO & its associated items

Further, tests on various items other than those listed in this section of technical specifications but otherwise mentioned in relevant general requirements (GR) issued by Telecommunication Engineering Centre (TEC), DoT are also to be completed in compliance to Department of Telecommunications(DoT), Ministry of Communications order dated 29.08.2018 on 'Public Procurement (Preference to Make In India) Order 2017 –Notification of Telecom products, Services or Works – regarding'.

3.3.2.1. Type Tests for Optical Fibres

The type tests listed below in table 3-3 shall be conducted on DWDM fibres to be supplied as part of overhead cables. The tests specific to the cable type are listed in subsequent sections.

Table 3-3
Type Tests for Optical Fibres

S. No.	Test Name	Acceptance Criteria	Test procedure	
1	Attenuation	As per Section-02 of TS	IEC 60793-1-40 Or EIA/TIA 455-78A	
2	Attenuation Variation with Wavelength	As per Section-02 of TS	IEC 60793-1-40 Or EIA/TIA 455-78A	
3	Attenuation at Water Peak	As per Section-02 of TS	IEC 60793-1-40 Or EIA/TIA 455-78A	
4	Temp. Cycling (Temp dependence of Attenuation)		IEC 60793-1-52 Or EIA/TIA 455-3A, 2 cycles	
5	Attenuation With Bending (Bend Performance)		IEC 60793-1-47 Or EIA/TIA 455-62A	
6	Mode Field dia.		IEC 60793-1-45 Or EIA/TIA 455-164A/167A/174	
7	Chromatic Dispersion		IEC 60793-1-42 Or EIA/TIA 455-168A/169A/175A	
8	Cladding Diameter		IEC 60793-1-20 Or EIA/TIA 455-176	
9	Point Discontinuities of attenuation		IEC 60793-1-40 Or EIA/TIA 455-59	
10	Core -Clad concentricity error		IEC 60793-1-20 Or EIA/TIA 455-176	
11	Fibre Tensile Proof Testing		IEC 60793-1-30 Or EIA/TIA 455-31B	
-End Of table-				

3.3.2.2. Type Tests for OPGW Cables

The type tests to be conducted on the OPGW cable are listed in Table 3-4 Type Tests for OPGW Cables. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table 3-4
Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test Procedure
1	Water Ingress Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.5
2	Seepage of filling compound	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.6
3	Short Circuit Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.3
4	Aeolian Vibration Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.1
5	Galloping test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.2
6	Cable Bend Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.2.3
7	Sheave Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.2.1
8	Crush Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.2.2
9	Twist Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.2.4
10	Creep Test	IEEE 1138-	IEEE 1138-2021

Table 3-4
Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test Procedure
		2021	Method 6.5.1.1
11	Strain Margin Test or MRDT Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.1.3
12	Stress Strain Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.1.2
13	Temperature Cycling Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.7
14	Corrosion (Salt Spray) Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.8
15	Ultimate Tensile Strength Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.1.4
16	Lightning Arc Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.4
17	DC Resistance Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.1.5
-End Of Table-			

3.3.2.3. Type Test on OPGW Cable Fittings

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

(i) Mechanical Strength Test for Suspension/Tension Assembly

Applicable Standards: IEC 61284, 1997.

Suspension Assembly

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

Part 1:

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

Part 2:

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

Tension Assembly

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

Part 1:

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

Part 2:

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

Acceptance Criteria for Tension/Suspension Assembly:

- No evidence of binding of the Nuts or Deformation of components at end of Part 1 of Test.
- No evidence of Fracture at the end of one minute at the minimum failure load during Part 2 of the Test.

Any result outside these parameters shall constitute a failure.

(ii) Clamp Slip Strength Test for Suspension Assembly

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length fibre optical cable shall be fixed in the clamps. Once the Suspension Clamp has been assembled, the test rig is tensioned to 1 kN and the position scale on the recorder 'zeroed'. The test rig is then tensioned to 2.5 kN and the relative positions of the Reinforcing Rods, Armour Rods and Suspension Clamp shall be marked by a suitable means to confirm any slippage after the test has been completed. The relative positions of the helical Armour Rods and associated Reinforcing Rods at each end shall be marked and also 2 mm relative position between clamp body and Armour Rods shall be marked on one side. The load shall be increased to 12 kN at a loading rate of 3 kN/min and held for one minute. At the end of this one minute period, the relative displacement between clamp body and the armour rods shall be observed. If the slippage is 2 mm or above, the test shall be terminated. Otherwise, at the end of one minute the position of the clamp body and 2 mm. relative positions between clamp body and armour rods shall be marked on the other side. After the one minute pause, the load shall be further increased at a loading rate of 3 kN/min, and recording of load and displacement shall continue until either the relative Position displacement between clamp body and armour rods reaches more than 2 mm or the load reaches the maximum slip load of 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:

- No slippage* shall occur at or below the specified minimum slip load.
 - * Definition of no slippage in accordance with IEC 61284, 1997:- Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the cable as a result of the test itself are not regarded as slippage.
- Slippage shall occur between the specified maximum and minimum slip load of 12 - 17 kN.
- There shall be no slippage of the Reinforcing Rods over the cable, and no slippage of the Armour Rods over the Reinforcing Rods.
- The relative movement (i.e. more than 2 mm between Armour Rods & Clamp body) between minimum 12 kN and maximum slip 17 kN, shall be considered as slip.
- The Armour Rods shall not be displaced from their original lay or damaged**.
 - ** Definition of no damage in accordance with convention expressed in IEC 61284: 1997 no damage, other than surface flattening of the strands shall occur.

Any result outside these parameters is a failure.

(iii) Slip Strength Test of Tension Clamp

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

Acceptance Criteria:

- No movement* shall occur between the OPGW and the Reinforcing Rods, or between the Reinforcing Rods and the Dead-End assembly.
- No failure or damage or disturbance to the lay of the Tension Dead-End, Reinforcing Rods or OPGW.

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

Any result outside these parameters shall constitute a failure.

(iv) Grounding Clamp and Structure Mounting Clamp Fit Test

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

(v) Structure Mounting Clamp Strength Test

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

3.3.2.4. Type Test on Vibration Damper

(a) Dynamic Characteristic Test

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

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

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

Acceptance criteria for vibration damper:

- (i) The above dynamic characteristics test on five damper shall be conducted.
- (ii) The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.
- (iii) The above mean reactance response curve should lie within following limits:
 V.D. for OPGW - $0.060 f$ to $0.357 f \text{ kgf/mm}^*$
 Where f is frequency in Hz.
- (iv) The above mean phase angle response curve shall be between 25° to 130° within the frequency range of interest.
- (v) If the above curve lies within the envelope, the damper design shall be considered to have successfully met the requirement.
- (vi) Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values.

(b) Vibration Analysis

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

- (i) The analysis shall be done for single fibre optic cable without armour rods. The

tension shall be taken as 25% of UTS of fibre optic cable for a span ranging from 100 m to 1100 m.

- (ii) The self damping factor and flexural stiffness (EI) for fibre optic cable shall be calculated on the basis of experimental results. The details to experimental analysis with these data shall be furnished.
- (iii) The power dissipation curve obtained from Damper Characteristics Test shall be used for analysis with damper.
- (iv) Examine the Aeolian Vibration level of the fibre optic cable with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.
- (v) From vibration analysis of fibre optic cable without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.
- (vi) From vibration analysis of fibre optic cable with damper(s) installed at the recommended location, the dynamic strain level at the clamped span extremities, damper attachment point and the antinodes on the fibre optic cable shall be determined. In addition to above damper clamp vibration amplitude and antinodes vibration amplitudes shall also be examined.

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

(c) Fatigue Tests

(i) Test Set Up

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

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

(ii) Fatigue Test

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to 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 $\pm 25/f$ mm where f is the frequency in Hz.

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

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

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

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

- (1) There shall not be any resonant frequency shift before and after the test by more than $\pm 20\%$
- (2) The power dissipation of the damper before and after test at the individual resonant frequencies do not differ by more than $\pm 20\%$

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

Sl No.	Test Name	Test Procedure
1	Visual examination & Dimensional and material verification	IEC 61897 Clause 7.1 & 7.2
2	Clamp Slip test	IEC 61897 Clause 7.5
3	Clamp bolt tightening test	IEC 61897 Clause 7.7
4	Attachments of weights to messenger cable	IEC 61897 Clause 7.8
5	Attachment of clamps to messenger cable	IEC 61897 Clause 7.8
6	Damper effectiveness evaluation	IEC 61897 Clause 7.11.3.2

3.3.2.5. Type Tests for Splice Enclosures (Joint Box)

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

(i) Temperature Cycling Test

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

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

(ii) Humid Heat test

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

(iii) Water Immersion test

The splice enclosure with optical fibres cable installed and fibres spliced fixed, shall be immersed in water for 24 hours. No water seepage or moisture shall be detected in the splice enclosure. The attenuation variation of the fibres after the test shall be less than $\pm 0.05\text{dB}$.

(iv) Vibration Test

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

(v) Bending and Torsion test

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

- a) 3 torsion cycles of $\pm 180^{\circ}$ shall be exercised on the cable. Each cycle shall be less than one minute.
- b) 3 flexure cycles of the cable, of $\pm 180^{\circ}$ with one cycle less than one minute.

The variation in the attenuation, of the fibres, shall be less than ± 0.05 dB. The cables connection ring shall remain securely fixed to the box with the connection maintained firmly. No defects/fissures shall be noted on the joint ring or on the splice enclosure

(vi) Tensile test

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

(vii) Drop Test

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

3.3.2.6. Type Tests for Fibre Optic Approach Cable

The type tests to be conducted on the Fibre Optic Approach cable are listed in table 3-5: Type Tests for Fibre Optic Approach Cable. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

**Table 3-5:
Type Tests Fibre Optic Approach Cable**

S.NO.	Test Name	Test Procedure
1	Water Ingress Test	(IEC 60794-1-F5 / EIA 455-82B) Test duration : 24 hours
2	Seepage of filling compound	(EIA 455-81A) Preconditioning : 72 hours, Test duration : 24 hours.
3	Crush Test	(IEC 60794-1-E3/ EIA 455-41)
4	Impact Test	(IEC-60794-1-E4/ EIA 455-25A)
5	Stress strain Test	(EIA 455-33A)
6	Cable Cut-off wavelength Test	(EIA 455-170)
7	Temperature Cycling Test	(IEC60794-1-F1/EIA-455-3A) – 2 cycles
-End Of Table-		

3.3.2.6.1. Impact Test

The Impact test shall be carried out in accordance with IEC:60794-1-E4. Five separate

impacts of 2.0 kg shall be applied at different locations. The radius of the intermediate piece shall be the reel drum radius $\pm 10\%$. A permanent or temporary increase in optical attenuation value greater than 0.05 dB/km shall constitute failure.

3.3.2.7. Type Testing on Aerial Optical Fibre Cable

The Bidder shall have valid Type Approval Certificate (TAC) from TEC/Technical Specification Evaluation Certificate(TSEC) given by BSNL QA for 24F/48F Self Supporting Metal Free Aerial Fibre Optic Cable (ADSS) OFCs suitable for Power Systems preferably for snow areas at the date of bid opening and a copy of valid TAC/TSEC certificate shall be submitted and proof for submission shall be submitted along with the bid. However, the bidder shall ensure that in all the cases the TSEC/TEC certificate would be valid at the time of award. In case type approval certificate validity expires after placement of Letter of Award (LoA), the contractor shall take advance action so that the supply is not delayed due to non-availability of type approval certificate for the offered fibre optic cable meeting the requirement. In case, TSEC/TEC certificate of Self Supporting Metal Free Aerial Fibre Optic Cable (ADSS) Optical fiber cable is not available, the Contractor shall submit the previously carried out type test report for the same design of cable for the tests listed in Table 3-6 below. The fibre should have been type tested as per relevant indian standards/International standards for the tests listed in Table-3-3 and the Bidder shall submit the test reports and certificates along with the bid.

The mechanical and testing parameters of the cable shall meet the requirements defined in Table 3-6 below:

Table 3-6

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
1	Tensile strength Test	To test the tensile strength Self Supporting Metal Free aerial Optical Fibre cable in order to examine the behaviour of the attenuation as a function of the load on a cable during installation and while the aerial optical fibre cable encounters the excess ice loading and the winds at high speed and to check its design parameters.	IEC 794-1-E1 The cable shall sufficient strength to withstand UTS load. The load shall be sustained for 10 minutes and the strain of the fibre and the attenuation shall be monitored at MWT, Max installation load & UTS. MWT & UTS shall be derived from SAG-TENSION data for aerial cable.	The load shall produce no strain ($\leq 0.05\%$ is to be treated as no strain) up to MWT and fibre strain shall not exceeding 0.25% in the fibre upto max installation load. At UTS fibre shall not break and shall not cause any permanent physical and optical damage to any component of the cable. The attenuation shall be noted before strain and after the release of strain. The change in attenuation of each fibre after the test shall be $\leq 0.05\text{dB}$

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
				both for 1310 nm and 1550 nm wavelength.
2	Abrasion Test	To test the abrasion resistance of the sheath and the marking printed on the surface of the cable.	IEC-794-1-E2 or by any other international test method The cable surface shall be abraded with needle (wt. 150 gm) having diameter of 1mm with 500 grams weight (Total weight more than equal 650 gms.) No. of cycles : 100 Duration : One minute (nominal)	There shall be no perforation & loss of legibility of the marking on the sheath.
3	Crush Test (Compressive Test)	The purpose of this test is to determine the ability of an optical fibre cable to withstand crushing.	IEC 794-1-E3 The fibres and component parts of the cable shall not suffer permanent damage when subjected to a compressive load of 2000 Newtons applied between the plates of dimension 100 x 100 mm. The load shall be applied for 60 Secs. The attenuation shall be noted before and after the completion of the test.	The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310 nm and 1550 nm wavelength.
4	Impact Test	The purpose of this is to determine the ability of an optical fibre cable to withstand impact.	IEC 794-1-E4 The cable have sufficient strength to withstand an impact caused by a mass weight of 50 Newtons, when falls freely from a height of 0.5 meters. The radius R of the surface causing impact shall be 300 mm. Ten such impacts shall be applied at the same place. The attenuation shall be noted before and after the completion of the test.	The change in attenuation of the fibre after the test shall be ≤ 0.05 db both for 1310 nm and 1550 nm wavelength.
5	Repeated Bending	The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated bending.	EIA-455-104 The cable sample shall be of sufficient length (5 m minimum to permit radiant power measurements as required by this test. Longer lengths may be used if required. Parameters : Weight : 5 kg Minimum distance from Pulley	During the test no fibre shall break and the attenuation shall be noted before and after the completion of the test. The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310 nm

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
			<p>Centre:216mm</p> <p>To holding device Minimum distance from Wt. To Pulley Centre : 457 mm</p> <p>Pulley Diameter: 20 D (D-cable diameter)</p> <p>Angle of Turning: 90° No. of cycles: 30 Time Required for 30 cycles : 2 min</p>	and 1550 nm wavelength.
6	Torsion Test	The purpose of this test is to determine the ability of an optical fibre cable to withstand torsion.	<p>IEC 794-1-E7</p> <p>The length of the specimen under test shall be 1 meters and the load shall be 75 N. The sample shall be mounted in the test apparatus with cable clamped in the fixed clamp sufficiently tight to prevent the movement of cable sheath during the test. One end of the cable shall be fixed to the rotating clamp, which shall be rotated in a clockwise direction for one turn. The sample shall then be returned to the starting position and then rotated in an anti-clock wise direction for one turn and returned to the starting position. This complete movement constitutes one cycle. The cable shall withstand ten such complete cycles.</p>	The cable shall be examined physically for any cracks, tearing on the outer sheath and for the damage to other component parts of the cable. The twist mark shall not be taken as damage. The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310nm and 1550 nm wave length.
7	Kink Test	The purpose of this test is to verify whether kinking of an optical fibre cable results in breakage of any fibre, when a loop is formed of dimension small enough to induce a kink on the sheath.	<p>IEC 794-1-E10</p> <p>The small length shall be 10 times the minimum bending radius of the cable. The sample is held in both hands, a loop is made of a bigger diameter and by stretching both the ends of the cable in opposite direction, the loop is made to the minimum bend radius and no kink shall form. The cable is then normal and attenuation reading is taken.</p>	The kink should disappear after the cable is brought to normal position. The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310nm and 1550 nm wavelength.

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
8	Cable Bend Test	The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated flexing. The procedure is designed to measure optical transmittance changes and requires an assessment of any damage occurring to other cable components.	IEC 794-1-E11 (Procedure-I) The fibre and the component parts of the cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped 4 complete turns of 10 complete cycles around a mandrel having diameter of 20 D, where D is the diameter of the cable. The attenuation shall be noted before and after the completion of the test.	The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310nm and 1550 nm wave length. Sheath shall not show any cracks visible to the naked eye when examined whilst still wrapped on the mandrel.
9	Snatch Test	This test is to determine the ability of the cable to withstand a sudden snatch load.	IEC 794-1-E9 The sample is terminated in a manner that the fibres, sheathing and any strength member/members are clamped together firmly. A hook of dimension has a shaft capable of bearing variable loads applied to it. The cable of 4.5 meters length is taken and firmly clamped at the two ends so that a sag of 300 mm., is formed. The attenuation is then measured. Testing load shall be 300 N and the radius of impacting surface of the crown of the hook shall be 12.5 mm. The hook with the mass attached, is held or supported over the cable so that the crown of the hook is centered over the lowest point of the cable at a height of 100 mm. The hook is then released so as to catch the cable after dropping from the height of 100 mm. It shall be repeated ten times. The	There shall be no permanent physical damage to the cable and the change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310nm and 1550 nm wave length.

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
			attenuation is measured. The load is then removed from the cable and attenuation is noted.	
10	Cable Bend Test at High & Low Temperature	To determine the ability of a optical fibre cable to withstand bending at low and high temperatures which might be encountered during cable placement.	EIA RS-455-37 Test Temperature : -30 °C to +70 °C Mandrel dia : 20D (D – dia of the cable) No of turns : 4 Conditioning time duration : 24 hours at each temperature.	Visual test for damage of the sheath shall be checked. The change in attenuation of the fibre after the test shall be ≤ 0.05 dB/Km both for 1310 nm and 1550 nm wave length. The attenuation shall be noted before and after the completion of the cycle.
11	Temperature Cycling	To determine the stability behaviour of the attenuation of a cable subjected to temperature changes which may occur during storage, transportation and usage.	IEC 794-1-F1 (To be tested on 2 Km $\pm 5\%$ of cable) The permissible temperature range of the cable for storage shall be from -40 °C to +70 °C. The rate of change of temperature during the test shall be 1 degree/minute approx. The cable shall be subjected to temperature cycling for 12 hours at each temperatures as given below: TA2 : -20 °C TA1 : -10 °C TB1 : +60 °C TB2 : +70 °C The test shall be conducted for 2 cycles at the above temperatures.	The change in attenuation of the fibre under test after the test shall be ≤ 0.05 dB both for 1310nm and 1550 nm wave length for entire range of temperature.
12	Cable Aging Test	To check the cable material change dimensionally as the cable ages.	At the completion of temperature cycle test, the test cable shall be exposed to 85 ± 2 degree C for 168 hours. The attenuation measurement at 1310 & 1550 nm wavelengths to be made after stabilisation of the test cable at ambient temperature for 24 hours.	The increase in attenuation allowed : ≤ 0.05 dB at 1310 & 1550 nm wavelengths. <i>(Note: The attenuation changes are to be calculated with respect to the base line attenuation values</i>

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
				<i>measured at room temperature before temperature cycling.)</i>
13	Water Penetration Test	To ensure that the installed optical fibre cable will not allow water passage in the cable.	IEC 794-1-F5 (Fig. B) 1992. A circumferential portion of the cable end shall face the water head. The water tight sleeve shall be applied over the cable. The cable shall be supported horizontally and one meter head of water, containing a sufficient quantity of water soluble fluorescent dye for the detection of seepage, shall be applied over the inner sheath for seven days at ambient temperature. No other colour dye is permitted.	No dye shall be detected when the end of the 3m length is examined with UV light detector.
14	Test of Figure of Eight on the cable	To check of easiness in formation of figure of 8 of the cable during installation in the field.	1000 meters (approx) length of the cable shall be uncoiled from the cable reel and shall be arranged in figure of 8. The diameter of each loop of the figure of 8 shall be maximum 2 meters.	It shall be possible to make figure of 8 of minimum 1000 meter length of the cable uncoiled from the cable reel without any difficulty. No visual damage shall occur.
15	Cable Jacket Yield Strength and Ultimate Elongation	To check the yield strength and elongation of polyethylene (HDPE) cable sheath.	FOTP –89 or ASTM D1248 Type III Class. (a) Sample shall be taken from the completed cable (The nylon to be removed for this test). The aged sample shall be conditioned at 100 ± 2 °C for 120 hours before testing. The cross-head speed shall be 50 mm per minute.	Refer Table A-1 below.
16	Drip Test	To determine the ability of jelly in the cable to withstand a temperature of 70 °C.	Take a sample of 30 cm length of cable with one end sealed by the end cap. Remove nylon jacket, black sheath binder tape for 5 cm from open end of the sample. Clean the jelly. Then the sample is kept vertically with open end downwards in the oven for 24 hours at 70 °C with a paper under the sample.	There should be no jelly drip or oil impression on the paper.

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
			Examine the paper placed below the cable sample inside the oven for dripping of the jelly after 24 hours.	
17	ECSR Test	To check the outer sheath of the cable for ECSR.	ASTM D 1693.	There should not be any visible cracks on the surface of the outer sheath, when examined with the help of a magnifying glass.
18	UV Resistance Test	To check the effect of UV radiation on the following: (i) On the outer sheath material (HDPE) (ii) On the Orange colour lines. (iii) On the meter and other legend marking.	ASTM G-53-96 Duration : 2000 hours Four test samples of the finished cable of required length (as per test chamber specifications) are to be prepared. 2 samples shall be kept inside and these test samples are to be compared after test with the other 2 samples kept outside.	There should not be any fading or change in the colour of the marking and that of sheath. <i>(Note: Earlier Carried out test certificates may be accepted for same raw material and similar design/construction of the cable).</i>
19	Embrittlement Test of Loose Tube	To check the embrittlement test of the loose tube	The minimum length of the test sample depends of the outside diameter of the loose tube and should be 85mm for tubes up to 2.5mm outside dia. The length of the bigger tubes should be calculated by using the following equation : $L_o > 100 \times ((D + d)/4)^{1/2}$ Where L_o = Length of tube under test D = Outside dia of loose tube. d = inside dia of loose tube. Both the ends of a buffer tube test sample may be mounted in a tool which is clamped in jaws of a tensile machine which exert a constant rate of movement. The	The tube should not get embrittled. No ink should appear on the tube up to the safe bend dia of tube (20 D) where D is the outside diameter of the loose tube. There should not be any physical damage or mark on the tube surface.

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
			movable jaw may move at a rate of 50 mm per minute toward the fixed jaw. Under load the tube will bend, so that the tube is subjected to tensile and compressive stresses. The fixture for holding the tube should be designed in a manner that the tube might bend in all directions without further loading.	
20	Kink Resistance Test on the Loose Tube	To check the kink resistance of the loose tube during installation and in splicing operation	A longer length of the loose tube is taken (with fibre and gel), a loop is made and loop is reduced to the minimum bend radius of loose tube i.e. 20 D. (where D is the outside dia of the loose tube). This test is to be repeated 4 times on the same sample length of the loose tube.	No damage or kink should appear on the surface of the tube.
21	Drainage Test for Loose Tube	To check drainage of the loose tube	A tube length to 40 cm shall be cut and filled with filling gel ensuring there are no air bubbles and the tube is completely full. The filled tube is placed in a horizontal position on a clean worktop and cut 5 cm from each end so that the finished length of the sample is 30 cm. The filled tube shall be left in a horizontal position at an ambient temperature for 24 hrs. The sample tube is then suspended vertically in an environment heat oven over a weighed beaker. It is left in the oven at a temperature of 70 °C for a period of 24 hrs. At the end of the 24 hrs. period the beaker is checked and weighed to see if there is any gel in the beaker.	There shall be no gel or oil in the beaker.
22	Check of Easy removal of Sheath	To check the easy removal of sheath of the optical fibre cable by using normal sheath removal tool.	The sheath shall be cut in circular way using a sheath removal tool and the about 300 mm length of the sheath should be removed in one operation. It should be observed during sheath removal process that no undue extra force is applied and no component part of the cable is damaged.	It shall be possible to remove the sheath easily. Easy removal of both the outer jacket and the inner sheath shall be checked separately.
23	Check of the effect of	To check the effect of	ISO 175.	The sample should not show any effect

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
	Aggressive Media on the Cable	aggressive media solutions of PH4 and PH10 on the cable.	The two test samples of the finished cable each of 600 mm in length are taken and the ends of the samples shall be sealed. These test samples are put in the PH4 and PH10 solutions separately. After 30 days these samples are taken out from the solutions and examined for any corrosion etc. on the sheath and other markings of the cables.	of these solutions on the sheath and other marking of the cable. <i>(Note: Earlier Carried out test certificates may be accepted for same raw material and similar design/construction of the cable).</i>
---End of Table ---				

Table A-1

Jacket material	Minimum Yield Strength		Minimum Elongation (%)
	(Mpa)	(psi)	
HDPE unaged	16.5	2400	400
HDPE aged	12.4	1800	375

3.3.2.8. Type Tests on Aerial FO cable Accessories & fixtures

The accessories and fixtures shall subject to the following tests. The applicability of the tests for the particular type of accessories and fixtures shall be as given below:

Visual Examination : Applicable to all fittings

Objective: To check the quality and the workmanship.

Visual examination shall be carried out for all the accessories and fixtures for quality and workmanship which is required to be of the high order with super quality finish without any manufacturing defects.

Verification of dimensions : Applicable to all fittings

Objective: To check the dimensions of the accessories and fixtures : shall be checked as per approved DRS/drawings.

Tensile strength test : Applicable to tension & suspension clamp assemblies

Objective: To assess the mechanical performance of fixtures under ultimate tensile strength.
Requirement: Cable UTS with factor of safety 1.5

All the load bearing metal fittings except those of elastomer pads and helically formed

fittings shall be tested to meet the above requirement.

Tensile strength test for helically formed product

This test shall be applicable to terminating Helix, Protective Helix and Armour grip suspension helix.

Objective : To check the tensile strength for the helically formed items.

Requirement : The tensile strength test shall be carried out to the method specified in the respective standards for wires and shall meet the requirements listed in earlier clauses.

Slip Strength Test

This test shall be applicable to the Terminating helix and Armoured grip suspension fittings.

Objective : To check the tensile load strength of the formed fittings to assess the performance for withstanding the guaranteed load.

Requirement : The helically formed terminating fittings shall not slip up to 90 % of the Cable UTS. The helically formed suspension fittings shall withstand the load up to a minimum of 25 % of cable UTS and shall slip before 50 % of cable UTS.

Resilience Test

This test shall be applicable to terminating Helix.

Objective : To check the resilience of the helically formed fittings (Terminating Helix)

Requirement : The helically formed fittings shall pass the resilience test while helically formed fittings are wrapped and unwrapped on a piece of optical fibre cable three times successfully. The helical fittings should not loose its resilience even after three applications and shall be able to pass the slip strength test after third application.

Galloping / Fatigue test

This shall be applicable to a complete assembly of one set of tension fittings together with one set of suspension fittings and spiral damper.

Objective : To assess the fatigue performance of fixtures and accessories and the performance of optical characteristics of the optical fibre cable under galloping conditions.

Requirement of test methods:

Length of the span	:	25 – 30 meters
Minimum vibration cycles	:	1 million
Frequency	:	> 30 Hz to 100 Hz.
Amplitude	:	Amplitude of vibration at antinodal points shall not be

less than 100 % of the cable diameter.

Requirement : The accessories and fixtures shall pass the test when tested for the test conditions as above and shall meet the requirement given below:

1. Change in attenuation shall not exceed more than 0.1 dB after the recovery period.
2. No damage on the accessories and fixtures.
3. No physical damage to optical fibre cable.

Aeolian Vibration Test

Objective : To assess the fatigue performance of accessories and fixtures and the optical characteristics of the optical fibre cable under Aeolian vibration.

Requirement of test method :

Minimum length of span : 25 meters.

Minimum vibration cycles : 1 million

Frequency : 10 Hz to 100 Hz.

Amplitude : Free loop peak to peak antinode amplitude shall be maintained at a level equal to one half of the cable diameter.

Requirement :

1. Change in attenuation shall not exceed more than 0.1 dB after the recovery period.
2. No visual damage observed on the accessories and fixtures.
3. No physical damage to optical fibre cable.

Tension and Attenuation Test (Dead End Assembly)

Objective : To assess the attenuation and the optical characteristics of the optical fibre cable after fixing and installing dead end assembly on the optical fibre cable.

Requirement of test method :

Minimum length of span : 25 meters

The test shall meet the following:

- a. Change in attenuation shall not exceed more than 0.1 dB after the recovery period.
- b. Any visual damage observed on the accessories and fixtures.
- c. No physical damage to optical fibre cables.

Wrapping Test

Objective : To check quality of the aluminum alloy wires.

Test Method : The formed fittings made of aluminum alloy wires shall be wrapped on a wire of its own diameter to form a close helix.

Requirement : The wires should not break or show fracture and shall meet the requirement specified above.

Galvanising Test

Objective : To check galvanized coating and the quality of galvanizing on accessories and fixtures

Test method : IS 2633-1972 for uniformity.

Requirement : The fittings shall meet the requirement of the specifications.

Hardness Test of Elastomer pad

Objective : To check the Ploychloroprene compounded elastomer pads of the suspension and cable jumper clamp.

Requirement : The Ploychloroprene compounded elastomer pads of the suspension unit shall be subjected for the test parameters as listed earlier in this specifications. The compounded material should meet the minimum properties specified therein.

3.4. Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out on OPGW Cable and associated hardware & fittings, Approach Cable and associated hardware fitting , Aerial FO cable(ADSS) and its Accessories & fixtures, Joint Box, FODP, and all other items for which price has been identified separately in the Bid Price Schedules.

Material shall not be shipped to the Employer until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Employer, and the Employer has issued CIP Clearance/Interim Inspection Report. Successful completion of the factory tests and the Employer approval to ship, shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Employer's authorised representatives unless waiver for witnessing by Employer's representatives is intimated to the contractor.

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

The factory acceptance test shall demonstrate the technical characteristics of the equipment

in relation to this specifications and approved drawings and documents. List of factory acceptance tests for Fibre Optic Transmission system, Termination Equipment Sub-system , NMS are given in specified Tables in this section. This list of factory acceptance tests shall be supplemented by the Contractor's standard FAT testing program. The factory acceptance tests for the other items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's / supplier's) standard FAT testing program. In general the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces, alarms and diagnostics etc.

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

During FAT stage, the employer has to verify all type test reports/certificates including Communication Protocol and security conformance tests of the devices offered for FAT as part of essential cyber security tests. The equipment/system besides for functionality shall also be tested in the factory for vulnerabilities, design flaws, parts being counterfeit or tainted, so as to minimize problems during on-site testing and installation. Cyber security conformance testing are to be carried out in the designated lab as identified by GoI/MoP.

The following auditor report and audit recommendations are to be verified during FAT.

1. Vulnerability assessment
2. Risk assessment
 - a. Network architecture validation with respect to design documents.
 - b. Penetration testing
 - c. System Hardening test

3.4.1. Sampling for FAT

From each batch of equipment presented by the Contractor for Factory acceptance testing, the Employer shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples. The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum 1) for all items. The physical verification shall be carried out on 100% of the offered quantities as per the approved FAT procedure. In case any of the selected samples fail, the failed sample is rejected and additional 20% samples shall be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected. In case a number of equipments are required for demonstration of the performance of any equipment during FAT, the sample size shall be taken as that number of equipments which are necessary to demonstrate the performance, irrespective of the percentage.

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

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

Since FAT testing provides a measure of assurance that the Quality Control objectives are being met during all phases of production, the Employer reserves the right to require the



Contractor to investigate and report on the cause of FAT failures and to suspend further testing/ approvals until such a report is made and remedial actions taken, as applicable.



3.4.2. Production Testing

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

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

3.4.3. Factory Acceptance Tests on Optical Fibre to be supplied with OPGW

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

**Table 3-7
Factory Acceptance Tests for Optical Fibres: Optical Tests**

S. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation Coefficient	TS Vol II ,Table 2-1(a)	EIA/TIA 455- 78A
2	Point Discontinuities of attenuation	TS Vol II, Section 2.1.1.2	EIA/TIA 455-59
3	Attenuation at Water Peak	TS Vol II ,Table 2-1(a)	EIA/TIA 455- 78A
4	Chromatic Dispersion		EIA/TIA 455-168A/169A/175A
5	Core – Clad Concentricity Error		EIA/TIA 455-/176
6	Cladding diameter		EIA/TIA 455-176
7	Fibre Tensile Proof Testing		EIA/TIA 455-31B
-End of table-			

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

3.4.4. Factory Acceptance Test on OPGW Cable

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

Table 3-8
Factory Acceptance Tests on OPGW
Applicable standard: IEEE 1138 / IEC 60794

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

3.4.5. Factory Acceptance Test on OPGW Fittings

The factory acceptance tests for OPGW Fittings as specified below in Table 3-9. The sampling plan shall be as per relevant standard:

Table 3-9
Factory Acceptance Tests On OPGW Fittings

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

Table 3-9
Factory Acceptance Tests On OPGW Fittings

S. No.	Factory Acceptance Test
8	Mechanical strength of each component
9	Galvanising Test
Vibration Damper	
10	Galvanising test on damper, masses and messenger wires
11	Damper response (resonant frequencies)
12	Clamp Slip test
13	Strength of messenger wires
14	Attachments of weights to messenger cable
15	Attachments of clamps to messenger cable
16	Clamp bolt tightening test
17	Clamp bolt torque test
18	Dynamic characteristic test.
19	Visual Material verification and dimensional checks as per approved DRS/Drawings
Structure Mounting Clamp	
20	Clamp fit test
21	Clamp Strength test
22	Visual Material verification and dimensional checks as per approved DRS/Drawings
End of Table	

3.4.6. Factory Acceptance Test on Approach Cable

The factory acceptance tests for Approach Cable specified below in Table 3-10:

Table 3-10
Factory Acceptance Tests On Approach Cable

--	--



S. No.	Factory Acceptance Test
1	Attenuation Co-efficient at 1310 nm and 1550 nm
2	Point discontinuities of attenuation
3	Visual Material verification and dimensional checks as per approved DRS/Drawings

The test report for the above tests for the fibers as per table 3-7 carried out by the Fiber Manufacturer and used in the OPGW cables shall be shown to the inspector during OPGW cable FAT and shall be submitted along with the OPGW cable FAT report.

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

The factory acceptance tests for Splice Enclosures/FODP as specified below in Table:

Table 3-11
Factory Acceptance Tests on Splice Enclosures (Joint Box)/FODP

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

3.4.8. Factory Acceptance Test on Test Equipment, Pigtail & other items

As per technical specification and approved DRS/Documents.

3.4.9. Factory Acceptance Tests on Self-supporting metal free Aerial optical fibre cable

The tests listed in Table 7-20 shall be carried out as Factory Acceptance Test for Self-supporting metal free aerial optical fibre cable meeting the requirements specified in this section. The factory acceptance tests for optical fibers listed in table 3-7 are applicable for the fibers in the ADSS cable. The factory acceptance test report for the optical fibers carried out by the Fiber Manufacturer and used in the Self-supporting metal free Aerial optical fibre cable (ADSS) shall be shown to the inspector during ADSS cable FAT and shall be submitted along with the ADSS cable FAT report.

Table 3-12
Factory Acceptance Tests on Self Supporting Metal Free Aerial Fibre Optic Cable



S. No.	Factory Acceptance Test
1	Attenuation Coefficient (1310, 1550): By EIA/TIA 455- 78A or OTDR
2	Point discontinuities of attenuation: By EIA/TIA 455- 78A or OTDR
3	Visual Material verification and dimensional checks as per approved drawings
4	Water Ingress test
5	Tensile strength test / Strain test
6	Impact test
7	Kink test
8	Environmental test
9	Crush Test
10	Drip test

3.4.10. Factory Acceptance Tests on Aerial FO cable accessories & fixtures

The FAT on accessories & fixtures of Self-supporting metal free aerial optical fibre cable shall be carried out as specified in Table 3-13.

Table 3-13

Factory Acceptance Tests on Fittings for Self Supporting Metal Free Aerial FO Cable

S. No.	Factory Acceptance Test
1	Visual and dimensional checks of all components
2	Tensile test
3	Slip test
4	Galvanising test
5	Wrapping test
6	Hardness test

3.5. Site Acceptance Tests

The Contractor shall be responsible for the submission of all equipment & test equipment



supplied in this contract for site tests and inspection as required by the Employer. All equipment shall be tested on site under the conditions in which it will normally operate.

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

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

3.5.1. Minimum Site Acceptance Testing Requirement for FO Cabling

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

3.5.1.1. Phases of Site Acceptance Testing

SAT shall be carried out link by link from FODP to FODP. SAT may be performed in parts in case of long links.

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

Sag and tension of OPGW shall generally be as per approved sag-tension chart and during installation, sag and tension of OPGW shall be documented. Upon completion of a continuous cable path, all fibres within the cable path shall be demonstrated for acceptance of the cable path. Fibre Optic cable site testing minimum requirements are provided in Table 3-14(a) through 3-14(c) below:

**Table 3-14(a)
Fibre Optic Cable Pre-Installation Testing**

Item:	Description:
1.	Physical Inspection of the cable assembly for damage
2.	Optical fibre continuity and fibre attenuation with OTDR at 1550 nm

Table 3-14(a)
Fibre Optic Cable Pre-Installation Testing

3.	Fibre Optic Cable length measurement using OTDR
----	---

Table 3-14(b)
Fibre Optic Cable Splicing Testing

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

Table 3-14(c)
Fibre Optic Cable Commissioning Testing

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

3.6. QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work as applicable, are in accordance with the specifications, the Contractor shall ensure suitable quality assurance programme to control such activities at all points necessary. A quality assurance programme of the Contractor shall be in line with ISO requirements & shall generally cover the following :

- a) The organisation structure for the management and implementation of the proposed quality assurance programme.
- b) System for Document and Data Control.



- c) Qualification and Experience data of Bidder's key personnel.
- d) The procedure for purchases of materials, parts, components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- e) System for shop manufacturing and site erection controls including process controls, fabrication and assembly control.
- f) System for Control of non-conforming products including deviation dispositioning, if any and system for corrective and preventive actions based on the feed back received from the Customers and also internally documented system for Customer complaints.
- g) Inspection and test procedure both for manufacture and field activities.
- h) System for Control of calibration of testing and measuring equipment and the indication of calibration status on the instruments.
- i) System for indication and appraisal of inspection status.
- j) System of Internal Quality Audits, Management review and initiation of corrective and Preventive actions based on the above.
- k) System for authorising release of manufactured product to the Employer.
- l) System for maintenance of records.
- m) System for handling, storage and delivery.
- n) A quality plan detailing out the specific quality control measures and procedure adopted for controlling the quality characteristics relevant to each item of equipment furnished and /or service rendered.
- o) System for various field activities i.e. unloading, receipt at site, proper storage, erection, testing and commissioning of various equipment and maintenance of records. In this regard, the Employer has already prepared Standard Field Quality Plan for transmission line/substation equipments as applicable, Civil/erection Works which is required to be followed for associated works.

The Employer or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

Quality Assurance Documents

The Contractor shall ensure availability of the following Quality Assurance Documents:

- i) All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication, and reports including radiography interpretation reports.
- ii) Welder and welding operator qualification certificates.
- iii) Welder's identification list, welding operator's qualification procedure and welding identification symbols.
- iv) Raw Material test reports on components as specified by the specification and in the quality plan.
- v) The Manufacturing Quality Plan(MQP) indicating Customer Inspection Points (CIPs) at various stages of manufacturing and methods used to verify that the inspection and testing points in the quality plan were performed satisfactorily.
- vi) Factory test results for testing required as per applicable quality plan/technical specifications/GTP/Drawings etc.
- vii) Stress relief time temperature charts/oil impregnation time temperature charts, wherever applicable.

3.7. INSPECTION, TESTING & INSPECTION CERTIFICATE

3.7.1 Contractor shall procure bought out items from sub-vendors as per the list in "Compendium of Vendors" available on POWERGRID web-site www.powergridindia.com after ensuring compliance to the requirements/conditions mentioned therein. Contractor shall explore first the possibilities of procuring the bought out items from POWERGRID approved existing vendors. In case of their unavailability / non-response, Contractor may approach POWERGRID for additional sub-vendor approval. In that case, the assessment report of proposed sub vendor by Contractor along with the enclosures as per Annexure-I shall be submitted within 60 days of the award. The proposal shall be reviewed and approval will be accorded based on the verification of the document submitted and/or after the physical assessment of the works as the case may be. The physical assessment conducted by POWERGRID, if required, shall be on chargeable basis. Charges shall be as per the POWERGRID norms prevailing at that time, which shall be intimated by POWERGRID separately. If proposal for sub-



vendor is submitted after 60 days, the Contractor's proposal normally will not be considered for current LOA. However, POWERGRID may process the case for developing more vendors for referred items, if found relevant. In all cases, It is the responsibility of the Contractor that Project activities do not suffer on account of delay in approval/non approval of a new sub-vendor.

For Telecom/LD&C packages, the makes/model of small items shall be finalized during approval of DRS by Telecom/LD&C department.

The responsibility and the basis of inspection for various items & equipment is placed at **Annexure-II** along with the requirement of MQP (Manufacturing Quality Plan), ITP(Inspection & Test Plan), FAT(Factory Acceptance Test) which should be valid & POWERGRID approved and Level of inspection envisaged against each item.

Contractor shall ensure that order for items where MQP/ITP/FAT is required will be placed only on vendors having valid MQP/ITP/FAT and where the supplier's MQP/ITP/FAT is either not valid or has not been approved by POWERGRID, MQP shall be generally submitted as per POWERGRID format before placing order. A Copy of MQP format is placed at **Annexure – III**.

Items not covered under MQP/ITP/FAT shall be offered for inspection as per POWERGRID LOA/technical Specifications/ POWERGRID approved data sheets/ POWERGRID approved drawings and relevant Indian / International standards.

Inspection Levels: For implementation of projects in a time bound manner and to avoid any delay in deputation of POWERGRID or its authorized representative, involvement of POWERGRID for inspection of various items / equipment will be based on the level below:

Level –I: Contractor to raise all inspection calls and review the report of tests carried out by the manufacturer, on his own, as per applicable standards/ POWERGRID specification, and submit to concerned POWERGRID inspection office/Inspection Engineer. CIP/MICC will be issued by POWERGRID based on review of test reports/certificates of manufacturers.

Level – II: Contractor to raise all inspection calls and carry out the inspection on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during inspection, the same would be intimated to Contractor and CIP/MICC will be issued by POWERGRID. Else, Contractor would submit their test reports/certificates to POWERGRID. CIP/MICC will be issued by POWERGRID based on review of test reports / certificates.



Level - III: Contractor to raise inspection calls for both, stage (as applicable) & final inspection and carry out the stage inspections(if applicable) on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during stage inspection, the same would be intimated to Contractor and CIP will be issued by POWERGRID. Else, Contractor would submit the test reports / certificates of stage inspection after their own review and CIP will be issued by POWERGRID based on review of test reports / certificates. Final inspection will be carried out by POWERGRID and CIP/MICC will be issued by POWERGRID.

Level – IV: Contractor to raise inspection calls for both, stage (as applicable) & final inspections. POWERGRID will carry out the inspection for both stage & final inspection as per applicable standards/specification and CIP/MICC will be issued by POWERGRID.

Contractor shall ensure that to implement the above inspection levels, particularly for the quality control and inspection at sub-vendor's works, they would depute sufficient qualified & experienced manpower in their Quality Control and Inspection department. Further, to assure quality of construction, Contractor shall have a separate workforce having appropriate qualification & experience and deploy suitable tools and plant for maintaining quality requirement during construction in line with applicable Field Quality Plan (FQP).

The Employer, his duly authorised representative and/or outside inspection agency acting on behalf of the Employer shall have at all reasonable times access to the Contractor's premises or Works and shall have the power at all reasonable times to ensure that proper Quality Management practices / norms are adhered to, inspect and examine the materials & workmanship of the Works, to carry out Quality/Surveillance Audit during manufacture or erection and if part of the Works is being manufactured or assembled at other premises or works. The Contractor shall obtain for the Employer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. The item/equipment, if found unsatisfactory with respect to workmanship or material is liable to be rejected. The observations for improvements during product/ process inspection by POWERGRID shall be recorded in Quality Improvement Register (available & maintained at works) for review & timely compliance of observations.

Contractor shall submit inspection calls over internet through POWERGRID website. The required vendor code and password to enable raising inspection call will be furnished to the main Contractor with in 30 days of award of contract on submission of documents by Contractor. After raising the



inspection calls, Contractor shall then proceed as per the message of that particular call which is available on the message board.

The Employer reserves the right to witness any or all type, acceptance and routine tests specified for which the Contractor shall give the Employer/Inspector Twenty one (21) days written notice of any material being ready for testing for each stage of testing as identified in the approved quality plan as customer inspection point(CIP) for indigenous inspections. All inspection calls for overseas material shall be given at least forty five (45) days in advance. Such tests shall be to the Contractor's account except for the expenses of the Inspection Engineer. The Employer/inspector, unless witnessing of the tests is waived by Employer, will attend such tests within Twenty one (21) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector three copies of tests, duly certified. Contractor shall ensure, before giving notice for type test, that all drawings and quality plans have been got approved. The equipment shall be dispatched to site only after approval of Routine and Acceptance test results and Issuance of Dispatch Clearance in writing by the Employer. CIP/Material Inspection clearance certificate (MICC) shall be issued by the Employer after inspection of the equipment or review of test reports as applicable. Employer may waive off the presence of Employer's inspecting engineer. In that case test will be carried out as per approved QP and test certificate will be furnished by the supplier for approval. CIP/MICC will be issued only after review and approval of the test reports.

Contractor shall generally offer material for inspection as per supply bar chart approved by POWERGRID and not before 30 days from schedule indicated in the bar chart. In case Contractor offers material(s) for inspection prior to 30 days from the scheduled date with necessary approval of POWERGRID, POWERGRID shall inspect the material and issue CIP only. However, in such an exceptional case, MICC shall be issued only as per provision of original / revised approved supply schedule.

Contractor shall minimize the number of inspection calls by offering optimum quantities in each inspection call at the respective manufacturer's works.

Contractor shall inspect the material themselves and only after they are fully convinced about the Quality, they shall offer the material for POWERGRID inspection and shall also ensure that relevant portion of LOA/NOA, approved drawing and data sheets along with applicable Quality Plans are available at the works of Contractor or their Sub-vendor before the material is offered for inspection.



Contractor shall ensure that material which has been cleared for dispatch after inspection will be dispatched within 30 days in case of domestic supplies and within 60 days in case of Off-shore supplies from the date of issuance of CIP. Material which is not dispatched within stipulated time as above will be reoffered for POWERGRID inspection or specific approval of POWERGRID QA&I shall be obtained for delayed dispatch .

The Employer or IE shall give notice in writing to the Contractor, of any objection either to conformance to any drawings or to any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Employer/Inspection Engineer giving reasons therein, that no modifications are necessary to comply with the Contract.

All Test Reports and documents to be submitted in English during final inspection of equipment by POWERGRID or as and when required for submission.

When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer/Inspection Engineer(IE) shall issue a certificate to this effect within fifteen (15) days after completion of tests & submission of documents by Contractor/manufacturer but if the tests are not witnessed by the Employer/IE, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Employer/IE. Contractor shall, on completion of all tests, submit test reports within Ten (10) days to POWERGRID IE. Failure of the Employer/IE to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Employer to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract.

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

The inspection and acceptance by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of



the Contractor in respect of the agreed quality assurance programme forming a part of the Contract, or if such equipment is found to be defective at a later stage.

The Employer will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

The Employer reserves the right for getting any additional field tests conducted on the completely assembled equipment at site to satisfy that material complies with specifications.

Rework/ Re-engineering, if any, on any item/equipment shall be carried out only after mutual discussions and in accordance with mutually agreed procedure. Contractor shall submit Joint Inspection Report of equipments under Re-Work/Re-Engineering alongwith procedure for the same to POWERGRID for approval, before taking up the Re-Work/Re-Engineering, failing which POWERGRID reserves the right to reject the equipment.

Contractor may establish a field test Laboratory to execute Civil Construction testing requirements at site with the condition that all testing equipment shall be calibrated from POWERGRID approved accredited Testing laboratories, with calibration certificates kept available at site and all testing personnel employed in the Field Testing Laboratories to be qualified and experienced Engineers or testing to be carried out at POWERGRID approved Third Party Laboratories.

Contractor shall ensure that all possible steps are taken to avoid damages to the equipment during transport, storage and erection.

The Employer reserves the right to increase or decrease their involvement in inspections at Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work based on performance of Contractor/sub Contractor.



Assessment report from Contractor for proposed sub-vendor along with following enclosures (to the extent available):

1. Registration / License of the works
2. Organization chart with name and qualification of key persons
3. List of Plant and Machinery.
4. List of testing equipment with their calibration status.
5. List of Raw material, bought out items with sourcing details
6. List of out-sourced services with sourcing details.
7. List of supply in last three years.
8. Third party approval, if any (viz. ISO, BIS),
9. Pollution clearance wherever applicable
10. Energy Conservation & Efficiency report
(Applicable to industries having contract load more than 100 KVA)
11. Formats for RM, in process and acceptance testing
12. Type test approvals conducted in last 5 years, if applicable
13. Performance Certificates from customers
14. Photographs of factory, plant and machinery & testing facilities

Annexure-II

MQP & INSPECTION LEVEL REQUIREMENT

Sl. No.	Item / Equipment	Requirement of MQP/ITP/FAT	Inspection Level
1	Battery	No	II
2	Battery Charger	Yes	III
3	Test Equipment	No	I *
4	FO Cable	Yes	III
5	OPGW & H/W	Yes	III
6	FODP including pigtail	No	II
7	Hardware Fittings for Fibre Optic approach cable	Yes	III
8	SDH Equipments (ADM), PDH, Primary Multiplexer	Yes	IV
9	Drop & Insert Multiplexer	Yes	IV
10	DACS	Yes	IV
11	Main Distribution Frame	No	I
12	HDPE Pipe	No	II
13	NMS, TMN	Yes	IV
14	Synchronization Equipment	No	Level-I
15	48V DCPS	Yes	III
16	Furniture	No	I

Note:

- * **MICC for test and measuring equipment shall be issued only after actual verification/demonstration of satisfactory performance at site.**
- ** **Though level-2 items, CIP can be issued also on review of TCs and visual inspection of these items.**



MANUFACTURING QUALITY PLAN

	Manufacturers Details (Name, Works Address etc.)	Customer	Vendor's Code:	Item:	Q.P. No.	Valid From:
		POWERGRID			Rev. No.	Valid Upto:
					Date:	

Sr. No.	Components / Operations & Description of Test	Type of check	Quantum of Check / Sampling with basis	Reference document for Testing	Acceptance Norms	Format of Record	Applicable Codes						Remarks
							1	2	3	4	5	6	
	A. Section: RAW MATERIAL INSPECTION												
	B. Section : IN PROCESS INSPECTION												



C. Section: FINAL TESTING																				
D. Section: PACKING & DISPATCH																				

MANUFACTURING QUALITY PLAN

2

		Customer POWERGRID	Vendor's Code:	Item:	Q.P. No. Rev. No. Date:	Valid From: Valid Upto:
--	--	-------------------------------------	-----------------------	--------------	--	--

Code 1	Indicates place where testing is planned to be performed i.e. Inspection location	Code 2	Indicates who has to perform the tests i.e. Testing Agency
A	At Equipment Manufacturer's works	J	The Equipment Manufacturer
B	At Component Manufacturer's works	K	The Component Manufacturer
C	At Authorised Distributor's place	L	The Third Party
D	At Independent Lab	M	The Turnkey Contractor
E	At Turn Key Contractor's location		
F	Not specified		
Code 3	Indicates who shall witness the tests i.e. Witnessing Agency	Code 4	Review of Test Reports/Certificates
P	Component Manufacturer itself	W	By Equipment manufacturer during raw material/bought out



Power Grid Corporation of India Ltd.
Volume II- Standard Technical Specification for OPGW works

		component Inspection.
Q	Component Manufacturer and Equipment Manufacturer	X By Contractor during product/process inspection
R	Component Manufacturer, Equipment Manufacturer and Contractor	Y By POWERGRID during product/process inspection By Contractor and/or POWERGRID during product/process inspection
S	Equipment Manufacturer itself	Z
T	Equipment Manufacturer and Contractor	
U	Equipment Manufacturer, Contractor and POWERGRID	
V	Third Party itself	
Code 5	Whether specific approval of sub-vendor / Component make is envisaged?	Code 6 Whether test records required to be submitted after final inspection for issuance of CIP/MICC
E	Envisaged	Y Yes
	Not Envisaged	N No

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

No table of contents entries found.

Section-4

Training and Support Services

Index

4.1. Training.....	2
4.1.1. System Design & Overview Training.....	2
4.1.2. Supervision, Maintenance and Installation Crew Training at Site.....	3
4.1.3. Fibre Optic cable Installation and Maintenance Training.....	3
4.1.4. Installation & Maintenance Training.....	3
4.1.5. Training Course Requirements.....	4
4.1.5.1. Class Size	4
4.1.5.2. Training Schedule.....	4
4.1.5.3. Manuals and Equipment	4
4.2. Support Services.....	5
4.2.1. Technical Support.....	5
4.2.2. Contractor's Future Hardware/Software Changes.....	5
4.3. Spare Parts and Test Equipment.....	5
4.3.1. Mandatory Spare Parts.....	5
4.3.2. Test Equipment.....	6
4.4. System Maintenance	6
4.4.1. Warranty Period	7
4.5. Miscellaneous Supplies	7

Section-4

Training and Support Services

This section describes the requirements for Contractor-supplied training, support services, and maintenance of the Fibre Optic Cabling System, FOTS, etc. The intent of the training and support program is to ensure a smooth transfer of systems and technologies from the Contractor to the Employer/Owner, and to ensure that Employer/Owner staff are fully trained to operate, maintain and expand the integrated telecommunication network.

4.1. Training

The Contractor shall provide a comprehensive training program that prepares the Employer/Owner's personnel for on-site installation support, operation, and maintenance of the telecommunication network.

Training may be conducted by the Contractor, the Contractor's subcontractors, and/or original equipment manufacturers (OEMs). The training requirements of this Specification shall apply to all such courses.

Training courses shall be conducted by personnel who speak understandable English and who are experienced in instruction. All necessary training material shall be provided by the Contractor. The training charges quoted by the Contractor shall include training materials and all associated expenses. However, for all training courses in India or abroad, the travel (e.g., airfare) and per diem expenses of the participants will be borne by the respective Employer/Owner. For courses conducted abroad, however, the Contractor shall extend all necessary assistance for making appropriate lodging arrangement.

Hands-on training shall be provided with equipment identical to that being supplied to the Employer/Owner.

The schedule, location and detailed training contents shall be submitted by the Contractor to the Employer/Owner for approval.

4.1.1. System Design & Overview Training

This training shall provide a functional description of the telecommunication subsystems for both fibre optic transmission system. The training shall include an overview of the network configuration and indicate the functional responsibilities of all major subsystems. The training shall highlight all significant methodologies to perform the required functions. High-level hardware configuration block diagrams and network/sub-network block/flow diagrams shall be included to enhance the understanding of the overall capability incorporated into all network.

The training shall be oriented to a user's point of view. The Employer/Owner users will include managers, design & planning personnel, communication support staff and maintenance personnel. As part of the proposal, the Contractor shall identify the number of days deemed appropriate for this training.

In addition, the contractor shall also provide the training on the DCPS & Battery for the supplied system. The training shall cover aspects covering installation, testing & commissioning of DCPS & Battery. Proper emphasis of the training shall be for effective operation & maintenance of

DCPS & Battery on routine & emergency basis by the Employer's personnel.

The overview training shall be customized for the specific functions, features, and equipment purchased by the Employer/Owner; it shall not be a general presentation of the Contractor's standard equipment repertoire. Personnel assigned by the Contractor to implement the Employer's system shall conduct this overview training. The Employer shall review and approve the contents of the overview training at least four (4) weeks prior to the course.

4.1.2. Supervision, Maintenance and Installation Crew Training at Site

The Installation, Supervision & Maintenance training course shall enable the trainees to effectively supervise the fibre optic cable installation work from an Employer perspective, particularly with respect to installation quality checks and safety procedures. The training shall cover FO cable handling techniques, stringing and installation, jointing & splicing, OTDR use and OTDR trace analysis, operation, preventive maintenance, troubleshooting procedures, corrective maintenance, and expansion procedures.

It shall also cover an appreciation of restorative procedures required after any likely cable failure such as cable breaks due to storms or falling trees, installation hardware failures or misalignments.

Installation crew training shall be predominantly hands-on training courses provided for a group of persons. The intent of this training is to enable Employer to undertake maintenance & restoration work in case of cable breaks or other such failures.

The Contractor shall submit for approval a detailed proposal for this training as per the agreed documentation schedule. The proposal shall include information such as proposed number of trainees, trainee profile, course duration, training facilities and methodology to be used etc. The training charges for this training course shall be separately identified in the Bid Price Schedules.

4.1.3. Fibre Optic cable Installation and Maintenance Training

There shall be installation & maintenance training for Fibre Optic cable & associated items. The installation & maintenance trainings shall enable the Employer to be self-sufficient in preventive & restorative maintenance of the Fibre Optic cable & associated items purchased by the Employer. The training courses shall cover Fibre Optic cable & associated items installation, testing & commissioning, preventive maintenance, diagnostic tools and troubleshooting procedures, corrective maintenance for Fibre Optic cable. The courses shall provide theoretical background and extensive hands on experience.

4.1.4. Installation & Maintenance Training

There shall be separate modules of the installation & maintenance training for the following systems:

FO Transmission System Training

The installation & maintenance trainings shall enable the Employer/Owner to be self-sufficient in preventive & restorative maintenance of the installed system. The training courses shall cover

equipment installation, testing & commissioning, operation, interfaces and cabling, preventive maintenance, diagnostic tools and troubleshooting procedures, corrective maintenance, and expansion procedures. The courses shall provide theoretical background and extensive hands on experience.

Courses shall also include troubleshooting and repair aspects.

4.1.5. Training Course Requirements

This section describes general requirements that apply to all training courses.

4.1.5.1. Class Size

The Employer/Owner plans to send a number of participants to the training courses for a specified duration as described in Appendices.

4.1.5.2. Training Schedule

The Contractor shall provide training in a timely manner that is appropriate to the overall project schedule. All training courses shall be available to the Employer/Owner for a minimum of five years after final acceptance of the communication system.

The training courses shall be offered in one cycle, such that none of the courses within the cycle overlap.

The Contractor shall take the above requirements into account in developing the preliminary training schedule. Contractor shall develop a final training schedule in consultation with the Employer/Owner after contract award.

4.1.5.3. Manuals and Equipment

The Contractor, subcontractor, or OEM shall prepare training manuals and submit them to the Employer for review at least one month prior to the start of classroom instruction. The training manuals shall be prepared specifically for use as training aids; reference manuals, maintenance manuals, and user's manuals may be used as supplementary training material. Principal documents used for training shall be tailored to reflect all the Employer requirements specified.

Each course participant shall receive individual copies of training manuals and other pertinent material at least two weeks prior to the start of each course. The Employer/Owner shall retain the master and two additional copies of all training manuals and materials as reference documentation. A complete set of instructor's manuals and training aids shall also be provided.

Upon completion of each course, instructor's manuals, training manuals, and training aids shall become the property of the Employer. As part of the delivered system documentation and the final documentation, the Contractor shall supply the Employer with all changes and revisions to the training manuals and other training documentation. The Employer reserves the right to copy all training manuals and aids for use in the Employer-conducted training courses.

The Contractor shall furnish for use during training courses all special tools, equipment, training

aids, and any other materials required to train course participants.

4.2. Support Services

Throughout design, implementation, factory testing, and field installation and testing, the Contractor shall supply consulting assistance, as required by the Employer for site preparation, field installation, and other areas where technical support may be required.

The Contractor shall be responsible for minor facility renovation, and maintenance of the supplied system up to and including successful completion of the Site Acceptance Test.

After final acceptance of the communications equipment, the Contractor shall offer continuing technical support and spare parts for the communications equipment for a minimum period of 15 years from operational acceptance by the Employer or 7 years after the declaration of withdrawal of equipment from production whichever is earlier. However the termination of production shall not occur prior to Operational Acceptance of the system by the Employer.

4.2.1. Technical Support

Consultation with Contractor's technical support personnel and trained field service personnel shall be readily available on a short-term/long-term basis to assist the Employer personnel in maintaining, expanding, and enhancing the telecommunication network upon expiration of the warranty period. The Contractor shall include in their offer(s), a proposal for ensuring continued technical support as stated above.

4.2.2. Contractor's Future Hardware/Software Changes

The Employer shall be informed of all alterations or improvements to the hardware supplied under this Specification. The Employer shall be placed on the Contractor's mailing list to receive announcements of the discovery, documentation, and solution of hardware/software problems as well as other improvements that could be made to supply equipment. The service shall begin at the time of contract award, and shall continue for a minimum period of 15 years from operational acceptance by the Employer or 7 years after the declaration of withdrawal of equipment from production whichever is earlier. The Contractor shall also include a subscription to the hardware subcontractors' change notification service from the time of contract award through the warranty period, with a Employer renewable option for extended periods.

4.3. Spare Parts and Test Equipment

The spare parts and test equipment shall be provided for each subsystem as described below.

4.3.1. Mandatory Spare Parts

BoQ provides the Mandatory Spare Parts Requirements described in subsystem sets. The mandatory spare parts table represents the minimum spares the Contractor shall be required to supply. The subsystem set of spare parts is defined to include all equipment modules, subunits and parts required to effect replacement, repair and restoration to full operational status of a defined unit of a subsystem.

4.3.2. Test Equipment

BoQ provides mandatory test equipment requirements, to be provided. The parameters / features of the mandatory equipments are enumerated in Table 8.3.2 below:

Table 8.3.2		
S.No.	Test equipment	Parameter
A.	Test Equipments for OPGW cable	
1	OTDR (Optical Time Domain Reflectometer) for 1310/1550 nm with laser source.	Equivalent to Anritsu MW9076B1 or better.
2	Optical Attenuators (variable 1310/1550nm).	Equivalent to JDSU OLA55 or better.
3	Optical Power meter (1310/1550nm) incl laser source	Equivalent to JDSU OLP55 or better
4	Laser Light Source (1310/1550nm)	Equivalent to EXFO FLS300-23BL or better.
5	Optical Fibre Fusion Splicer incl. Fibre cleaver	Equivalent to Sumitomo T-39-SE or better.
6	Splice kit	FIS – FI-0053-FF or equivalent
7	Optical test accessory kit including all necessary connectors, adaptors, cables, terminations and other items required for testing	FIS – FI-0053-TS-ST or equivalent

In case the offered make/model of test equipment has multiple options for the parameters, the option of higher range shall be acceptable. The supplied test equipment shall be suitable for use in the high EMI/EMC environment. The Contractor shall submit performance certificate for offered test equipment from at least one customer. The Contractor shall offer only reputed make test equipment such as Acterna (JDSU)/Anritsu/Sumitomo/Agilent/EXFO etc.

The Contractor shall provide in their bid, additionally recommended test equipment list necessary to support specified system outage requirements. These lists shall include all relevant technical descriptions and recommended minimum quantities based upon the guidelines consistent with the telecommunications resource management hierarchy and continuing maintenance concept. The recommended test equipment shall not be considered for evaluation and may be included in the final scope of supply.

4.4. System Maintenance

As per DoT guidelines, operation and maintenance of the network shall be entirely by Indian engineers and dependence on foreign engineers shall be minimal within a period of two years from date of LoA. The contractor shall be responsible to maintain the confidentiality of the Employer's System Information that Employer shares with the contractor for maintenance period.



4.4.1. Warranty Period

The one year period commencing immediately after the operational acceptance is called the Warranty Period/Defect liability Period. In addition to the responsibilities covered under Vol-I Condition of Contracts during Defect Liability Period, the Contractor shall also be responsible for maintenance of the Fibre Optic Cabling System supplied under this Package. The specification for the maintenance of the system after Operational Acceptance is enclosed at Annexure-I.

4.5. Miscellaneous Supplies

The Contractor shall provide all required consumable and non-consumable supplies necessary to support all installation and test activities through final operational acceptance. However, if there are any problems in the SAT and additional consumables are required, the same shall also be supplied by the Contractor at no additional cost.

Annexure-I

Technical Specifications for Maintenance after operational acceptance during maintenance period (i.e. Warranty/defect liability period & AMC Period)

A -1.0 GENERAL

The Contractor shall be responsible for comprehensive maintenance of the Fibre Optic communication equipment including NMS & DCPS system supplied & installed under this Contract. The maintenance contract shall commence after completion of the project i.e. after Operational Acceptance. Communication network & BOQ as given in Appendices. There may be some variation during detailed engineering. Contractor shall meet system availability of 99.9% for fibre optic system. Contractor will have to make their own assessment of the network and deploy manpower accordingly. However, it is to be ensured that specified manpower of requisite qualification are deployed.

Contractor's maintenance engineer/service engineer shall have minimum qualification of graduate in Computer or IT or Electronics & Telecommunication with minimum one year experience or Diploma with three years maintenance/testing & commissioning experience on the equipment proposed to be supplied & installed. The Degree/Diploma must be recognised Indian professional qualification. This staff shall be supported by head office technical staff for restorative problem or other assistance as may be required. Maintenance engineer shall have technical background and trained in first & second level maintenance on the supplied Fibre Optic communication system, DCPS & Battery and NMS system of their own without technical assistance from Head Office.

Contractor will arrange for adequate transportation for their staff as per the work demand. Contractor's staff (at all locations) should be equipped with necessary tool kits, mobile phones, vehicle etc.

The Maintenance of the system supplied & installed by the Contractor shall be comprehensive and all the spares required during maintenance period shall be provided by the Contractor at no additional cost to the Employer.

A - 1.1 RESOURCE DEPLOYMENT

In order to cover the entire network, it is imperative that Contractor's maintenance engineers are strategically located so as to reach the site within shortest possible time frame. Thus a minimum of two (2) engineers will be deployed at two (2) locations, this however, does not relieve contractor from its obligation to maintain required system availability of 99.9% for Fibre Optic System. Accordingly, Contractor shall assess the actual manpower requirement and place them suitably at locations, if required. The exact location for deploying engineer shall be finalised during detailed engineering. The central control and monitoring of communication system will be performed from centralized location by means of the centralized NMS. The other locations will work under the control/instruction of the Co-ordinator located at Centralized NMS system.

A 1.2 MONITORING

Network will be monitored through centralized NMS. Network Monitoring Team (NMT), whenever, notices any fault/abnormality in the system (including the third party optical interfaces/SFPs supplied & commissioned under a subsequent different package in the Communication equipment commissioned by the bidder under the current package) shall notify to the Contractor's maintenance Co-ordinator at NMS location, over phone with an event no. An event report shall be generated as per the enclosed formats. On issuance of Event report by NMT, corrective action(s) shall be carried out by Contractor's maintenance personnel for rectification. Contractor's representative must report within four (4) hours at locations where Contractor's engineers are stationed and within reasonable time at all other location which shall in no case exceed more than 12 hours (including travel time). Time mentioned here is irrespective of normal working hours or holidays. The NMT shall co-ordinate and control any site visits to ensure that communication network is operating with a minimum of disruption during these visits. The NMT will inform to facilitate the access to the site/equipment where fault is suspected.

The main responsibilities of the Employer's Network Monitoring Team are:

- a) Communication Network monitoring through Network Management System (NMS)
- b) Detect faults, prioritizing them and notifying to the Contractor for immediate corrective actions.
- c) Follow up on corrective actions to verify that the agreed time frames are met.
- d) Record all faults in the fault record sheet and summary of action taken for fault rectifications.
- e) Co-ordinate all planned / breakdown site visits to minimize disturbance of service.
- f) Update status information of operated network to users communication network.

A 1.3 MAINTENANCE

Maintenance activities are either Event Based (Fault/breakdown maintenance,) or planned site visits (Semi annual site visit, testing of channel/s, augmentation and modification in the network if end equipment for data/speech does not communicate with corresponding equipment as and when required. Planned visits shall mainly carried out during working days.

Event based work is to be carried out round the clock seven days a week, A start status shall be jointly filled by Employe & Contractors representative at 10.00 Hrs of commencement date of maintenance contract.

Planned site visits shall be carried out twice in a year (semi-annually) at all the sites in the network or time to time if speech/data is affected at a particular site. Thus, in a year, not less than two planned site visits to all locations will be undertaken.

Contractor will maintain record of events during the maintenance services ; simultaneously Employer shall also record the events in the LOG BOOK available in the NMS control room.

The tasks during the planned site visits for the system include but are not limited to following:

- Visual inspection of equipment
- Alarm measurement verification
- Status report of site
- Updating of log records
- Cleaning the equipment
- Tightening of connectors
- Sealing of cabinets to arrest entry of rodents etc.
- Measurement of earth resistance
- Checking of Joint box for water penetration & sealing of entries (To be done Anually)
- Fibre loss measurement

Work to be taken up during semi-annual site visits is given in enclosed Format.

Fault/Breakdown maintenance is a process of fault correction / trouble shooting/interfaces with other contractor (for data & Speech connectivity of existing RTUs & EPABXs etc.) as per the fault reported by NMT. Contractor will maintain a log of activities carried out at all locations and necessary History will include site name, visit date, actions taken and site condition. Detailed report in this respect shall be submitted by the contractor in the monthly meeting. Whenever fault is reported in the third party interfaces/SFPs supplied & commissioned under a subsequent different package in the Communication Equipment commissioned by the bidder under the current package, the same shall be reported to the optical interface/SFP supplier by the Contractor's maintenance personnel for necessary resolution/corrective measure.

The POWERGRID/Constituent representatives will associate in trouble shooting, change of unit as per programme notified/intimated by the contractor however, due to any reason if POWERGRID/Constituen can not depute their representative, contractor will proceed for the work so as to attend the breakdown/testing as per their programme.

The scope of corrective maintenance is as follows:

- Troubleshooting on a network element and its interfaces as and when required and directed by NMT, engineer/coordinator of POWERGRID/Constituent.
- Diagnostics on interfaces to locate problems in network elements. If required, the contractor shall depute maintenance engineer for joint inspection with other vendors for pin-pointing the fault.
- Identification of the faulty hardware unit, replacing it.
- Performance of function verification in co-ordination with the NMT operators
- Handing over of faulty unit to POWERGRID/Constituent at site or Control Centre.

MAINTENANCE OF DC POWER SUPPLY SYSTEM

(DCPS includes charger, Batteries, DCDB and other associated cables/connectors, Meters, relays, switches, surge protection devices etc.)

The Contractor shall carry out both preventive and break down maintenance of the supplied DCPS & Battery System.

Preventive Maintenance (PM)

This consists of necessary measures to maintain the equipment in the proper operating condition. Preventive maintenance includes functional checking, cleaning and necessary repair/replacement/adjustments etc. It will be carried out quarterly at mutually agreed dates.

Break Down Maintenance

Break Down Maintenance is to be carried out in the event of malfunctioning of DCPS equipment, which blocks the normal operation of the DCPS. Break down maintenance includes faultfinding, repair or replacement of defective parts and functional checking.

Immediately on noticing the fault, the fault will be reported by the constituent/POWERGRID on phone to the contractor. The fault reporting time on phone shall be taken as reference time for the purpose of RT and TAT.

(RT is Response Time when contractor's person report at site after reporting of fault in system. TAT is Turn-Around-Time when system is brought back in service after necessary rectification/replacement works.

A 1.4 HARDWARE SERVICES

In case any failure or malfunction is discovered, the maintenance team shall identify the problem, organise to promptly attend the fault, replace the faulty equipment/card/module or any other hardware component with a spare unit and ship the faulty unit to specified location. Each faulty unit shall be accompanied with correctly filled-out Event Report. Contractor shall ensure maximum utilisation of the channel capacity, hence healthy channel/s will be put in use and hardwired to respective DDF/MDF point, in coordination with POWERGRID/Constituent, without disturbing end user (PABX, PLCC, RTU) connection so that outright replacement of card is avoided. Card shall be replaced when all the healthy channels are faulty. Necessary modification (temporary) in drawing/s in site copy and at NMS location will have to be done without changing original document.

The Contractor shall be responsible for providing all the spares (cards/modules/accessories etc.) for supplied & installed equipment such as SDH, MUX, NMS etc. The spares shall be provided/arranged by the contractor at no extra cost to Employer. For early restoration during the emergency condition, if spares are made available by Employer, the same shall have to be replenished by the Contractor within thirty (30) days.

Contractor's hardware services shall also cover support for the NMS hardware & Software

supplied to Employer as part of the Contract. Contractor shall be responsible for providing spares for the supplied NMS system, if required, during maintenance period at no additional cost to the Employer.

Contractor will carry out the following tasks for hardware services:

- a) Handover the faulty unit/s to Employer
- b) Replace faulty units from their own spares stock.
- c) Send faulty units to Original equipment supplier's representative in India on Employer behalf with the correctly completed Failure Report with site information and symptoms of failure.
- d) Test the repaired unit for their healthiness after the same is rectified by the original manufacturer.

A 1.5 MAINTENANCE SERVICES SUMMARY

The Maintenance Services are summarised below:

ON SITE SUPPORT / MAINTENANCE	
Scope	To maintain required system availability of 99.9% for Fibre Optic System and specified response time.
Availability	On all working days of week except on Sundays & holidays during office hours. After office hours / Holidays, duty phone to be contacted (with co-ordinator)
Task	Troubleshooting & Fault rectification
MAINTENANCE FAULT/BREAKDOWN	
Equipment Scope	As per approved BoQ
Scope	Rectification /Corrective maintenance
Availability	On call basis as mentioned above in TS
PLANNED SITE VISIT	
Equipment Scope	As per approved BoQ
Scope	Visual inspection of equipment, alarms measurement verifications, status report of site, updating of log record, cleaning the equipment, modification & augmentation
Availability	Semi-annual / planned visits

A 1.6 OUTAGE TIME DEFINITION:

An outage time refers to period in which loss of communication is detected on any part of the telecommunication network / equipment and continues until the fault is cleared by taking into account conditions listed below.

- a) Time of unavailability excludes running with faulty equipment on specific instruction from POWERGRID/Constituent (not affecting communication or monitoring of other units other than faulty unit).
- b) The time of unavailability excludes the transportation time to a faulty site average of twelve (12) hours and time to get authorization for access to the telecommunication room and to the equipment.
- c) An event would not be considered as failure when the system features allow to continue the data/voice transmission utilizing redundancies available in the subsystem/equipment.
- d) In case of failure of any E1, no consequential lower level channel failure shall be accounted for.
- e) In case a loss of communication is detected in system of third party (PLCC/PABX equipment, RTU/SCADA, existing SDH/PDH equipment procured under separate contract) and no corresponding alarm is detected in NMS the event will be jointly studied with the parties and plan/schedule of fault finding will be made. However, under such conditions of fault attribution to the third party, it would be contractor's responsibility to logically establish such attribution.
- f) If it is needed to identify the fault, it is allowed to disconnect/loop circuits for trouble shootings. This testing time shall not be counted in the outage time calculations. However, interruption time for healthy channel should not exceed 10 minutes. Proper planning and coordination with all concerned may be required while carrying out this activity so as to minimize outage time.
- g) Outage due to force majeure conditions (Not attending fault due to war, curfew, earthquake at the location of fault, serious accident during traveling for attending fault) or outage due to failure in power system equipment (or AC/DC).
- h) Outages which are not attributable to equipment faults such as fault in fibre optic cable will not be considered for calculation in system availability.

A 1.7 DOCUMENTATION DURING MAINTENANCE PERIOD

Events shall be recorded by using of event form. The forms shall be filled in duly dated, timed and signed by representatives of both the parties. Absence of one or the other party's representative shall not render the record invalid but assumes only that such representative signs the record at his earliest convenience.

The initial condition of the system shall be recorded on the start status form to constitute or reference for later events. All the events recorded in the start status form shall have to be rectified within 15 days. Faults not attended within 15 days will be considered as outage. Any and all events such as incoming and existing alarms, fault occurrence, action taken for remedies etc. shall be recorded in the event report forms. If a unit is replaced or repaired both the new and the replaced or repaired unit is to be recorded in the event report form. Contractor shall submit the detailed report for fault occurrence after the cards/equipment is rectified at the works of supplier.

A 1.8 CALCULATION OF NETWORK AVAILABILITY

The system availability shall be calculated as per following formula during the Maintenance period.

Availability Calculation Formula.

$$\text{System Availability} = \frac{T_t * Ch_t - \sum Ch_n * T_n}{T_t * Ch_t} \times 100\% \quad (n=1 \text{ to } Ch_t)$$

Where

SA = System Availability (%)

T_t = Total test time (24* days in a month)

Ch_t = Total number of channel

Ch_n = Number of channels affected by event En

T_n = Outage time of event En

The NMS availability for both PDH/SDH shall be calculated as follows:

$$\text{Availability of NMS(Av)} = \frac{T_t * NE_t - \sum NE_n * T_n}{T_t * NE_t} \times 100\%$$

Where

Av = NMS Availability(%)

T_t = Total test time(24 * days in a month)

NE_t = Total number of network Element

NE_n = Number of NE affected by an event

T_n = Outage time of NE

A 1.9 AVAILABILITY REQUIREMENT

The availability of wideband communication equipment shall be measured in categories as below:

- a) Channel (Voice, Asynchronous & Synchronous data circuits and management data channels)
- b) E-1 /Ethernet channels
- c) Availability of NMS system

The availability requirement for type of channels for wideband communication equipment and NMS systems shall be 99.9%.

However not withstanding the commutation of availability of the communication system as specified above, the prompt restoration of the faulty equipment/part of the network is also of equal importance and any delay in restoration of the faulty system shall be governed as per terms & condition of the contract.

A 1.10 SCOPE OF WORK DURING MAINTENANCE PERIOD

Sl.no.	Description	Detailed Scope
1	Overall Infrastructure	Infrastructure includes the building, air conditioners, AC/DC system, UPS, cable trenches, Earthing etc provided by Employer. They will be maintained by Employer.
1.1	Equipment site	
1.1.1	General conditions	General checking during semi annual / troubleshooting site visits and advise
1.1.2	Cleanliness of the room	General checking during semi annual / troubleshooting site visits and advise.
1.1.3	Earthing interconnections	Checking, connector cleaning, redoing the connection during semi annual / troubleshooting site visits (limited to the earthing of equipment under scope of maintenance)and as required specifically. Earthing interconnection will be checked upto earthing star point). Earthing interconnection shall also be checked and corrected during troubleshooting site visits if it is considered the probable cause of fault. Measurement of earth resistance during semi-annual site visit
1.1.4	Air conditioning	General checking during semi annual / troubleshooting site visits and advise
1.1.5	Cable route	General checking during semi annual / troubleshooting site visits and advise
1.1.6	EMI issues	Contractor shall study in special case of repeated faults if the probable cause is earthing interconnection at the station or possibility of spurious signals through various cable connections to the wideband equipment and advise.
1.2	Interfacing with others	Checking interfacing with other equipment and take corrective actions on its MDFs if required. The scope will be limited to the MDFs where the cables of wideband communication system have been terminated. Report and advise on others' if it is the probable cause of fault.
1.3	Indoor cabling	Checking terminations, re-kroning, if necessary, during semi-annual/troubleshooting site visits. It shall also be checked during troubleshooting site visits if it is the probable cause of faults.
1.4	Out-door cabling	Checking terminations, re-kroning, if necessary, during semi-annual/troubleshooting site visits. It shall also be checked during troubleshooting site visits if it is the probable cause of faults.
1.8	Fibre Optic Cable	Checking with OTDR. Rectification if fault is found to

		be in the OPGW Cable, approach cable, patch cord etc. up to DDF. Splicing of fibres due to excessive loss or breakage due to any reason.
2	<i>Main Equipment</i>	
2.1	PDH MUX & Digital Cross Connect	Faulty equipment to be replaced at site as per conditions of Maintenance Plan.
2.2	Fibre Optic terminal SDH	Faulty equipment to be replaced at site as per conditions of Maintenance Plan.
2.3	GPS Clock	Faulty equipment to be replaced at site as per conditions of Maintenance Plan. Contractor shall be responsible for providing hardware , if required, during maintenance without any additional cost implication to Employer.
2.4	<i>NMS of SDH</i>	
2.4.1	Computer hardware and Routers	Faulty equipment to be replaced at site as per conditions of Maintenance Plan. Comprehensive maintenance with hardware suppliers to be tied up by the Contractor. Contractor shall be responsible for providing all hardware & software required during maintenance without any additional cost implication to Employer.
2.4.2	Alarm handling, Backups etc. - software part	Alarm deletions, Backups as per maintenance plan. Consumables to be provided by Employer. Software corruption to be corrected as per actual requirement.
2.5	<i>NMS of PDH(D/I Mux& DACS)</i>	
2.5.1	Computer hardware	Faulty equipment to be replaced at site as per conditions of Maintenance Plan. Comprehensive maintenance with hardware supplier to be tied up by the Contractor. Contractor shall be responsible for providing all hardware & software required during maintenance without any additional cost implication to Employer
2.5.2	Alarm handling Backups etc. software part	Alarm deletions, Backups as per agreed back up plan. Consumables to be provided by Employer. Software corruption to be corrected as per actual requirement.
2.5.3	Monitoring and general operation of communication link	Regular monitoring of the communication link operations through NMS in association with the Employer's staff. Investigations for abnormal behaviour and take corrective actions.
2.5.4	Provisioning/ Re-provisioning of channels	As per requirement.
2.6	Repeater Shelter &	Regular monitoring of the Repeater Shelter & it's

	it's associated subsystem	associated subsystem in association with the Employer's staff. Investigations for abnormal behaviour and take corrective actions.
3	Contractor's set-up	Generally in consonance with the set-up mentioned in the maintenance plan.
4 MAINTENANCE OF DC POWER SUPPLY SYSTEM (DCPS includes charger, Batteries, DCDB and other associated cables/connectors, Meters, relays, switches, surge protection devices etc.)		
Details of Job to be carried out during Preventive Maintenance		
1	Physical inspection of DCPS at all specified locations	
2	Cleaning of System	
3	Tightening of all the power and control connections including checking the input power cable terminations at both ends.	
4	Checking of DC Voltage	
5	Checking for AC Voltage L-L, L-N	
6	Checking AC Current	
7	Checking for ripple Voltage	
8	Functional checking Of DC System For Normal Operation including battery charging	
9	Checking for Normal operation of each Module	
10	Checking of earthing of the system by measurement of earth to neutral potential.	
11	Checking of charging condition of the batteries	
12	Checking of the physical conditions of the batteries	
13	Checking of each battery voltage during quarterly visits & battery impedance/resistance measurement twice during the contract during 2nd & 4th quarterly visit.	
13	Three discharge tests per year at normal load for three hours during 1st, 2nd and 4th quarterly visit.	
14	Checking of present load on charger.	
15.	Matching of DCPS parameters with SCADA system	
16.	Proper guidance to the operation staff for satisfactory working of the equipment and its proper upkeep.	
17.	Checking of battery terminals for corrosion and cleaning thereof, torquing and greasing.	
18.	C-3 discharge test on batteries once a year during 3rd quarterly visit.	
Above observations shall be recorded as per enclosed format and duly signed at site by Employer Engineer.		
Details of Job to be carried during Break Down Maintenance		
1	Repair and replacement of Faulty Module	
2	Repairing and replacement of faulty components in the system	
3	Analysis report of the fault	
4	Plan for preventive measure to arrest recurrence of such faults	

A 2.0 Cyber Security Audit

Cyber Security Audit for the network shall be conducted through a CERT-In empaneled auditor once in every year till the end of maintenance service contract. Network forensics, Network hardening, Vulnerability Assessment, Network penetration test, Risk assessment, Actions to fix problems and to prevent such problems from reoccurring etc. shall be covered under network audit.

The contractor upon any incidence of Cyber Security Breach shall carry out cyber security tests at any lab designated for cyber testing by Ministry of Power. These tests shall be similar to Pre-Commissioning Security Test and those essential for carrying out Post Incident Forensics Analysis.

All critical and high vulnerabilities shall be closed within a period of one (1) month and medium as well as low non-conformity before the next audit. Root cause analysis for all reportable events shall be carried out and corrective action taken, so as to ensure that any re-occurrence of such event can be managed with ease.

A 3.0 PENALTY FOR DEFAULT IN SERVICES

- (a) Contractor will maintain an adequate level of qualified staff for carrying out this maintenance contract, failing which Rs 50,000/- per month will be deducted by Employer from the amount due to contractor under this contract. In addition 5% of the total payable amount shall be deducted for every fall of 1% or part thereof in the specified availability.
- (b) In addition to above, a penalty of Rs 1000/- per day shall be imposed for not attending the fault in specified period for all non-communication equipment. For non-communication equipment maximum allowable restoration time shall be 48 Hrs.
- (c) Employer shall have the right to terminate the contract after giving notice of two month if the availability of the system is not attained as per specification consecutively for two months.

A 4.0 CO-ORDINATION REQUIREMENTS

A 4.1 MEETING PRACTICE

Regular meeting between Employer and the Contractor is vital for communication and information flow between these two organisations. The purpose of the meeting is to tackle the essential issues concerning the services and network performance. The suggested schedule for meeting is once in every month. The meeting agenda shall be decided between Employer and Contractor and could for example consist of the following issues:

- Services and network performance according to the report during last month
- Review of emergency situation
- Status of spare
- Action plan
- Next Meeting
- Alarms/events unattended till the date of meeting



The following participants should be present in this meeting:

- Co-ordinator (Contractor)
- Members of the Contractor team as needed
- Co-ordinator Employer representative
- Operation and maintenance staff as designated to attend (Employer)

A 4.2 EMERGENCY MEETING

Whenever a major outage occurs in any part of the network, an emergency meeting may be called if desired by Employer. In the meeting, the outage will be discussed in the context of cause, correction and prevention.

A 4.3 REPORTING PROCEDURE

The purpose of report is to summarize the activities performed during the reporting period. The report provides the information on the performance of the services and describes the current status of the network. The report is a monthly report from Contractor to Employer which shows the trends in the network and services provided by the Contractor. By analysing the report data, management and expert of Employer and contractor are able to focus attention on the areas where further improvement is needed.

Emergency Reports: Contractor reports to Employer every time the emergencies call up and call out service is invoked. In these cases, on termination of the emergency all details of the fault and clearance information are submitted within five working days.

A 4.4 INTERFACE BETWEEN EMPLOYER AND CONTRACTOR

Contractor Interfaces

Contractor shall submit detail of personnel deployed in the enclosed format through which all problems identified by APTRANSCO are to be reported to contractor via duty phone

Description			
Name			
Telephone			
Fax			
Email			

Co-ordinator :

Telephone no :

Mobile no:

FAX No :

E-mail address:

(Details to be provided later)



Contacts in Employer

Name	Responsibility	Phone number (Residence) (mobile)	Phone number office	Fax number, E-mail address



Form-I

EVENT REPORT FORM

Event Report No _____ Date: _____

Station: _____ Constituent: _____

Affected Path:

Fault Description: _____

A) Event start time (as per NMS) date _____ time _____

B) Reporting time by NMT date _____ time _____

REPORT

i) Failure within contractor system

Yes _____ No _____ (If No then date _____ time _____)

ii) Entrance to site and room for rectification date _____ time _____

iii) Rectification start time by Contractor date _____ time _____

iv) Fault fixed date _____ time _____

Total Outage time _____

Comments:

Faulty unit Sl. No: _____

New Unit Sl. No.: _____

Date:

POWERGRID/Constituent _____ Contractor _____



Form-II

START STATUS FORM

Page: (1)
Report no:

Start: Date : _____

Time : 10.00 Hrs:

	Station	Description
1	_____	_____
2	_____	_____
3	_____	_____
4	_____	_____
5	_____	_____
6	_____	_____
7	_____	_____
8	_____	_____
9	_____	_____
10	_____	_____

Special test conditions or action:

Attachments:

Initials:

POWERGRID/Constituent _____

Contractor _____



FORMAT TO BE FILLED DURING SEMI ANNUAL SITE VISIT

1. SITE INFORMATION:

Site name :-----
 Address :-----
 Contact Person :-----
 Telephone & Fax :-----

2. GENERAL CLEANLINESS

Communication room air conditioner

- Is air conditioner on? Yes/No
- Are filters clean? Yes/No
- Is air conditioner cooling O.K? OK/NOT OK
- Action Required by APTRANSCO-----

Communication room cleanliness

- Check if communication room is in good condition (Over all)

- Check if regular cleaning of telecom room done.

- Check if room is manned.

- Check if AC/DC sully has been tapped for other uses.

- Is the room having any damp wall.

- Action required by Employer.

Contractor's representative

POWERGRID/Constituent representative



Form-III contd/-

EQUIPMENT RACK CLEANLINESS:

- Check if cabinets are closed and key available with room in charge.

Key available Not Available Cabinet Closed Open

- Clean the equipment with vacuum cleaner. Cleaned

Actions required by Employer: _____

Action required by Contractor: _____

3.0 TEMPERATURE MEASUREMENT:

Room temperature

- Check the room temperature (25°C is recommended) _____
- Temperature very near equipment cabinet _____
- Temperature inside the telecom equipment rack _____

Action Required by Employer : _____

4.0 POWER SUPPLY MEASUREMENT

- Input DC Voltage at MCB _____
- Input DC Voltage at Cabinet TB _____
- AC Voltage at the time of station visit (Primary source): _____
- Availability of AC Supply in 24 hours _____
- Charger Voltage _____
- Battery Voltage (Charger AC Supply off) _____

Actions required by Employer _____

4.0 MULTIPLEXER & SDH EQUIPMENT ALARM CHECK

Visual check for the alarm on Mux & SDH equipment, in case of any alarm present further investigation and corrective action.



Healthiness of spare Fibre

Fibre no:

Colour :

Form-III contd/-

From :

To :

Condition :

Equipment used :

Action required by Contractor: _____

5.0 CABLE CHECK

- Check the cable terminations at all MDFs visually. Recrone if any loose wires.
- Check cable route for any abnormality.
- Are cable trenches covered properly?

6.0 DOCUMENTS AND TEST INSTRUMENTS

- Check the documents at site. Available Not available
- Check the availability of test instrument/tool kit at site.(Multimeter,Screw driver,plier etc.) _____available

7.0 EARTHING CHECK

- All the cables are connected properly with the ground point.
- Clean the end points if required while removing the earth cable first put temporary earth cable. After correction place the original cable and remove loop cable.
- Clean star point with sand paper and put petroleum jelly.
- Measurement of earth resistance: _____Ω

Contractor's representative

POWERGRID/Constituent's representative



Form- IV

Format

DC POWER SUPPLY EQUIPMENT MAINTENANCE FORMAT TO BE FILLED AT SITE

SITE INFORMATION

SITE NAME : _____

ADDRESS : _____

TELEPHONE AND FAX NO -----

	DESCRIPTION	VALUE,IF ANY	REMARKS
1	Cleaning done		
2	Power connections checked for tightening & over heating		
3	Control Connections are all tight		
4	All indications/meters/display on the panel are working		
5	Input frequency		
6	Rectifier LEDs		
7	Normal Operation on each module		
8	Float voltage		
9	Checking for ripple Voltage		
10	Checking for AC Voltage L-L, L-N		
a	R - Y		
b	Y - B		
c	R - B		
11	Checking AC Current		
12	Checking of DC Voltage		
13	Checking of earthing		
14	Battery voltage/resistance measurement done & enclosed		
15	Load test done on batteries as enclosed		
16	Check functioning of hooter/Buzzer (Alarm Annunciation)		
17	Parameters checked in SCADA system		
18	Proper guidance given for normal day to day operation.		

Suggestions from Contractor :

Remarks from Customer :

CONSTITUENT/POWERGRID representative



Form -V

CONTRACT NO./DATE :

DESCRIPTION OF JOB :

CONTRACTOR :

BIO-DATA OF CONTRACTOR'S EMPLOYEES

NAME :

AGE :

TRADE :

RESIDENTIAL ADDRESS :

TEMPORARY :

PERMANENT :

LANGUAGES KNOWN :

SPEAK :

READ :

WRITE :

QUALIFICATION :

TRAINING IN SAFETY :

/ HEALTH / ENVIRONMENT

QUALITY/TRADE :

JOB EXPERIENCE :

PHOTO

DATE:

SIGNATURE:

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

Section-05

Documentation and Deliverables

5.1. System Functional Description Document.....	2
5.2. System Documentation.....	2
5.3. Supplementary Documentation.....	2
5.4. Test Documentation.....	2
5.5. Drawings.....	3
5.6. Drawing and Document Approval Procedure.....	3
5.7. Final Documentation.....	4

Section-05

Documentation and Deliverables

This section describes the documentation requirements and provides a list of deliverable that the Contractor shall provide to the Employer. Complete documentation necessary for the operation and maintenance of the communication system is required. All the documentation shall be provided in **Hard disk** in full compliance with the specification. Conditions pertaining to Document Review and Approval Rights and Document Submission Scheduling are specified in this specification.

As detailed in subsequent sections the documentation shall include the following:

- (a) Detailed list of the deliverables
- (b) Description of the products
- (c) Technical particulars
- (d) Installation manuals
- (e) Maintenance manuals
- (f) Quality assurance manuals, Manufacturing Quality Plan (MQP) & Field Quality Plan (FQP)
- (g) Tests (type test, production, FAT, SAT) documentation

5.1. System Functional Description Document

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

5.2. System Documentation

A detailed documentation plan and document submission schedule shall be prepared and submitted for approval. The guidelines specified in table 5-1 and 5-2 shall be followed.

5.3. Supplementary Documentation

If during the training courses or while performing maintenance on such equipment during the warranty period, the Employer determines that additional information is required to perform the maintenance function, the Contractor and/or its subcontractors shall provide the specific supplemental information necessary to perform the maintenance function. This information shall be documented in a form suitable for incorporation into the appropriate maintenance document.

5.4. Test Documentation

The Contractor shall provide documentation for all factory and field tests.

The test documentation shall include the following:

- (a) Test Procedure Document
- (b) Type test documents



- (c) Factory Acceptance Test Documents
- (d) Site Acceptance Test Documents

5.5. Drawings

All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component, break-up for packing and shipment, shipping arrangement required, the dimensions required for installation and any other information specifically requested in the Specifications.

Each drawing submitted by the Contractor shall be clearly marked with the Employer name, the unit designation, the specification title, the specification number and the name of the Project. All titles, notes, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in metric units. The drawing revision level/ issue no, issue date shall be marked on each drawing and the drawing shall carry issue history information and appropriate signatures (eg: originator, checker and approving authority).

5.6. Drawing and Document Approval Procedure

The drawings/documents submitted by the Contractor shall be reviewed by the Employer as far as practicable within stipulated duration and shall be modified by the Contractor if any modifications and/or corrections are required by the Employer in compliance with the Specifications. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval. Any delays arising out of failure by the Contractor to rectify the drawings in good time shall not alter the contract completion date.

The drawings/documents submitted for approval to the Employer shall be in triplicate. One print of such drawings shall be returned to the Contractor by the Employer marked with one of the categories as listed below:-

Category Inference

Cat I Approved/Released for implementation.

Cat II Approved/Released for implementation subject to incorporation of comments. Revised drawing required.

Cat III To be resubmitted for approval after incorporating comments.

Cat IV For information and record.

The approval of the drawing/document conveyed vide above marked copy shall neither relieve the Contractor of its contractual obligations and its responsibilities towards weights, qualities, design details, assembly fits, performance particulars and conformity of supplies with the Indian Statutory Laws as may be applicable, nor shall it limit Employer's right under the contract.

Depending upon the category of approval the Contractor shall resubmit the drawings/documents



for review by Employer after incorporating all corrections.

Further work by the Contractor shall be strictly in accordance with the Cat-I, Cat-II or Cat-IV approved drawings and no deviation shall be permitted without the written approval of the Employer.

All manufacturing and fabrication work in connection with the equipment/material prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment/material conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the Contractor of any of his responsibilities and liabilities under the Contract.

5.7. Final Documentation

Final documentation shall consist of the documents approved in Cat I and Cat IV listed in Table 5-1. The documents will be used by the Employer personnel for operating and maintaining the equipment after acceptance.

Until acceptance of the equipment by the Employer, the Contractor shall be responsible for supplying documentation revisions or changes necessitated by inaccuracies, installation requirements, omissions determined by usage, and design or production alterations to the equipment. All changes shall be issued in the form of replacements for the affected drawings, diagrams, charts, graphs, tables, lists, and pages in the various documentation such that all documentation describes the equipment "as delivered".

For all CAT-I & CAT-IV approved documents listed in table (except Type, FAT & SAT related), Three (3) sets of the final approved documentation shall be provided to the Employer in hard disk and two sets in hardcopy.

All final Contractor-supplied documentation shall be easily reproducible by the Employer.

Table 5-1 Documentation Plan for Communication System Package				
S. No	Document	Applicable Equipments / Item	Brief Description	Category of Approval
1.	Documentation plan & schedule		This document shall contain the list of all documents to be submitted for approval and their submission/approval schedule.	IV
2.	Survey guidelines		As per Technical Specifications	I
3.	Data Requirement	For each and every item to be supplied including OPGW	These document(s) shall describe all the technical parameters of the	Cat-I(for

Table 5-1
Documentation Plan for Communication System Package

S. No	Document	Applicable Equipments / Item	Brief Description	Category of Approval
	Sheets (DRS) and Guaranteed Technical Parameters & Drawings	Cable, Optical fibre, OPGW hardware & fittings, UGFO, Approach cable, Joint Box, FODP, earthing cables, patch cords etc	equipment being offered.	DRS) & Cat-IV (for brochure)
4.	Sag Tension charts	For OPGW cable	Shall accompany the DRS document	I
5.	Mechanical drawings	As applicable	This document shall fully describe the equipment racks/enclosures, MDF, peripherals and related hardware with particular reference to mechanical construction, materials and dimensions, appearance, mounting methods, earthing clearances required from walls/roof/other panels, cable entry details, dust and moisture ingress protection provisions etc.	I
6.	Equipment Manuals & Standard Documents	For all items	Complete set of all equipment manuals (Construction, Installation, Maintenance, Reference etc) for that product. A set of product brochures, photographs etc.	IV
7.	Previous type test reports	For all items for which type testing is envisaged.	Shall be complete in all respect including all test graphs, curves, calculations, photographs etc.	Acceptance letter by Employer
8.	Manufacturing Quality Plan	For all items to be supplied		I#
9.	Type test schedule	For all items for which type testing is required.	Shall indicate the start & finish data for each test & sequence of tests if applicable, test labs.	I
10.	Type test report	For all items for which type testing is required.		I
11.	Site survey	For each site	Link wise survey reports as per	

Table 5-1				
Documentation Plan for Communication System Package				
S. No	Document	Applicable Equipments / Item	Brief Description	Category of Approval
	reports		specifications,	*
12.	Link & Engineering Analysis	For each Fibre Optic link	Link budget calculations etc.	I
13.	Bill of Quantity	For each items and each line		I
14.	Numbering, Marking, labeling Document	As applicable.	Must include numbering, marking, labelling and naming conventions for channels, cables, connectors, subracks, cubicles etc	I
15.	Physical planning/site preparation manuals	As applicable.	Must contain data gathered during the site survey, including test results, if any. The document shall also contain floor plan, cable trenching/raceway drawings, station block diagrams, rack/cabinet elevation drawings, air-conditioning and power supply requirements, and power supply distribution and earthing system details.	*
16.	Factory acceptance test report	For all Factory acceptance tests		Acceptance letter by Employer
17.	Transportation & Handling Procedures	For all items	This document shall describe the procedures & precautions to be observed during overseas & inland transportation, equipment handling during transport, storage & pre-installation. It shall also include packing details and package labelling details.	IV
18.	Field Quality Plan	One Document with multiple subdocuments if required	Field Quality Plan shall describe the quality control to be exercised during the field activities. This document can include the following information: (a.) The list of performance & safety checks applied to	I [#]

Table 5-1				
Documentation Plan for Communication System Package				
S. No	Document	Applicable Equipments / Item	Brief Description	Category of Approval
			installation equipment, tools & tackles, checks, check on physical health & training records of installation crew etc. (b.) The list of Site Acceptance tests (including statement of acceptance criteria). The inclusion of list of site acceptance tests in FQP is analogous to the inclusion of list of FAT in the MQP. The formats for recording & reporting Site acceptance tests can also be reproduced	
19.	Approach Cable & FODP layout document- site wise	For each site	To describe the layout of approach cable at each site and the floor plan of the FODP.	I
20.	Training Manuals	System document	An advance copy of all training material.	IV
21.	Maintenance Philosophy & Procedures	System document	Shall cover breakdown maintenance procedures, preventive maintenance schedules and procedures	IV
22.	SAT reports	Per Link and per location		*

Note

*: To be reviewed & approved by site.

#: To be reviewed & approved by QA&I.

Table 5-2(a) Expected Contents & Structure of Equipment Installation Manual		
1.	Installation procedure	<u>Description of activities of installation gangs</u> : Preparation & Setting up, Stringing, sagging, attaching hardware, attaching down lead clamps & cable routing on the tower, securing cable ends (for protection before work by jointing gang). Precautions for preventing damage etc shall be highlighted.
2.	Safety Instructions	<u>Instructions & procedures related to ensuring installation crew safety</u> : personnel grounding & safety, installation equipment safety, Safety for power system & environment (viz preventing accidental tripping, precaution for railway crossings etc)
3.	Description of Installation Equipment	Sketches, drawings, photographs, safe working ratings of installation equipment, tools & tackles etc., handling instructions & precautions.
4.	Cable routing	Illustrations of the position of tower attachments clamps (down lead clamps), routing of FO cable on the tower, service loop(s), joint box position, various possible cable routing (Intra cabinet and inter cabinet, within the same room and located in different rooms/buildings etc.) methods.
5.	References	References to other related documents covering the installation, jointing & testing, such as SAT administrative & functional test plans & test procedures Field Quality Plan & Field Quality Audit Storage & Handling Instructions Drawings, technical parameters, DRS etc Employer & Statutory safety rules, safety manuals, standards, codes of practices etc.

1.	Installation procedure	Description of activities of installation gangs: Preparation & Setting up, Stringing, sagging, attaching hardware, attaching down lead clamps & cable routing on the tower, securing cable ends (for protection before work by jointing gang). Precautions for preventing cable damage shall be highlighted.
2.	Safety Instructions	Instructions & procedures related to ensuring installation crew safety: personnel grounding & safety, installation equipment safety, Safety for power system & environment (viz preventing accidental tripping, precaution for railway crossings etc)
3.	Description of Installation Equipment	Sketches, drawings, photographs, safe working ratings of installation equipment, tools & tackles etc., handling instructions & precautions.
4.	Cable routing	Illustrations of the positions of tower attachment clamps (down lead clamps), routing of FO cable on the tower, service loop(s), joint box position.
5.	References	References to other related documents covering the installation, jointing & testing, such as <ul style="list-style-type: none"> • SAT administrative & functional test plans & test procedures • Jointing Procedures • Field Quality Plan & Field Quality Audit • Storage & Handling Instructions • FO cable & hardware drawings, technical parameters, DRS etc • Employer & Statutory safety rules, safety manuals, standards, codes of practices etc.

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

Section 6 Project Management, Schedule and Implementation Plan

Index

6.1. Project Management.....	2
6.1.1. Reporting Period.....	2
6.1.2. Progress Meetings.....	2
6.1.3. Transmittals.....	2
6.1.4. Quality Assurance.....	2
6.1.4.1. General.....	2
6.1.4.2. Quality Assurance System and Requirements.....	3
6.1.4.3. Variance Reporting and Processing.....	4
6.1.4.4. Additional Quality Assurance Requirements.....	6
6.1.5. Software Configuration Management.....	6
6.1.6. Document Review and Approval Rights.....	6
6.2. Project Schedule.....	7
6.2.1. Implementation Schedule.....	7
6.2.2. Contractor Activities.....	8
6.2.3. The Employer Activities.....	9
6.2.4. Documentation Schedule.....	9
6.2.5. Training Schedule.....	9
6.3. Progress Reporting.....	9
6.3.1. Monthly Progress Reports.....	9
6.3.2. Quarterly Progress Review Meetings.....	10
6.4. Implementation Plan.....	12
6.4.1. Implementation Steps.....	12
6.4.2. Implementation phases.....	13
6.4.3. Implementation Schedule.....	13

Section -6 Project Management, Schedule and Implementation Plan

This section describes the project management, schedule, quality assurance, and implementation plan requirements for the package.

6.1. Project Management

The Contractor shall assign a project manager with the authority to make commitments and decisions that are binding on the Contractor. The project manager's responsibility shall include interface and coordination with the Project contractor(s). The Employer will designate a project manager to coordinate all the Employer project activities. All Project correspondence and communications between the Employer and the Contractor shall be coordinated through the project managers.

The project shall be staffed from the list of project management and engineering personnel presented in the proposal. Principal participants shall have previous experience in a similar position on at least two other projects of similar scope to this project. The assignment and reassignment of the Contractor's principal participants in the project shall be subject to the Employer's approval.

6.1.1. Reporting Period

The Project Manager shall provide updated project schedules and complete progress reports on monthly basis for the duration of the project. All references to the reporting period throughout this Specification shall refer to this monthly period.

6.1.2. Progress Meetings

The Project Manager shall schedule and attend Progress Meetings as deemed necessary but no less than once every two months.

6.1.3. Transmittals

Every document, letter, progress report, change order, and any other written or electronic media transmissions exchanged between Contractors and the Employer shall be assigned a unique transmittal number. Discussions and phone calls where project related information is exchanged shall be documented in a transmittal. The Contractor shall maintain a correspondence index and assign transmittal numbers consecutively for all Contractor documents. The Employer will maintain a similar correspondence numbering scheme identifying documents and correspondence that the Employer initiates.

6.1.4. Quality Assurance

6.1.4.1. General

The Contractor shall adhere to a Quality Assurance (QA) program for the preparation of all Contract deliverables, including documentation, hardware, firmware and software. The program shall provide



for early detection of actual or potential deficiencies, timely and effective corrective action, and a method of traceability of all such deficiencies.

The Bidder's proposal shall include the relevant ISO 9000 certificates from the main Bidder and from all subcontractors which have a major part (over 10%) of the delivery.

The relevant ISO 9000 standards to be provided are the following:

- ISO 9001: model for quality assurance in design, development, production, installation and servicing
- ISO 9002: model for quality assurance in production and installation
- ISO 9003: model for quality assurance in final inspection and testing

The Quality Assurance procedures, documentation standards, and software development procedures which were included with the Bidder's proposal will be incorporated into the Contract.

6.1.4.2. Quality Assurance System and Requirements

The ISO 9001 Certificate and the assessment and visit reports shall be available to the Employer throughout the duration of the contract.

The Quality Assurance program shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of contract. A Quality Assurance program of the Contractor shall generally cover but not limited to the following:

- a. Organization structure for the management and implementation of the proposed quality assurance program.
- b. Documentation control system.
- c. Qualification data for Contractor's key personnel
- d. The procedure for purchases of materials, parts/components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- e. System for shop manufacturing including process controls and fabrication and assembly controls.
- f. Control of non-conforming items and system for corrective action.
- g. Control of calibration and testing of measuring and testing equipments.
- h. Inspection and test procedure for manufacture.



- i. System for indication and appraisal of inspection status.
- j. System for quality audits
- k. System for authorizing release of manufactured product to the Employer.
- l. System for maintenance for records.
- m. System for handling storage and delivery
- n. A quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics of the product.

The Quality Assurance Plan shall be mutually discussed and approved by the Employer after incorporating necessary corrections by the Contractor as may be required.

This Quality Assurance plan shall then form part of the contractual documentation and shall not be changed without prior agreement with the Employer. The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Assurance Plan at the time of the Employer's inspection of equipment/material.

The Employer or his duly authorised representatives reserve the right to carry out Quality Audit and Quality Surveillance of the systems and procedures of the Contractor/his vendor's Quality Management and Control Activities.

6.1.4.3. Variance Reporting and Processing

An automated variance recording and tracking system shall be placed in service at least one month before the initially scheduled beginning of the FAT. This system shall be designed to record and track variances for documentation deficiencies, functional deficiencies, performance deficiencies, procedural deficiencies (as when deviations from contractually required QA procedures are observed), and test deficiencies (as when the System cannot satisfactorily pass a step within a test procedure).

Variances may be initiated by both Contractor and the Employer personnel and shall be classified as follows:

- a. Open (recorded but not necessarily agreed to)
- b. Assigned (denoting acceptance by the Contractor)
- c. Pending (denoting fixed, in the Contractor's opinion, and awaiting retest or verification)
- d. Resolved (denoting the Employer acceptance or verification).

For the tracking of the variances and to support the automatic printout of subset lists, the



following information fields shall be stored for each variance:

- e. Variance number (automatically assigned)
- f. Date initially recorded
- g. Status (open/assigned/pending/resolved)
- h. Date current status recorded
- i. Names of the involved Employer personnel
- j. Names of assigned Contractor personnel
- k. Subsystem involved
- l. Test name (where applicable)
- m. Description (up to five lines in a full printout and part of the first line in a one-line- per-variance printout)
- n. Urgency description (1, 2, or 3).

The variance recording and tracking system shall allow full printouts of all of the above information, condensed printouts of abbreviations of the above information (one-line-per-variance) and shall produce subsets of the variances based on searches of the fields singly or in combinations. For example, it shall be possible to produce a printout of all the variances (and only those variances) that were at level 1 of 2 urgency, concerning a specific named subsystem, had open or assigned status, and were initiated within a named period.

Depending on its impact, each variance shall be assigned to one of three urgency levels by the Contractor with the Employer having level assignment approval rights.

level 1 Testing will stop for immediate evaluation and correction by the

Contractor level 2 Testing will continue and the variance will be corrected at the
end of the
current session or day

level 3 Testing will continue and the variance will be corrected and tested at a
mutually agreed upon time (e.g., at the end of the test or later in the test
period prior to shipment).

A variance status summary shall be included in the monthly project progress reports, and up-to-date variance reports shall be made available to the Employer on demand.

The variance recording and tracking system shall be subject to approval by the Employer.



6.1.4.4. Additional Quality Assurance Requirements

The Employer shall have access to the Contractor's premises at any mutually agreed time and be provided access to inspect and assess the quality system should any specific need arise. The Employer shall also be able to conduct on site reviews as mutually agreed.

The Employer shall have access to any relevant documentation for verification that quality procedures are in accordance with the contract-specific quality plan.

6.1.5. Software Configuration Management

All software development performed by the Contractor shall be under a formal, documented software configuration management procedure. The procedure shall encompass the following aspects:

- (a) Inventory control
- (b) Version control
- (c) Change control
- (d) Build management.

The software configuration management scheme shall be managed by a designated software administrator(s). In case, the software is already a developed product, software configuration management shall begin at the time software is initially installed on the system. In case of new or continuing development, software configuration management shall be immediately initiated during the earliest phases of development. The administrator(s) shall work closely with the Contractor software staff and shall be responsible for enforcing the software management procedures.

6.1.6. Document Review and Approval Rights

To ensure that the proposed systems conform to the specific provisions and general intent of the Specification, the Contractor shall submit documentation describing the systems to the Employer for review and approval.

The Employer will respond with written comments to the Contractor within thirty (30) calendar days after receipt of the documents. Documents requiring correction must be resubmitted by the Contractor to the Employer within 30 calendar days. The Employer will respond to resubmitted documents within fifteen (15) calendar days after receipt of the document. No implementation schedule relief is to be implied for documents requiring correction and resubmission to the Employer.

The Employer shall have the right to require the Contractor to make any necessary documentation changes at no additional cost to the Employer to achieve conformance with the Specification.

Any purchasing, manufacturing, or programming implementation initiated prior to written the