Section 5
Specifications for Aerial cabling (ADSS) and associated hardware & fittings

Table of Contents

5.0 Self Supporting Metal Free Aerial Fibre Optic Cable

5.1 Basic Construction

5.1.1 Secondary Protection

5.1.2 Number of fibres

5.1.3 Required Optical Fibre Characteristics

5.1.4 Strength Member

5.1.5 Cable Core Assembly

5.1.6 Core Wrapping

5.1.7 Moisture barrier (Protection)

5.1.8 Filling compound

5.1.9 Inner Sheath

5.1.10 Reinforcement

5.1.11 Outer jacket

5.1.12 Cable diameter and tolerance

5.1.13 RIP Cord

5.1.14 Raw Material

5.1.15 Cable Material Compatibility

5.1.16 Safety Requirement

5.1.17 Operating requirement

5.1.18 Sag of the span lengths

5.1.19 FO Cable Link Lengths

5.1.20 Cable Ends

5.1.21 The nominal drum length

5.1.22 Optical Fibre Strain

5.1.23 Cable Marking

5.3 Installation, Accessories and Fixtures for Aerial Cable

5.3 Optical Fibre Splicing

5.3.1 Optical Fibre Termination and Splicing

5.3.2 Optical Fibre Connectors

5.3.3 Service Loops

5.4 Methodology for Installation and Termination

5.5 Cable Raceways

Section 5

Specifications for Aerial Fibre Optic cabling and associated hardware & fittings

This Chapter describes the functional & technical specifications of Aerial Fibre Optic cabling and associated hardware & fittings.

5.0 Self Supporting Metal Free Aerial Fibre Optic Cable (ADSS)

Self Supporting Metal Free Aerial Optical Fibre Cable shall be installed on existing 33/11kV lines. The estimated cable route length requirements are indicated in the appendices. However, the Contractor shall supply & install the Self Supporting Metal Free Aerial Optical Fibre Cable as required based on detailed site survey to be carried out by the Contractor during the project execution. The Contract price shall be adjusted accordingly.

5.1 Basic Construction

The Metal Free Aerial Optical Fibre Cable shall be low in weight, and shall have small diameter, small volume and high flexibility. The Optical Fibre cable shall also have good mechanical protection with stable temperature performance conditions, as it will be exposed to varying environmental conditions in the field like applicable wind loading.

5.1.1 Secondary Protection

The secondary protection may be provided for the primary coated fibres by loose packaging within a tube or tubes and or in groove, which shall be filled with thixotropic jelly.

5.1.2 Number of fibres

24/48/96 nos. of DWSM G.652D fibres shall be provided in the cable.

5.1.3 Required Optical Fibre Characteristics

DWSM fibres shall conform to ITU-T G.652D and the characteristics are specified in Chapter-02 of this specification.

5.1.4 Strength Member

The strength member (s) shall be provided for strength and flexibility of the cable. The strength member(s) shall be solid FRP non-metallic and shall have anti buckling properties. These shall also keep the fibre strain within permissible values. The non-metallic strength member(s) may be in the cable core or embedded within the sheath.

5.1.5 Cable Core Assembly

Primary coated fibres in loose tube/tubes and/or in groove stranded together around a central strength member using helical or reverse lay techniques shall form the cable core. Alternatively multiple units of fibres may be placed loosely in a single tube with the strength members in the

sheath.

5.1.6 Core Wrapping

The main cable core containing fibres shall be wrapped by layer/layers of Polyester foil/tape. The nylon/polyester binder tape or thread shall be used to hold the tape if required.

5.1.7 Moisture barrier (Protection)

The main cable core (containing fibres & core wrapping) shall be protected by flooding compound (jelly) have properties of non hygroscopic dielectric material and/or by water swellable tape. The core wrapping shall not adhere to the secondary fibre coating.

5.1.8 Filling compound

The filling compound used in the loose tube and in the cable core shall be compatible to fibre, secondary protection of fibre, core wrapping etc. The drip point shall not be lower than +70 degree C. The fibre movement shall not be constrained by stickiness & shall be easily removable for splicing. Reference material test method to measure drop point shall be as per ASTM D 556. The filling and the flooding jelly compound shall be as per the latest TEC specs or equivalent.

5.1.9 Inner Sheath

A non-metallic moisture barrier sheath may be applied over and above the cable core. The core shall be covered with tough weather resistant High Density Polyethylene (HDPE) sheath black in colour (UV Stabilised). Thickness of the sheath shall be uniform & shall not be less than 1.8 mm including the strength members if used in the sheath. The sheath shall be circular, smooth, free from pin holes, joints, mended pieces and other defects. Reference test method to measure thickness shall be as per IEC 189 para 2.2.1 and para 2.2.2.

5.1.10 Reinforcement

The aerial optical fibre cable shall be reinforced with Aramid Yarn in the periphery over the inner sheath. The Aramid Yarn shall be uniformly and equally distributed on the entire periphery (circumference) of the cable. The quantity of the Aramid Yarn used per kilometre length of the cable with its D-Tex value shall be indicated by the Contractor.

5.1.11 Outer jacket

Outer jacket shall be circular and uniform tough weather resistant & UV stabilised polyethylene compound HDPE material. Sheath/jacket black in colour shall be provided over and above the reinforcement of aramid yarn. The thickness of the outer sheath/jacket shall not be less than 2.0 mm. The sheath shall be free from pin holes, joints, scratches, mended pieces and other defects etc. and it shall have smooth finish.

5.1.12 Cable diameter and tolerance

The manufacturer shall define the cable diameter. The finished cable diameter shall be within ± 0.5 mm from the defined cable diameter.

5.1.13 RIP Cord

The two suitable (minimum) water blocking rip cords shall be provided which shall be used to open the inner and outer (HDPE) sheath of the cable. It shall be capable of consistently slitting the sheath without breaking for a length of 1 meter at the installation temperature. The rip cord(s) shall be properly waxed to avoid wicking action and shall not work as water carrier. The rip cord used in the cable shall be readily distinguishable from any other components (e.g. Aramid Yarn etc.) utilized in the cable construction.

*The Contractor may offer cable(s) of other design , however, the offered cable shall meet the specified technical and testing requirements. The Bidder shall submit details of cable design, test reports and customers certificates for successful operation of the offered cable.

5.1.14 Raw Material

The cable shall use the raw materials approved against the latest TEC specs or equivalent. The change in the design of the optical cable shall call for fresh type testing. The HDPE Black in colour used for sheath shall be UV stabilized and shall withstand UV test for 2000 hrs (minimum). The material used in optical fibre cable must not evolve hydrogen that will affect the fibre loss.

A test certificate from a recognized laboratory or institute may be acceptable.

5.1.15 Cable Material Compatibility

Optical fibre, buffers/core tubes, and other core components shall meet the requirements of the compatibility with buffer/core tube filling material(s) and/or water-blocking materials that are in direct contact with identified components within the cable structure as per latest TEC specs or equivalent.

5.1.16 Safety Requirement

The material used in the manufacturing of the optical fibre cables and for use in splicing and maintenance shall be non-toxic and dermatologically safe in its life time and shall not be hazardous to health.

5.1.17 Operating requirement

The design and construction of aerial metal free optical fibre cable shall be inherently robust and rigid under all conditions of operation, adjustment, replacement, storage and transport. The optical fibre cable shall be able to work in the environment prevailing in Northern Part of India. The Contractor shall take into consideration the UTS of transmission line while designing the Aerial Cable. The details of the transmission lines are given in appendices.

Life of cable shall be at least 25 years. Documentary evidence in support of guaranteed life span of cable & fibre shall be submitted by the Contractor during detailed engineering.

It shall be possible to operate and handle the aerial metal free optical fibre cable with tools as per latest TEC specs or equivalent.

It shall be possible to install the Aerial optical fibre cable with accessories and fixtures as per the latest TEC specs or equivalent.

The Aerial optical fibre cable shall work satisfactorily in electrical field environment of 11 KV and shall not degrade with presence of electrical field. The cable shall be installed on 33KV/11KV lines and the fittings location shall be so selected the field at the point of installation shall not exceed 11 KV.

The Self Supporting Metal Free Aerial Optical Fibre Cable shall be designed and manufactured to meet the following minimum conditions of operation, installation & storage:

(a) Minimum design Span length : 100 meters
(b) Wind Speed : As applicable for specified site

The bidder may consider the minimum design span length of 100 meter for bidding purpose. However, actual span length shall be determined by the Contractor during the site survey.

The supplied cable shall meet the span, wind loading requirement of the specified location where the cable is to be installed.

5.1.18 Sag of the span lengths

(i) Maximum sag allowed without excess load (i.e. with self weight and no wind & ice load condition) : 1% of the span length.
(ii) Maximum sag allowed with excess load (i.e. with all applicable loads) : 2% of the span length

Temperature range

(i) Operation : -20°C to +70°C
(ii) Installation : -15°C to + 50°C
(iii) Storage : -50°C to + 70°C

Tensile force design parameter : As required to meet the specified requirement.
Minimum bending Radius : 20 D (D is diameter of the cable)

5.1.19 Optic Fibre Cable Lengths

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

OPGW cable to be supplied shall be in drum lengths to be specified by the Employer. Payment shall be made on actual optical fibre lengths delivered which will include route length plus length required for sag, splicing and service loop etc, which has been considered as around 4%. Hence contractor shall limit the wastages of cable upto 4% by utilising the cable optimally for various links and splicing shall be allowed on any pole for which hardware fittings as required shall be supplied. Extra length beyond 4% shall attract recovery of cost of OPGW and installation shall be payable on route length basis.

5.1.20 Cable Ends

Both cable ends (the beginning end and end of the cable reel) shall be sealed and readily accessible. Minimum 5 meter of the cable of the beginning end of the reel shall accessible for testing. Both ends of the cable shall be kept inside the drums and shall be located so as to be easily accessible for the test. The drum (confirming to latest TEC Specs or equivalent) should be marked to identify the direction of rotation of the drum. Both ends of cable shall be provided with cable pulling (grip) stocking and the anti twist device (free head hook).

Anti-twist device (Free head hook) shall be provided attached to the both end of the cable pulling arrangement. The arrangement of the pulling eye and its coupling system along with the anti twist system shall withstand the prescribed tensile load applicable to the cable.

5.1.21 The nominal drum length

Generally, the length of aerial optical fibre cable in each drum shall be 2 km ± 5 %. However, the cable drum lengths shall be supplied as per the approved drum schedule. The drum shall be marked with arrows to indicate the direction of rotation. Packing list supplied with each drum shall have at least the following information: Drum no., Type of cables, Physical Cable length, No. of fibres, Length of each fibre as measured by OTDR, The cable factor – ratio of fibre/cable length, Attenuation per km. of each fibre at 1310 & 1550 nm, User's/consignee's name, Manufacturer's Name, Month, Year and Batch no., Name of the route.

5.1.22 Optical Fibre Strain

The following shall be ensured while performing sag tension calculations:

(a) The Maximum Working Tension (MWT) is defined as the maximum cable tension at which there is no fibre strain.

(b) The cable strain margin is defined as the maximum cable strain at which there is no fibre strain.

(c) The maximum allowable tension (MAT) is defined as the maximum tension experienced at worst wind load and snow load conditions.

(d) The Cable everyday tension (EDT) is defined as the maximum cable tension at 32 degree C, no wind load and no ice load.

(e) The ultimate/ rated tensile strength test is defined as the maximum tensile load applied and held constant for one minute at which the specimen shall not break.

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

The Contractor shall offer suitable aerial optical fibre cable for various spans for the aerial FO cable meeting the following conditions for Employer's approval:

(i) The MAT / maximum strain shall be less than or equal to the MWT / strain margin of the cable.

(ii) The sag shall meet the requirement specified in this technical specification

(iii) The MAT shall be less than or equal to 0.4 times the rated UTS of the cable.

(iv) The EDT shall not exceed 20 % of the rated UTS of the cable.

(v) The ground clearance & Electrical clearance shall be met for the actual site conditions.

(vi) There should not be any fibre strain at any condition.

5.1.23 Cable Marking

The cable marking shall be imprinted and in delible (indented). The marking on the cable shall be indelible of durable quality and at regular intervals of one meter length. The alternatively permanent printing with the laser shall also be acceptable. In case of laser printing method; the impress ion shall not exceed the depth of 0.15 mm. The accuracy of the sequential marking must be within –0.25% to +0.5% of the actual measured length.The markings on the cable must not rub off during normal installation.

The marking shall be of clearly contrast colour on the black HDPE sheath in case hot foil indentation method is used. The colour used must withstand the environmental influences experienced in the field.

Two orange colour (UV stabilized) lines of minimum 3 mm width diametrically opposite to each other, continuous over the length of the cable shall be applied (marked) for easy identification of this cable from other cables.

The type of legend marking on O.F. cable shall be as follows:

(i) Company Legend
(ii) Legend containing international acceptable Laser symbol
(iii) Type of cable i.e. Slotted or Loose Tube or Uni-tube (Central Tube)
(iv) Type of Fibre ie. DWSM

(v) Number of Fibres
(vi) Year of manufacturer
(vii) Sequential length marking
(viii) Employer's Name

5.2 Installation, Accessories and Fixtures for Aerial Cable

The scope of supply of the Self Supporting Metal Free Aerial Optical Fibre Cable includes the assessment, supply and installation of all required installation accessories and fixtures. The Bidder shall provide documentation justifying the adequacy and suitability of the hardware used. To ensure their satisfactory performance, the Contractor shall determine the exact requirements of all accessories and fixtures used to install and secure the cable.

The cable hardware accessories and fixtures shall follow the general requirements regarding design, materials, dimensions & tolerances and markings etc. as specified in latest TEC spec and equivalent. The cable accessories & fixtures 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 required joint box shall also be provided by the Contractor and the details of which shall be submitted for Employer's approval. The joint box shall comply to ingress protection class IP 66 or better. The in-line splice enclosures shall be metallic type and support mechanical opening and closing.

The required strengthening of existing structures/towers/poles shall be carried out by the Contractor for installation of offered aerial cable. Additional poles, if required, shall also be supplied and installed at no additional cost to the Employer.

As the aerial cable is designed for 100 m span for self supporting condition and for the span greater than 100 m , the additional strength wire alongwith the clipping arrangement and/or poles to support the aerial cable for installation of aerial cable system shall also be provided by the Contractor at no additional cost to the Employer. However, the actual span lengths may vary at site and the fittings & accessories shall be provided as per site requirement.

The above requirement of additional poles, strength wires, strengthening of existing structure/poles/towers shall be submitted by the Contractor for Employer's approval and same shall be provided as per approval.

5.3 Optical Fibre Splicing

Splicing of the optical fibre cabling shall be minimized through careful planning. There shall be no mid-span splices allowed. All required splices shall be planned to occur within facilities or 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. No more than six (6) fibres shall be installed in each splice tray.

(d) For each link, bi-directional attenuation of single mode fusion splices measured at 1550 nm shall not average more than 0.05 dB. The bi-directional splice loss of each splices shall not exceed 0.1 dB when measured at 1550 nm.

(e) For in-line 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.

5.3.1 Optical Fibre Termination and Splicing

Optical fibre terminations shall be installed in Fibre Optic Distribution Panels (FODP) designed to provide protection for fibre splicing of preconnectorized pigtails and to accommodate connectorized termination and coupling of the fibre cables. The Contractor shall provide rack /wall mounted Fibre Optic Distribution Panels (FODPs) sized as indicated in the appendices and shall terminate the fibre optic cabling up to the FODPs. The location of FODP rack shall be fixed by the Contractor, with the Employer's approval.

The technical specification of FODP is given in Chapter -02 of this specification.

5.3.2 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.

5.3.3 Service Loops

For purposes of this specification, cable and fibre service loops are defined as slack (extra) cable and fibre provided for facilitating the installation, maintenance and repair of the optical fibre cable plant.

(a) Outdoor Cable Service Loops: In-line splice enclosures installed outdoors and mounted on the utility towers, shall be installed with sufficient fibre optic cable service loops such that the recommended minimum bend radius is maintained while allowing for installation or maintenance of the cable to be performed in a controlled environment at ground level.

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

(c) Fibre Units Service Loops: For all fibre optic cable splicing, the cable shall be stripped back a sufficient length such that the fan-out of fibre units shall provide for at least one (1)metre of fibre unit service loop between the stripped cable and the bare fibre fan-out.

(d) Pigtail Service Loops : Connectorised pigtails spliced to bare fibres shall provide at least 1 metre of service loop installed in the FODP fibre organizer and at least one (1) metre of service loop to the couplings neatly stored behind the FODP coupling panels.

(f) Fibre Service Loops : At least 0.5 metre of bare fibre service loop shall be provided on each side of all fibre splices. The bare fibre service loops shall be neatly and safely installed inside covered splice trays.

5.3.4 Anti Rodent Compliance

ADSS cable is to be installed on rodent prone areas; ADSS should have anti rodent complied.

5.4 Methodology for Installation and Termination

All optical fibre cable termination, installation, stringing and handling plans, guides and procedures, and engineering analysis (e.g. tension, sag, vibration etc.) shall be submitted to the Employer for review and approval in the engineering/design phase of the project, prior to establishing the final cable lengths for manufacture. Installation procedures including details of personnel and time required shall be documented in detail and submitted to Employer for approval. All installation practices shall be field proven and ISO accredited.

All cable segments shall include service loops as specified in this specification .The maximum allowable stringing tension, maximum allowable torsional shear stress, crush strength and other physical parameters of the cable shall not be exceeded. The preventative measures to be taken shall be documented in detail and submitted to Employer in advance of installation.

Optical fibre attenuation shall be measured after installation and before splicing. Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable segment failure. In the event of cable damage or any fibre damage, the complete section (tension location to tension location) shall be replaced as mid-span joints are not acceptable.

Any or all additional steel work or modifications required to attach the fibre cabling to the overhead transmission/ distribution line towers shall also be carried out by the Contractor. It shall be the Contractors responsibility to provide adequate communications among all crew members and support staff to ensure safe and successful installations.

5.5 Cable Raceways

To the extent possible, existing cable raceways shall be utilised. The Contractor is required to provide and install any additional indoor cable raceways which may be required for proper implementation of the fibre optic cabling system. This requirement shall be finalised during

survey. The cable raceways shall conform to the following:

(a) All cable raceways shall be sized to support full loading requirements plus at least a 200% safety loading factor.

(b) Indoor cable raceways shall be fabricated from construction grade aluminium, galvanized iron or anodized sheet metal or any other suitable material approved by the Employer. Suitable anti-corrosion measures shall be provided. Steel fabricated raceways shall be finished inside and out, treated to resist rust and to form a metal-to- paint bond.

(c) Mechanical construction drawings of the cable raceways shall be submitted for Employer's information & review.

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