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SERIES L: ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Optical fibre cables – Guidance and installation technique

Installation of optical ground wire cable

Recommendation ITU-T L.151

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Recommendation ITU-T L.151

Installation of optical ground wire cable

Summary

Recommendation ITU-T L.151 refers to the installation of optical fibre ground wire cable. It deals with the factors that should be considered in determining the characteristics of this type of cable, the apparatus that should be used, the precautions that should be taken in handling the reels, and the method that should be used to string the cable and joint it.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T L.151/L.34	1998-10-09	6	11.1002/1000/4506
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Keywords

Installation, optical fibre, OPGW.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Introduction

Optical fibres are particularly suitable for use as transmission media by means of aerial power lines of high-voltage networks.

Some of the advantages of optical fibres are:

- low attenuation (long distance between repeaters);
- large bandwidth (high transmission capacity);
- immunity to electromagnetic influences;
- no cross-talk.

For these reasons, optical fibres are widely installed with high-voltage power lines. There are several types of cable and installation technology.

Among them, optical ground wire (OPGW) cable technology is specifically designed for high-voltage power line installations. This technology takes advantage of the presence of a necessary cable (ground wire) to use it also for communications.

However, users of OPGW need to be aware that if the cable fails, it may not be repaired quickly. Therefore, an alternative routing for the optical circuits needs to be considered.

These cables consist of a nucleus containing optical fibres and an armour generally composed of one or more layers of aluminium wire, aluminium-magnesium-silicon alloy wire, steel wire or aluminium-coated steel wire. The additional features of these cables compared to others types of cable are basically as follows:

- greater tensile strength;
- protection of fibres against excessively high temperatures when high current densities occur in the cable.

This Recommendation has been developed considering:

– that OPGW cables are widely used in high-voltage aerial power lines;

– that their installation is basically different from that of other types of cable;

– that installation companies may need basic guidelines for installation procedures and methods.

Recommendation ITU-T L.151

Installation of optical ground wire cable

1 Scope

This Recommendation describes the installation of optical ground wire cable along electrical power lines.

This Recommendation refers to:

– the considered characteristics of this type of cable;
– the hardware that should be used to fix the cable;
– the precautions that should be taken in handling the reels;
– the tensile method that should be used to string the cable;
– the splicing of fibre and criteria of the installation;
– installation experiences from different countries.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[IEC 60794-4-10] IEC 60794-4-10:2014 Optical fibre cables – Part 4-10: *Family specification – Optical ground wires (OPGW) along electrical power lines*.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 optical ground wire (OPGW): Metallic optical cable that has the dual performance functions of a ground wire with telecommunication capabilities.

NOTE – The fibres of an OPGW are usually embedded loosely in protective buffer tubes. To fulfil mechanical and electrical requirements; an armouring of one or more layers with aluminium, aluminium alloy, and aluminium clad steel, galvanized steel or a mixture of them is helically stranded.

3.2.2 rated tensile strength (RTS): The calculated tensile load that the cable shall withstand without mechanical failure.

3.2.3 hardware: Attachments or fittings that are in direct contact with the cable, and which are used for stringing and clipping of optical ground wire (OPGW) to the structures at the end of the installation procedure.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ODF Optical Distribution Frame

OPGW Optical Ground Wire

OTDR Optical Time Domain Reflectometer

RTS Rated Tensile Strength

5 Conventions

None.

6 General requirement

6.1 Cable consideration

The following factors should be considered in determining the type of cable, maximum tension and the installation conditions:

– the fibre count;

– maximum short-circuit current through the cable;

– disconnection time of a short-circuit to earth/ground;

– sag of the phase conductors;

– spans;

– positions in relation to poles/towers;

– maximum wind speed;

– maximum ice load;

– the typical weather condition, maximum/minimum/average temperature of the year;

– other aspects such as: risk of atmospheric discharge, fire, discharge of bird-shot, saline fog, aggressive chemical agents in the atmosphere.

6.2 Hardware

The following installation materials and equipment should be used:

– Anchoring units: Also called tension units, used to lash the cable to the poles/towers where necessary, they should be able to withstand installation tensions even under the worst working conditions envisaged (wind, ice) without damaging the cables or affecting their useful life.

– Suspension units: Placed on poles which do not have a cable anchorage to support them. Their characteristics should be the same as those of the anchoring units.

– Ground wire clamp: Used to introduce the short-circuit current to the earth/ground when lightning happens.

– Vibration suppressors: Also called vibration dampers, used to absorb vibrations produced by the wind.

– Down lead clamp element: Used to fasten the cables and splice cases to the poles/towers.

– Payoff reel with a brake in the spin axis: Used to maintain a certain tension in the cable to be installed.

– Cable grips with anti-rotational device: Used to attach the OPGW cable to the pulling rope.

– Sheaves: Located at the poles/towers and used to guide the pulling rope and the cable during the installation procedure.

  To prevent damage to the cable during installation, a minimum sheave diameter is needed. The diameter depends on the type of cable, the tension applied to it and the degree of deflection (typically 25 times the diameter of the cable or as recommended by the cable manufacturer).

– Capstan: Used to pull the draw rope.

– Cable storage assembly: Used to store the cable in the poles/towers for fibre connection and maintenance.

– Splice cases: Used to house the fibre splices. It is usually a joint box.

7 Operation

7.1 Cable inspection

The following information should be checked before starting the installation:

– The cable type. Specification and quantity of the product shall comply with the requirements of the contract.

– The attenuation coefficient of each fibre provided shall not exceed the maximum value required by the contract.

– There should be no discontinuity point for the continuous length of single-mode fibre, and no obvious steps, spike reflections or breakpoints, usually measured by optical time domain reflectometer (OTDR).

– The length of the measured optical cable shall be the length of the list required in the order contract, and the negative tolerance is not allowed.

7.2 Precautions

The following precautions should be taken when handling the reels:

– Always keep in a vertical position with the ends secured.

– Inspect following transportation to ensure that no damage has occurred.

– Protect reels from bumps and falls.

– Always turn in the direction indicated on the reel.

– Take care to ensure that the ends of the cable are sealed as required to keep out humidity.

7.3 Tension method

The tension method should be used to string the cable. This is a universal method that can be used in all cases. The procedure is as follows:

– After selecting the tension span, position the stringing equipment in such a way that the cable exit angle is as small as possible in relation to the ground.

– Position the stringing sheaves on the poles/towers.

– If the pulling cable has not been installed, it should be installed in the usual way. The breaking strength of the pulling rope should be greater than the maximum stringing tension. In all cases, the direction of the lay of the pulling cable should be the same as that of the cable to be strung.

– Position the cable grip with an anti-rotational device between the pulling cable and the OPGW.

– If necessary, depending on the instructions of the cable manufacturer, an anti-rotational device should be attached to the cable.
– Position the pulling cable on the capstan and start to pull.
– During the stringing operation, sufficient mechanical tension should be maintained to prevent the cable from touching the ground or any other obstacle. Control the speed and maximum tension of stringing so that the recommended values are not exceeded.
– Once the cable has been strung, lash to the first pole/tower, ensuring that the requisite length of cable is left for splicing.
– Place the cable under tension and continue positioning all the suspension or anchoring units in such a way that the corresponding stringing tension of the cable is maintained. In all these operations, the recommended minimum bending radius should be respected.
– When all the lashings are in place, attach the ends to the poles/towers at the beginning and end of the span using clamping elements.
– The sag of each span should be adjusted to satisfy the design requirements.
– Repeat the operation for the remaining spans until the whole route has been completed.

The typical installation sketch map of the cable, fittings and joint box to the poles/towers is shown in Figure 1.

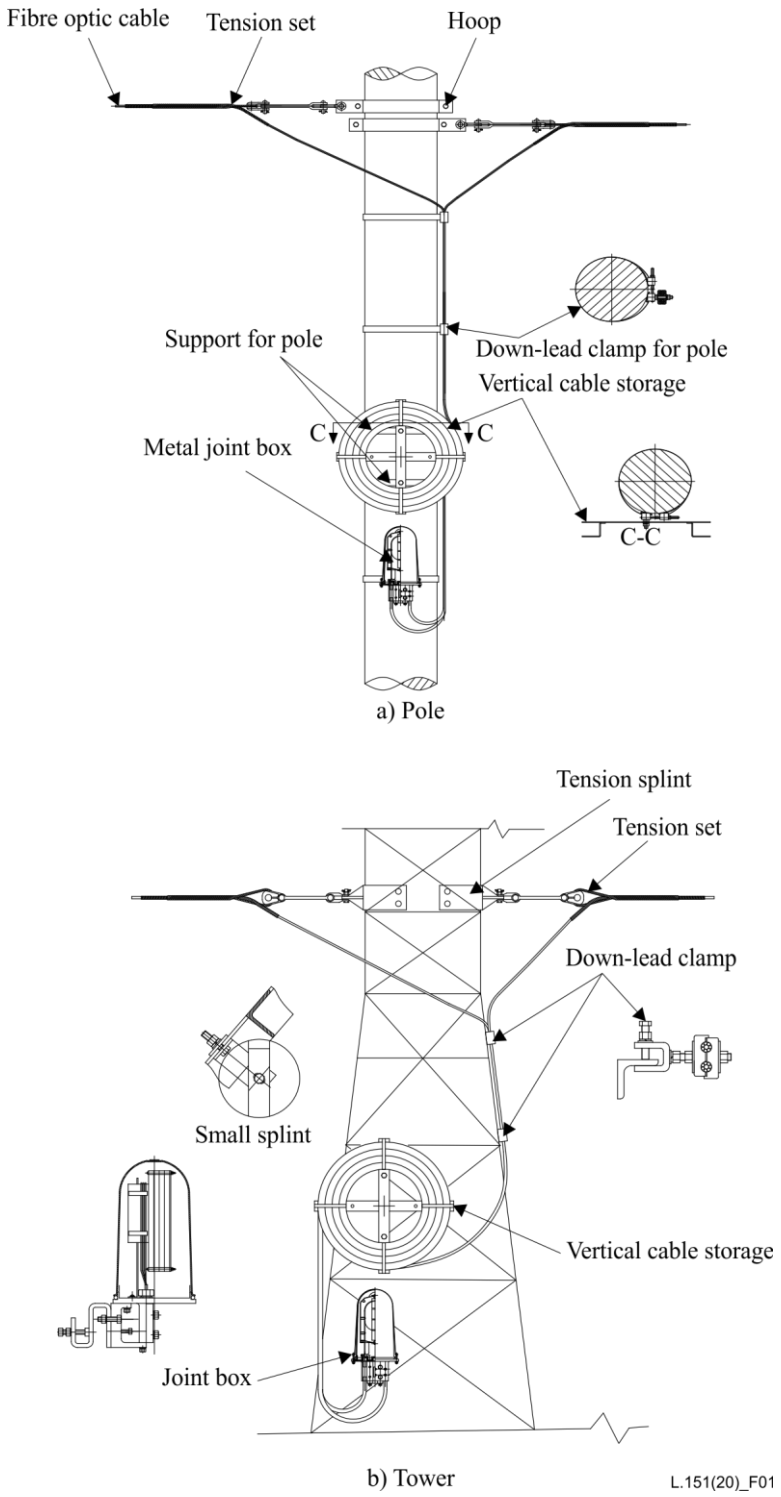

Figure 1 – The typical installation sketch map

7.4 Splicing consideration

The following should be borne in mind in splicing:

Structure-mounted splice cabinet technology is widely used. With this method, once the cable ends are available and prepared for splicing, the splices should be carried out and housed in accordance with the instructions given by the cable and splice case manufacturers. When splicing takes place on the ground, the splice case is subsequently raised to the appropriate height on the pole/tower, the cable being wound and fastened in such a way that the minimum bending radii indicated by the manufacturer are respected.

Midspan splicing technology involving a special splice case to support stringing tensions offers the advantage of allowing the use of random length reels without waste of cable. However, the difficulties presented by this technology in terms of delays in the stringing operation, difficulty of access to the case itself for maintenance, and the need for specially designed splice cases have hitherto discouraged its widespread use.

7.5 Criteria of the installation

The criteria of the installation shall be based on the final report of the construction quality record to determine whether to meet the engineering design and the requirements of the user.

Appendix I

Chinese experience: Installation of optical ground wire (OPGW) cable

(This appendix does not form an integral part of the Recommendation.)

I.1 Product inspection before installation

1) The cable type, specification and quantity of the product shall comply with the requirements of the contract.

2) The attenuation coefficient of each fibre shall not exceed the maximum value required by the contract.

3) There should be no discontinuity of more than 0.10 dB for the continuous length of single-mode fibre, and no obvious steps, spike reflections or breakpoints.

4) The length of the measured optical cable shall be the length of the list required in the order contract, and the negative tolerance is not allowed.

I.2 OPGW installation

1) OPGW installation must use a special tension machine. The length of the pay-off section should be selected to match the length of the reel.

2) The position of the operate field is generally set on the extension line of the OPGW line segment. Generally, the distance S between the tension machine and the cable drum is about 5 to 10 m, and the distance L from the tension machine to the first base tower is more than 3H (H is the tower height).

3) The position of the operating place should ensure that the elevation angle of the input and outgoing lines meets the manufacturer requirements, it is generally not more than 25°, and the horizontal declination should be less than 7°.

4) The OPGW cable drum, tension machine, and the line on the tower should be in a straight line.

5) The length of the OPGW drawn from the tower at both ends of the pay-off section must meet the requirements for testing, welding and joint box installation operations, generally tower height plus 15 m.

6) The envelope angle of OPGW to the take-up pulley shall not exceed 60°. When the envelope angle is greater than 60°, a double pulley should be used.

7) The tension of the OPGW should meet the manufacturer's requirements. When the manufacturer does not make special requirements, the OPGW's take-up tension should normally be no more than 25% rated tensile strength (RTS) while meeting the requirements for cross-over and ground distance.

8) During the installation process of OPGW, the initial speed should be controlled within 5 m/min, and the speed increase should be smooth. The speed should not exceed 60 m/min after normal operation.

I.3 OPGW accessory installation

1) The OPGW should be installed immediately after the tightening is completed. The OPGW should not stay on the pulley for more than 48 hours.

2) The OPGW must be grounded before the accessory is installed. When lifting the wire, the wire should be taken in accordance with the requirements of the manufacturer. When using other methods, the tool that is in contact with the wire must be wrapped with rubber or wrapped with aluminium tape. The surface of the wire should not be touched by a hard tool.

3) When installing the clamps, fixtures and anti-vibration hammers, use the manufacturer-approved torque wrench and tighten the bolts according to the torque specified in the design drawings to control the pressure of the clamps on the OPGW.

I.4 Acceptance

The acceptance of the project shall be based on the final report of the construction quality record to determine whether to meet the engineering design and the requirements of the user.

1) Measurement items:
   a) Fibre transmission loss (dB) and attenuation (dB/km) of the route.
   b) Optical path length (m) of the route.
   c) Fibre backscattered signal curve of each optical path.
   d) Polarization mode dispersion (PMD) is to be determined.
2) Optical path measurement:
   a) Trunk segment measurement shall be measured on the ODF after completion of both ends of the route.
   b) The test method of the attenuation shall be bidirectional measurement (OTDR).
   c) The wavelength of the measurement laser wave shall be the actual transmission wavelength.
   d) The number of measuring optical paths is 100%.
   e) The ODF should be checked at both ends of the intermediate stage before the measurement, and the order of the pigtails should be checked to ensure consistency.

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