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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

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## Criteria for optical fibre cable installation with minimal existing infrastructure

Recommendation ITU-T L.163

# ITU-T L-SERIES RECOMMENDATIONS

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

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## Recommendation ITU-T L.163

### Criteria for optical fibre cable installation with minimal existing infrastructure

#### Summary

Recommendation ITU-T L.163 describes criteria for the installation of optical fibre cables defined in Recommendation ITU-T L.110 in remote areas with lack of usual infrastructure for installation including the procedures of cable-route planning, cable selection, cable-installation scheme selection, cable tension and temperature consideration and the handling, bend protection and river/lake closing of the cable together with pilot tests and training for installation.

This Recommendation also describes how to mitigate the considerable risks and/or issues to which the optical fibre cable may be exposed when infrastructures are minimal during installation, maintenance and operation procedures.

#### History

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# Recommendation ITU-T L.163

## Criteria for optical fibre cable installation with minimal existing infrastructure

### 1 Scope

This Recommendation describes criteria for optical fibre cable installation in situations with minimal existing infrastructure. This Recommendation also describes how to mitigate the considerable risks and/or issues to which the optical fibre cable may be exposed when infrastructures are insufficient during installation, maintenance and operation procedures. This Recommendation considers only point-to-point network architectures.

This Recommendation is equally applicable to the developing countries where creation of telecommunications infrastructure is underway to bridge the digital divide and can be extended to cover difficult rural areas comprising high altitudes, coasts, forest and similarly situated regions of the world. This Recommendation will be very helpful in quick restoration of telecom services that may be frequently interrupted by other developmental activities.

### 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.

- [ITU-T G.657] Recommendation ITU-T G.657 (2016), *Characteristics of a bending-loss insensitive single-mode optical fibre and cable*.
- [ITU-T L.110] Recommendation ITU-T L.110 (2017), *Optical fibre cables for direct surface application*.
- [ITU-T L.150] Recommendation ITU-T L.150/L.35 (1998), *Installation of optical fibre cables in the access network*.
- [ITU-T L.154] Recommendation ITU-T L.154/L.49 (2003), *Micro-trench installation technique*.
- [ITU-T L.158] Recommendation ITU-T L.158/L.56 (2003), *Installation of optical fibre cables along railways*.
- [ITU-T L.161] Recommendation ITU-T L.161/L.46 (2000), *Protection of telecommunication cables and plant from biological attack*.
- [ITU-T L.201] Recommendation ITU-T L.201/L.13 (2003), *Performance requirements for passive optical nodes: Sealed closures for outdoor environments*.
- [ITU-T L.261] Recommendation ITU-T L.261/L.89 (2012), *Design of suspension wires, telecommunication poles and guy-lines for optical access networks*.
- [ITU-T L.302] Recommendations ITU-T L.302/L.40 (2000), *Optical fibre outside plant maintenance support, monitoring and testing system*.
- [ITU-T L.430] Recommendation ITU-T L.430/L.28 (2002), *External additional protection for maritized terrestrial cables*.

- [ITU-T L.1700] Recommendation ITU-T L.1700 (2016), *Requirement for low-cost sustainable telecommunications infrastructure for rural communications in developing countries*.
- [IEC 60794-3-30] IEC 60794-3-30 (2008), *Outdoor cables – Family specification for optical telecommunication cables for lakes, river crossings and coastal application*.

### 3 Definitions

#### 3.1 Terms defined elsewhere

For the purposes of this Recommendation, the definitions given in [ITU-T L.110] apply.

#### 3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

**3.2.1 DSA cable:** Optical fibre cable for direct surface application as defined in [ITU-T L.110].

**3.2.2 infrastructure for optical fibre cable installation:** Physical structures to support the safety and security of optical fibre cables when installed such as underground pipes, utility poles, trenches, suspension wires and other cable protection and/or cable supporting mechanisms besides those built in as a part of cable structure.

### 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

|       |                                      |
|-------|--------------------------------------|
| CAPEX | Capital Expenditure                  |
| CNOC  | Centralised Network Operation Centre |
| DIY   | Do It Yourself                       |
| DSA   | Direct Surface Application           |
| FTTH  | Fibre to the Home                    |
| GIS   | Geographic Information System        |
| IXP   | Internet exchange Point              |
| MTBF  | Mean Time Between Failures           |
| MTTR  | Mean Time To Repair                  |
| OF    | Optical Fibre                        |
| OPEX  | Operating Expense                    |
| OTDR  | Optical Time Domain Reflectometry    |
| PE    | Polyethylene                         |
| RoW   | Right of Way                         |
| VSAT  | Very Small Aperture Terminal         |

### 5 Conventions

None.

## 6 Needs and goals

The ITU Connect 2020 Agenda for Global Telecommunication/Information and Communications Technology (ICT) Development has identified Goal 2 "Bridging the digital divide and providing broadband for all". Broadband brings education, healthcare, financial services, etc. into rural communities, but also brings distant cultures to advanced countries, cultures which have preserved values now forgotten by many modern societies. Thus, broadband benefits us all.

As a result of the massive costs of installing broadband connectivity, the rural-urban digital divide is often more pronounced in developing countries.

[ITU-T L.1700] recently identified ultimate affordability with best-effort reliability as the priority requirement for telecommunications infrastructure for rural communications. The installation cost of conventional optical fibre cables has been typically 70-80% of the entire capital expenditure (CAPEX) of the network.

[ITU-T L.110] specified direct surface application (DSA) cable as the key to the realization of ultimately affordable rural connectivity. The DSA cable can be affordably installed on the ground surface while eliminating the need for ducts, underground pipes, poles, heavy machinery as well as skilled human resources. However, the local community should continually secure the cable by optimizing its location, placement and environment to address potential natural/unnatural disturbances and local convenience.

The objective of this Recommendation is to describe the criteria for the installation of the DSA cable with a view to ultimate affordability with best reliability with respect to [ITU-T L.1700].

## 7 Installation general requirements

Key requirements for the installation of DSA cables are:

- Ultimate affordability with best-effort reliability;
- Target availability of 99%.

Affordability and reliability should consider CAPEX/OPEX and mean time between failures / mean time to repair (MTBF/MTTR), respectively as defined in clause 6.1 of [ITU-T L.1700]. Compared with no service at all, a meaningful target of availability would be 99% based upon the assumption that a communication failure in a rural location may occur once a year and be repaired in approximately three to four days.

For example, an Asian developing country allows MTBF and MTTR of 7-9 months and 2-4 weeks, respectively as noted in Appendix I.5 of [ITU-T L.1700]. Other requirements defined in [ITU-T L.1700] for rural connectivity are high data rate, upgradability, flexibility, scalability, energy efficiency and environmentally friendly life cycle.

## 8 Prior to installation

### 8.1 Requirements for infrastructure for DSA cable installation

To achieve ultimate affordability with best reliability, the DSA cable can be placed directly on the ground surface with minimal infrastructure in a do it yourself (DIY) manner.

In remote areas cable laying directly on the ground surface is possible and will speed up the deployment process.

However, a length of the cable may be submerged, aurally suspended or buried underground without splices. Here, the use of minimal physical infrastructure is necessary, together with local experiences, wisdom and non-professional human resources as intangible infrastructure.

See clause 4.8 of [b-IEC TR 62691] for more on installation in special cases.

### 8.1.1 Cable installation on the ground surface

When optical fibre cables are exposed on the ground surface across rural areas, they may face many kinds of natural and unnatural attacks. In fact, clause 4.4 of [ITU-T L.161] suggests that steel wire armouring works well against pests. But imperfect splicing, mechanical damage or corrosion may lead to discontinuity in the armour thus leading to damage from beetles and larvae.

The DSA cable with metal core tube construction with a welded seam (welded core tube) could be used on the ground surface for the better protection. Additional use of steel wire armour increases the cable durability. Installing the DSA cables with welded core tube on the ground surface demands minimal basic infrastructure. Other types of cables discussed in [ITU-T L.110] may also be used.

#### a) Along the road or walking trail

Since no large-scale land slide, rock falls, floods or mudflows might be expected along a road or walking trail, no specific infrastructure may be needed here for the DSA cables.

NOTE – Clause 5.3.2 of [b-ITU-T L.107] states that metallic barriers such as steel tape or wire armouring can provide suitable and effective protection against rodent attacks. The DSA cables with welded core tube described in Appendix I.1 of [ITU-T L.110] are extremely robust against fire, crushing, rodents and vibration as shown in Figures 6-9 of [b-ITU-T L-Suppl.22].

#### b) Through original forest or unexplored land

A walking trail should be created as infrastructure by cutting trees and branches or removing obstacles for cable installation and later maintenance. The cable may be laid by moving the cable drum with a backpack carrier or a handy cart, or by manually pulling the cable end with the drum position fixed.

NOTE 1 – The weight of typical DSA cables with welded core tube shown in Appendix I.1 of [ITU-T L.110] is 180-200 kg/km, 85 kg/km or 20 kg/km.

NOTE 2 – Rollers or quadrant brocks may be needed to keep the tension and bend radius of the cable safe when employing the end-pull method.

#### c) Steep terrain or vertical routes

It is necessary to fix the DSA cable using suitable fittings or clamps and/or cable loops to avoid excessive fibre strain and movement, when the cable is placed on the surface of steep terrain or vertical routes.

#### d) Theft and vandalism

Cost-effective safeguarding of the cable can be accomplished by using the following measures as appropriate:

- bury the cable to hide it using, for example, hand picks, e.g., a few cm;
- patrol by the local community;
- display short cable pieces at some intervals to show that a no value material is used;
- post a notice indicating that a "no-value material is used" and "significant social loss if cable if damaged".

#### e) Optical fibre cable visibility

To avoid on-surface cables being damaged during civil works for example, the optical fibre cable may be made noticeable by using a shiny-colour outside jacket of the cable. However, such a cable may have a higher risk of theft/vandalism. Shiny-colour polyethylene (PE) sheath could have a shorter life than black. Another option is to use black PE sheath with a distinctive stripe. The cable visibility issue may need to be decided at each community.

### 8.1.2 Cable shallow burial

The DSA cable may be directly buried in a shallow simple trench or groove to protect landscape, avoid theft/vandalism and mitigate environmental impacts.

#### a) Trench width and depth

Due to the robustness of the DSA cable, the depth of the trench or groove can be less than 0.5 m. The depth should be determined upon terrain, cost, construction speed, security, trust ability and longevity.

NOTE – Clause 4.7.2 of [b-IEC TR 62691] suggests the minimum installation depths (to the bottom of the trench) as 0.8 m, 0.6 m and 0.5 m for data rates of heavy concentration (trunk), medium (distribution) and low (service/drop), respectively. It further states the cables should be provided with special protection (e.g., by means of cable duct) if the depths are less. Since the welded core tube in DSA cable is a "special protection", less-than 0.5 m burial should basically be acceptable.

Using optic fibre cable with minimum criteria such as DSA cables as defined in [ITU-T L.110], trenching and backfilling can be avoided, hence the initial costs for civil works can be reduced significantly. The trench depth in remote locations can be between 0.1 m to 0.2 m at some points due to protection reasons.

#### b) Bottom of trench

Where threatening pressure is expected to be applied to the in-trench cable, the bottom of the trench should be made flat by using backfill soil which should not contain cable-damaging obstacles.

#### c) For stony or rocky areas

For stony or rocky areas where cable burial is not always possible, any on-surface part of the cable can be covered by sand and/or soil.

#### d) Micro-trenching

Installing the DSA cable on an asphalt road or concrete pavement should be avoided if vehicles can tread over the cable because hard gravel could lie between the cable and the road surface that could easily damage the cable.

To avoid vehicles running over the DSA cable, the micro-trench installation technique identified in [ITU-T L.154] should be applied. It suggests that the cutting depth of a groove in the asphalt should be no less than 7 cm but avoid cutting entirely through the asphalt. It states that groove width may vary (e.g., 10-15 mm).

NOTE – For micro-trenching, clause 2 of [ITU-T L.154] requires that the cable have crush resistance and temperature resistance against hot bitumen during the sealing operation (between 100°C to 170°C).

### 8.1.3 Cable aerially suspended

The DSA cable may be aerially suspended for a short length to cross a river, valley or road, or to avoid a potential flood, landslide, avalanche or moving glacier. Here, the cable may depend on the cable's self-supporting capability, or the cable is lashed to a suspension wire.

The use of a stable rock or tree could be more cost-effective for anchoring than building utility poles. Suitable wire, metal fixtures or cable clamps should be appropriately used with trees considering that the growth in height and thickness of trees varies depending on the tree species, age, sun/shade, rain, temperature and other factors. The smallest suspension wire with a satisfactory strength should be used because the effect of wind and ice loading increase with enlarged suspension wire.

As suggested in clause 4.5.3 of [b-IEC TR 62691], unless the DSA cable is constructed to withstand the lashing to pre-tensioned support wire, it is recommended to attach hanger rings or similar to a