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Coaxial cables used in cabled distribution networks - Part 8 Repair and substitute of damaged buried cables

Koaxialkabel für Kabelverteilanlagen - Teil 8: Reparatur und Ersatz beschädigter Koaxialkabel

Câbles coaxiaux pour réseaux câblés de distribution - Partie 8: Réparation et remplacement de câbles coaxiaux souterrain

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Coaxial cables used in cabled distribution networks - Part 8: Repair and substitute of damaged buried cables

Câbles coaxiaux pour réseaux câblés de distribution -
Partie 8: Réparation et remplacement de câbles coaxiaux souterrain

Koaxialkabel für Kabelverteilanlagen -
Teil 8: Reparatur und Ersatz beschädigter Koaxialkabel

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CENELEC
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Foreword

This document (CLC/TR 50117-8:2013) has been prepared by CLC/SC 46XA "Coaxial cables".

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

EN 50117 is divided into the following parts:

- EN 50117-1, *Coaxial cables — Part 1: Generic specification*
- EN 50117-2-1, *Coaxial cables — Part 2-1: Sectional specification for cables used in cabled distribution networks — Indoor drop cables for systems operating at 5 MHz - 1 000 MHz*
- EN 50117-2-2, *Coaxial cables — Part 2-2: Sectional specification for cables used in cabled distribution networks — Outdoor drop cables for systems operating at 5 MHz - 1 000 MHz*
- EN 50117-2-3, *Coaxial cables — Part 2-3: Sectional specification for cables used in cabled distribution networks — Distribution and trunk cables for systems operating at 5 MHz - 1 000 MHz*
- EN 50117-2-4, *Coaxial cables — Part 2-4: Sectional specification for cables used in cabled distribution networks — Indoor drop cables for systems operating at 5 MHz - 3 000 MHz*
- EN 50117-2-5, *Coaxial cables — Part 2-5: Sectional specification for cables used in cabled distribution networks — Outdoor drop cables for systems operating at 5 MHz - 3 000 MHz*
- EN 50117-3-1, *Coaxial cables — Part 3-1: Sectional specifications for cables used in Telecom applications — Miniaturized cables used in digital communication systems*
- EN 50117-4-1, *Coaxial cables — Part 4-1: Sectional specification for cables for BCT cabling in accordance with EN 50173 — Indoor drop cables for systems operating at 5 MHz - 3 000 MHz*
- EN 50117-5, *Coaxial cables used in cabled distribution networks — Part 5: Sectional specification for indoor drop cables for use in networks operating at frequencies between 5 MHz and 2150 MHz*
- EN 50117-6, *Coaxial cables used in cabled distribution networks — Part 6: Sectional specification for outdoor drop cables for use in networks operating at frequencies between 5 MHz and 2150 MHz*
- CLC/TR 50117-8, *Coaxial cables used in cabled distribution networks — Part 8 Repair and substitute of damaged buried cables*

1 Scope

This Technical Report describes the procedure to repair damaged CATV cables.

The following coaxial cables are considered in this guide:

- Coaxial cables with semi air spaced dielectric
  Outer conductor: **copper band, longitudinal welded**
- Coaxial cables foamed polyethylene or solid polyethylene dielectric
  Outer conductor: **copper band, longitudinal welded**
- Coaxial cables foamed polyethylene or solid polyethylene dielectric
  Outer conductor: **Overlapped foil of copper or aluminium with braid**
- Coaxial cables foamed polyethylene or solid polyethylene dielectric
  Outer conductor: **Overlapped foil of copper or aluminium without braid**
- Coaxial cables foamed polyethylene dielectric
  Outer conductor: **Corrugated copper**

This guide is a helpful tool for providers and installers to find out the extend and the effects of damaged cables and to achieve and to evaluate appropriate repair operation.

For not buried cables, e.g. indoor cables, the application of this guide is analogous.

NOTE The kind respectively the material of the cable sheath makes the coaxial cable an "underground" cable. In the underground area the cable jacket determines the long term behaviour of the cable significantly. For this purpose, only plastics with a high long-term stability are used, usually polyethylene (PE). This material provides protection against ingress of water or water-diffusion with good mechanical properties.

2 Normative References

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50117 (series), *Coaxial cables*

EN 50117-1:2002, *Coaxial cables — Part 1: Generic specification*

EN 50290-1-2:2004, *Communication cables — Part 1-2: Definitions*

EN 50290-4-2, *Communication cables — Part 4-2: General considerations for the use of cables — Guide to use*

EN 60728-1, *Cable networks for television signals, sound signals and interactive services — Part 1: System performance of forward paths (IEC 60728-1)*

EN 60728-1-1, *Cable networks for television signals, sound signals and interactive services — Part 1-1: RF cabling for two way home networks (IEC 60728-1-1)*

IEC 61196-1-108, *Coaxial communication cables — Part 1-108: Electrical test methods — Test for characteristic impedance, phase and group delay, electrical length and propagation velocity*

IEC 61196-1-112, *Coaxial communication cables — Part 1-112: Electrical test methods — Test for return loss (uniformity of impedance)*

IEC 61196-1-115, *Coaxial communication cables — Part 1-115: Electrical test methods — Test for regularity of impedance (pulse/step function return loss)*

3 Terms and definitions

For the purposes of this document the terms and definitions given in EN 50117-1:2002 and in EN 50290-1-2:2004 apply.

4 Coaxial cables

4.1 Construction of coaxial cables

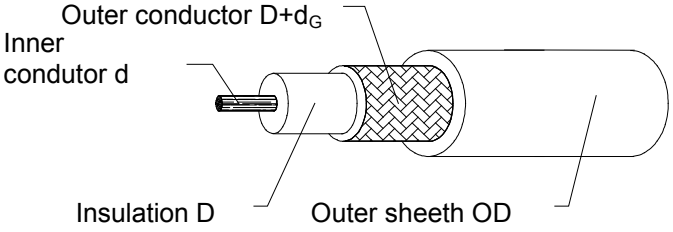

Figure 1 — Construction of a coaxial cable

Coaxial cables (Figure 1) consist of an inner conductor, the dielectric and an overlying outer conductor. The structure is protected by a plastic sheath. The outer conductor also acts as a shield against radiation and electromagnetic fields.

The outer conductor respectively the screen may consist of a single braid, or a combination of metal bonded sheets and braids. The shielding characteristics are determined by the construction of the screen and the optical coverage. Optimal shielding effect is achieved by cables with a continuously closed metal tube, which for example, is often used in case of buried cables for cabled TV distribution.

Coaxial cable for direct burial can also be provided with other elements, such as intermediate sheaths or moisture barriers.

4.2 Long term behaviour and asset of coaxial underground cables

High-quality underground cables are of good long-term stability. They are most durable and without loss of quality. Good example for the high durability are the CATV cable types ikx, nkx, qkx and skx. These cables have a cable sheath of PE and fulfil to date the demands on the transmission characteristics according to the applicable standards for the transmission characteristics, even after 25 years and more of use.

Today, these cables are also used for the transfer of the so-called "Triple Play" services; that means, additional to the digital transmission of radio and television signals the transmission of signals for Internet access services and telephony services using Voice over IP. By means of digital transmission methods, conventional coaxial cables offer transmission bit rate of the high Gigabit range. Only fibre optic cable offers a higher transmission power.

The laid underground cables are thus a valuable and lasting transmission resource, one of the business basics of cable operators. This applies regardless of the age of cable laid, as the transmission performance does not deteriorate, except in case of damage of the cable.

5 Laying of underground cables

5.1 General

For general hints for laying, see EN 50290-4-2.

5.2 Laying in the sand bed

Typically, the cables are laid in the sand bed in a cable trench. The sand bed provides protection against damage by stones and dissipates the weight of the overlying ground, under the best possible protection of the cable. The so-called Warning tape marked "Caution Cable", or "Cable Television" above the laid cable in the sand bed is supposed to draw attention to possible earthworks on the underground cables underneath.

5.3 Laying in ducts

Basically it is the same installation technology as in the laying of cables in the sand bed. However, instead of a cable, a conduit is laid, through which the cable is pulled or blown after laying the conduit.

Laying in ducts is also possible, with the so-called "Press to move procedure" (Pressverfahren), whereby a drive head, driven by compressed air produces an underground channel. In this channel, a conduit is pushed where finally the cable is blown or pulled.

There are other procedures in which the conduit is injected or otherwise introduced into the earth. Since at the latter procedure not a cable trench is made, there is no Warning Tape. Nevertheless, such laid cables can be located with appropriate cable fault location systems.

5.4 Laying in a duct system

Duct systems consist of bundles of pipes of installed cables or cable ducts with "cable stones" (Kabelsteine) in certain intervals. The cables are placed in the respective tube.

5.5 Laying in the conduit

Laying in the conduit is done by install conduits, or cable trays etc. In the event of damage procedures described in this guide apply accordingly.

6 Effects of damage

6.1 General

Coaxial cables are sensitive and should be laid with great care. The manufacturer's instructions specify characteristics like minimum bending radius and maximum pulling force. Even small changes in dimensions affect the characteristics of the various parameters of the coaxial cables.

6.2 Repair

Repairs of coaxial cables require special care. Coaxial cables are components that can serve its purpose only if the continuous construction is not altered in their mechanical dimensions. Even small changes in the dimensions of the cable structure cause reflections that affect the transmission characteristics.

In analogy, the coaxial cables can be considered as a water pipe, in which changes of the cross-section influences the flow of water, (holes in the pipe leads to the leakage of liquid-ness).

By external influences coaxial cables may be damaged, with all the negative impact performance which are described below.

Frequent causes of damage are dredging. In this case, the cable is cut in the ground, stretched, torn, bruised or otherwise damaged. A proper repair is essential to ensure the full transmission capacity of the affected cable. Repair of the cable shall guarantee the intended long-term continued operation.

Even minor damage to the sheath affect the transfer properties and durability of the cable sustainable. Even the smallest damage to the cable sheath causes far-reaching implications due to moisture penetration. Mechanical deformation of the cable causes a deterioration of the transmission characteristics. The affected cable cannot fulfil its purpose extensively and loses its lasting value.

Only repair measures, which are suitable to restore the original transfer properties, are necessary for the operation of cable networks. Doubtful solutions that may cause damage to an unspecified date, are hereby rejected.

The range of appropriate repair measures ranges from the replacement of sleeves and the partial replacement of cables, to the replacement of complete cable lengths between the respective ends or points of connection.

In consequence damages cause changes in the design of the damaged cable. This may affect the cable only selective but at worst on the entire cable length. The following parameters, characteristics or construction details of the cable are affected by an accident:

– diameter of the inner conductor,
– shape of dielectric,
– diameter of the outer conductors,
– outer diameter of cable sheath,
– impermeability to water,
– long-time behaviour.

6.3 Influence to electric characteristics

The effects listed under 6.1 on the mechanical design of the affected cables are coupled in sequence with a deterioration of electrical characteristics. This in turn determines the transmission performance of the cable for the distribution of analogue and digital radio and television programs. Furthermore, digital transmission methods of telecommunication services such as internet telephony or internet account with Voice over IP, etc. are affected.

Cable damage changes the transmission behaviour for the worse. Faults or damage and/or failures of telecommunications services are the result. Besides the physical damage with the possible effects on the long life performance, the following radio frequency and electrical characteristics are deteriorated:

– characteristic impedance,
– attenuation,
– return loss,
– screening attenuation,
– transfer impedance,
– conductor loop resistance,
– current carrying capacity.

The above parameters for coaxial cables are specified in EN 50117-1 and are used for planning and construction of telecommunications networks, such as cable-TV networks. A deterioration of the transmission characteristics of coaxial cables leads naturally to the deterioration of signal quality, which is described for example in EN 60728-1 and EN 60728-1-1 (see also Clause 8).

Basically, a change of the relevant parameters has following impacts:

– A change in the characteristic impedance leads to reflections and causes a deterioration of the attenuation and return loss. A direct impact of the signal transmission, in particular of digital signals is the result.

– Deterioration of screening attenuation and transfer impedance increase the radiation of disturbing power (exceeding the allowable limits) and reduce the noise immunity of the system. The resulting so-called "Ingress" disturbs the back-channel operation and may impact two-way services such as Internet access and Voice over IP substantially or make its transmission even impossible.

– An increase in the loop resistance affects the current carrying capacity, which has an adverse impact on the cables to the remote power feeding over the coaxial cables and affects the power supply of the active components supplied thereon.

7 Types of errors

7.1 General

When cables are stretched or ruptured through external influence (e.g. by dredging), this basically leads to a permanent elongation of the affected cable connected. Since the material is pulled in the length, the dimensions of the inner conductor, the dielectric and the outer conductor will be permanently transformed, or damaged. The extent of damage depends on the technical structure of the stressed cable type.

NOTE For examples of errors, see Annex B.

7.2 Transection without stretching (shearing, cutting)

The simplest case of damage is given when a cable was severed by a smooth cut without strain. However, these simple damages are purely rare.

7.3 Disruption / cable elongation with impact on indefinite length

In general, the underground cables will be ruptured. This happens, for example by a backhoe bucket, which slips under the wire and breaks the cable with the extension of the excavation. Naturally, enormous tensile forces are applied to the cable, which are several times higher than allowed forces by the cable manufacturers. A lasting damage to the cable is the result.

7.4 Strain / elongation without tearing effect with an indefinite length of cable

Damage is also given if the cable is not ruptured, but was stretched by contact with the tool (for example by bucket). The cable is deformed in the affected area, probably with damaged sheath. Even if the cable was not ruptured, the damage may in principle be treated equally, as if the cable was torn.

7.5 Other damage with selective or limited local impact

7.5.1 General

This category includes the types of damage where it is completely sure, that no extension and / or elongation has affected an indefinite length of cable. In particular, these are the following effects on the affected cables.

7.5.2 Deformation without stretching, such as squeezing, compressing, dropping below the minimum bending radius

These types of damage are not always apparent to the layman as harm. Nevertheless, a professional repair is absolutely necessary, as the electrical parameters - and thus the performance of the affected cable is reduced. Furthermore, because of the damage to the cable sheath it is a risk that water penetrates into the cable and destroys the cable at an unspecified date, if not immediately a proper repair is done. The required actions are described in Clause 8.

7.5.3 Damage to the outer sheath by fire or heat

In case of fire and heat, in addition to the cable sheath the core of the cable, the dielectric, is heated and can become deformed. As a result, the inner conductor moves from its centre position. This is