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SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Sheath closures for terrestrial copper telecommunication cables

Recommendation ITU-T L.18

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Sheath closures for terrestrial copper telecommunication cables

Summary

Recommendation ITU-T L.18 deals with the design, mechanical and environmental characteristics of cable sheath closures for copper cables, applied in telecommunication networks in duct, tunnel, buried, surface troughing and aerial installations.

Source

Recommendation ITU-T L.18 was approved on 29 May 2008 by ITU-T Study Group 6 (2005-2008) under Recommendation ITU-T A.8 procedure.

FOREWORD

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CONTENTS

Introduction

A copper cable telecommunication network will require, at certain locations, cable interconnections (cable joints) because:

a) cables are not necessarily continuous from one terminal point to the other

b) cables may need to be branched

c) cables may have been damaged.

A cable joint consists of spliced conductors and a closure. The methods for splicing conductors are covered in a separate Recommendation ITU-T L.9: *Methods of terminating metallic cable conductors* and further information is also found in the ITU-T Handbook, *Outside plant technologies for public networks* (Part II, Chapter 3 – Symmetrical and coaxial pairs jointing techniques).

Basically, a closure is a structure, which is attached at the outer surface of the ends of the sheaths of the cables to be jointed, covering the spliced conductors and thereby restoring the integrity of the cable sheaths at the cable joint. The closure should:

– Protect the spliced conductors from the environment in the type of plant where it is installed, directly buried, in ducts and tunnels, in surface troughing and as an aerial installation (wall, pole and pole line).

– Provide mechanical strength across the sheath opening between the cable ends.

– Provide electrical bonding and grounding of the metal parts of the sheath where required. The method of achieving this will vary with the type of cable sheath. Further information is given in Recommendations ITU-T K.11 and K.25 and the ITU-T manual: *Protection of telecommunication lines against lightning discharges*.

Recommendation ITU-T L.18

Sheath closures for terrestrial copper telecommunication cables

1 Scope

This Recommendation:

– Deals with the design of cable sheath closures for copper cables used in telecommunication networks, for all types of outside plant environments.

– Deals with the mechanical and environmental characteristics of sheath closures for copper cable.

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 60068.x] IEC 60068.x-series, *Environmental testing*.

3 Characteristics of closures for copper cable

Closure design and the required characteristics may be differentiated depending on a number of parameters as listed below. The type of network for which the closure is designed (pressurized, underground, etc.), as well as any limitation in its application domain (for example, compatibility with branch configurations) should be clearly indicated to the user. Clear and correct installation instructions should be made available, indicating which tools are required, the necessary safety regulations and precautions to be taken and how to select the correct closure size.

3.1 Design of the closure

3.1.1 Installation environment and sealing level

The closure should be mechanically suitable with respect to its application and the environment in which it is to be placed.

To prevent corrosion or other electro/chemical damage, the materials should be compatible with other materials normally used in outside plant.

The level of sealing (water-tightness) must be in accordance with the application environment and pressure in the network.

3.1.1.1 Underground closures

Closures for underground networks (for example, ducted, direct buried) should be resistant to permanent water immersion.

Closures for use in pressurized plant should be able to withstand the operating pressure without leaking during their expected lifetime. Air valves are required to reduce the pressure for safe re-entry or as a feeding point to increase the pressure and may be required on the closure for measurement purposes.

3.1.1.2 Aerial closures

For aerial networks, different levels of sealing are applied, depending on the network and local practices.

For a sealed network, the closure should not allow air exchange with the environment, and in general it would be suitable for accidental submersion.

For free-breathing networks, the closure design should prevent water penetrating the actual splice due to rain, wind or water running along the cable. Openings should be provided to evacuate water or condensation from the closure. The size of these openings should be limited in order to prevent entry of harmful insects.

3.1.2 Direction by which the cables enter the closure

Closure designs can also be differentiated by the direction through which the cables enter the closure:

– butt closures: all cables enter and leave the closure at one end

– in-line closures: cables enter or leave the closure via two opposite ends

– Y or T-shaped closures: main cables enter the closure via opposite ends (cfr in-line) while one or more (branch) cables leave the closure under an angle (Y) or perpendicular (T) to the main axis of the closure.

3.1.3 Cable characteristics & configuration

The materials of the closure should be compatible with the materials of the cable sheath.

Special provisions may be required in order to cope with cables having various sheath combinations.

The closure should not affect the specified electrical characteristics of the cable or the spliced conductors.

The closure should be able to cope with the required cable sizes and cable configurations entering the closure, as agreed between customer and supplier.

3.1.4 Wrap-around installability

Designs may allow for installation around a continuous cable without having to cut all of the conductors, for example, when connecting a customer drop cable within a cable length. This feature is also referred to as "wrap-around" closures. Tubular closure designs do not provide this feature, requiring all conductors to be cut and re-spliced in order to be able to add a branch cable.

3.1.5 Filling compounds

Some closures rely on the application of a filling compound to protect the splice from water penetration. Filling compounds can be greases, gels or reactive 2-component systems. The filling compound may be already present from the factory or added upon installation.

3.1.6 Installation method

Closure designs employ cold or hot installation processes based upon the sealing method used.

Cold installed closures make use of mastics, tapes, grommets, O-rings, rubber shapes, pastes, gels, potting compounds, adhesives, etc., which do not require heat. Cold installed closures include mechanical closures which can be reused.

Hot installed closures include the use of thermo-shrinkable materials, lead plumbing and polyethylene injection welding. The heat source may be a gas flame, a hot air generator or electrical resistance heating.

Closures should be installable at temperatures between –10°C and +45°C, unless agreed otherwise between customer and supplier.

3.1.7 Re-entrability and addition of cables

For certain applications, it may be necessary to reopen closures and even add additional cables. In that case, reopening of the closure should be possible without interruptions to the working circuits.

3.2 Mechanical characteristics

The mechanical characteristics should be considered according to the conditions of the installation. Where appropriate, test methods according to [IEC 60068.x] should be used for mechanical tests.

3.2.1 Bending

After installation, the closure may be subjected to bending stresses due to dynamic conditions encountered by the cables and shifts in the earth in directly buried applications. The closures should maintain a seal to the cable sheaths and should not permit cable movement which could transfer strain to the conductors.

3.2.2 Axial tension

Dynamic conditions, especially in aerial and duct plant and shifts in the soil in directly buried applications, may cause cyclic and static tensile loads in the cable. These tensile loads should be supported by the closure without affecting the seal to the sheaths and transferring strain to the conductors.

3.2.3 Crush and impact

The closure may be subjected to crush (also called "static load") and impact both just after installation and during operational life at different temperatures. The closure should protect the spliced conductors under normal crush and/or impact loading experienced during the life of the cable system. In certain circumstances, for directly buried closures, additional protection may be provided, for instance, by placing the closure within a suitable housing.

3.2.4 Torsion

Under dynamic conditions during operation, the cable may be subjected to torsion. The closure should be able to transmit the torque across the joint without cable slippage while maintaining the seal to the cable sheaths.

3.2.5 Vibration

Cable joints may be located on messenger strands, underground in manholes, on bridges and other structures or directly buried. As a result of their location, they may be subjected to vibrations from wind, traffic, railways, etc. The closure should be able to withstand these vibrations without loss of function.

3.3 Environmental characteristics

The environmental characteristics should be considered according to the conditions of the location of the closure. Wherever appropriate, test methods according to [IEC 60068.x] should be used for environmental tests.

3.3.1 Temperature variations

During their operational life, cable joints may experience severe temperature variations. The closure should be able to withstand the temperature variations without loss of function.

Operating temperature range should be in accordance with the application environment. An example of environmental classification with typical operating temperatures can be found in Appendix I.

3.3.2 Water penetration

The closure should prevent the entry of water.

3.3.3 Moisture permeation

During their operational life, cable joints may be immersed in water or exposed to high humidity. High humidity levels in the joint are not desirable because of corrosion and possible condensation with changes in temperature. Therefore, it is important to take the humidity of the environment into account when selecting the type of closure and the materials used in the joint.

A desiccant may be installed in the closure to control the humidity in the closure during its lifetime. Based upon the moisture characteristics of the closure, the quantity of desiccant can be defined in order not to exceed a given level of relative humidity. Various materials, such as a metal screen, will reduce the moisture permeation rate.

3.3.4 Electrical continuity of metal sheaths

The metal sheath (if present) of the cables terminating into a cable joint will usually have to be electrically interconnected with one another at the joint. This can be done for measurement purposes, for safety considerations or for minimizing the possible effects of lightning.

When the cable may be subjected to induced voltage from electrified railways, insulation of the metallic sheath at the joint is sometimes prescribed.

3.3.5 Grounding

Provisions for grounding may be required at the closure (for example, for areas with frequent or severe lightning (high keraunic level) or in the vicinity of power lines), in accordance with local practices or regulations.

3.3.6 UV (solar) radiation

Cable joints may be subjected to UV radiation from sunlight when installed in aerial plant or other sun exposed locations. All closures, intended for use in this type of environments, should be UV resistant.

3.3.7 Snow and ice

In some aerial and duct applications, the closure will be exposed to and be coated with snow and/or ice. The performance of the closure should not be degraded by the presence of snow or ice.

3.3.8 Fluid resistance

The closure should resist the fluids that it might normally be exposed to during its lifetime.

3.3.9 Fire resistance

In tunnels and other internal installations, closures may be required to be manufactured from material having defined flammability and smoke emission properties.

Appendix I

Environmental classification

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

For passive copper joints, a set of five basic different environmental classes covers the majority of the applications around the globe. This appendix describes these environmental classes in some more detail.

I.1 Basic environmental classes

IC: Indoor temperature controlled

– inside buildings protected by a roof and walls all around, heating or air-conditioning available

– contact with chemical and biological contaminants is negligible, e.g., inside central offices, some remote network buildings/houses, residential buildings.

IN: Indoor non-temperature controlled

– inside buildings protected by a roof and walls all around, no heating or air-conditioning available

– contact with chemical and biological contaminants is negligible, e.g., cable vaults, basements, remote network buildings/houses, inside garages, warehouses.

OA: Outdoor above ground

– all outdoor non-sheltered locations, above ground level

– no other sources of heat or extreme temperatures than the surrounding air or solar radiation

– exposed to contaminants and dust that may occur in the atmosphere in rural, city or industrial areas

– e.g., wall mounted, pole mounted, strand mounted nodes.

OG: Outdoor ground level

– outdoor, standing on the ground, perhaps with a base that resides partially below the ground; this class may also apply to outdoor wall mounted products which are close to ground level

– exposed to contaminants and dust that may occur in the atmosphere in rural, city or industrial areas; the base of the product may be permanently in contact with soil, biological and chemical contaminants that occur at or just below ground or street-level, e.g., along roads, pavements and railroads.

OS: Outdoor underground (Sub Terrain)

– outdoor below ground level

– exposed to soil or water-borne contaminants, including organic and inorganic agents related to the presence of roads and traffic, e.g., in man-holes, hand-holes or direct buried.

I.2 Special conditions

Extreme

– any environment for which at least one of the environmental parameters exceeds the boundaries of the five basic environmental classes as specified above, e.g., more extreme temperature excursions

– exact test settings are to be agreed between the supplier and the customer.

Additional requirements

– In specific cases, extra constraints may be required on top of the conditions of one of the basic environmental classes (e.g., bullet resistance, accidental flooding, etc.). This is not included under the term "extreme" conditions: For these occasions, additional requirements or tests can be added on top of the test program of the basic environmental class;

– see also Appendix III for information on potential additional requirements.

Table I.1 – Summary of typical parameters for the basic environmental classes

	Indoor		**Outdoor**		
	IC	**IN**	**OA**	**OG**	**OS**
Exposure ↓	Temp controlled	Temp non controlled	Above ground	Ground level	Underground
Temp Min (°C)	+5	–10	–40	–40	–30
Temp Max (°C)	+40	+60	+65	+65	+60
Solar Radiation	No		Yes	Yes	No
Relative Humidity (max) (%)	93% (decreasing once above 30°C)		100% (occasional/permanent exposure to water possible)		
Precipitation	No		Rain, Snow,...	Rain, Snow,...	N.A.
Submersion	No [b)]		No	No [b)]	Yes
Vibration (m/s²)	10-55 Hz 1 m/s² (~0.1g) (whole system) 5 m/s² (~0.5g) (components)		5-500 Hz 10 m/s² (~1g) (due to, e.g., traffic, wind, etc.)		
Chemical	Negligible [a)]		Atmospheric	Atmospheric + Soil (base only)	Soil/waterborne
Biological	Negligible		Atmospheric	Atmospheric + Soil (base only)	Soil/waterborne

a) In areas where corrosive atmospheres can be expected (marine and coastal areas, industrial areas, urban pollution), increased corrosion protection may be requested as an additional requirement.

b) If accidental flooding may occur, e.g., in vaults or basements, this is to be added as a conditional requirement. This will also correspond to a higher IP rating according to [b-IEC 60529].

Appendix II

Typical performance requirements for sealed non-pressurized copper closures

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

Performance criteria	Method and conditions		Intern. Norm/ref	Requirements
Performance criteria references				
Appearance	Examination with the unaided naked eye			No defects which will adversely affect product performance
Tightness[1)]	Test temperature: Internal pressure: Test time:	(23 ± 3)°C (40 ± 2) kPa 15 min	[IEC 60068-2-17] Test Qc	No continuous emission of air bubbles
Installation tests				
Closure installability	Assembly between:	(–10 and 45) ± 2°C		Tightness Prior to subsequent product testing
Mechanical tests				
Axial tension[2)]	Test temp. range: Test pressure: Load:[3)] Test time:	(–5 to +45) ± 2°C (40 ± 2) kPa regulated D/45 × 1000 N, max. 1000 N or D/45 × 500 N, max. 500 N 8 hrs each cable		Tightness
Bending[2)]	Test temp. range: Test pressure: Bend: Force: Clamp at: Duration:	(–5 to +45) ± 2°C (40 ± 2) kPa regulated 30° or max. 300 mm displacement max. 500 N 10 × D (min. 250 mm) 2 cycles/cable		Tightness
Impact[2)]	Test temp. range: Test pressure: Impact tool: Weight: Drop height: Site of impact: No. of impacts:	(–5 ± 2)°C (40 ± 2) kPa regulated Steel ball (1000 ± 10) g 2 m in the centre 1		Tightness
Static load[2)]	Test temp. range: Test pressure: Time: Load: Area: No. of applications:	(–5 to +45) ± 2°C (40 ± 2) kPa regulated 5 min (1000 ± 10) N 25 cm^2 ± 10% 2		Tightness

Performance criteria	Method and conditions		Intern. Norm/ref	Requirements
Torsion[2)]	Test temp. range: Test pressure: Torque: Clamp at: Duration: No. of cycles:	(–5 to +45) ± 2°C (40 ± 2) kPa regulated Max. 50 Nm or 90° rotation 10 × D (min. 250 mm) 5 min 2 cycles/cable		Tightness
Vibration	Test temp. range: Test pressure: Vibration: Amplitude: Clamping distance: Test time:	(+10 to +45) ± 2°C (40 ± 2) kPa regulated 10 Hz, sinusoidal 3 mm (6 mm peak-to-peak) 10 × D (min: 250 mm) 10 days	[IEC 60068-2-6] Test Fc	Tightness
Environmental tests				
Resistance to aggressive Media A	Test temperature: Test pressure: Test media: Test time:	(23 ± 3)°C (40 ± 2) kPa regulated pH 2, pH 12 30 days		Tightness
Resistance to aggressive Media B[4)]	Test temperature: Test pressure: Test media: Test time:	(23 ± 3)°C (40 ± 2) kPa regulated Diesel for cars Petroleum jelly 7 days	EN 590	Tightness
Resistance to residual stress cracking	Test temperature: Test pressure: Test medium: Test time:	(50 ± 2)°C (40 ± 2) kPa regulated 10% Igepal 7 days		Tightness No visible cracking
Temperature cycling	High temperature: Low temperature: Dwell/Transition time: Cycle duration: Internal pressure: No. of cycles:	(60 ± 2)°C (–30 ± 2)°C 4 hrs/2 hrs 12 hrs (40 ± 2) kPa regulated 10	[IEC 60068-2-14] Test Nb	Tightness
Salt fog	Test temperature: Spray solution: Test time:	(35 ± 2)°C 5% NaCl 30 days	[IEC 60068-2-11] Test Ka	No visible degradation

Performance criteria	**Method and conditions**		**Intern. Norm/ref**	**Requirements**
Waterhead[5)]	Test temperature: Depth: Test time:	(23 ± 3)°C 5 m 30 days	[IEC 60068-2-17] Test Qf	No water ingress

1) For closures that are complete filled (e.g., grease, rubber gel, reactive filling compound), testing with internal pressure is not appropriate. For this style of closures, tightness can be checked by visual check or resistance measurement during water immersion.

2) Low end test temperature should be at least –5°C, but may be lower upon agreement between supplier and customer. For some tests, minimum test temperature may also be limited by the properties of the cables used.

3) D = Diameter of the cable in mm; Required axial tension level to be agreed between customer and supplier.

4) Aggressive media B are not required for products that will only be used above ground.

5) Waterhead test is not mandatory for aerial closures.

Appendix III

Typical performance requirements for sealed pressurized copper closures

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

Performance criteria	Method and conditions		Intern. Norm/ref	Requirements
Performance criteria references				
Appearance	Examination with the unaided naked eye			No defects which will adversely affect product performance
Tightness[1)]	Test temperature: Internal pressure: Test time:	(23 ± 3)°C (100 ± 2) kPa 15 min	[IEC 60068-2-17] Test Qc	No continuous emission of air bubbles
Installation tests				
Closure installability	Assembly between:	(–10 and 45) ± 2°C		Tightness Prior to subsequent product testing
Mechanical tests				
Axial tension[2)]	Test temp. range: Test pressure: Load:[3)] Test time:	(–5 to +45) ± 2°C (70 ± 2) kPa regulated D/45 × 500 N, max. 500 N or D/45 × 1000 N, max. 1000 N 8 hrs each cable		Tightness
Bending/ Ladder test[2) 5)]	Test temp. range: Test pressure: Bend: Force: Clamp at: Duration: Duration: Load:	(–5 to +45) ± 2°C (70 ± 2) kPa regulated Cables < 50 mm: Bend test ±30° or max. 300 mm displacement max. 500 N 10 × D (min. 250 mm) Hold 5 min per position 2 cycles/cable Cables > 50 mm: Ladder test 1 × 2 hrs per (group of) cables(s) 800 N		Tightness
Impact[2)]	Test temp. range: Test pressure: Impact tool: Weight: Drop height: Site of impact: No. of impacts:	(–5 ± 2)°C (70 ± 2) kPa regulated Steel ball (1000 ± 10) g 2 m in the centre 1		Tightness

Performance criteria	Method and conditions		Intern. Norm/ref	Requirements
Static load[2)]	Test temp. range: Test pressure: Time: Load: Area: No. of applications	(–5 to +45) ± 2°C (70 ± 2) kPa regulated 5 min (1000 ± 10) N 25 cm² ± 10% 2		Tightness
Torsion[2)]	Test temp. range: Test pressure: Torque: Clamp at: Duration: No. of cycles:	(–5 to +45) ± 2°C (70 ± 2) kPa regulated Max. 50 Nm or 90° rotation 10 × D (min. 250 mm) 5 min 2 cycles/cable		Tightness
Vibration	Test temp. range: Test pressure: Vibration: Amplitude: Clamping distance: Test time:	(+10 to +45) ± 2°C (70 ± 2) kPa regulated 10 Hz, sinusoidal 3 mm (6 mm peak-to-peak) 10 × D (min: 250 mm) 10 days	[IEC 60068-2-6] Test Fc	Tightness
Environmental tests				
Resistance to aggressive Media A	Test temperature: Test pressure: Test media: Test time:	(23 ± 3)°C (70 ± 2) kPa regulated pH 2, pH 12 30 days		Tightness
Resistance to aggressive Media B[4)]	Test temperature: Test pressure: Test media: Test time:	(23 ± 3)°C (70 ± 2) kPa regulated Diesel for cars Petroleum jelly 7 days	EN 590	Tightness
Resistance to residual stress cracking	Test temperature: Test pressure: Test medium: Test time:	(50 ± 2) °C (70 ± 2) kPa regulated 10% Igepal 7 days		Tightness No visible cracking
Temperature cycling	High temperature: Low temperature: Dwell/Transition time: Cycle duration: Internal pressure: No. of cycles:	(60 ± 2)°C (–30 ± 2)°C 4 hrs/2 hrs 12 hours (70 ± 2) kPa regulated 10	[IEC 60068-2-14] Test Nb	Tightness
Salt fog	Test temperature: Spray solution: Test time:	(35 ± 2)°C 5% NaCl 30 days	[IEC 60068-2-11] Test Ka	No visible degradation

Performance criteria	Method and conditions		Intern. Norm/ref	Requirements
Waterhead[6]	Test temperature: Depth: Test time:	(23 ± 3)°C 5 m 30 days	[IEC 60068-2-17] Test Qf	No water ingress

[1] For closures that are complete filled (e.g., grease, rubber gel, reactive filling compound), testing with internal pressure is not appropriate. For this style of closures, tightness can be checked by visual check or resistance measurement during water immersion.

[2] Low end test temperature should be at least –5°C, but may be lower upon agreement between supplier and customer. For some tests, minimum test temperature may also be limited by the properties of the cables used.

[3] D = Diameter of the cable in mm; Required axial tension level to be agreed between customer and supplier.

[4] Aggressive media B are not required for products that will only be used above ground.

[5] For cables > 50 mm Outer diameter, traditional bending test is not representative for real life situations.

For these cable sizes, the ladder test, simulating the load of an installer, stepping on a product that is supported by its cables is recommended.

[6] Waterhead test is not mandatory for aerial closures.

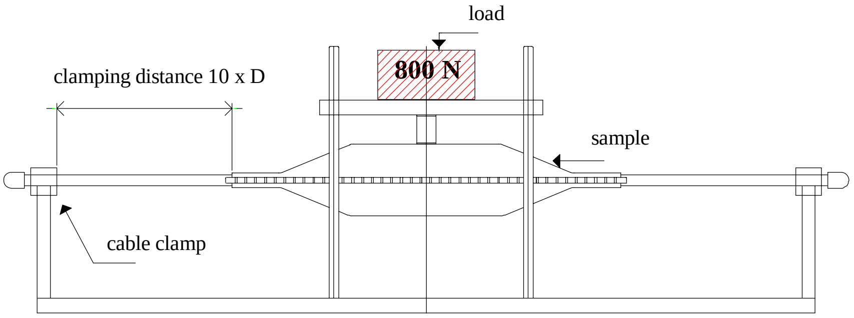

Figure III.1 – "Ladder test" for cables with diameter > 50 mm

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[b-ITU-T K.25] Recommendation ITU-T K.25 (2000), *Protection of optical fibre cables*.

[b-ITU-T L.9] Recommendation ITU-T L.9 (1988), *Methods of terminating metallic cable conductors.*

[b-ITU-T Handbook] ITU-T Handbook (1992), *Outside Plant Technologies for Public Networks*. (It describes in detail various closure systems in use in the telecommunications network (see Part II, Chapter 4 – Methods of jointing cable sheaths).)

[b-ITU-T manual] ITU-T manual (1995), *The Protection of Telecommunication Lines and Equipment against Lightning Discharges*.

[b-IEC 60529] IEC 60529 (2001), *Degrees of protection provided by enclosures (IP Code)*. <http://webstore.iec.ch/webstore/webstore.nsf/artrum/026766>

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