INTERNATIONAL TELECOMMUNICATION UNION

CCITT

K.29

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

PROTECTION AGAINST INTERFERENCE

COORDINATED PROTECTION SCHEMES FOR TELECOMMUNICATION CABLES BELOW GROUND

Recommendation K.29

Geneva, 1992

FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is a permanent organ of the International Telecommunication Union (ITU). CCITT is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation K.29 was prepared by Study Group V in close collaboration with Study Group VI and was approved under the Resolution No. 2 procedure on the 15th of January 1992.

CCITT NOTE

In this Recommendation, the expression “Administration” is used for conciseness to indicate both a telecommunication Administration and a recognized private operating agency.

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COORDINATED PROTECTION SCHEMES FOR TELECOMMUNICATION CABLES BELOW GROUND

1 Introduction

When telecommunication cables need protection against danger and interference from a.c. power and traction lines, lightning and corrosion, it is convenient to provide coordinated measures to assure protection against all these sources.

Since corrosion problems appear mainly on cables below ground, this Recommendation suggests coordinated protection schemes for such cables.

The environment is the main factor to be considered in deciding whether or not protection is necessary, in particular the following factors should be taken into consideration:

a) protection against lightning:

- keraunic level,
- orographic conditions,
- altitude,
- soil resistivity (in the top layer);

b) protection against effects of electric power and traction lines:

- soil resistivity (in deep layers),
- inducing current,
- distance between the telecommunication cable and the electric power and traction line;

c) protection against corrosion:

- soil resistivity (in the top layer),
- corrosive components (ions) in the soil,
- stray currents in the soil (sources of d.c. stray currents are d.c. traction rails, earthing electrodes associated with d.c. sources, metallic structures with cathodic protection and the like).

Protection of underground communication cables against corrosion is achieved mainly with protective plastic coverings on the metal cable sheath.

Regarding the environment, the installed cable behaviour is different if an insulating or conductive plastic material is used as protective covering. Therefore, coordinated protection schemes are also different and the two cases should be considered separately.

2 Coordinated protection with insulating plastic coverings

2.1 *Metallic cables*

Coordinated protection of telecommunication metallic cables, i.e. cables with metal conductors (symmetrical or coaxial pairs), against induction, lightning and corrosion with insulating plastic coverings requires the consideration of:

- suitable metal sheath;
- adequate covering with adequate dielectric strength;

– earth connections of the metal sheath;

– use of a shield wire. The manual "The protection of telecommunication lines and equipment against lightning discharges" contains useful information for determining the need for shield wires.

If an Administration has positive experience with respect to corrosion, then periodic inspection of the insulating covering is not necessary. In areas where stray currents exist or corrosion due to interference currents has been observed, periodic inspection may be recommended.

The distance, *d* between earthing electrodes and their resistance, *R* can be established on the basis of:

– the specific calculation methods, taking into account the limit values for the voltage between any metal components and earth due to induction from power and traction lines (ref. "Directives concerning the protection of telecommunication lines against harmful effects from electric power and electrified railway lines");

– the transfer impedance of telecommunication cables;

– the thunderstorm activity, i.e. number of thunderstorm days per year or ground flash density.

Nevertheless, the following indications about the values of *d* and *R* can be taken into account:

– local cables are usually earthed only at the ends; for extended cable installations it is recommended to earth the cables additionally at intermediate points;

– long-distance cables are earthed at the repeater stations or additionally at intermediate locations.

Multipoint sacrificial anodes may be considered as earth electrodes; in such cases, the earth resistance values have to be controlled during their lifetime. Such a control can be recommended for normal earth electrodes.

2.2 *Optical fibre cables*

2.2.1 *Metal-free cables*

Metal-free cables do not require protection against power induction, lightning damage and metal corrosion, although lightning damage to such cables is conceivable when they are installed below ground in metal ducts.

2.2.2 *Metal components in the cable core and sheath*

From the protection point of view, this type of cable is the same as a metal cable; therefore the coordinated protection, described in § 2.1, applies.

Nevertheless, the poor shielding effect of the moisture barrier may not allow a sufficient reduction of the overvoltages inside the cable and may require, as a consequence, the installation of surge arresters between the metal pairs and the moisture barrier, and the bonding of the strength member to the moisture barrier.

The use of cables which have metal components, but adequate resistibility to lightning surge currents (in agreement with Recommendation K.25 "Lightning protection of optical fibre cables"), can offer an adequate shielding effect against induction from power or traction lines if the metal sheath is earthed following the criteria indicated in § 2.1.

2.2.3 *Metal-free cable core*

In this case the cable has only one metal component, the sheath(s).

The protection against lightning can be achieved selecting a cable with a higher capability to withstand lightning surge currents or with the installation of shield wires following the criteria suggested in § 2.1.

The protection against induction can be obtained keeping the shield(s) continuous at splices, providing appropriate earthing at repeaters and providing earth electrodes at splices only where required to limit the shield-earth voltage to values below the limits.

Another coordinated protection scheme can be the use of both of the following protection means:

– the installation of shield wires;

– the interruption of the metal shield, i.e. the moisture barrier, at each splice or additionally at intermediate locations as required to keep the induced shield-earth voltage values below the limits.

3 Coordinated protection with conductive plastic coverings

3.1 *Metallic cables*

Coordinated protection of telecommunication metallic cables, i.e. cables with metal conductors (symmetrical or coaxial pairs), against induction, lightning and corrosion with a conductive plastic covering, requires the consideration of:

– suitable covering characteristics;

– use of shield wires when conditions warrant. Generally their use is considered as well for bare cables.

The manual "The protection of telecommunication lines and equipment against lightning discharges" contains useful information for determining the need for shield wires.

Along the line, ground connections of the metal sheath are not necessary.

The compound type below the conductive coverings may be the same as for non-conductive coverings.

On the basis of some experimental results, the possible limit values of the main properties of the conductive plastic covering to be considered are shown in Tables 1/K.29 and 2/K.29.

In particular the chemical characteristics in Table 1/K.29 are recommended to render negligible the effects of the galvanic corrosion between conductive plastic coverings and metals used in buried telephone plants.

Though periodic inspection of the covering is not possible, it is also not important since the low corrosion rate of the metal sheath renders the corrosion damages negligible.

Safety for personnel is assured by the continuous earthing of the metal sheath; the need for protection against electromagnetic induction is unlikely, although, in some cases it may be necessary.

TABLE 1/K.29

Limit values of conductive plastic covering characteristics

Properties	Conductive covering		Test method
	PE	PVC	
Carbon black content (%)	< 13	< 25	IEC 811-4-1 Clause 11
Polymer density (g/cm^3)	0.920-0.935	1.3-1.4	IEC 811-1-3 Clause 8
Cold bend test at –15 °C	No visible crack	No visible crack	IEC 811-1-4 Clause 8
Melt flow index (g/10 min)	0.05-0.1	–	IEC 811-4-1 Clause 10

TABLE 2/K.29

Limit values of electrical, mechanical and physical characteristics of the conductive plastic covering

Properties	Conductive covering		Test method
	PE	PVC	
Volume resistivity (ohm·m)	< 10	< 10	IEC 93
Tensile strength at break (MPa)	> 9	> 9	IEC 811-1-1 Clause 9
Percent elongation at break (%)	> 200	> 130	IEC 811-1-1 Clause 9
Environmental stress cracking resistance	Procedure B	—	IEC 811-4-1 Clause 8
Water absorption at 24 h at 100 °C (%)	< 1	< 1	IEC 811-1-3 Clause 9

3.2 *Optical fibre cables*

The conductive plastic covering can also be used around a metal moisture barrier of an optical fibre cable; in this case the coordinated protection described in § 3.1 applies.

Up to now, conductive plastic covering has not been experienced in optical cable plants.