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

Protection of telecommunication cables and plant from biological attack

ITU-T Recommendation L.46

(Formerly CCITT Recommendation)

ITU-T Recommendation L.46

Protection of telecommunication cables and plant from biological attack

Summary

This Recommendation describes biological attacks and countermeasures for protection of telecommunication cables. It deals with the kinds of biological attack, weakness of cables, features of damage, and considers alternative ways of protecting the plant including dependence on cable position.

Source

ITU-T Recommendation L.46 was prepared by ITU-T Study Group 6 (1997-2000) and approved by the World Telecommunication Standardization Assembly (Montreal, 27 September – 6 October 2000).

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T 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 World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation L.46

Protection of telecommunication cables and plant from biological attack

1 Scope

There is evidence that the outside of the plant can be damaged from biological attack. Some attacks are localized to particular environments which nurture certain types of infestation. Sometimes movement of the plant away from these areas is enough to avoid damage. More typically, the plant is shielded against attack by preventing penetration of pests some of which are listed in clause 2.

2 The kinds of biological attacks

It is known that cable damage may be caused by:

– mammals, squirrels, mice, rats, moles, gophers and other rodents;

– birds like woodpeckers and cockatoos;

– insects such as termites, ants, beetles, wasps and caterpillars;

– micro-organisms like bacteria, fungus and/or moulds.

3 Types of damage experienced

From an investigation of the damage sustained it is possible to determine the type of pest involved. Typical features of damage are given below.

3.1 Mammals (e.g. squirrels, rats, mice and gophers)

Vertical chiselling of incisors on the edge of irregular holes is typical of the damage caused by rodents.

Spherical or cylindrical holes with smooth walls are characteristic for the attack of moles. The animals are often found in the hole.

3.2 Insects

3.2.1 Termites and ants

Irregular holes that may extend over the whole circumference, looking as though the sheath has been peeled off, are typical of termites and ants.

A mat appearance, to a surface that has been chewed over, is typical of termite gnawing, because they dig and lever upward with their short squat mandibles. Scratch marks and a transverse assault on the cable are characteristic of the ant, which has long, sharp mandibles and adopts a cutting action. In the early stages, the attack is characterized by local gatherings of numerous, small, individual holes.

Ants and termites can give off an acidic secretion that is corrosive to lead.

3.2.2 Beetles, larvae and other insects

Horizontal traces of mandibles of different shapes on the edges of the holes, are indications of attacks by insects and larvae. Circular bores are typical of larvae and beetles. Depending on the angle at which they penetrate the sheath, they may look circular or elongated with a width equal to the diameter of the bore.

3.3 Birds

Irregular nibbles by beaks on the edge of and around irregular holes, are signs of attacks by birds.

NOTE – Earwigs, spiders, pupas and other animals, often invade junction boxes and other open spaces. If the ventilation holes are big enough, even bird-nests, squirrel-nests and mice-nests can be found in the boxes. The debris these animals (in 3.1 to 3.3) produce from their excrements, also contribute to the breakdown of the insulation of connectors and terminal blocks.

3.4 Micro-organisms

Deterioration of the mechanical properties of cellulose fibres and elasticized polymers, is characteristic of attacks by fungi and bacteria. These attacks depend on the material and its manufacturing process.

Local aeration corrosion cells can be produced by the attachment of barnacles, which are tight enough to exclude oxygen. These cells can be the result of bacterial metabolism in a polluted environment.

4 Type of protection

4.1 Positioning of plant in certain locations

Attacks on telecom plants may be confined to certain areas where the conditions allow the pests to thrive. If it is possible to re-route the plant away from these areas, instances of attack and plant damage can be avoided.

Examples of particular environments and the type of biological attacker found in them are shown in Table 1.

Table 1/L.46 – Typical environment for pests

Environment	Pest
Breeding places in rubber estates	Insects
Willow, cascara, scrub oak areas and old trees	Olive beetles
Telecom plant in contact with plants (vegetable) – cable drums-poles-wood debris-bamboo-roots	Insects and larvae
Dry rotting tree roots and wood debris	Termites
Above ground Up to 1.5 m in hard soil Deeper in soft soil	Ants
Polluted soil and water creating anaerobic conditions	Bacterial metabolism
Overhead	Squirrels and birds

4.2 Elimination of the pest

Where it is not possible to re-site the plant one possible action could be to eliminate the pests such as insects and rodents using chemicals or poisons.

It should be noted that some chemicals and poisons are useful as a countermeasure for biological attacks, but they sometimes can also be a danger to humans and cause environmental pollution. Therefore, very careful handling is required when using any chemical method to prevent biological attacks. Also, materials' safety data and other specifications should be referred to before they are

used. Poisons and chemicals should be stored safely in accordance with the supplier's recommendations.

Some chemicals are useful as a deterrent. These chemicals do not work as poisons but they repel the attacker. For example, some chemicals are sprayed on the cable surface and leave a special smell as a deterrent.

4.3 Protection of telecom plant

Another option for protection of the plant is to shield it by the use of protective materials around the plant in order to prevent access. Examples of the way to prevent access of the pests are given in Table 2.

Table 2/L.46 – External measures for protection against pests

Action	Pest
Application of screens over ventilation opening	Squirrels, rodents and birds
Steel net over cable	Squirrels
Tightening of fittings in junction boxes, blocking with epoxy resin casting in small boxes	Ants, insects and beetles
Compact into hard soil around cables and joints	Ants and insects
Cables in small diameter duct to prevent entry	Rats and mice
Galvanized iron guards around the cables as they emerge from the ground	Rodents, ants and insects
Chemical repellents sprayed on telecom plant or spread around it	Insects, spiders and wasps
Covering/repair of damaged duct	Rats

4.4 Cable construction

Cables with sheaths of lead, polyethylene, polyvinylchloride, neoprene and other polymers are all susceptible to attacks. Examples of cable constructions that offer protections are given in Table 3.

Table 3/L.46 – Cable construction for protection against pests

Protection	Pest
Steel wire, fibreglass or aramid armouring	Squirrels and rodents
Steel sheath or steel tape laminate	Birds
Polyamide sheath	Ants and termites
Helical steel or brass tape	Birds (woodpeckers) and termites
Helical steel (0.2 mm) lapping with bituminous compound flooding	Contact with plants induce beetle and larvae attack

Aluminium tape offers limited protection, especially thin foil (e.g. 0.1 mm) that is easy to penetrate. Therefore, the thickness of aluminium tape should be considered carefully.

Cables with steel armouring and/or dielectrical armouring such as fibreglass do not suffer any damage of this type as long as the armour is intact. Discontinuity in the armor leads to damage from beetles and larvae. Openings in the steel armour may have their origin in imperfect splicing and careless repairs, wrinkles and mechanical damage or by corrosion.

Coatings of hessian, jute yarn or paper fibres impregnated with tar or bituminous compounds, give no protection.

APPENDIX I

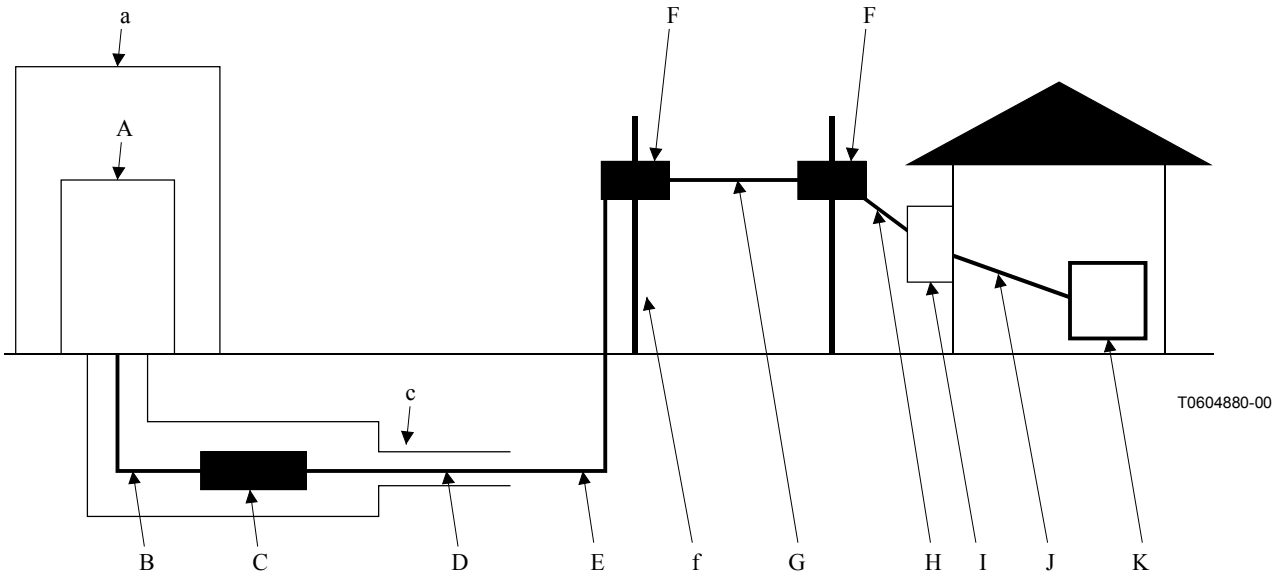
Table I.1 shows the main biological attackers and countermeasures.

Table I.1/L.46 – The main biological attackers and countermeasures

Caused by	Attackers	Position	Troubles	Countermeasures
Mammals	Rats and Mice	Underground cables Duct cables Indoor cables	Bite, Food, Cut	Armouring net OLMA Sealing of duct Chemicals
Mammals	Moles	Underground cables	Cut	Armouring net OLMA
Mammals	Squirrels	Aerial	Bite, Cut	OLMA
Birds	Woodpeckers Other Birds	Aerial	Peck, Make hole Make nest	Steel tape OLMA
Insects	Ants and Termites	Underground Aerial	Bite Bite	Polyamide jacket Steel tape and Brass tape Air tightness of closures
Insects	Cicada	Aerial	Lay Eggs, Make hole	Steel tape
Micro organism	Bacteria	----------	----------	---------
OLMA Over Lay Metallic Armouring				

APPENDIX II

Experience for biological attacks is shown in this Appendix from Table II.1 to II.7. The information is gathered from Argentina, Italy, Japan, Spain, Ukraine and Brazil. The places of attacks are shown in Figure II.1.



A Transmission Facilities, ex. FTM, DSU
B Cables installed in tunnels, Metallic/Optical
C Underground Closure
D Duct Cables
E Underground (Direct buried) Cables
F Aerial Closures
G Aerial Cables, Metallic/Optical
H Dropping Cables
I Terminal Box, ex. Arrester Box
J Indoor Cables
K Equipment
a Telecom facilities
b Tunnel
c Ducts
d Manhole
f Pole

Figure II.1/L.46 – Illustration for places attacked by plants and animals

Table II.1/L.46 – Argentine experience

Place (Figure II.1)	Season	Caused by	Kind of cause	Example of trouble	When occurred	Countermeasures
B	All season	Mammals	Rats	Bite	–	None
G	All season	Bacteria	Others	Peck	–	None
F	All season	Bacteria	Others	Make Nest	–	None

Table II.2/L.46 – Italian experience

Place (Figure II.1)	Season	Caused by	Kind of cause	Example of trouble	When occurred	Countermeasures
D	All season	Mammals	Rats	Bite	1993 to 1995	None

Table II.3/L.46 – Indonesian experience

Place (Figure II.1)	Season	Caused by	Kind of cause	Example of trouble	When occurred	Countermeasures
Jakarta	All season	Mammals	Rats	Bite, cut	1998	Making sealing of the cable's ducts
Jakarta	All season	Insect	Ants	Bite, make nest	1997	Chemicals, inserting wax
Ujung Pandang	All season	Insect	Ants	Bite, short circuit	1997	None
Many places	All season	Mammals	Mice	Bite, cut, short circuit, make nest	1996-1998	None
Ambon	All season	Birds	Cockatoos	Bite	1997-1998	None

Table II.4/L.46 – Japanese experience

Place (Figure II.1)	Season	Caused by	Kind of cause	Example of trouble	When occurred	Countermeasures
G	All season	Mammals, insects	Rats, squirrels, mice, caterpillars	Bite (Figures II.2 and II.3)	1996-1999	OLMA (Steel outer layer) (Figure II.4) Replacement with HS cable (Figure II.5)
F	Autumn	insects	Ants	Bite	1998	Improvement of airtightness
H	Summer	insects	Cicada	Lay eggs	1998	OLMA (Steel outer layer) Replacement with HS metallic wire

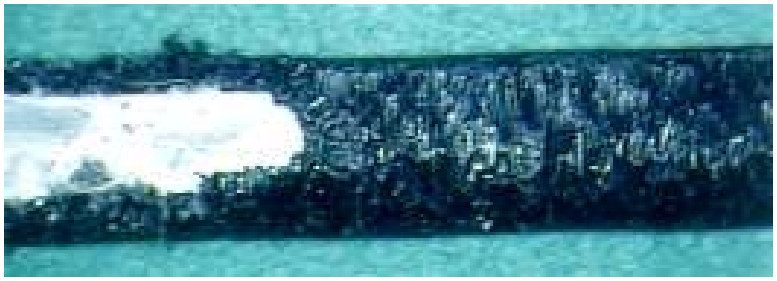


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Figure II.2/L.46 – Example of trouble by rats

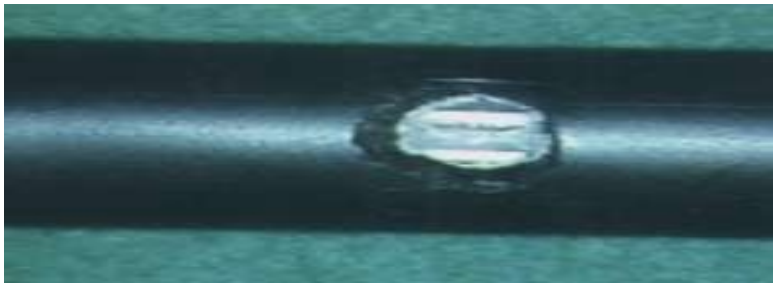

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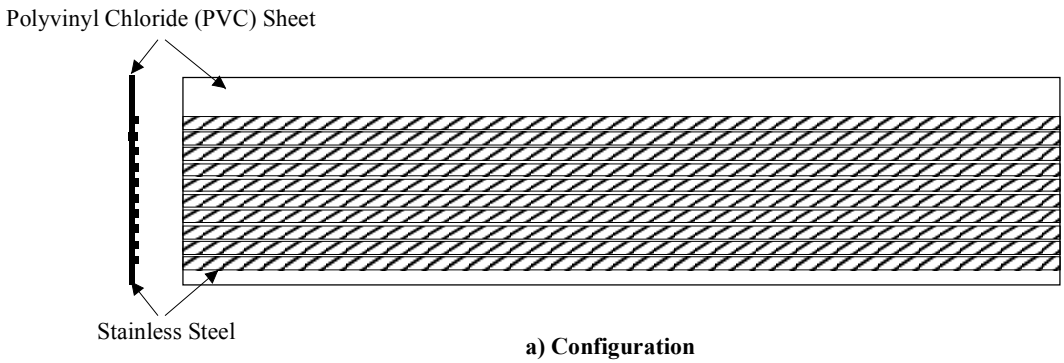
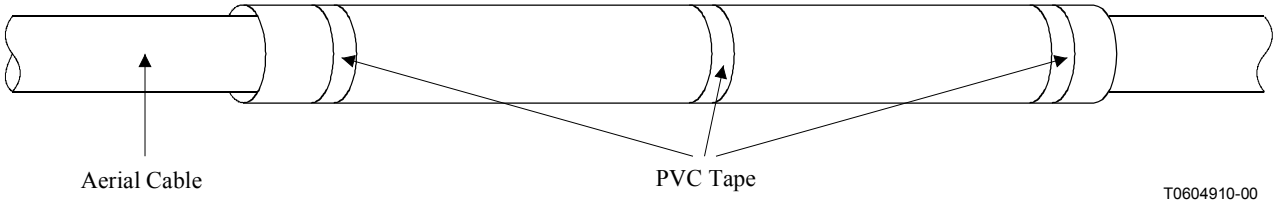
Figure II.3/L.46 – Example of trouble by caterpillars



a) Configuration



b) Illustration of how to use OLMA

Figure II.4/L.46 – OLMA

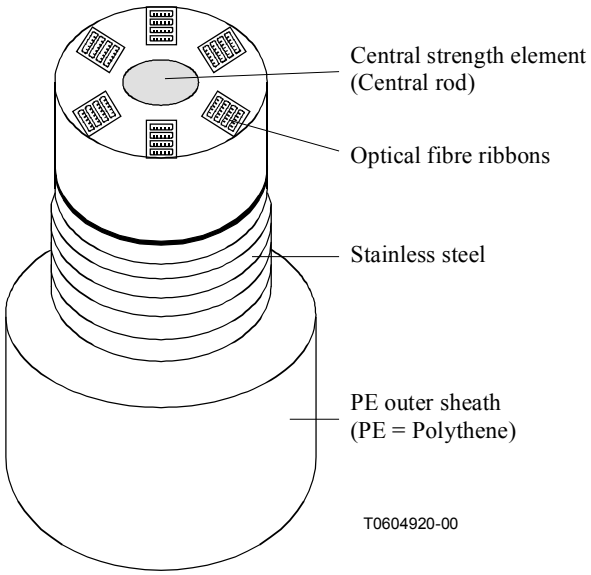


Figure II.5/L.46 – Configuration of high strength (HS) cable

Table II.5/L.46 – Spanish experience

Place (Figure II.1)	Season	Caused by	Kind of cause	Example of trouble	When occurred	Countermeasures
D	All season	Mammals	Rats	Cut	1996	None
M	All season	Mammals	Rats	Cut	1996	None
M	All season	Mammals	Rats	Cut	1997	None
M	All season	Mammals	Rats	Cut	1997	Sealing

Table II.6/L.46 – Ukrainian experience

Place (Figure II.1)	Season	Caused by	Kind of cause	Examplof trouble	When occurred	Countermeasures
J (3 events)	All season	Mammals	Rats	Bite	1998	Over lay metallic fray
J (3 events)	All season	Mammals	Rats	Food, Bite	1998	OLMA
D, J	All season	Mammals	Rats	Bite, Cut, Scratch	1998	Armouring Net, chemicals
D	All season	Mammals	Rats	Bite	1996	Over lay
D (20 event)	All season	Mammals	Rats	Bite	1997	Over lay
D	All season	Mammals	Rats	Bite	1998	Making sealing of duct
D (2 event)	All season	Mammals	Rats	Cut, Food, Bite	1998	Over lay
D	All season	Mammals	Rats	Food	1998	OLMA

Table II.6/L.46 – Ukrainian experience *(continued)*

Place (Figure II.1)	Season	Caused by	Kind of cause	Examplof trouble	When occurred	Countermeasures
D (manhole)	All season	Mammals	Rats	Bite	1998	OLMA
E	All season	Mammals	Rats	Scratch (gnawed sheath)	1997	Armouring Net
E (2 event)	All season	Mammals	Rats	Food (gnawed sheath)	1998	
D	Spring Summer	Mammals	Rats	Bite (gnawed sheath)	1998	
D (10 event)	Spring Summer	Mammals	Rats	Food (gnawed sheath)	1998	Chemicals
D (manhole 4 event)	Spring Summer	Mammals	Rats	Food (gnawed sheath)	1998	Chemicals
D (manhole)	Summer Autumn	Mammals	Rats	Bite (gnawed sheath	1998	
J	Spring	Mammals	Rats	Bite	1997	
J (4 event)	Spring	Mammals	Rats	Bite	1998	
J	Spring	Mammals	Rats	Bite	1998	Over lay
J	Spring	Mammals	Rats	Bite	1998	Chemicals
D (2 event)	Spring	Mammals	Rats	Bite (FO damaged)	1996	
D (2 event)	Spring	Mammals	Rats	Bite	1998	Chemicals
D (2 event)	Spring	Mammals	Rats	Food, Bite	1998	Over lay
D (7 event)	Spring	Mammals	Rats	Bite	1998	
D (manhole 4 event)	Spring	Mammals	Rats	Bite	1996	Chemicals
D (manhole)	Spring	Mammals	Rats	Bite (damaged cables; 10 mm)	1998	Making embedding cable with OLMA
B	Spring	Mammals	Rats	Bite	1998	Armouring Net
E (2 event)	Spring	Mammals	Rats	Food	1998	OLMA
E	Spring	Mammals	Rats	Bite	1998	Armouring Net
E	Spring	Mammals	Rats	Bite	1998	Chemicals

Table II.6/L.46 – Ukrainian experience *(continued)*

Place (Figure II.1)	Season	Caused by	Kind of cause	Examplof trouble	When occurred	Countermeasures
J (3 event)	Summer	Mammals	Rats	Bite	1998	Over lay
D	Summer	Mammals	Rats	Bite (FO damaged)	1996	
D	Summer	Mammals	Rats	Bite (Damaged cables; 3 m)	1996	Over lay
D	Summer	Mammals	Rats	Food (consumed leaden sheath)	1996	Over lay
D (2 event)	Summer	Mammals	Rats	Bite (damaged cable; 0.5-3 m)	1997	Over lay
D	Summer	Mammals	Rats	Food	1998	Over lay
D	Summer	Mammals	Rats	Food	1998	Over lay
D (4 events)	Summer	Mammals	Rats	Bite	1998	
D (manhole 4 events)	Summer	Mammals	Rats	Bite	1998	Chemicals
D (manhole 20 events)	Summer	Mammals	Rats	Bite	1998	
E	Summer	Mammals	Rats	Food	1998	OLMA
E	Summer	Mammals	Rats	Bite	1998	Armouring Net
E	Summer	Mammals	Rats	Cut	1998	
E	Summer	Mammals	Rats	Bite	1998	Chemicals
D	Autumn	Mammals	Rats	Bite (FO damaged)	1998	
D	Autumn	Mammals	Rats	Food	1998	Over lay
D	Autumn	Mammals	Rats	Bite	1998	Chemicals
D (50 events)	Autumn	Mammals	Rats	Cut	1998	
D (20 events)	Autumn	Mammals	Rats	Cut	1998	Chemicals
D (8 events)	Autumn	Mammals	Rats	Scratch, Food, Bite	1998	Over lay
D (manhole)	Autumn	Mammals	Rats	Bite (FO damaged)	1997	
D (manhole)	Autumn	Mammals	Rats	Bite	1998	

Table II.6/L.46 – Ukrainian experience *(continued)*

Place (Figure II.1)	Season	Caused by	Kind of cause	Examplof trouble	When occurred	Countermeasures
D (manhole 4 events)	Autumn	Mammals	Rats	Bite	1998	Chemicals
E (2 events)	Autumn	Mammals	Rats	Cut	1998	Chemicals
J	Winter	Mammals	Rats	Bite	1998	Chemicals
J	Winter	Mammals	Rats	Cut	1998	
D	Winter	Mammals	Rats	Cut	1997	OLMA
D (2 events)	Winter	Mammals	Rats	Bite	1998	
D	Winter	Mammals	Rats	Bite	1998	Over lay
D (manhole)	Winter	Mammals	Rats	Bite	1998	
D	Autumn	Mammals	Mice	Bite, Cut, Scratch (gnawed sheath: 40×100 mm)	1998	Armouring Net, chemicals
E	Autumn	Mammals	Mice	Scratch (gnawed sheath)	1996	
E	Spring – Autumn	Mammals	Mice	Bite, Food, Nest (D=0.5-10 mm)	1997 1998	Chemicals
E	Spring Summer	Mammals	Mice	Cut, Food	1998	
D	Spring Summer	Mammals	Mice	Bite (gnawed sheath)	1998	
E (2 events)	Spring	Mammals	Mice	Food, Cut, Make Nest, Scratch	1998	OLMA
E	Spring	Mammals	Mice	Bite (circle d=10 mm)	1997	OLMA
E	Spring	Mammals	Mice	Food (damaged cables)	1998	
D (2 events)	Spring	Mammals	Mice	Cut, Food (damaged cables)	1998	
D (2 events)	Spring	Mammals	Mice	Others	1998	Over lay

Table II.6/L.46 – Ukrainian experience *(continued)*

Place (Figure II.1)	Season	Caused by	Kind of cause	Examplof trouble	When occurred	Countermeasures
E	Summer	Mammals	Mice	Bite (damaged cables: 4 m, 2 m)	1997	Over lay
E	Summer	Mammals	Mice	Make Holes	1997-1998	Chemicals
E (2 events)	Summer	Mammals	Mice	Bite	1998	Armouring Net
E (2 events)	Summer	Mammals	Mice	Cut, Make Nest, Scratch	1998	OLMA
E	Summer	Mammals	Mice	Food	1998	
E (2 events)	Summer	Mammals	Mice	Cut, Bite (damaged cables)	1998	
E	Summer	Mammals	Mice	Food (damaged cables)	1998	
D	Summer	Mammals	Mice	Food (damaged cables)	1998	
D (2 events)	Summer	Mammals	Mice	Cut, Food (damaged cables)	1998	
D	Summer	Mammals	Mice	Food (damaged cables)	1998	
D (manhole)	Summer	Mammals	Mice	Others	1998	Chemicals
E (events)	Autumn	Mammals	Mice	Bite (damaged cables: 2~6 m, 10 m)	1991-1992, 1996	Over lay
E	Autumn	Mammals	Mice	Others	1997	Over lay
E (events)	Autumn	Mammals	Mice	Cut, Food (damaged cables)	1998	
E	Autumn	Mammals	Mice	Food	1998	OLMA
D	Autumn	Mammals	Mice	Others	1997	Over lay
D	Autumn	Mammals	Mice	Food (damaged cables)	1998	

Table II.6/L.46 – Ukrainian experience *(continued)*

Place (Figure II.1)	Season	Caused by	Kind of cause	Examplof trouble	When occurred	Countermeasures
J (2 events)	Autumn	Mammals	Rats, Mice	Bite, Make Nest (gnawed sheath: 2 m~10 m)	1997-1998	Chemicals Armouring Net
D (2 events)	Autumn	Mammals	Rats, Mice	Bite, Make Nest (gnawed sheath: 2 m~10 m)	1997-1998	Chemicals Armouring Net
B (2 events)	Autumn Summer	Mammals	Rats, Mice	Cut, Bite	1998	Over lay
E (12 events)	Winter	Mammals	Rats, Mice	Cut, Bite	1998	Over lay
D (manhole)	Autumn	Mammals	Rats, Mice	Bite, Cut (L=30 mm)	1998	Over lay
E (37 events)	Autumn	Mammals	Rats, Mice	Bite (gnawed sheath: up to 1 m)	1998	
E	Spring Summer Autumn	Mammals	Rats, Moles	Bite, Food, Make Nest, Cut (gnawed sheath: 10 mm~ 3 m)	1997-1998	Chemicals Armouring Net
D (39 events)	Autumn	Mammals	Rats, Mice, Gophers	Cut, Bite, Food, Scratch	1997-1998	Over lay Chemicals
E	Autumn	Mammals	Gophers	Food	1998	OLMA Chemicals
E (3 events)	Spring	Mammals	Gophers	Bite (damaged cables: 15 m, 10 m)	1998	Over lay
E	Spring	Mammals	Gophers	Bite	1998	Armouring Net
E	Spring	Mammals	Gophers	Cut	1997	
E	Summer	Mammals	Gophers	Bite (damaged cables: 2 m)	1996	Over lay
E	Summer	Mammals	Gophers	Bite (damaged cables: 2 m)	1997	Over lay
E	Summer	Mammals	Gophers	Cut	1998	Armouring Net

Table II.6/L.46 – Ukrainian experience *(continued)*

Place (Figure II.1)	Season	Caused by	Kind of cause	Examplof trouble	When occurred	Countermeasures
E	Summer	Mammals	Gophers	Food	1996	OLMA Chemicals
E (3 events)	Autumn	Mammals	Gophers	Bite, Make Nest (damaged cables: 0.1 m, 0.5 m)	1997	Over lay
E (3 events)	Autumn	Mammals	Gophers	Bite (damaged cables: 0.2 m,0.5 m)	1995 1997	Over lay
E (2 events)	Autumn	Mammals	Gophers	Cut	1998	Armouring Net
E (2 events)	Autumn	Mammals	Gophers	Food	1995 1997	OLMA Chemicals
E	Autumn	Mammals	Gophers	Cut, Make Nest, Scratch	1998	OLMA
E	Winter	Mammals	Gophers	Bite (damaged cables: 50 mm)	1998	Over lay
E (6 events)	Winter	Mammals	Gophers	Bite (damaged cables: 0.15~0.3 m, 20 m)	1996 1998	Over lay
E	Winter	Mammals	Gophers	Cut, Make Nest, Scratch	1998	OLMA
E (4 events)	Spring	Mammals	Moles	Cut, Food (damaged cables)	1998	
E (2 events)	Summer	Mammals	Moles	Bite (gnawed sheath), Food (damaged cables)	1998	
E	Summer	Mammals	Moles	Make Holes	1998	Armouring Net
E	Autumn	Mammals	Moles	Bite (gnawed sheath)	1998	
E	Autumn	Mammals	Moles	Food	1998	OLMA

Table II.6/L.46 – Ukrainian experience *(continued)*

Place (Figure II.1)	Season	Caused by	Kind of cause	Examplof trouble	When occurred	Countermeasures
E	Summer	Mammals	Hamsters	Food (gnawed sheath)	1998	OLMA
E (13 events)	Spring Autumn	Mammals	Hamsters	Bite	1998	
E (3 events)	Winter	Mammals	Hamsters	Bite (hole d:20 mm)	1996-1998	OLMA
E	Summer	Mammals	Hamsters	Bite	1998	Armouring Net
E (2 events)	Autumn	Mammals	Hamsters	Bite	1998	Armouring Net
E (2 events)	Summer	Mammals	Beavers	Cut	1995-1996	Armouring Net
E (3 events)	Autumn	Mammals	Beavers	Cut	1998	Armouring Net
E	Summer	Mammals	Ondatra	Bite (damaged cables: 0.3 m)	1995	Over lay
D (manhole)	Winter	Mammals	Dogs	Bite (FO damaged)	1994	
G (4 events)	Summer	Birds	Woodpeckers	Peck (peck and holes in poles)	1998	
F (2 events)	Spring	Birds	Woodpeckers	Peck (holes d=25 mm, 30 mm)	1998	
F (10 events)	Autumn	Birds	Woodpeckers	Peck (nest)	1998	
F (8 events)	Spring Summer	Birds	Storks	Make Nest	1998	Over lay
F (3 events)	Autumn Summer	Insects	Beetles (barkbeetles)	Lay Eggs Food	1997-1998	Over lay
H (2 events)	Autumn	Insects	Wasps	Cut, Make Nest	1998	Over lay
I	Summer Autumn	Insects	Wasps	Make Nest	1998	Over lay
E	Spring	Insects	Ants	Lay eggs, Degradation of insulation	1998	Over lay
D	Autumn	Bacteria	Unknown	Culture media	1998	
E	Autumn	Bacteria	Unknown	Culture media	1998	

Table II.6/L.46 – Ukrainian experience *(concluded)*

Place (Figure II.1)	Season	Caused by	Kind of cause	Examplof trouble	When occurred	Countermeasures
D	Autumn	Bacteria	Unknown	Culture media	1998	
D	Spring	Fungus	Fungus	Corrosion	1998	Chemicals
E	Summer	Plants	Unknown	Cut	1998	

Table II.7/L.46 – Brazilian experience

Place (Figure II.1)	Season	Caused by	Kind of cause	Example of trouble	When occurred	Countermeasures
B (Buried Optical Cable)	All season	Mammals	Rodents	Bite, Make Holes	1994	OLMA, dielectric armour
B (Induct Optical cable)	All season	Mammals	Rats	Bite, Make Holes, Scratch, Cut	1996	OLMA (Figure II.6)
F (Aerial Closure-metallic)	All season	Insects	Ants	Make Pressure, Corrosion	1994	–
E (Metallic Cable)	All season	Insects	Termites	Make Holes	1982	OLMA (Figure II.7)
G (Aerial Optical Cable)	All season	Birds	Others	Bite, Make Holes	1993	–
B (Buried Optical Cable)	All season	Mammals	Rodents	Bite, Make Holes, Scratch	1995	OLMA, dielectric armour (Figure II.8)
G (Aerial Optical Cable)	All season	Mammals	Rodents	Bite, Make Holes	1999	(Figure II.9)
OLMA Over Lay Metallic Armouring						

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Figure II.6/L.46 – Induct optical cable

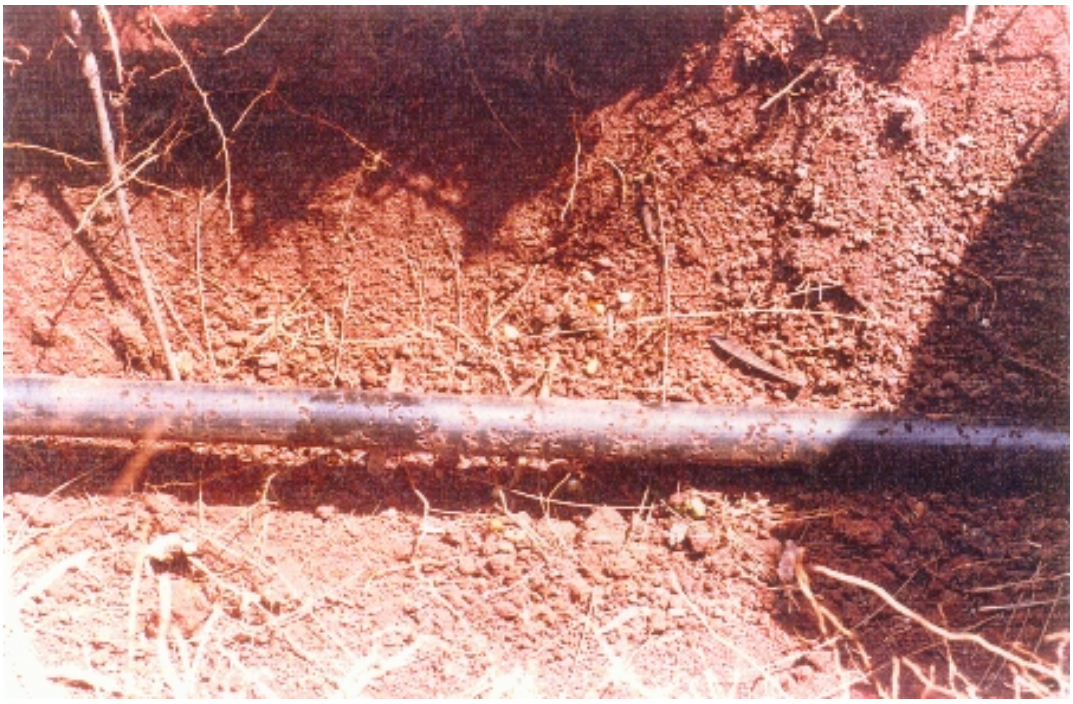

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Figure II.7/L.46 – Metallic cable damaged by insect

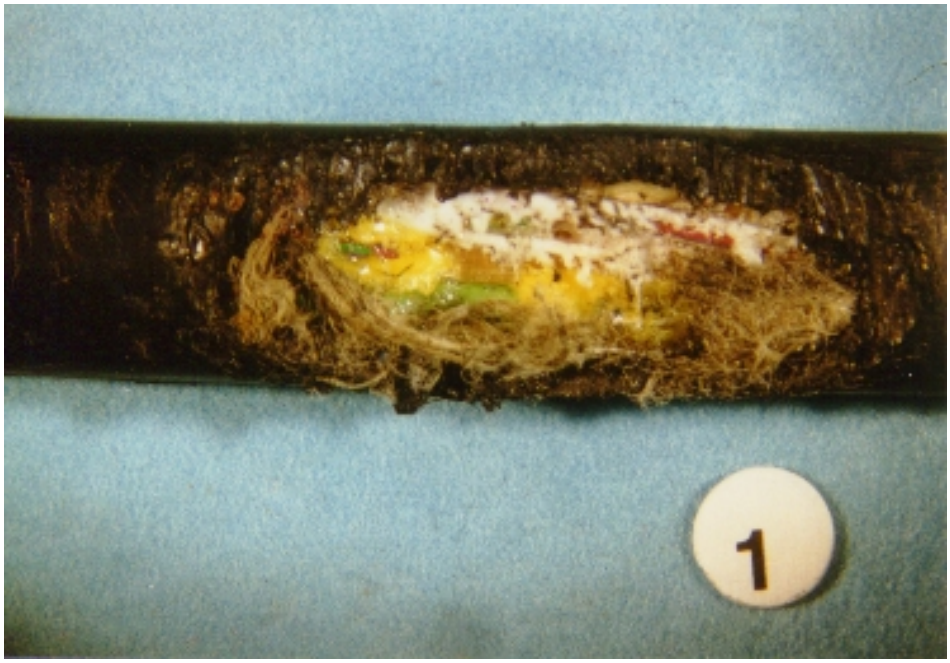

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Figure II.8/L.46 – Buried cable

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Figure II.9/L.46 – Aerial cable

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