SVENSK STANDARD SS-EN 50397-1

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Svenska Elektriska Kommissionen, SEK

Kraftkablar – Belagda linor och tillbehör för friledningar med märkspänning 1-36 kV – Del 1: Belagda linor

Covered conductors for overhead lines and the related accessories for rated voltages above 1 kV a.c. and not exceeding 36 kV a.c. – Part 1: Covered conductors

Som svensk standard gäller europastandarden EN 50397-1:2006. Den svenska standarden innehåller den officiella engelska språkversionen av EN 50397-1:2006.

Nationellt förord

Tidigare fastställd svensk standard SS 424 14 63, utgåva 2, 1988, gäller ej fr o m 2009-07-01.

ICS 29.240.20

Denna standard är fastställd av Svenska Elektriska Kommissionen, SEK,
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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 50397-1

November 2006

ICS 29.240.20

English version

Covered conductors for overhead lines and the related accessories for rated voltages above 1 kV a.c. and not exceeding 36 kV a.c. Part 1: Covered conductors

Conducteurs gainés pour lignes aériennes et accessoires associés pour des tensions assignées supérieures à 1 kV c.a. et ne dépassant pas 36 kV c.a. Partie 1: Conducteurs gainés

Kunststoffumhüllte Leiter und zugehörige Armaturen für Freileitungen mit Nennspannungen über 1 kV und nicht mehr als 36 kV Wechselspannung Teil 1: Kunststoffumhüllte Freileitungsseile

This European Standard was approved by CENELEC on 2006-07-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 50397-1:2006 E

Foreword

This European Standard was prepared by TF "*Covered Overhead Line Conductors* (COHL)" of the Technical Committee CENELEC TC 20, Electric cables.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50397-1 on 2006-07-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2007-07-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2009-07-01

This European Standard consists of two parts:

– Part 1 "Covered conductors"; and
– Part 2 "Accessories for covered conductors: Tests and acceptance criteria".

This standard covers the construction, performance and test requirements for covered conductors for overhead lines having a nominal voltage *U* above 1 kV a.c. up to and including 36 kV a.c., and for the related accessories.

Contents

Introduction

Covered conductors consist of a conductor surrounded by a covering made of insulating material as protection against accidental contacts with other covered conductors and with grounded parts such as tree branches, etc. In comparison with insulated conductors, this covering has reduced properties, but is able to withstand the phase-to-earth voltage temporarily.

Since covered conductors are unscreened, they are not touch-proof, i.e. they must be treated as bare conductors with respect to electric shock.

This standard does not cover aspects related to the installation of overhead lines such as determination of clearances, spans, sags, etc.

1 Scope

This Part 1 contains the requirements for covered conductors with or without integrated longitudinal watertightness and/or semi-conductive conductor screen for applications in overhead lines with rated voltages *U* above 1 kV a.c. and not exceeding 36 kV a.c.

2 Normative references

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

EN 50182	Conductors for overhead lines – Round wire concentric lay stranded conductors
EN 50356	Method for spark testing of cables
EN 60811 series	Insulating and sheathing materials of electric and optical fibre cables – Common test methods (IEC 60811 series)
EN 61284	Overhead lines – Requirements and tests for fittings (IEC 61284)
HD 380	Test methods for evaluating resistance to tracking and erosion of electrical insulating materials used under severe ambient conditions (IEC 60587)
HD 605	Electric cables – Additional test methods

3 Definitions

For the purpose of this European Standard, the following definitions apply.

3.1 Definitions relating to tests

3.1.1
type tests (symbol T)
tests required to be made before supplying a type of product covered by this European Standard on a general commercial basis in order to demonstrate satisfactory performance characteristics to meet the intended application. These tests are of such nature that, after they have been made, they need not be repeated unless changes are made in the material, design or manufacturing process which might change the performance characteristics

3.1.2
sample tests (symbol S)
tests made on samples of completed product or components taken from the completed product adequate to verify that the finished product meets the design specifications

3.1.3
routine tests (symbol R)
tests made on all production lengths to demonstrate their integrity

3.2
rated voltage
the reference voltage for which the conductor is designed and which serves to define the electrical tests.

The rated voltage is expressed by the value *U*, expressed in kilovolts, where *U* is the r.m.s. value between any two-phase conductors

4 Covered conductors

4.1 Code designation

Covered conductors shall be designated as follows:

Type code	CC;
Covering material	S (for semi-conductive conductor screen, if any),
	X (for cross-linked polyethylene),
	T (for thermoplastic polyethylene);
Conductor material and cross-section	according to EN 50182;
Conductor design	W (for watertight),
	K (for compacted);
Rated voltage *U* in kV	…kV.

EXAMPLE OF DESIGNATION

"CCX 66-AL3 WK 20kV" is a XLPE-covered conductor with a rated voltage of 20 kV, longitudinal watertight compacted conductor of aluminium alloy AL3 and a nominal conductor cross-section of 66 mm².

4.2 Construction requirements

4.2.1 Conductor

Number of conductors: 1

Conductor material: aluminium alloy or steel reinforced aluminium

Nom. cross-section: 35 mm² to 240 mm² (aluminium alloy), 50 mm² to 150 mm² (total cross-section for steel reinforced aluminium)

Conductor design: the conductors may be compacted or non-compacted.

Information on bare conductors in frequent use may be found in the national lists, contained in Annex F of EN 50182. However, for the purpose of this European Standard, conductors may be selected from any national table. Conductors deviating in design from the standard values have to be given by the manufacturer, but fulfilling all requirements given in EN 50182.

Non-compacted conductors shall comply with EN 50182 (with the exception of the filling, if any).

For compacted conductors, based on conductors according to EN 50182, the following paragraph applies: The outer diameter of the compacted conductor shall be 95 % (± 1 % for 7- and 19-wire constructions, ± 1,5 % for 37-wire constructions) of the diameter given in EN 50182. The rated tensile strength (RTS) shall be at least 95 % of the value given in EN 50182. The d.c. resistance shall not exceed the value given in EN 50182 by more than 5 %.

Special conductors may also be used (see Annex A).

4.2.2 Filling

The stranded conductor may be longitudinally watertight by means of adequate measures as e.g. filling with an adequate mass. The filling mass or other materials for obtaining the longitudinal watertightness, shall be compatible with the conductor material and the material of the covering (see Table 2).

4.2.3 Covering

The covering shall consist of a cross-linked polyethylene compound, which shall comply with the requirements according to Table 1, column 3 or of a thermoplastic polyethylene compound, complying with the requirements according Table 1, column 4.

It shall be possible to remove the covering without damage to the conductor.

Table 1 – Properties of the covering materials

1	2	3	4
	Unit		
Compound designation		X	T
Basic material		XLPE	PE
Maximum operating temperature of the conductor	°C	90 [a]	70
Mechanical properties			
before ageing on sample (EN 60811-1-1, Subclause 9.1)			
minimum tensile strength	MPa	12,5	12,5
minimum elongation at break	%	200	300
after ageing on sample (EN 60811-1-2, Subclause 8.1, ageing method a))			
temperature	°C	135	110
duration	h	168	336
minimum tensile strength	MPa	-	12,5
maximum variation T1/T0	%	± 25	-
minimum elongation at break	%	-	300
maximum variation T1/T0	%	± 25	-
after ageing on complete product sample [b] (EN 60811-1-2, Subclause 8.1.4)			
temperature	°C	100 ± 2	100 ± 2
duration	h	168	168
minimum tensile strength	MPa	-	12,5
maximum variation T2/T0	%	± 25	-
minimum elongation at break	%	-	300
maximum variation T2/T0	%	± 25	-

Table 1 – Properties of the covering materials *(continued)*

1	2	3	4
	Unit		
Physical and chemical properties			
hot set test (EN 60811-2-1, Clause 9)			
temperature	°C	200	-
duration	min	15	-
mechanical stress	MPa	0,2	-
maximum elongation under load	%	175	-
maximum residual elongation	%	15	-
pressure test at high temperature (EN 60811-3-1, Subclause 8.1)			
temperature	°C	-	80
duration	h	-	4
coefficient k	-	-	0,8
maximum depth of indentation	%	-	50
water absorption (EN 60811-1-3, Subclause 9.2)			
temperature	°C	85	85
duration	h	336	336
maximum variation of mass	mg/cm²	1	1
shrinkage test (EN 60811-1-3, Clause 10)			
distance L between marks	mm	200	200
duration	h	1	1
temperature	°C	130 ± 3	100 ± 3
maximum shrinkage	%	4	4
Shore D hardness (HD 605, Subclause 2.2.1)			
minimum hardness	ShD	-	55

[a] Maximum operating temperature of the conductor is limited to 80 °C due to mechanical reasons.

[b] For use together with watertight conductors only. Adequate measures e.g. neutral capping to prevent leakage of filling material shall be taken.

An UV-protection shall be provided. If carbon black is used, the content of carbon black shall be (2,5 ± 0,5) %.

The nominal thickness of the covering shall be calculated according to the following formula:

$$S = 0{,}11\ U$$

where

S is the nominal thickness of the covering in mm (rounded to one decimal place);

U is the rated voltage (see 3.2) in kV.

The nominal thickness of the covering shall be not less than 2,3 mm.

The minimum thickness of the covering at any place shall not be less than the nominal value by more than (0,1 mm + 10 % of the nominal value). The mean value of the thickness of the covering shall not exceed the nominal value by more than (0,1 mm + 10 % of the nominal value).

A semi-conductive conductor screen, if any, shall not be measured as covering thickness.

5 Marking

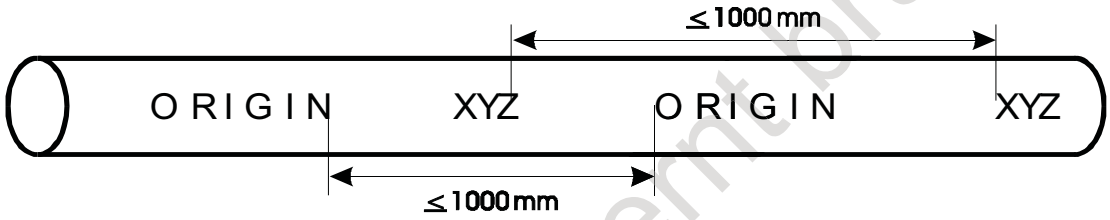
5.1 Indication of origin

Covered conductors shall be provided with an identification of origin consisting of a continuous marking of the manufacturer's name or trademark on the surface of the covering. This marking shall be made by embossing.

5.2 Continuity of marks

The distance between the end of a mark and the beginning of the next identical mark shall not exceed 1 000 mm.

The diagram below shows an example of the marking, where the word "ORIGIN" stands for the mandatory information required in 5.1 and "XYZ" stands for one of any other mandatory marks required in 5.3.



5.3 Other markings

Covered conductors shall be equipped with a continuous embossing as follows:

– code designation according to 4.1;

– year of production;

– standard number.

Optional markings (e.g. slippage factor according to Annex D, meter marking) may be added upon agreement between manufacturer and user. These optional markings may be made by printing or embossing.

5.4 Durability

Printed markings shall be durable. Durability shall be checked by the test according to HD 605, Subclause 2.5.4. The markings shall be legible after this test.

5.5 Legibility

All markings shall be clearly legible. Printed markings shall be in contrasting colours.

6 Tests

The compliance with the requirements according to 4.2 and Clause 5 shall be established by visual examination and the tests listed in Table 2.

A type test shall be performed on every covered conductor type, irrespective of the cross sectional area. The results will be valid across the whole range of cross sectional areas for that type.

NOTE The slippage test shall be performed on each cross sectional area (see D.3.1).

Table 2 – Tests

1	2		3	4	5
No	**Tests**		**Category of tests**	**Requirements**	**Test methods**
1	Electrical tests				
1.1	Conductor resistance		T, S [b]	[a]	HD 605, Subclause 3.1.1
1.2	High voltage test				
1.2.1	– for CC without conductor screen:			no breakdown	HD 605, Subclause 3.2.2.2
	Test voltage (a.c.)	1 *U*			
	Number of specimen	1			
	Length of specimen (minimum)	5 m			
	Duration of immersion in water (minimum)	1 h			
	Temperature of water	(20 ± 5) °C			
	Test duration	15 min 3 h	S T		
1.2.2	– for CC with conductor screen or upon agreement between customer and producer:			no breakdown	HD 605, Subclause 3.2.2.2
	Test voltage (a.c.)	1 *U*			
	Number of specimen	1			
	Length of specimen (minimum)	5 m			
	Duration of immersion in water (minimum)	1 h			
	Temperature of water	(20 ± 5) °C			
	Test duration	4 h 48 h	S T		
1.3	Spark test on the covering [c]		R	no breakdown	EN 50356
	Test voltage:	a.c. 0,7 *U* or d.c. 1 *U*			
1.4	Leakage current		T	maximum 1 mA	Annex B
	Test voltage (a.c.)	0,7 *U*			
1.5	Tracking resistance [d]		T	Annex C	Annex C
2	Construction and dimensions				
2.1	Compliance with the design requirements		T, S, R	Subclause 4.2	visual inspection
2.2	Thickness of the covering		T, S, R	Subclause 4.2.3	EN 60811-1-1, Subclause 8.1
3	Construction and mechanical properties of the conductor				
3.1	Rated tensile strength		T, S [b]	[a]	[a]
3.2	Construction and dimensions		T, S	[a]	[a]
4	Non-electrical tests on the covering				
4.1	Mechanical properties				
	a) before ageing of sample		T	Subclause 4.2.3	EN 60811-1-1, Subclause 9.1
	b) after ageing of sample		T	Subclause 4.2.3	EN 60811-1-2, Subclause 8.1, ageing method a)

Table 2 – Tests *(continued)*

1	2		3	4	5
No	**Tests**		**Category of tests**	**Requirements**	**Test methods**
4.2	Carbon black content [e]		T	Subclause 4.2.3	EN 60811-4-1, Clause 11
4.3	Resistance to UV rays [f]		T		HD 605 S1:1994 /A2 :2001, Subclause 2.4.23
5	Test of compatibility [g]				
	Ageing of complete product sample		T	Subclause 4.2.3	EN 60811-1-2, Subclause 8.1.4
6	Thermal properties of the covering				
6.1	Shrinkage test		T	Subclause 4.2.3	EN 60811-1-3, Clause 10
	Distance “L” between marks	(200 ± 5) mm			
6.2	Hot-set-test [h]		T, S	Subclause 4.2.3	EN 60811-2-1, Clause 9
6.3	Pressure test at high temperature [i]		T	Subclause 4.2.3	EN 60811-3-1, Subclause 8.1
7	Further tests on the covering				
7.1	Water absorption		T	Subclause 4.2.3	EN 60811-1-3, Subclause 9.2
7.2	Shore D hardness [i]		T	Subclause 4.2.3	HD 605, Subclause 2.2.1
8	Test of the longitudinal watertightness [g]				
8.1	With heat cycle		T	no leakage	IEC 60502-2, Annex F
	Number of specimen	1			
	Length of specimen	3 m			
	Test duration	24 h			
	Bending radius	20 D			
8.2	Without heat cycle		S	no leakage	IEC 60502-2, Annex F [j]
	Number of specimen	1			
	Length of specimen	1 m			
	Test duration	1 h			
9	Marking				
9.1	Content, legibility		T, S, R	Clause 5	visual inspection
9.2	Durability		T	Subclause 5.4	HD 605, Subclause 2.5.4
10	Slippage test		T	Annex D	Annex D

[a] Requirements and/or test procedures respectively, whatever applicable, according to EN 50182, to Annex A of this standard or to 4.2.1 of this standard.

[b] For compacted conductors only

[c] Alternatively a high voltage test can be performed on the whole production length under the following conditions: Test voltage 4 kV a.c., duration of immersion in water (minimum) 10 minutes, water temperature (20 ± 5) °C, test duration 5 minutes, no break down.

[d] For $U \geq 30$ kV or on request

[e] If carbon black is used for UV-stabilisation

[f] If other than carbon black is used for UV-stabilisation

[g] For longitudinal watertight versions only.

[h] For cross-linked polyethylene only

[i] For thermoplastic polyethylene only

[j] Water column connected to one end of specimen by means of an appropriate fitting.

Annex A
(normative)

Special conductors

In addition to the conductors described in 4.2.1, the conductors in Table A.1 may be used.

These conductors shall be compacted. All wires shall be stranded together according to EN 50182, Subclauses 5.5 and 5.6.

Table A.1 – Special conductors

1	2	3	4	5	6
Code	**Minimum number of wires**	**Nominal conductor diameter** mm	**Rated tensile strength** kN	**Mass per unit length** kg/km	**Maximum d.c. resistance at +20 °C** Ω/km
35-AL2	7	6,9 ± 0,20	10,3	91	0,986
50-AL2A	7	8,0 ± 0,20	14,2	123	0,720
50-AL2B	7	8,3 - 0,2/+ 0,4	14,7	135	0,720
70-AL2	7	9,7 ± 0,25	20,6	182	0,493
95-AL2A	7	11,3 ± 0,30	27,9	249	0,363
95-AL2B	7	11,6 - 0,2/+ 0,4	26,9	256	0,363
120-AL2	19	12,8 ± 0,30	35,2	315	0,288
150-AL2	19	14,2 ± 0,30	43,4	390	0,236
150-AL7	19	14,2 - 0,2/+ 0,4	30,4	405	0,198
185-AL2	34	15,8 ± 0,30	54,3	487	0,188
240-AL2	34	18,1 ± 0,35	70,4	638	0,145

Annex B
(normative)

Measurement of the leakage current

B.1 Test equipment

- a.c.-source with power frequency (48 Hz to 62 Hz), an output voltage of 0,7 *U* and an output current of 5 mA at least
- Ampere meter (true r.m.s.) with an accuracy of ± 0,1 mA at least
- Resistor (1 ± 0,05) kΩ
- Plain copper wire with a diameter of (2,0 ± 0,05) mm
- Ethanol
- Water tank

B.2 Sampling

The specimen shall be taken at least 5 m away from any end of a production length. The length of the specimen shall be (1 000 ± 10) mm.

The surface of the covering of the specimen shall be cleaned from any present contamination by wiping off with ethanol. Then the specimen shall be immersed in water at a temperature of (20 ± 5) °C for 24 h at least. The further preparations and the test shall be performed immediately after the end of the immersion in water. The specimen shall be dried by wiping it off to ensure, that no moisture connections between the measuring electrode and the conductor can occur.

On one end of the specimen, the covering shall be removed over a length of (5 ± 1) mm and the conductor surface shall be cleaned.

At a distance of (450 ± 5) mm from the other end of the specimen, a plain copper wire with a diameter of (2,0 ± 0,05) mm shall be wound around the covering to build up a closed helix with a length of (100 ± 2) mm (measured in the axis of the specimen) as a measuring electrode. The winding of the copper wire shall be done in a way which avoids any damage and minimizes deformation of the covering.

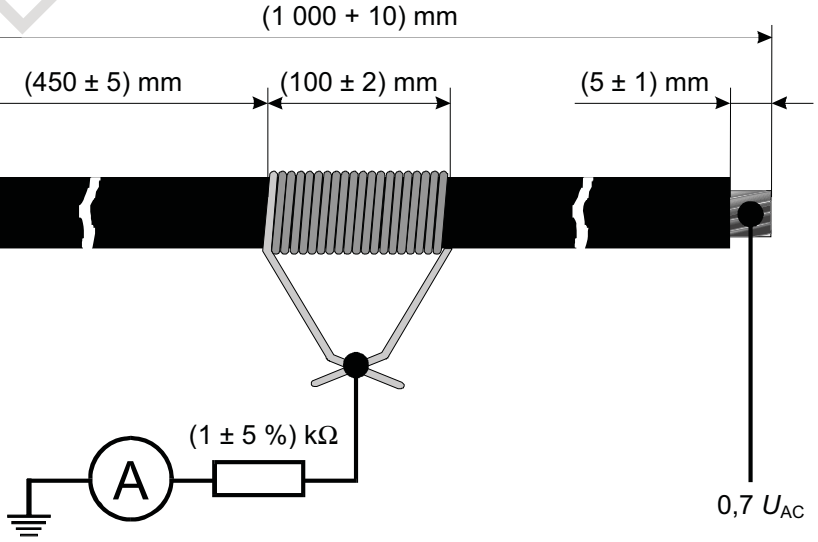


Figure B.1 – Test arrangement

B.3 Test procedure

Between the conductor and the measuring electrode the voltage shall be applied and the current shall be measured by the ampere meter. The value of the current shall be read one minute after application of the voltage.

B.4 Test evaluation

The measured value of the current shall not exceed the value given in Table 2.

Annex C
(normative)

Tracking resistance

C.1 Scope and object

This annex, based on HD 380 (IEC 60587), describes the test method for the evaluation of electrical insulating materials for use at power frequencies (48 Hz to 62 Hz) by measurement of the resistance to tracking and erosion, using a liquid contaminant and inclined cable samples.

NOTE 1 The test conditions are designed to accelerate the production of the effects, but do not reproduce all the conditions encountered in service.

With the test apparatus described in the following sub-clauses, the track starts at the lower electrode.

The end point of the test is reached when the value of the current in the high voltage circuit through the specimen exceeds 60 mA. An overcurrent device then breaks this circuit.

NOTE 2 This end point criterion permits the use of an automatic apparatus testing several specimens simultaneously.

C.2 Definitions

C.2.1
track
conducting or partially conducting path created by tracking

C.2.2
tracking
progressive degradation of the surface of a solid insulation material by local discharges to form conducting or partially conducting paths

C.2.3
erosion, electrical
wearing away of electrical insulating material by the action of electrical discharges

C.2.4
time-to-track
time in a tracking test until tracking reaches a specified end-point criterion

C.3 Test specimens

C.3.1 Dimensions

Specimens of finished covered conductor at least 200 mm in length.

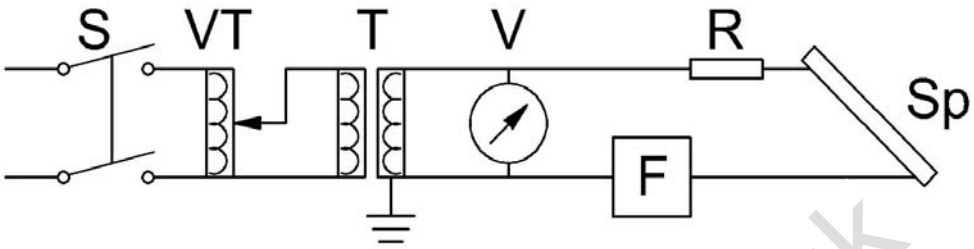
C.3.2 Preparation

Unless otherwise specified, the surface of the specimens shall be lightly abraded. The abrasion should be done with a fine silicon carbide abrasive paper Number 600 under de-ionized or distilled water until the whole surface wets and appears uniformly matted when dry. If abrasion has not been used, the method of cleaning shall be mentioned in the test report.

C.4 Apparatus

C.4.1 Electrical apparatus

A schematic circuit is given in Figure C.1. As the test will be carried out at high voltages, it is obviously necessary to use a grounded safety enclosure.



Key

S	power supply switch
VT	variable ratio transformer
T	high-voltage transformer
R	series resistor
V	voltmeter
Sp	specimen
F	overcurrent device, fuse or relay

Figure C.1 – Schematic circuit diagram

The circuit comprises:

C.4.1.1 Power supply

A power supply with an output voltage stabilized to ± 5 % with a rated current not less than 0,1 A for each specimen. The test voltage shall be according to Table C.1, column 1.

NOTE If only one power supply is used for several specimens, each should have a circuit-breaker or similar device (see C.4.1.4).

C.4.1.2 Resistor

A 200 W resistor with ± 10 % resistance tolerance shall be connected in series with each specimen on the high-voltage side of the power supply. The resistance of the resistor shall be taken from Table C.1, column 3.

Table C.1 – Series resistor and contaminant flow rate

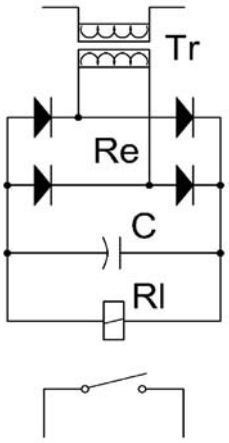
1	2	3
Test voltage	**Contaminant Flow rate**	**Series resistor, Resistance**
kV	ml/min	kΩ
3,5	0,30	22

C.4.1.3 Voltmeter

A voltmeter with an accuracy of 1,5 % of reading.

C.4.1.4 Overcurrent delay relay

An overcurrent delay relay (for example see Figure C.2) or any other device which operates when 60 mA or more has persisted in the high-voltage circuit for 2 s.



To the power supply switch
(S in Figure C.1)

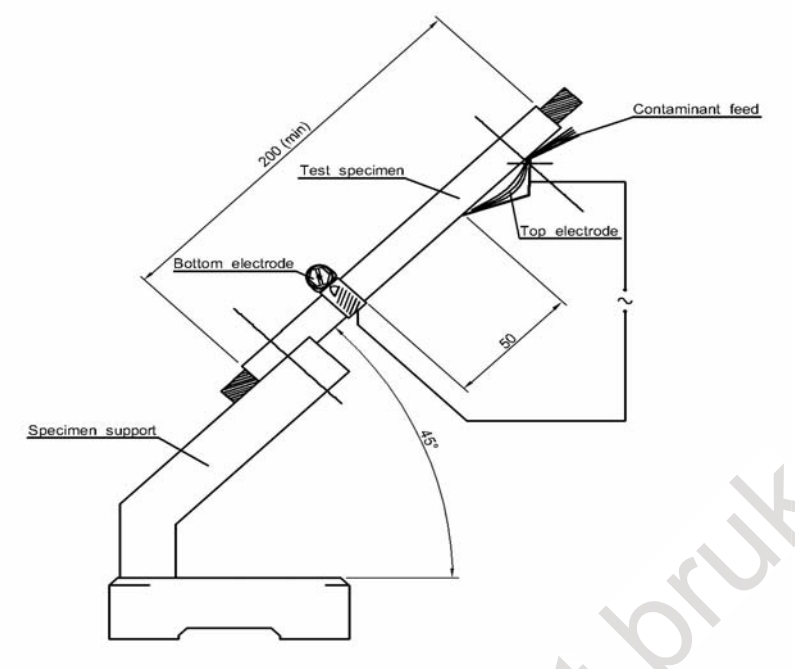
Key

Re	rectifier
Tr	transformer (winding 300/900 turns)
Rl	relay (2 500 Ω / 11 000 turns)
C	capacitor (200 μF)

Figure C.2 – Typical circuit for an overcurrent delay relay

C.4.2 Electrodes

All electrodes, fixtures and assembly elements associated with the electrodes, such as screws, shall be made of stainless steel. The electrode assembly is shown in Figure C.3 . The electrodes shall be cleaned prior to each test and replaced when necessary.

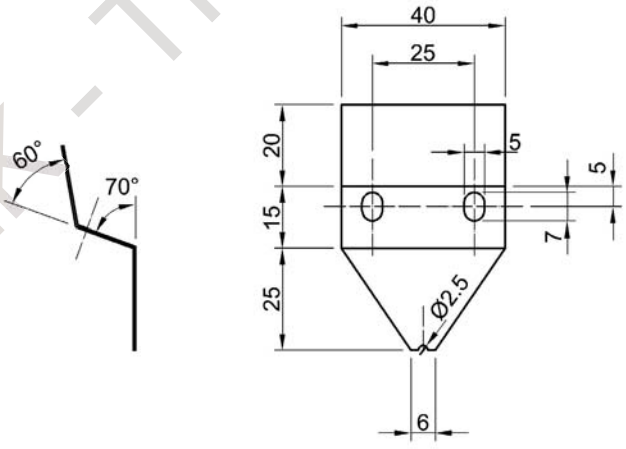


All dimensions in mm

Figure C.3 – Test assembly schematic

C.4.2.1 Top electrode

The top electrode is shown in Figure C.4. This electrode is fixed to the sample with a suitable plastic cable tie passed through the oval holes and around the sample.



All dimensions in mm

Figure C.4 – Top electrode, stainless steel, 0,5 mm thick

C.4.2.2 Bottom electrode

The bottom electrode is a standard stainless steel screw clamp.

C.4.3 Contamination

C.4.3.1 Contaminant

Unless otherwise specified use:

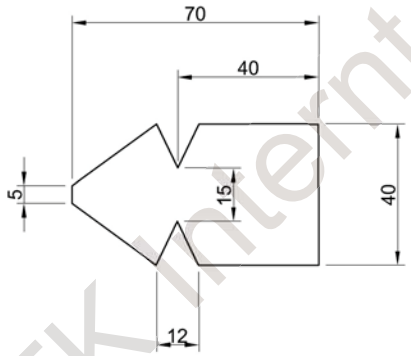
(0,1 ± 0,002) % by mass of NH_4Cl (ammonium chloride) analytical quality and (0,02 ± 0,002) % by mass of iso-octylphenoxypolyethoxyethanol (a non-ionic wetting agent) in distilled or de-ionized water.

This contaminant shall have a resistivity of (3,95 ± 0,05) Ω.m at (23 ± 1) °C.

The contaminant shall be not more than four weeks old and its resistivity shall be checked before each series of tests.

C.4.3.2 Applicator paper

Eight layers of filter-paper of the approximate dimensions in mm given in Figure C.5 are clamped between the top electrode and the specimen to act as a reservoir for the contaminant.



All dimensions in mm

Figure C.5 – Applicator paper

C.4.3.3 Contaminant flow

The contaminant shall be fed into this filter-paper pad so that a uniform flow between the top and the bottom electrodes shall occur before voltage application.

NOTE This can be done by pumping the contaminant through a tube into the filter paper pad. The tube can be held between the filter papers by a clip of stainless steel. Another possibility is to drip the contaminant into the filter paper pad with a fixed drop size and fixed number of drops per minute.

C.4.3.4 Flow rate

The rate of application of contaminant shall be that specified in Table C.1, column 2.

C.4.4 Timing device

A timing device with an accuracy better than ± 1 min/h.

NOTE For example a 1 min pulser with a counter is acceptable.

C.4.5 Depth gauge

A depth gauge with an accuracy of ± 0,01 mm. The point of the probe shall be hemispherical with a radius of 0,25 mm.

C.5 Procedure

C.5.1 Preparation of the test

C.5.1.1 Ambient conditions

Unless otherwise specified, the test shall be carried out at an ambient temperature of (23 ± 2) °C on five specimens.

C.5.1.2 Mounting

The specimen shall be mounted at an angle of 45° to the horizontal as shown in Figure C.3 with the electrodes (50 ± 0,5) mm apart.

For each test, a new filter-paper pad shall be used.

C.5.1.3 Adjustment of the contaminant flow

Start introducing the contaminant into the filter-paper pad allowing the contaminant to wet the paper thoroughly. Adjust the contaminant flow and calibrate to give a flow rate as specified in Table C.1, column 2. Observe the flow for at least 10 min and ensure that the contaminant flows steadily down the face of the test specimen between the electrodes. The contaminant shall flow from the quill hole of the top electrode and not from the sides or the top of the filter-paper.

C.5.2 Application of the voltage

With the contaminant flowing uniformly at the specified rate, according to Table C.1, column 2, switch on and raise the voltage to the test level according to Table C.1, column 1 and start the timing device. The voltage shall be maintained constant for 6 h.

C.5.3 Test evaluation

The test is successful if the current in the high-voltage circuit does not exceed 60 mA for any of the five specimens during 6 h.

The maximum depth of erosion shall be reported.

C.6 Test report

The report shall include:

Type and designation of the specimen tested.

Details of the specimens: Dimensions, cleaning procedure and solvent used, surface treatment if any. The covering thickness shall be reported.

Annex D
(normative)

Slippage test

D.1 Scope and object

This annex describes the test method for the evaluation of the slippage of the covering over the conductor under defined conditions.

D.2 Definitions

D.2.1
SMFL
the SMFL (specified minimum failure load) is the minimum load, specified by the purchaser or declared by the supplier, at which mechanical failure will not take place (EN 61284, definition 3.20)

D.2.2
RTS
RTS is the rated tensile strength, given in 4.2.1

D.3 Test specimens

D.3.1 Dimensions

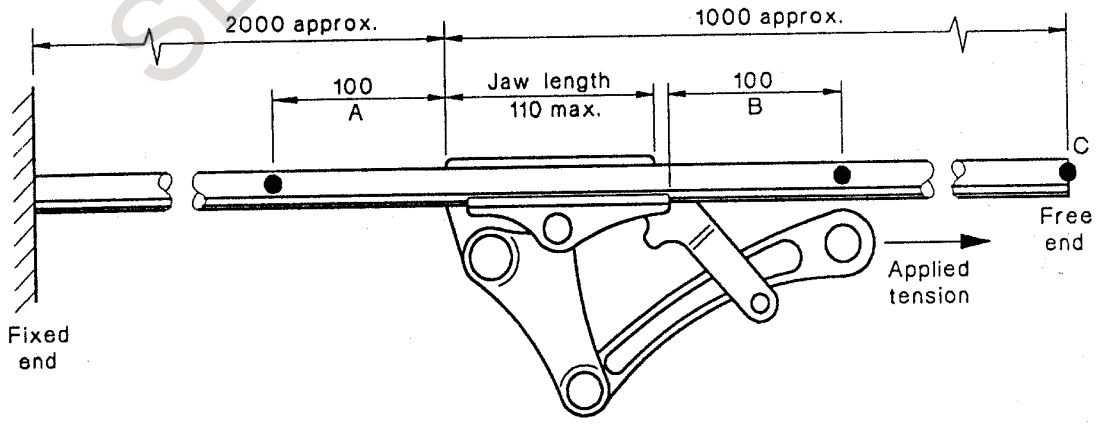
Type test shall be carried out on all nominal cross-sectional areas and on five samples, each 3 m long, taken from one production length and at least one metre from its end.

D.3.2 Preparation

The samples shall be kept at an ambient temperature of (23 ± 2) °C during 24 h before the test starts.

D.4 Apparatus

D.4.1 Clamp



All dimensions in mm

Figure D.1 – Clamping device

D.5 Procedure

The test shall be carried out according to the principle as shown in Figure D.1. The fixed end of the sample shall be fastened in an appropriate way, maintaining that both the conductor and the covering are fixed safely. The free end of the sample shall be finished clean with a file or similar so that all burrs and loose fragments will be removed from the conductor and the covering. A gripping device with half-round and grooved jaw profile, of a type that exists on the market, with 110 mm maximum jaw length, shall be applied approximately 2 m from the fixed end of the sample. The covering shall be provided with two marks, A and B, on each side of the gripping device and on a distance of 100 mm from the jaw (see Figure D.1).

Apply tension, F, in the gripping device. Start with F = 10 % of RTS. Maintain this tension for 10 min. If no slippage occurs, increase the tension by 10 % and maintain this tension for 10 min. Continue tension increase until one or more requirements according to D.6 are not met.

If the gripping device slips on the covering surface, the test has to be repeated and - if necessary - another gripping device has to be used.

NOTE Use of gripping devices with smooth jaws or with rounded grooves can lead to excessive slipping of the gripping device on the covering surface and should therefore be avoided.

D.5.1 Preparation of the test

Unless otherwise specified, the test shall be carried out at an ambient temperature of (23 ± 2) °C.

D.6 Requirements

Record the highest applied force, at which nothing of the following occurred during the test:

- the distance A exceeds 105 mm;
- the distance B is less than 95 mm;
- the covering protrudes by more than 3 mm outside the conductor in the free end (point C in Figure D.1);
- cracks appear in the covering.

D.7 Test report

Test report shall include code designation, number of sample, applied force (F) in N, type of slippage that occurred and calculated X-value.

The X-value of each sample shall be calculated according to the following formula:

$$X = (F / RTS)*100$$

where

X-value is in %;
F is the applied force according to D.6 in N;
RTS is the rated tensile strength in N.

The X-value for every tested set of samples is the median value of the calculated values.