IEC TR 61901

Edition 2.0 2016-05

TECHNICAL REPORT

Tests recommended on cables with a longitudinally applied metal foil for rated voltages above 30 kV (U_m = 36 kV) up to and including 500 kV (U_m = 550 kV)

IEC TR 61901:2016-05(en)

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INTERNATIONAL
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COMMISSION

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TESTS RECOMMENDED ON CABLES WITH A LONGITUDINALLY APPLIED METAL FOIL FOR RATED VOLTAGES ABOVE 30 kV (U_m = 36 kV) UP TO AND INCLUDING 500 kV (U_m = 550 kV)

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IEC TR 61901, which is a Technical Report, has been prepared by IEC technical committee 20: Electric cables.

This second edition cancels and replaces the first edition, published in 2005. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Recommendations on the tests to be performed at the different stages of the cable and cable system qualification (development tests, type tests, sample tests, routine tests, after installation tests) have been provided.

b) The performance level of the tests related to the longitudinally applied metal foil which depends on the cable design has been detailed.

c) Three cable designs that represent the world production of cables with longitudinally applied metal foil have been detailed.

d) A test on the weld design has been included, following the appearance of a new cable design with smooth and longitudinally welded aluminium foil (referred to in this document as combined design).

e) An examination of the cable at the end of the type test has been included.

f) The cable system approach (cable with installed accessories) has been considered and a short circuit test with accessories has been introduced.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
20/1551/DTR	20/1621/RVC

Full information on the voting for the approval of this Technical Report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

Numerous technical improvements have appeared on laminated coverings since 1992 and the publication of CIGRE Electra 141[1][1], in parallel with service experience. In 2006, CIGRE requested an upgrade of Electra 141 which was issued in February 2011 as Technical Brochure 446[2].

This new data was analysed and resulted in the revision of the first edition of IEC TR 61901.

1 Numbers in brackets refer to the Bibliography.

TESTS RECOMMENDED ON CABLES WITH A LONGITUDINALLY APPLIED METAL FOIL FOR RATED VOLTAGES ABOVE 30 kV (U_m = 36 kV) UP TO AND INCLUDING 500 kV (U_m = 550 kV)

1 Scope

IEC TR 61901, which is a Technical Report, specifies test methods and requirements for power cable systems, cables with extruded insulation and their accessories for fixed installations, for rated voltages above 30 kV (U_m = 36 kV) up to and including 500 kV (U_m = 550 kV).

The requirements apply to single-core cables and to their accessories for usual conditions of installation and operation, but not to special cables and their accessories, such as submarine cables, for which modifications to the tests may be necessary or special test conditions may need to be devised.

2 Normative references

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

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Definitions concerning the tests

3.1.1
routine test
test made by the manufacturer on each manufactured component (length of cable or accessory) to check that the component meets the specified requirements

3.1.2
sample test
test made by the manufacturer on samples of complete cable or components taken from a complete cable or accessory, at a specified frequency, so as to verify that the finished product meets the specified requirements

3.1.3
development test
test made during the development of the cable system

3.1.4
type test
test made before supplying on a general commercial basis a type of cable system in order to demonstrate satisfactory performance characteristics to meet the intended application

Note 1 to entry: Once successfully completed, these tests need not be repeated, unless changes are made in the cable or accessory materials, or design or manufacturing process which might change the performance characteristics.

3.1.5
prequalification test
test made before supplying on a general commercial basis a type of cable system in order to demonstrate satisfactory long term performance of the complete cable system

3.1.6
electrical test after installation
test made to demonstrate the integrity of the cable system as installed

3.2 Definitions concerning cable design

NOTE The following explanations are definitions of general designs types and not related to any specific construction specified in any IEC standard. Technological advances may lead to developments of these examples.

3.2.1
combined design
CD
metal screen that combines radial watertightness and electrical properties

Note 1 to entry: More details are given in Clause A.1.

3.2.2
separate design
SD
design with radial watertightness and electrical properties, managed by different metal components

Note 1 to entry: More details are given in Clause A.2.

3.2.3
separate semi-conductive design
SscD
design with separated electrical and radial watertightness properties with semi-conductive plastic coated foil

Note 1 to entry: More details are given in Clause A.3.

3.3 Other definitions

3.3.1
cable system
cable with installed accessories including components used for thermomechanical restraint of systems limited to those used for terminations and joints only

4 Development tests

4.1 Tests on cables

4.1.1 Impact test

There are three classes for resistance of the cable sheath to mechanical impact depending on the design and installation conditions of the cable, see Table 1.

Table 1 – Impact test requirements

Impact test	Design CD	Design SD	Design SscD [a]
Height (m)	0,27	1	N/A
Weight (kg)	27	5	N/A
Radius (*R*) (mm)	1	2	N/A
Number of impacts per location	4 impacts per location	1 impact per location	N/A
Number of locations	2 different points (see Figure 2 for locations)	5 different points more than 100 mm apart	N/A
[a] Impact test is not needed as this cable design is not intended to be directly buried.			

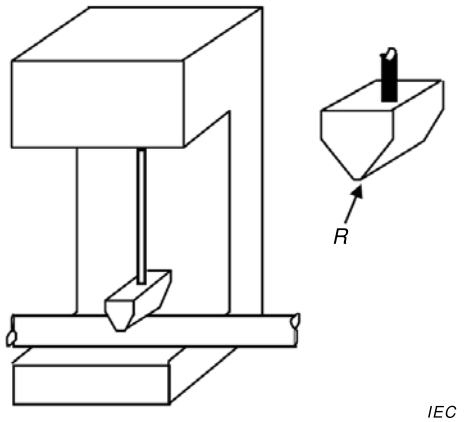


Figure 1 – Test apparatus for the impact test

Sample: A piece of cable, at least 1 m in length.

Test:

a) Test on CD design

The cable should be installed on a rigid metal base.

The test should be undertaken at a temperature of (20 ± 15) °C using a weighted metal of 27 kg, wedge of 90°, falling onto the cable from a height of 0,27 m. The wedge should have a radius of curvature of R = 1 mm at the point of impact and its axis should be perpendicular to that of the cable (Figure 1).

The requirements for the impact test are presented in Table 1.

The test should be performed on the overlap or on the welded seam (Impact point A) and on the opposite side of the cable (Impact point B) (see Figure 2).

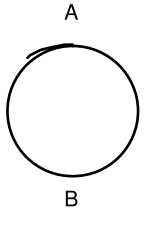


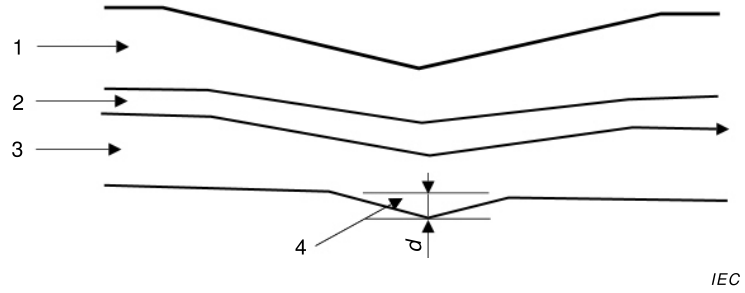
Figure 2 – Positions of the points of impact

Result: Visual inspection and measurement of impact depth.

After the impacts, the sample should be cut longitudinally along two lines at 90° from the points of impact. The inner side of the metal screen or metal sheath should be examined with normal vision:

– there should be no puncture at the points of impact A and B;

– a longitudinal cut should be made through the points of impact A and B (Figure 3). The insulation should not be deformed by more than 1 mm (distance *d,* see Figure 3) and should not show a deflection having a sharp angle into the insulation at the point of impact.



Key

1 oversheath

2 screen or metal sheath

3 outer semiconductive layer

4 penetration into the insulation

Figure 3 – Deformation at the impact points to be examined

b) Test on SD design

The cable, at least 1 m in length, should be installed on a rigid metallic base. The test should be undertaken at (20 ± 15) °C using a weighted metal wedge of 5 kg falling onto the cable from a height of 1 m. The 90° wedge should have a radius of curvature of R = 2 mm at the point of impact and its axis should be perpendicular to that of the cable (Figure 1).

An impact should be successively made at five different points along the cable; the distance between any two impact points should be at least 100 mm.

Result: Visual inspection

A 1 m sample should be dissected and visually examined. Examination of the samples with normal or corrected vision without magnification should reveal no cracks or separation of the metal foil of laminated protective coverings or harmful damage to other parts of the cable.

c) Test on SscD design

No test is needed due to the specific installation conditions.

4.1.2 Abrasion test

The abrasion test should be carried out if the oversheath material is not of type ST2 (PVC) or ST7 (MDPE – HDPE) as mentioned in IEC 60840[3] and IEC 62067[4].

The abrasion test should be performed on new materials, where satisfactory feedback on abrasion resistance from operation has not been provided.

Test:

A complete piece of cable should be tightly fixed to a metal base.

A conical test piece should be applied to the upper surface line of the cable. The conical piece should have a radius of curvature at its point of contact of 1 mm and the angle to the surface line of the cable should be 90°. The mass of the piece should be of 48 kg. The conical surface should be smooth.

The conical piece should be subjected to a to and fro motion, at constant speed, between the marks A and B as shown in Figure 4:

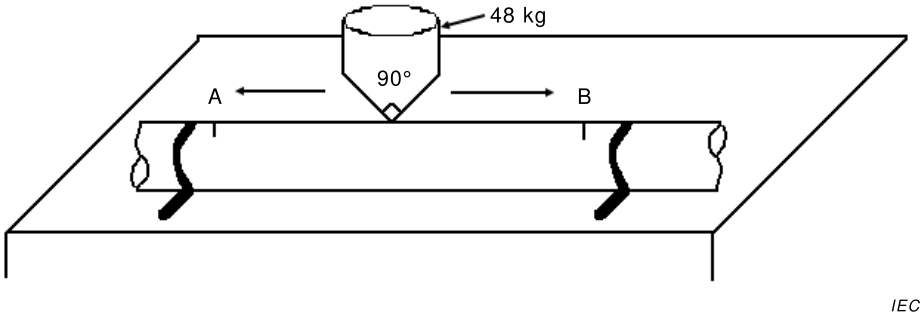


Figure 4 – Test arrangement for the abrasion test

The characteristics of the test should be as follows:

- distance between A and B: 50 cm ± 10 cm;
- speed of the conical piece between points A and B: 0,3 m/s with a tolerance of ±15 %;
- four to and fro motions of the conical piece.

At the end of the test, it should not be possible to see, with normal or corrected vision and without magnification, the metal screen under the oversheath between the A and B marks.

Case of SscD design

No test is needed due to the specific installation conditions.

4.1.3 Sidewall loading test

Current installation practice allows for a sidewall loading test, according to Table 2 , when the oversheath materials are ST2 or ST7 as mentioned in 4.1.2.

The test should be carried out if the designed value of sidewall loading during installation is expected to be higher than the one indicated in Table 2, provided the cable has successfully passed the impact (4.1.1) and abrasion (4.1.2) tests.

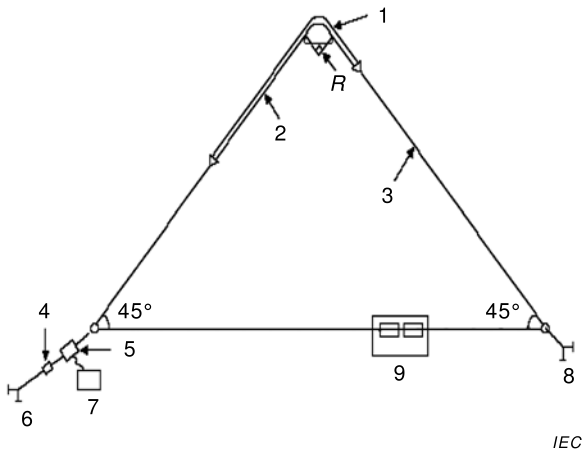
For special cable design (i.e. where optical elements are integrated into the power cable structure), it is recommended to carry out the test even if the sidewall loading during installation does not exceed the values in Table 2.

Table 2 – Maximum acceptable sidewall loadings

Design	CD/ST7	CD/ST7 + wires	SD/ST7	SscD/ST2
T/R (kN/m) [a]	25	10	10	7,5
[a] T = tension in the cable, R = bending radius.				

Test:

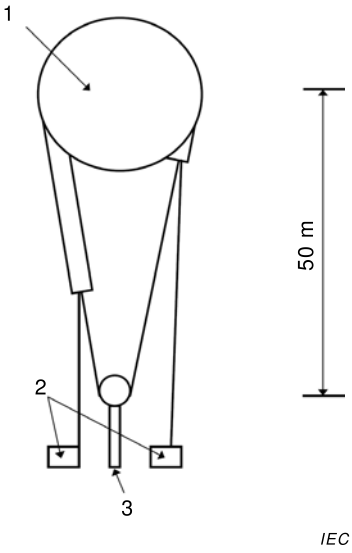
A cable sample 15 m in length should be tested using a test arrangement such as that shown in Figures 5a, 5b or 5c.



Key

1 fixed wheel (radius *R*)
2 cable sample
3 steel wire
4 tensioner
5 load cell
6,8 anchoring
7 recorder
9 winch

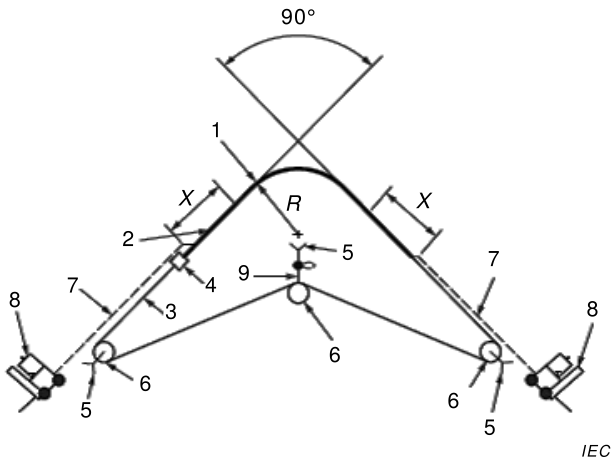
Figure 5a – Example (Arrangement A) for the sidewall loading test



Key

1 fixed wheel
2 winch
3 hydraulic pulling device

Figure 5b – Example (Arrangement B) for the sidewall loading test



Key

1 fixed wheel (radius *R*)
2 cable sample
3 steel wire
4 load cell
5 anchoring
6 sheave block
7 tow rope
8 towing device
9 chain block

Figure 5c – Example (Arrangement C) for the sidewall loading test

Figure 5 – Sidewall loading test arrangements

The cable should be subjected to one pass forward and one pass backward around a fixed wheel under the assigned sidewall loading (T/R), calculated using the tension in the steel wire (T) and the wheel radius (R). The radius should not be greater than the radius used for the bending test (see 5.1). The cable should be in contact with the wheel for at least 90° during the test. Lubricant should be applied at the contact point on the wheel.

The test may be made by other means, for example by pulling a cable 180° around a fixed wheel (Figure 5b or Figure 5c). A number of small diameter rollers (50 mm to 100 mm) can also be used.

The use of rollers may result in very high local pressure. The amount of pressure depends on many parameters: diameter of the rollers, bending radius, distance between rollers, cable stiffness, etc. The method/rule to define the diameter of the rollers and the distance between the rollers should be set according to the practice of the cable manufacturer and the information presented in CIGRE TB 194:2001, paragraph 4.2.1.3 [5].

Result: visual inspection

A 1 m sample subjected to the sidewall loading should be dissected and visually examined. Examination of the samples with normal or corrected vision without magnification should reveal no cracks or separation of the metal foil of laminated protective coverings, or harmful damage to other parts of the cable.

4.1.4 Long-term ageing of adhesive bonds of components of laminated covering

Test conditions

A 1 m sample bent in 5.1 should be placed in a solution of 1 % NaCl, 1 % Na_2SO_4 with NaOH added to adjust a pH of 8,5 ± 0,5. The solution should be maintained at (80 ± 3) °C during the test. The cable with both ends sealed should be immersed at a depth of at least 0,5 m.

The cable sample should be removed from the solution after 3 000 h of immersion and should comply with the following requirements.

Requirements

The adhesion strength and peel strength of the metal foil should be measured at room temperature in accordance with 6.1. The results should comply with the requirements of Table 3.

A 1 m sample should be dissected and visually examined. Examination of the sample with normal or corrected vision without magnification should reveal no cracks and no corrosion of the metal sheet of the laminated protective covering and no harmful damage to other parts of the cable.

4.1.5 Mechanical properties of the weld (case of CD design)

Test arrangement

The test arrangement is described in Figure 6. The test samples should be prepared either by decreasing the sheath thickness down to 0,5 mm, so the metal surface is not altered and the mechanical contribution of the sheath remaining thickness is negligible as compared to the metal laminate, or taking the samples just before extrusion of the plastic sheath. The edges of the samples should be smoothed or laser cut to avoid initiation of cracks from a cutting defect.

The test should be performed at ambient temperature. The distance between grips should be about 100 mm; the sample width should be between 10 mm and 50 mm. The separation rate

of the grips of the tensile testing machine should be 20 mm/min. The test should be performed on 5 samples including the welded zone and on 5 samples not including a welded zone.

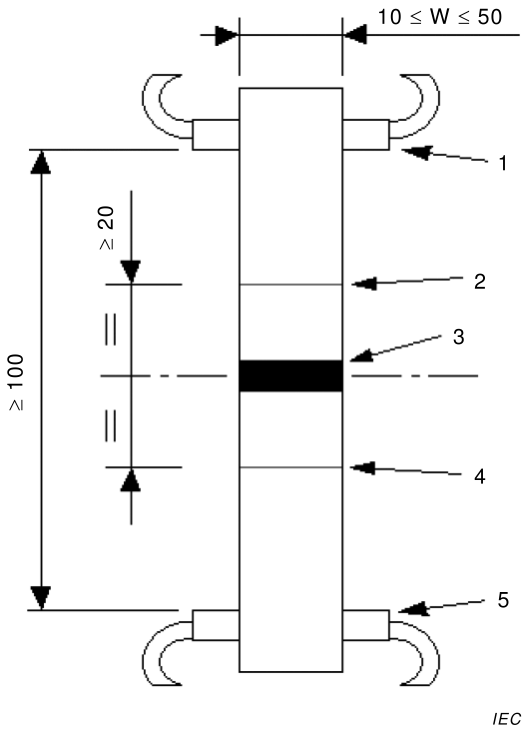
Two marks should be drawn on the sample, one on each side of the weld. Reference marks should be taken at not less than 10 mm from the weld, at each side, as shown in Figure 6.

Results

The median values of tensile strength and elongation at break should be calculated.

The median elongation at break (EB) and the median tensile strength (TS) of the samples with the weld should be more than 70 % (for EB) and more than 80 % (for TS) of that of the "non welded samples", measured between the two marks.

Dimensions in millimetres



Key

1,5 grip

2,4 reference mark

3 weld

Figure 6 – Test arrangement for the measurement of the mechanical properties of the weld

4.2 Tests on cable systems

4.2.1 General

The stated maximum temperature of the metal screen or metal wires is higher than the one stated in IEC 61443[6]. These changes are consistent with the requirements of the short-circuit test (visual examination). They have been verified through experimental testing (refer to CIGRE Report B1-101:2008 [7]), and are used in some national standards.

4.2.2 Short-circuit test

In the case of a single phase short-circuit, the current can flow through the metal screen, the metal screen/accessory connection and the ground lead of the joint or the termination.

The following test has been designed to test these components and connections in a simple way. It simultaneously tests the cable, the connection to accessories, the accessories, the grounding connection and the grounding cables.

If the requested short current is higher than 50 kA and no suitable equipment is available, the applied current may be minimum 50 kA and the time increased to reach the calculated temperature.

Sample

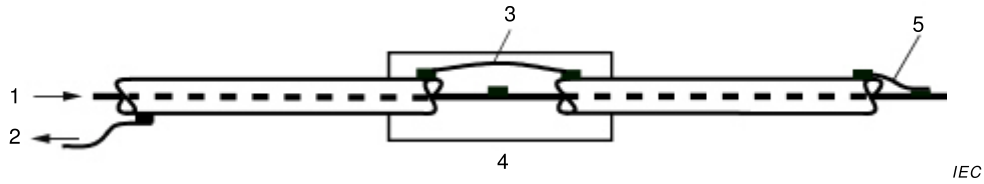
The test piece should be about 5 m long and consist of a cable with a joint and/or termination connection. There should be at least 2 m of cable on each side of the joint, earth connection and ground connection cables should be at least 2m long as well.

If two different metal foils are connected together inside the cable length during manufacturing, such a metal foil connection should be included in the test.

Test arrangement

In Figure 7, the short circuit-test arrangement is given for three kinds of joints:

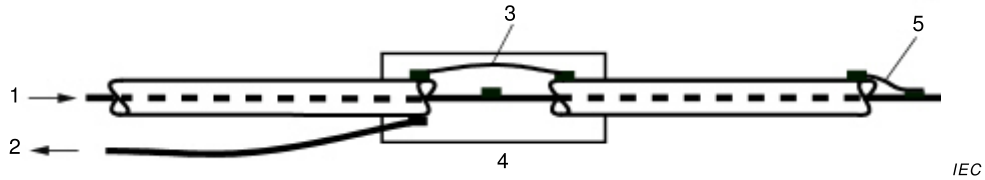
- straight through joint;
- joint with earth connection;
- sectionalized joint.



Key

1 short-circuit current IN
2 short-circuit current OUT
3 screen continuity
4 joint without earthing
5 electrical connection between conductor and shield

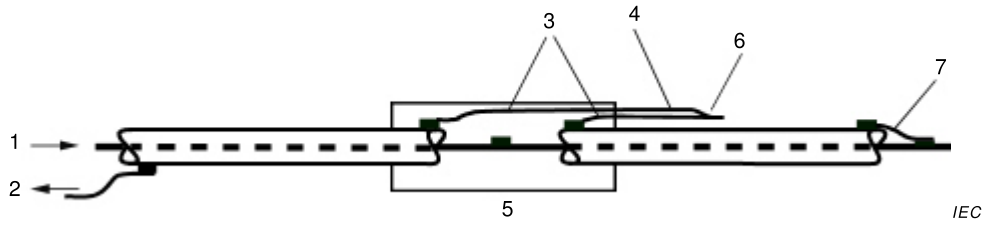
Figure 7a – Straight through joint



Key

1 short-circuit current IN
2 short-circuit current OUT
3 screen continuity
4 joint with earth connection
5 electrical connection between conductor and shield

Figure 7b – Joint with earth connection



Key

1 short-circuit current IN
2 short-circuit current OUT
3 bonding wires
4 bonding lead
5 sectionalized joint
6 bonding leads connected together
7 electrical connection between conductor and shield

Figure 7c – Sectionalized joint

Figure 7 – Short-circuit test arrangement for three kinds of joints

Rating

The short-circuit rating should be determined by calculation.

The maximum short-circuit duration is 5 s.

Asymmetry should not be taken into account.

Calculation of short-circuit rating for design CD

Calculations should be performed according to IEC 60949[8]:

- for the calculation of the non adiabatic factor for oversheaths, the formula of given in IEC 60949:1988, 6.1 should be applied;

- the factor *F* (factor to account for imperfect thermal contact) should be 0,9;
- the maximum temperature of the metal screen during the short-circuit should be 250 °C.

Short-circuit rating for design SD or CD plus wires

Calculations should be made according to IEC 60949:

- the current share between the two different metal screen components is equal to the inverse ratio of their respective resistances;
- for the calculation of the "non adiabatic factor" for oversheaths, the formula given in IEC 60949:1988, 6.1 should be applied;
- the factor *F* (factor to account for imperfect thermal contact) should be 0,9 for the laminated covering and 0,7 for the screen wires;
- the maximum temperature of the screen wires during short-circuit should be 250 °C.

When there is a layer thermally separating the screen wires from other materials in the cable, a temperature of 350 °C should be allowed.

Short-circuit rating for design SscD

Calculations should be performed according to IEC 60949:

- the current share between the two different metal screen components is equal to the inverse ratio of their respective resistances;
- for the calculation of the "non adiabatic factor" for oversheaths, the formula given in IEC 60949:1988, 6.1 should be applied;
- the factor *F* (factor to account for imperfect thermal contact) should be 0,9 for the laminated covering and 0,7 for the screen wires;
- the short-circuit temperature considered in IEC 61443 is 200 °C for the laminated covering. National rules or manufacturers' recommendations might supersede these values.

Test

Three short-circuits should be applied successively to the assembly:

- before the short-circuit test, the cable conductor should be heated and stabilized for at least 2 h at a temperature between 90°C and 95 °C;
- the short-circuits should be separated by an interval of time long enough to cool down the cable screen to within 5 K of its initial temperature.

Result: visual examination and integrity of the laminate

A 1 m cable sample including the metal foil connection, if any, should be dissected and visually examined. Examination of the sample with normal or corrected vision without magnification should reveal no cracks or separation of the metal foil of laminated protective coverings or damage to other parts of the cable.

There should be no sign of harmful deterioration of the cable/joint screen connection, neither at the cross bonding leads nor at the grounding connections.

The adhesion strength and peel strength should be according to Table 3.

Range of approval

The cable system design will be qualified for other cross-sections and voltages, provided that the calculated temperature at the end of the short-circuit and the maximum current for the other cross-sections, if lower than 50 kA, are both lower or equal to the one tested.

4.2.3 Corrosion at the accessories

The test should be performed according to IEC 62067:2011, Annex G or IEC 60840:2011, Annex G.

The test should be carried out using natural or tap water. Deionized water should not be used.

Result: examination

There should be no sign of corrosion of any metal part of the accessory, in particular the connection of the cable to the accessory, the accessory screen, or the accessory bonding leads.

5 Type tests

5.1 Test on cables – Bending test

The bending test is carried out before the following tests:

- long-term ageing of the adhesive bonds of the components of the laminated covering;
- electrical tests.

The cable sample should be bent around a test cylinder (for example, the hub of a drum) at ambient temperature for at least one complete turn and unwound, without axial rotation. The sample should then be rotated through 180° and the process repeated. This cycle of operations should be carried out three times in total.

The diameter of the test cylinder should not be greater than

- 20 ($D + d$) + 5 % for CD,
- 25 ($D + d$) + 5 % for SD and CD + wires,
- 10 D_s + 5 % for SscD.

where

D is the nominal overall diameter of the cable;

d is the nominal diameter of the conductor;

D_s is the nominal diameter of the shielding layer.

A negative tolerance is not specified, but testing at diameters below the specified values should only be carried out by agreement with the manufacturer.

Result

One sample of 3 m length should be examined. There should be no delamination, folding of the metal foil, radial buckling or crossing of the screen wires.

Adhesion and peel test should be carried out and the results should comply with the requirements of Table 3.

In the case of SccD, no delamination should occur.

5.2 Tests on cable system

The tests and the sequence of tests follows the relevant IEC standard (IEC 60840 or IEC 62067) but the bending test should be replaced by the one defined in 5.1.

The examination at the end of the type test should include a piece of cable, to show that there is no delamination or folding of the metal foil, radial buckling or crossing of the screen wires.

6 Sample test on cables

6.1 Adhesion and peel strength of the laminated metal foil

Adhesion and peel strength are defined as

$$F/w$$

where

F is the force (N);

w is the width of tape (mm).

In the case of a CD design, the concern is that delamination could damage the metal component and alter the electric functionality of the screen. Therefore, the adhesion strength and peel strength of the laminated covering should be of the highest degree.

In the case of an SD design, there is no concern that delamination will alter the electric functionality of the screen. The cable can be operated with short-circuit capability provided by the presence of the screen wires. However, the adhesion strength and peel strength should be high enough to preserve the laminate from folding and buckling.

In the case of an SscD design, the test cannot be performed because the metal foil is so thin that it breaks during the adhesion or peeling strength test.

Table 3 – Minimum acceptable adhesion or peel strength forces

Adhesion or peel strength	Type of screen					
	CD		SD		SscD	
N/mm	Copper	1,5	Copper	1,0	Lead	NA
N/mm	Alu	1,5	Alu	1,0	Alu	NA
N/mm	Overlap	1,5	Overlap	1,0	Overlap	NA
NA The test cannot be performed.						

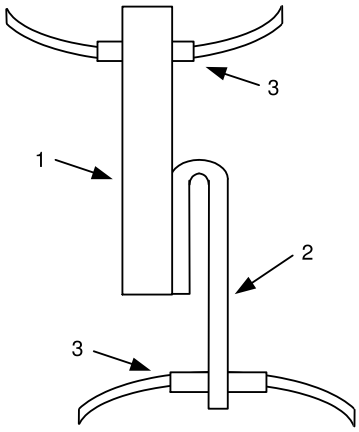
Test: Adhesion strength

The test specimens should be taken from the cable covering where the metal foil adheres to the oversheath.

There should be a total of 5 test specimens, 3 of them on the overlap or the weld of the metal screen and 2 of them on the opposite side.

The length and width of the test specimen should be approximately 200 mm and 10 mm respectively.

One end of the test specimen should be peeled between 50 mm and 120 mm and inserted in a tensile testing machine by clamping the free end of the oversheath or the insulation screen in one grip. The free end of the metal foil should be turned back and clamped in the other grip as shown in Figure 8.



Key

1 oversheath

2 metal foil

3 grip

Figure 8 – Adhesion of metal foil

The specimen should be held approximately vertically in the plane of the grips during the test.

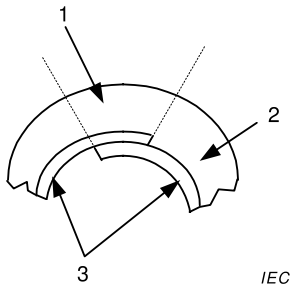
After adjusting the continuous recording device, the metal foil should be stripped from the specimen at an angle of approximately 180° and the separation continued for a sufficient distance to indicate the adhesion strength value. At least one half of the remaining bonded area should be peeled at a speed of approximately 50 mm/min.

When the adhesion strength is greater than the tensile strength of the metal foil so that the latter breaks before peeling, the test should be terminated and the break point should be recorded.

Test: Peel strength of overlapped metal foil

Procedure

A sample specimen 200 mm in length should be taken from the cable including the overlapped portion of the metal foil. The test specimen should be prepared by cutting only the overlapped portion from this sample as shown in Figure 9.



Key

1 specimen

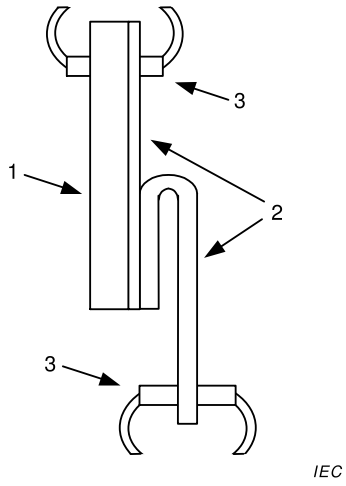
2 oversheath

3 metal foil or laminated metal foil

Figure 9 – Example of overlapped metal foil

The test should be conducted in the same manner as described for the adhesion strength test. The arrangement of the test specimen is shown in Figure 10.

The test should be performed on a total of 3 specimens.



Key

1 oversheath

2 metal foil or laminated metal foil

3 grip

Figure 10 – Peel strength of overlapped metal foil

6.2 Electrical properties and dimensions

The DC resistance of the screen and the dimensions of the metal part of the laminate should be checked in accordance with the relevant standards.

7 Routine tests

There is no specific routine test to be associated with advanced laminated coverings. The relevant standard should be applied.

8 After installation tests

There is no specific after installation test to apply. The relevant standard should be applied.

Annex A
(informative)

Details on cable designs given in 3.2

A.1 Combined design (CD)

A combined design cable covers a metal screen that combines radial watertightness and electrical properties:

- XLPE insulation system;
- semi-conductive bedding (water swellable if required);
- thick metal foil either welded or glued, that carries the full short-circuit current
  i) coated, and
  ii) bonded to the outer sheath (usually ST7).

Additional wires can eventually be added to match the short-circuit requirement. The metal foil is usually aluminium; copper can be used as well.

An example of a CD cable is shown in Figure A.1.

IEC

Figure A.1 – Example of combined design 500 kV cable

A.2 Separate design (SD)

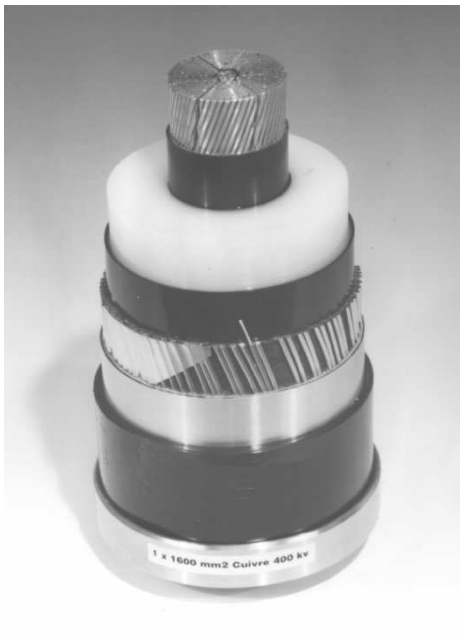
A separate design cable covers a design with radial watertightness and electrical properties, managed by different metal components:

- XLPE insulation system;
- copper or aluminium wires;
- water swelling tapes to block the screen area;
- coated laminated metal foil for example Al 0,2 mm + 0,05 mm coating on one side;

- oversheath (usually ST7)

The metal foil is usually aluminium; copper or other metal laminated foils can be used.

An example of SD cable is shown in Figure A.2.



IEC

Figure A.2 – Example of separate design 400 kV cable

A.3 Separate semi-conductive design (SscD)

A separate semi-conductive design cable covers a design with separated electrical and radial watertightness properties with semi-conductive plastic coated foil:

- XLPE insulation system;
- round copper wires screen, with non swelling semi-conductive tape;
- thin lead or Al foil (0,05 mm typical) with glue on one side, inner side (screen side) coated with typically 0,05 mm thick semi-conductive plastic;
- oversheath (usually ST2).

An example of SscD cable is shown in Figure A.3.

IEC

Figure A.3 – Example of separate semi-conductive design 275 kV cable

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