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EN 50397-2

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English version

Covered conductors for overhead lines and the related accessories for rated voltages above 1 kV AC and not exceeding 36 kV AC - Part 2: Accessories for covered conductors - Tests and acceptance criteria

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 2: Accessoires pour conducteurs gainés - Exigences et essais

Kunststoffumhüllte Leiter und zugehörige Armaturen für Freileitungen mit Nennspannungen über 1 kV und nicht mehr als 36 kV Wechselspannung - Teil 2: Armaturen für kunststoffumhüllte Freileitungsseile - Prüfungen und Anforderungen

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CENELEC

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

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 50397-2:2009 E

Foreword

This European Standard was prepared by 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 50397-2 on 2009-04-22.

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)	2010-05-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2012-05-01

EN 50397 consists of two parts: Part 1 "Covered Conductors" and Part 2 "Accessories". It covers the construction, performance and test acceptance criteria for covered conductors for overhead lines having a nominal voltage above 1 kV a.c. up to and including 36 kV a.c., and for the related accessories.

This European Standard EN 50397-2 covers the accessories.

NOTE It has been assumed in the preparation of this document that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

WARNING This European Standard calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

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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.

EN 50397-2 does not cover aspects related to the installation of overhead lines such as determination of clearances, spans, sags, etc.

1 Scope

This Part 2 of EN 50397 contains the requirements for accessories that are for use with the covered conductors in accordance with EN 50397-1. They are for applications in overhead lines with rated voltages *U* above 1 kV a.c. and not exceeding 36 kV a.c.

NOTE This European Standard describes the requirements and tests only for the accessories installed on the covered conductor itself.

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 50397-1:2006	*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*
EN 50483-5	*Test requirements for low voltage aerial bundled cable accessories - Part 5: Electrical ageing test*
EN 50483-6:2009	*Test requirements for low voltage aerial bundled cable accessories - Part 6: Environmental testing*
EN 61284:1997	*Overhead lines - Requirements and tests for fittings* (IEC 61284:1997)
EN 61467	*Insulators for overhead lines - Insulator strings and sets for lines with a nominal voltage greater than 1 000 V - AC power arc tests* (IEC 61467)
EN ISO 1461	*Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods* (ISO 1461)
IEC 60050-461	*International Electrotechnical Vocabulary (IEV) - Part 461: Electric cables*
ISO 2859-1	*Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*
ISO 2859-2	*Sampling procedures for inspection by attributes - Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*
ISO 3951 series	*Sampling procedures for inspection by variables*

3 Terms and definitions

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

3.1
type tests (symbol T)
tests required to be made before supplying a type of product covered by this EN on a general commercial basis in order to demonstrate satisfactory performance characteristics to meet the intended application

NOTE 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.

3.2
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

3.3
routine tests (symbol R)
tests intended to prove conformance of fittings to specific requirements and made on every fitting

3.4
rated voltage
the reference voltage (*U*), for which it is designed and which serves to define the electrical tests

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

3.5
ambient temperature
the temperature from 15 °C to 30 °C

3.6
factory-formed helical conductor fitting
fitting consisting of helically formed wires which provide the force necessary to grip the conductor by self-tightening

3.7
tension clamp
device which firmly attaches a covered conductor to a support and is designed to transmit the specified mechanical tension in the conductor to the supporting structure

[IEV 461-18-01 modified]

3.8
tension joints
mid-span sleeve designed to joint two lengths of tensioned conductor

3.9
non-tension joints
sleeve designed to joint two lengths of non tensioned conductor

3.10
suspension clamp
device which attaches a covered conductor to a support in order to carry its weight and any specified load

[IEV 461-18-02 modified]

3.11
top clamp
device to clamp the covered conductor on the top of a pin or line post insulator in order to carry its weight and any specified load

3.12
terminals
metallic device to connect a covered conductor to an electrical equipment

3.13
branch connector
metallic device for connecting a branch conductor to a main conductor at an intermediate point on the latter

[IEV 461-17-05]

3.14
arc protection devices (APD)
metallic device installed on the conductor or on accessories to protect the conductor against the possible arcs

3.15
arc protection system
assembly of arc protection devices, insulators and conductor, including all needed accessories

3.16
earth parking devices (EPD)
device installed on the conductor to allow temporary earthing

3.17
specified minimum slip load (SMSL)
minimum load specified by the purchaser or declared by the supplier at which slippage will not take place

3.18
specified minimum failure load (SMFL)
minimum load specified by the purchaser or declared by the supplier at which mechanical failure will not take place

NOTE From the probabilistic point of view, the specified minimum failure load corresponds to the value having the probability of e % in the distribution function of the strength of the fitting. The exclusion limit e % is usually taken within 2 % to 5 % with 10 % being the upper limit (see IEC 60826).

3.19
specified minimum mechanical damage failure load (SMMDL)
minimum load specified by the purchaser or declared by the supplier at which unacceptable deformation will not take place

3.20
rated tensile strength (RTS)
estimate of the conductor breaking load calculated using the specified tensile properties of the components wires (see EN 50397-1, 4.2.1)

3.21
minimum breaking load (MBL)
minimum breaking load of the conductor given by the manufacturer if not defined in EN 50397-1

4 Requirements

4.1 General requirements

General requirements shall be according to EN 61284, 4.1.

4.2 Specific requirements for fittings used on covered conductor

The piercing part or element of any accessories shall not decrease the mechanical strength of the conductor below than 90 % of the rated tensile strength (RTS) of the conductor. They can be watertight or not. If they are watertight, they shall prevent moisture ingress in the conductor. The water tightness shall be tested according to 7.8.

4.2.1 Tension clamps

For the purpose of terminating covered conductors over the covering fitting shall include, but are not limited to, the following:

- cone, bolted or wedge type clamp;
- preformed helical fittings.

The fittings shall be able to withstand the specific minimum failure load (SMFL) and shall not damage the covering and shall be designed to prevent the ingress of moisture during service.

NOTE "shall not damage the covering" means no damage shall occur which could affect the correct function of the covering.

4.2.2 Suspension and top clamps

Fittings for the purpose of suspension over the covering include, but are not limited to the following:

- top-clamps;
- pre-formed helical fittings;
- suspension clamp according to EN 61284, 11.4.

The fittings shall not damage the covering and shall be designed to prevent the ingress of moisture during service.

NOTE "shall not damage the covering" means no damage shall occur which could affect the correct function of the covering.

The suspension clamps shall be so designed that the effects of vibration, both on the covered conductor and on the clamps themselves, are minimised. The clamps shall be designed to avoid localized pressure or damage to the covered conductor.

If needed the suspension clamps shall have sufficient current carrying capability to avoid damage by fault currents.

The wear resistance of the articulation assembly shall be sufficient to prevent deterioration in service.

4.2.3 Connectors for piercing the covering

Connectors shall be capable of carrying the load current, and fault current if any.

4.2.4 Arc protection devices

These protection devices are designed to protect insulator sets and covered conductors against damage caused by power arcs (arcing horns, arcing rings).

The maximum short-circuit current shall be 10 kA for 1 s.

This device shall be delivered with an installation instruction. It shall include the description of the conditions for installation of arc protection system in order this whole installation withstands the arc power test at 1 kA and 10 kA.

The arc protective devices shall withstand a mechanical load in order to support the installation strengths.

4.2.5 Earth parking devices

The earth parking device shall be capable of carrying the short circuit current. The maximum short circuit current shall be 10 kA for 1 s.

These fittings shall withstand a mechanical load in order to support the installation strengths.

4.2.6 Joint

The joint shall be suitable for the covered conductor for which they are designed.

The joint shall have the same basic insulation properties as the conductor covering. In this case, the test shall by carried out according to EN 50397-1, Table 2, ref. 1.2 “High voltage test”. The conductor shall have a sufficient length so that the joint is immersed and the test duration shall be same as for sample test.

4.3 Marking

All products mentioned above shall permanently bear:

– manufacturer’s trade mark or logo;
– product code or reference;
– traceability code / batch number;
– the minimum and maximum cross section for which the unit is suitable;
– tightening torque or die reference, if applicable;
– recycling code, if any.

NOTE Other specific markings should be agreed between customer and manufacturer.

A test for marking is provided in 7.3.

5 Quality assurance

A quality assurance programme taking into account the requirements of this standard can be used by agreement between the purchaser and the supplier to verify the quality of the fittings during the manufacturing process.

NOTE Detailed information on the use of quality assurance is given in EN ISO 9000, and other standards in the same series.

6 Classification of tests – Type tests, sample tests, routine tests

6.1 Type tests

6.1.1 General

Type tests are intended to establish design characteristics. They are normally only made once and repeated only when the design or the material of the fitting is changed. The results of type tests are recorded as evidence of compliance with design requirements.

6.1.2 Application

Fittings shall be subject to type tests in accordance with Table A.1.

6.2 Sample tests

6.2.1 General

Sample tests are intended to verify the quality of materials and workmanship.

6.2.2 Application

Overhead line fittings shall be subjected to sample tests as listed in Table A.1. The samples to be tested shall be selected at random from the lot offered for acceptance. The purchaser has the right to make the selection.

6.2.3 Sampling and acceptance criteria

Unless otherwise agreed between purchaser and supplier, the sampling plan procedures according to ISO 2859-1, ISO 2859-2 (inspection by attributes) and to ISO 3951 (inspection by variables) shall be applied.

For each sample test, the type of inspection (by attributes or by variables) and the detailed procedures (inspection level, acceptable quality level, single, double or multiple sampling, etc.) shall be agreed between purchaser and supplier (see example in Annex B for inspection by attributes, and Annex C for inspection by variables).

NOTE Sampling inspection by variables is an acceptance sampling procedure to be used in place of inspection by attributes when it is more appropriate to measure on some continuous scale the characteristic(s) under consideration. In the case of failure load tests and similar expensive tests, better discrimination between acceptable quality and objective quality is available with acceptance sampling by variables than by attributes for the same sample size.

The purpose of the sampling process may also be important in the choice between a variables or attributes plan.

For example, a purchaser may choose to use an attributes acceptance sampling plan to ensure that parts in a shipment lot are within a required dimensional tolerance; the manufacturer may make measurements under a variables sampling plan of the same dimensions because he is concerned with gradual trends or changes which may affect his ability to provide shipment lots which meet the AQL.

6.3 Routine tests

6.3.1 General

Routine tests are intended to prove conformance of fittings to specific requirements and are made on every fitting. The tests shall not damage the fitting.

6.3.2 Application and acceptance criteria

The compliance with the requirements according to Clause 4 shall be established by the tests listed in Table 1. The tests are only for fittings which are clamping the conductor over the covering.

7 Tests

Three samples of fittings or clamps shall be tested, except when the specific subclause requires another number.

Annex A provides a table of the general tests required for each product.

NOTE This clause defines only the tests for fittings used over the covering.

For fittings directly used on conductor itself, see EN 61284.

7.1 Visual examination

This test shall include visual examination to ascertain conformity of the fittings, in all essential respects, with the contract drawings. Deviations from the drawings shall be subject to an agreement between supplier and purchaser and shall be appropriately documented as an agreed concession.

7.2 Dimensional and material verification

These tests shall include verification of dimensions, to ensure that fittings are within the dimensional tolerances stated on contract drawings. The purchaser may choose to witness the measurement of selected dimensions or may inspect the supplier's documentation when this is available. Measuring devices/gauges shall be selected with regard to the required precision and accuracy. Documentary evidence of calibration of such devices shall be provided on request.

Routine tests shall include a specified level of dimensional checking when required by the contract quality plan.

NOTE Particular attention should be given to those dimensions potentially affecting fitting interchange ability (for example ball and socket couplings (HD 474); clevis and tongue couplings (IEC 60471)) or mechanical and/or electrical performance.

7.3 Test for permanent marking

7.3.1 Principle

This test ensures that the marking of accessories is readable and durable.

7.3.2 Test arrangement

Three samples shall be tested.

7.3.3 Procedure

The marking shall be rubbed by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

NOTE Petroleum spirit is defined as the aliphatic solvent hexane with a content of aromatics of maximum 0,1 % by volume, a kauri-butanol value of 29, initial boiling point of 65 °C, a dry point of 69 °C and a specific gravity of 0,68 g/cm³.

7.3.4 Requirement

The marking shall remain clear and allow the accessory to be easily identified.

7.4 Mechanical tests

Number of fittings to be tested:

- **type tests**: mechanical type tests shall be carried out on three fittings. All fittings shall pass the test;

- **sample tests**: mechanical sample tests shall be carried out according to the procedures in EN 61284, 6.2.3.

7.4.1 Damage and failure load test for tension and suspension clamps (without helical fittings)

7.4.1.1 Principle

This test shall be carried out to ensure that the clamps are capable of sustaining loads without permanent deformation, which may affect the proper function of the clamp.

7.4.1.2 Test arrangement

The test shall be carried out as in Figures 1a, 1b, 1c, 1d or according to an equivalent scheme. Armour rods shall be applied to the covered conductor if any are used in service.

7.4.1.3 Procedure

The number of fittings tested, the method for increasing the load during the test and the method for evaluating the test results shall be those stated in EN 61284, 11.3.1. The angle α and the angle β, at the minimum damage load shall be the maximum design angle specified by the supplier.

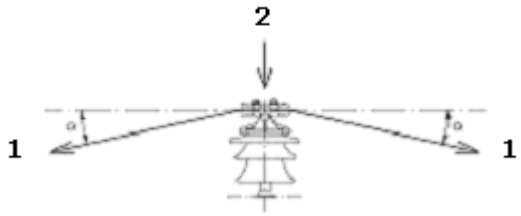


Figure 1a

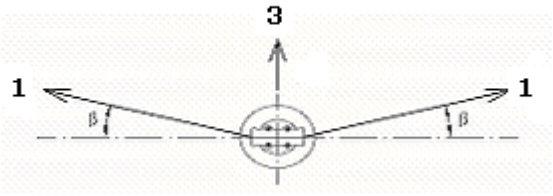


Figure 1b

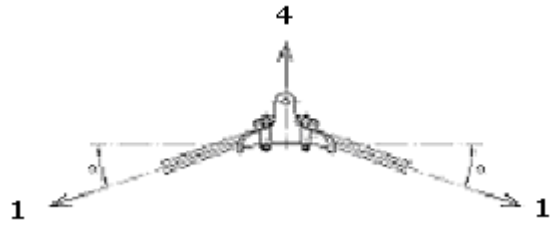


Figure 1c

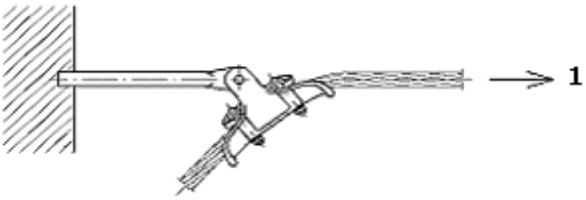


Figure 1d

Key

1 Specified mechanical minimum damage load (T)
2 Load (R)
3 Side Load (R2)
4 Liftload (R1)
α Max. design angle
β Max. design angle

Figure 1 - Test arrangement for damage and failure load test

7.4.1.4 Acceptance criteria

Regarding damage load, the test is passed if no permanent deformation, which can affect the proper function of the fitting, occurs at or below the specified mechanical minimum damage load.

7.4.2 Slip test at ambient temperature for suspension clamps

7.4.2.1 Principle

This test shall be carried out at ambient temperature to ensure that if high loads are applied to the covered conductor the suspension clamp will not allow the conductor to slip through the clamp below specified load.

7.4.2.2 Test arrangement

The covered conductor used in the test shall be the one for which the clamp is intended. The test shall be carried out on two samples using one of the three arrangements shown in Figure 2 depending on design of the test sample as follows (see Figures 2a, 2b and 2c).

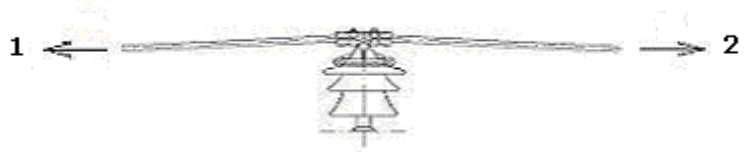


Figure 2a

Figure 2b

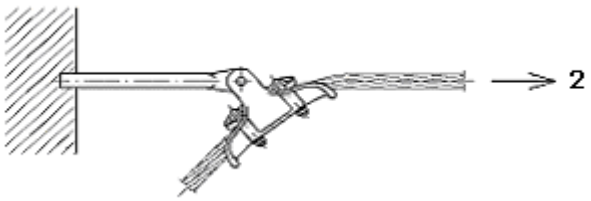


Figure 2c

Key

1 Static counter load, (G)
2 Applied load, (T)

Figure 2 - Test arrangement of slip test at ambient temperature

7.4.2.3 Procedure

a) Assemble the covered conductor section between the extremities of a tension machine and subject it to a load T (15 % of the MBL). If the maximum bending load of the insulator or insulator pin is less than the values T, this bending load value shall be applied.

b) Assemble the clamp on the covered conductor whilst it is under the load T, and tighten the nuts or bolts with the torque specified by the supplier, if any.

c) Reduce the load T applied to the conductor to zero, and detach the conductor from one end of the tension machine.

d) Attach the clamp to the free extremity of the tension machine.

e) Apply a load to 20 % of the specified minimum slip load (SMSL), to whole unit, with a displacement transducer fitted in such a way that the movement of the conductor relative to the fitting can be detected. In the absence of a transducer, a mark shall be made on the conductor to detect the above mentioned movement.

f) Gradually increase the load until it reaches minimum slip load. This load shall be maintained for 60 s.

g) Gradually increase the load until slippage of the conductor inside the clamps occurs.

h) For helical fittings (side ties) and other accessories a constant counter load G can be applied if needed to ensure the proper function of the fitting. This force G shall be agreed between customer and supplier. If counter load is used, the minimum slip load is the difference of applied load T and counter load G.

7.4.2.4 Acceptance criteria

No slippage greater than 5 mm shall occur at or below the specified minimum slip load. The fitting shall still be securely attached to the insulator despite any deformation that may take place.

The fitting shall be removed and the covering of the conductor examined. No tearing of the covering should have occurred.

7.4.3 Slip test at low temperature for suspension clamps

7.4.3.1 Principle

The suspension clamp shall be subjected to a steady load G and the part of the conductor close to the clamp is held at low temperature. The test shall be carried out in order to ensure that the conductor does not slip through the clamp and the clamp and the conductor remain undamaged.

This test shall also verify that all plastic parts of fittings are able to withstand the stress during assembling and operation at low temperature.

7.4.3.2 Test arrangement

The covered conductor used in the test shall be the one for which the clamp is intended. The test shall be carried out as follows (see Figure 3).

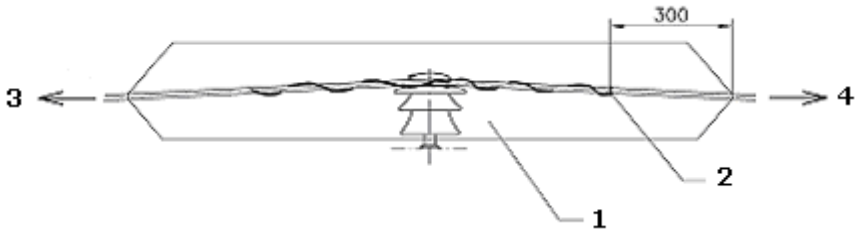


Figure 3a

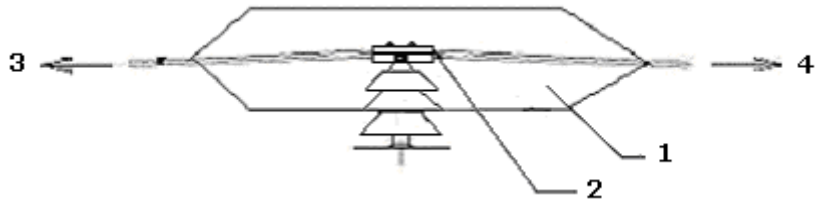


Figure 3b

Key

1 Low temperature zone
2 Marking
3 Static counter load (G)
4 Applied load (T)

Figure 3 - Slip test arrangement at low temperature

7.4.3.3 Procedure

a) The suspension clamp and a 300 mm section of the conductor shall be cooled to (-10 ± 3) °C for 24 h before assembling at this temperature.

b) The temperature shall be maintained at (-10 ± 3) °C.

c) Then the test shall be carried out according to 7.4.2.3, items a) to h).

NOTE 1 Assembly and slip test may be done in different chambers.

NOTE 2 For application in areas of very low temperature, the use of -10 °C may be inadequate. In such cases, upon agreement between manufacturer and customer, the product may be tested using a lower temperature. The chosen temperature shall be recorded in the test report.

7.4.3.4 Acceptance criteria

No slippage greater than 5 mm shall occur at or below the specified minimum slip load; at the end of the test the fitting shall still be securely attached to the insulator despite any deformation that may take place.

The fitting shall be removed and the covering of the conductor examined. No tearing of the covering should have occurred.

For non metallic ties, special test requirements like unbalanced shock load may be done but they shall be agreed between customer and supplier.

7.4.4 Slip test for suspension clamps at high temperature (optional)

This is a heat cycle test done with the maximum operating temperature of the conductor (see EN 50397-1, Table 1).

7.4.4.1 Principle

The suspension clamp shall be subjected to mechanical loads at high temperature to ensure that they are capable of sustaining loads likely to be encountered in service without being damaged or damaging the conductor.

The specified minimum slippage load shall be agreed between purchaser and supplier.

7.4.4.2 Test arrangement

Two suspension clamps shall be tested.

The covered conductor used in the test shall be the one for which the clamp is intended. The test shall be carried out as follows.

a) The clamp shall be installed in a test rig as shown in Figure 2.

b) A constant mechanical load shall be maintained on the clamps throughout the test. This load shall be agreed between purchaser and supplier.

c) Tails approximately 500 mm long shall remain outside the two clamps for connection to a current source.

7.4.4.3 Procedure

a) This load shall be stabilised at ± 10 %, and shall be maintained for a period of at least 6 h.

b) Temperature variation shall be achieved by passing current through the conductors.

c) The test assembly shall undergo 100 heat cycles at a rate of max four cycles per day.

d) The load shall be maintained for the duration of the test.

e) The conditions for each temperature cycle shall be:
   - an initial temperature at ambient;
   - the conductor temperature gradually increased to the maximum normal operating temperature of the conductor ± 5 K, in less than 2 h;
   - this high temperature maintained for 4 h;
   - the conductor and the tension clamp allowed to cool naturally to ambient temperature before the next cycle begins;
   - the temperature shall be measured underneath the covering of the conductor with a thermocouple. This thermocouple shall be positioned by sliding it under the strands of the outer layer of the conductor core and the covering.

7.4.4.4 Acceptance criteria

No damage shall occur which could affect the correct function of the suspension clamp or the conductor.

No damage shall occur on the covering.

The slippage, if any, of the covering shall be less than 20 mm.

7.4.5 Lift load and side load test for suspension clamp at ambient temperature

7.4.5.1 Principle

This test shall be carried out to ensure that the suspension clamp manage to hold the conductor in lift and side forces according to Table 1 without destroying the covering or slipping of the insulator.

7.4.5.2 Test arrangement

The covered conductor used in the test shall be the one for which the clamp is intended. The test shall be carried out on two samples, as follows (see Figure 4a or 4b).

Table 1 - Specified minimum loads

Cross section S mm²	**Specified minimum side load R2** N
25 ≤ S ≤ 35	1 400
35 < S ≤ 70	3 300
70 < S ≤ 120	3 900
120 < S ≤ 185	4 900
185 < S	5 500

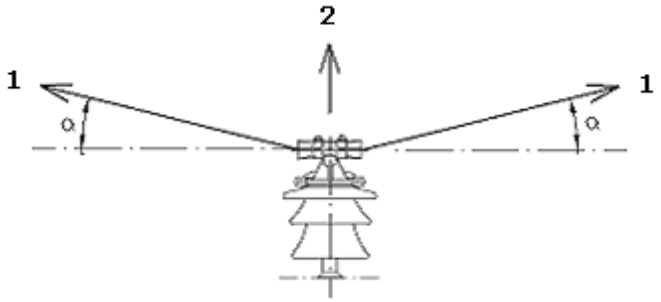


Figure 4a - Lift load test

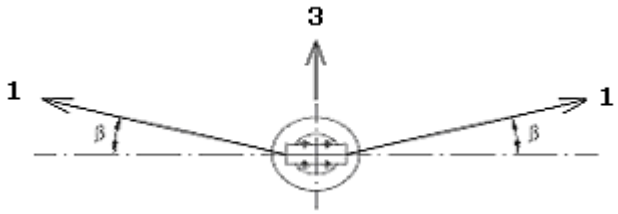


Figure 4b - Side load test

Key

1 Test load (T)
2 Lift load force (R1)
3 Side load force according to Table 1 (R2)
α Lift angle
β Side angle

Figure 4 - Lift and side load test

7.4.5.3 Procedure

a) For lift load test: The covered conductor is assembled between the extremities of a tensile machine. Then a tensile load is applied in order that the lift load R1 reaches 2 000 N. The angle α shall be less than 15°.

b) For side load test: The covered conductor is assembled between the extremities of a tensile machine. Then a tensile load is applied in order that the side load R2 reaches the minimum value given in Table 1. The angle β shall be less than 15°.

c) Assemble the clamp on the covered conductor whilst it is under the tensile load, and tighten the nuts or bolts with the torque specified by the supplier, if any.

d) Gradually increase the load until it reaches specified minimum lift or side load. This load shall be maintained for 60 s.

7.4.5.4 Acceptance criteria

No damage shall occur at or below the specified minimum lift or side load. The fitting shall still be securely attached to the insulator despite any deformation that may take place.

The fitting shall be removed and the covering of the conductor examined. No tearing of the covering should have occurred.

7.4.6 Thermal test for suspension clamp

7.4.6.1 Principle

The suspension clamp shall be subjected to mechanical loads at high temperature to ensure that they are capable of sustaining loads likely to be encountered in service without being damaged or damaging the conductor.

7.4.6.2 Test arrangement

One suspension clamp shall be tested.

The covered conductor used in the test shall be the one for which the fitting is intended. The test shall be carried out as follows:

a) the suspension clamp shall be installed in a test rig as shown in Figure 4b using the maximum angle for which the clamp is designed;

b) a constant mechanical load of 15 % of SMFL shall be maintained on the fitting throughout the test.

7.4.6.3 Procedure

a) This load shall be stabilised at the specified value with a tolerance of ± 10 % and shall be maintained for a period of at least 6 h.

b) Temperature variation shall be achieved by passing current through the conductors.

c) The test assembly shall undergo 100 heat cycles at a rate of max. 4 cycles per day.

d) The load shall be maintained for the duration of the test.

e) The conditions for each temperature cycle shall be:
   - an initial temperature at ambient;
   - the conductor temperature gradually increased to the maximum normal operating temperature of the conductor ± 5 K, in less than 2 h;
   - this high temperature maintained for 4 h;
   - the assembly allowed cooling naturally to ambient temperature before the next cycle begins.

7.4.6.4 Acceptance criteria

No damage shall occur which could affect the correct function of the fitting.

No damage shall occur which could affect the correct function of the covering.

7.4.7 Tensile test for tension clamps at ambient temperature

7.4.7.1 Principle

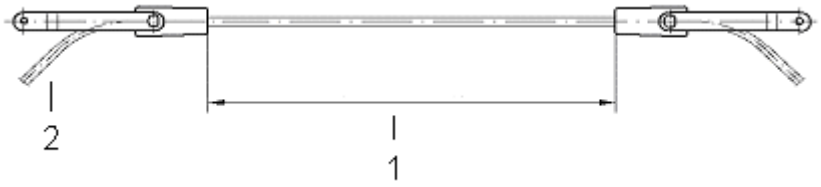
Two tension clamps shall be subjected to high mechanical loads at ambient temperature to ensure that they are capable of sustaining loads likely to be encountered in service without being damaged or damaging the conductor.

7.4.7.2 Test arrangement

Two tension clamps shall be assembled on to the covered conductor upon the covering in accordance with the manufacturing instructions and fitted into a tensile test machine as shown in Figure 5: the length of the tails on the unloaded side of the clamp shall be at minimum of 500 mm.

The distance between the two clamps shall be at minimum of 100 x d. d is the diameter of the covered conductor including covering.

The test shall be carried out at ambient temperature.



Key

1 Min.100 x d
2 Length of the tail 500 mm

Figure 5 - Tensile test arrangement

7.4.7.3 Procedure

The load shall be increased to 20 % of the SMFL. Then, the conductor shall be marked where it exits from the clamps.

The load shall be gradually increased until it reaches 60 % of the SMFL of the assembly. The load shall be maintained to this value for a time of 60 s.

Without any subsequent adjustment of the fitting, the load shall be steadily increased in not less than 30 s until the SMFL is reached. Such load shall be kept constant for 60 s at least.

Without any subsequent adjustments of the fitting, the load shall be steadily increased until failure occurs. The failure load shall be recorded.

7.4.7.4 Acceptance criteria

The test is passed if the movement of the conductor relative to the clamp is less than 3 mm and no failure of the clamp or covered conductor occurs below the SMFL, where SMFL= 0,80 x MBL.

NOTE For this test the SMFL refers to the grip of the clamp and the friction between covering of the conductor and the metallic surface of the conductor.

7.4.8 Tensile test for tension clamps at low temperature

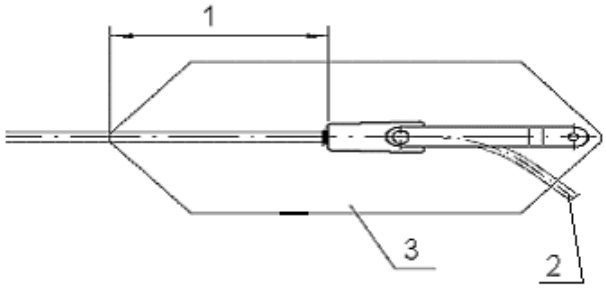
7.4.8.1 Principle

The tension clamp shall be subjected to a steady load whilst at least one tension clamp and the part of a cable close to the clamp are held at low temperature. The test shall be carried out in order to ensure that the covered conductor does not slip through the clamp and that the clamp remains undamaged.

7.4.8.2 Test arrangement

Two tension clamps shall be assembled on to the covered conductor upon the covering in accordance with the manufacturing instructions and fitted into a tensile testing machine as shown in Figure 5. The fitting shall be installed in a cold temperature zone as shown in Figure 6: the length of the tails on the unloaded side of the clamp shall be at minimum of 500 mm.

NOTE Assembly and tensile test may be done in different chambers.



Key

1 300 mm
2 Length of the tail 500 mm
3 Low temperature zone

Figure 6 - Arrangement for the low temperature zone

7.4.8.3 Procedure

The distance between the two clamps shall be at minimum of 100 x d, where d is the diameter of the covered conductor including covering.

The test shall be carried out with a static load of 0,7 x MBL.

At least one tension clamp and a 300 mm section of the conductor shall be cooled to (-10 ± 3) °C for 1 h during which time a tensile load is maintained at ± 10 %. See Figure 5 and Figure 6.

NOTE For application in areas of very low temperature, the use of -10 °C may be inadequate. In such cases, upon agreement between manufacturer and customer, the product may be tested using a lower temperature. The chosen temperature shall be recorded in the test report.

Before starting the 24 h period the conductor shall be marked at the point where it exits the tension clamp. These marks shall be used for reference purposes to measure slippage. Marking shall be applied of a load to 20 % of the specified minimum slip load.

After assembling of the covered conductor section between the extremities of a tension machine, the conductor shall be subjected to a load, which is agreed between purchaser and supplier.

To assemble the clamp on the covered conductor, the nuts or bolts shall be tightened with the torque specified by the supplier.

The tension clamp shall be maintained at the specified minimum slip load agreed between the purchaser and supplier for 24 h at (-10 ± 3) °C.

After 24 h a gradual increase of the load until slippage of the conductor inside the tension clamp occurs.

7.4.8.4 Acceptance criteria

No slippage more than 3 mm shall occur at or below the specified minimum slip load. No damage shall occur which could affect the correct function of the tension clamp.

7.4.9 Tensile test for tension clamps at high temperature

This is a heat cycle test done with the maximum operating temperature of the conductor (see EN 50397-1, Table 1).

7.4.9.1 Principle

The tension clamp shall be subjected to mechanical loads at high temperature to ensure that they are capable of sustaining loads likely to be encountered in service without being damaged or damaging the conductor.

The specified minimum slippage load shall be agreed between purchaser and supplier.

7.4.9.2 Test arrangement

Two tension clamps shall be tested.

The covered conductor used in the test shall be the one for which the clamp is intended. The test shall be carried out as follows:

a) the clamp shall be installed in a test rig as shown in Figure 5;

b) a constant mechanical load shall be maintained on the clamps throughout the test. This load shall be agreed between purchaser and supplier;

c) tails approximately 500 mm long shall remain outside the two clamps for connection to a current source

7.4.9.3 Procedure

a) The load shall be stabilised at ± 10 %, and shall be maintained for a period of at least 6 h at ambient temperature.

b) Temperature variation shall be achieved by passing current through the conductors.

c) The test assembly shall undergo 100 heat cycles at a rate of maximum four cycles per day.

d) The load shall be maintained for the duration of the test.

e) The conditions for each temperature cycle shall be:

- an initial temperature at ambient;
- the conductor temperature gradually increased to the maximum normal operating temperature of the conductor ± 5 K, in less than 2 h;
- this high temperature maintained for 4 h;
- the conductor and the tension clamp allowed to cool naturally to ambient temperature before the next cycle begins;
- the temperature shall be measured underneath the covering of the conductor with a thermocouple. This thermocouple shall be positioned by sliding it under the strands of outer layer of the conductor core and the covering.

7.4.9.4 Acceptance criteria

No damage shall occur which could affect the correct function of the tension clamp or the conductor.

No damage shall occur on the covering.

If any, the slippage of the covering shall be less than 20 mm.

7.4.10 Clamp bolt tightening test

7.4.10.1 For tension and suspension clamps

7.4.10.1.1 Principle

This test shall be used for both tension and suspension clamp bolts.

This test shall be carried out to ensure that nuts and bolts used to apply the pressure needed to clamp the covered conductor are not damaged, and do not damage the clamp during use.

7.4.10.1.2 Test arrangement

Two clamps shall be tested.

The test shall be carried out at ambient temperature.

The clamp shall be installed on to the covered conductor for which the clamp is designed.

The bolts and/or nuts shall be tightened to the installation torque specified by the manufacturer.

7.4.10.1.3 Procedure

The torque shall be increased to 1,1 x the specified installation torque value.

The bolts and/or nuts shall then be slackened until they exert no pressure on the conductor bundle and the clamp becomes loose enough to remove.

NOTE The clamp may be left in place during this test as long as the loosening process is to such an extent that the clamp could be removed if required.

The tightening and loosening process shall be completed 10 times.

The torque shall then be increased until damage occurs. Tightening torque and damage shall be recorded.

7.4.10.1.4 Acceptance criteria

No damage shall occur, during the tightening and loosening process which could affect the correct function of the clamp or its nuts.

7.4.10.2 For connectors

7.4.10.2.1 Principle

To ensure that when tightened, the bolts used to make the electrical connection and provide mechanical security, do not cause the IPC to fail mechanically during installation.

7.4.10.2.2 Test arrangement

Two connectors shall be tested.

The conductor on to which the IPC is to be installed shall be tensioned to 20 % of the MBL.

The IPCs shall be installed onto conductors for which it is designed. Where the IPC is designed to accept more than one size of conductor, two samples shall be tested in each of the following conductor combinations:

Main	**Branch**
Max.	Max.
Min.	Min.
Min.	Max.

7.4.10.2.3 Procedure

The connectors shall be tightened, to the maximum torque specified by the manufacturer, plus 20 %.

7.4.10.2.4 Torque application

The tightening shall be carried out at a rate of approximately 1 full turn in 8 s or at the rate specified in the manufacturer's installation instructions.

7.4.10.2.5 Acceptance criteria

The connector shall be undamaged.

7.4.11 Shear head function test

7.4.11.1 Principle

To ensure that the shear head mechanism functions correctly within the specified torque range.

7.4.11.2 Test arrangement

Three samples shall be tested at each of the following temperatures:

- the minimum temperature shall be (-10 ± 3) °C;
- the maximum temperature shall be (50 ± 3) °C.

NOTE For application in areas of very low temperature, the use of -10 °C may be inadequate. In such cases, upon agreement between manufacturer and customer, the product may be tested using a lower temperature. The chosen temperature shall be recorded in the test report.

The samples shall be tested in the following cross section combinations:

Main	**Branch**
Min.	Min.
Max.	Max.

In case of arc protection device or earth parking device, the branch conductor shall be replaced by the rod.

7.4.11.3 Procedure

The connector assemblies shall be pre-conditioned until they reach the test temperature. The temperature shall be maintained for a minimum of 15 min.

The shear head shall then be tightened, in accordance with the manufacturer's installation instructions, until the head shears. This torque shall be recorded.

The test shall be repeated for the three samples at each of the specified temperatures and cross section combination.

7.4.11.4 Acceptance criteria

For each of the test temperatures and cross section combination, the torque at which the shear head shears, shall be within the tolerances of the manufacturer's specified torque.

7.4.12 Test for mechanical damage to the main conductor

7.4.12.1 Principle

This test ensures that the mechanical performance of the conductor is not impaired as a consequence of installation of the connector.

7.4.12.2 Test arrangement

Two specimens shall be tested. Where the connector is designed to accept more than one size of conductor, two specimens shall be tested in each of the following conductor combinations:

Main	**Branch**
Max.	Max.
Min.	Max.
Min.	Min.

In case of arc protection device or earth parking device, the branch conductor shall be replaced by the rod.

The conductor shall be mounted in a tensile machine in a suitable manner.

The conductor, on which the connector will be tested, shall be tensioned to between 10 % and 20 % of the MBL.

The conductor length shall be between 0,5 m and 1,5 m.

7.4.12.3 Procedure

Connectors shall be installed in accordance with the manufacturer's instruction.

The connector shall be tightened to the manufacturer's specified maximum torque when the connector is designed with a shear head, or 1,1 x the manufacturer's specified nominal torque when the connector is designed without a shear head.

The connectors shall be applied to the main conductor and the connector shall be tensioned until it reaches 90 % of the MBL.

The load shall be maintained for 1 min.

7.4.12.4 Acceptance criteria

The conductor shall maintain the test for one minute without any failure or any damage that would prevent the correct function of the conductor.

7.4.13 Branch cable pull-out test

7.4.13.1 Principle

To ensure that the connector provides mechanical security of the branch conductor.

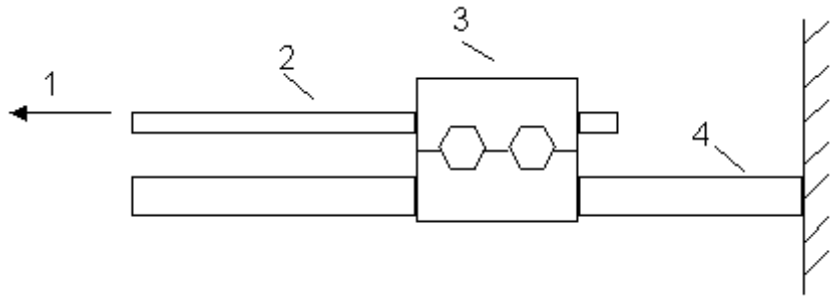
7.4.13.2 Test arrangement

Two specimens shall be tested. Where the connector is designed to accept more than one size of conductor, two specimens shall be tested in each of the following conductor combinations:

Main	**Branch**
Max.	Max.
Min.	Min.

The branch connector shall be positioned and then installed in accordance with manufacturer's instruction.

The general arrangement is shown in Figure 7.



Key

1 Axial load of 1 kN or 10 % of SMFL whichever less
2 Branch
3 IPC installed accordance with manufacturer's rec.
4 Main secured mechanical

Figure 7 - Test arrangement

7.4.13.3 Procedure

The conductor shall be marked at the connector so that any slippage during the test can be measured.

A tensile load shall be applied approximately axially between the branch conductor and the opposing main conductor, at a rate between 100 N/min and 500 N/min. This load shall be 1 kN or 10 % of SMFL, whichever is less.

The load shall be maintained for 1 min.

7.4.13.4 Acceptance criteria

Conductor slippage shall not exceed more than 3 mm.

The conductor shall maintain the test for one minute without failure or any damage that would prevent the correct function of the cable.

7.4.14 Low temperature assembly test

7.4.14.1 Principle

To ensure electrical contact is established when the IPC is applied in cold conditions.

7.4.14.2 Test arrangement

Two samples shall be tested. Where the IPC is designed to accept more than one size of conductor, two samples shall be tested in each of the following conductor combinations:

Main	**Branch**
Max.	Max.
Min.	Min.
Min.	Max.

7.4.14.3 Procedure

The connectors and conductor shall be further pre-conditioned until they reach the test temperature of (-10 ± 3) °C, before they are assembled.

NOTE For application in areas of very low temperature, the use of -10 °C may be inadequate. In such cases, upon agreement between manufacturer and customer, the product may be tested using a lower temperature. The chosen temperature shall be recorded in the test report.

Electrical continuity shall be measured between the main and branch cables.

Assembly shall be made in the cold temperature chamber, at (-10 ± 3) °C.

The IPC shall be installed in accordance with the manufacturer's instructions using a torque meter.

Alternatively the assembly can be removed from the cold chamber and the torque applied outside. In this case the temperature of the connector and the core shall be monitored and the torque applied within the temperature limits defined above. This temperature shall be within these limits once contact is made.

7.4.14.4 Torque application

The tightening shall be carried out at a rate of approximately 1 full turn in 8 s or at the rate specified in the manufacturer's installation instructions.

NOTE 1 Initial tightening may be carried out without the use of tools until the nut, or bolt, cannot be further tightened using the fingers and thumb or one hand.

The torque at which continuity is achieved shall be recorded.

NOTE 2 Accuracy of torque meters is usually guaranteed at positive temperature ranges. Where the torque is measured within the cold chamber the accuracy of the torque meter may not be guaranteed.

7.4.14.5 Acceptance criteria

Electrical continuity shall be achieved at a torque value less, or equal to, 70 % of the manufacturer's specified minimum installation torque.

7.4.15 Mechanical test on earth parking device (EPD)

7.4.15.1 Principle

The earth rod shall withstand the applied forces during installation of earthing links and the weight of these links. So this test is intended to check if the mechanical properties of the clamps are able to withstand to the expected forces, and if conductor is not damaged by the installation as well that by the use of this earthing point.

7.4.15.2 Test arrangement

The arrangement is shown in Figure 8. The tension of the conductor during the test shall be 35 N/mm². The total length of the conductor shall be at least 2 m and the EPD shall be fitted at 1 m from one end. The EPD shall be tightened at the nominal torque given by the manufacturer.

7.4.15.3 Procedure

The electrical resistance between the EPD and the conductor shall be measured for each clamp before and after the mechanical test. The measurement points shall be the same before and after the test.

The force is applied using a clamp tightened on the bare bail.

The EPD shall be subjected, first, to a horizontal force (Fh) parallel to the axis of the cable of 300 N.

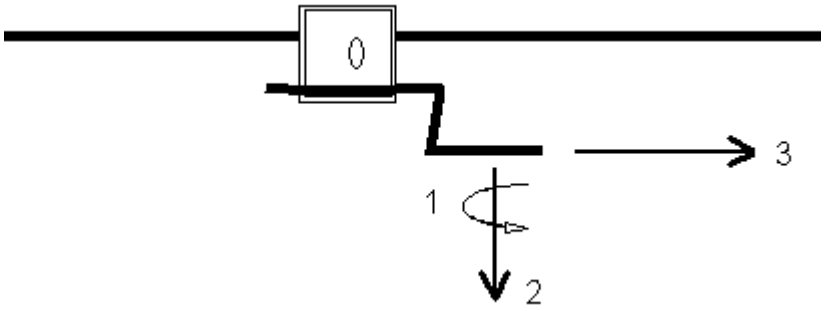
Then, the EPD shall be subjected to a vertical force (Fv) of 500 N.

For the last step EPD shall be subjected to a torque moment (M) of 36 Nm applied on the bail around a vertical axis.

For each step, the loads are gradually applied until the rated value, maintained for 15 s and then released.

7.4.15.4 Acceptance criteria

At the end of the test no visible displacement or damage shall be observed. The change of the electrical resistance shall be less than 20 %. The breaking value of the main conductor shall be at least 90 % of the MBL.



Key

1 Torque moment
2 Vertical force
3 Horizontal force

Figure 8 - Mechanical stresses on earth parking device

7.5 Hot dip galvanizing test

7.5.1 Principle

If metallic parts of the clamps are hot dip galvanized, type and sample tests shall include hot dip galvanizing tests to ensure that galvanizing coatings comply with the acceptance criteria as specified in EN ISO 1461.

7.6 Water tightness test for IPC

7.6.1 Principle

The covered conductor used in testing shall be immersed in water together with the fittings in order to ensure that no water can penetrate the covering. This test shall be made with non-water-blocked conductors.

7.6.2 Test arrangement

The connector or other piercing shall be assembled on the covered conductor according to the supplier's instruction and immersed in water (see Figure 9). The test shall be carried out in the following conductor combination:

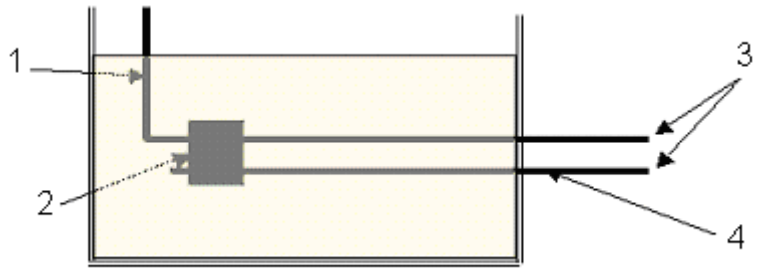
Main	Branch
Min.	Min.
Max.	Min.

7.6.3 Procedure

The conductor and the mounted fitting shall be immersed in water 200 mm depth and a length of 300 mm to the wall of the container for 48 h.

7.6.4 Acceptance criteria

No water shall penetrate the conductor and shall move through the conductor, see Figure 9.



Key

1 Main conductor
2 Piercing accessory
3 Checkpoint about water on main or tap
4 Tap conductor with end cap or anchor or earthing rod

Figure 9 - Test arrangement for water tightness test

7.7 Electrical ageing test for connectors

This test shall be carried out according to the procedures of EN 50483-5 for class B connectors, but with the following changes:

- the conductors are described in EN 50397-1;
- the temperature during the heat cycles shall be according to the maximum operating temperatures given in EN 50397-1.

7.8 Short-circuit test on APD or EPD

7.8.1 Principle

Arc protection device (APD) and earth parking device (EPD) shall be able to carry the short circuit current. This test is intended to check the current capability of the connectors tightened on steel rods.

7.8.2 Test arrangement

The test arrangement is shown in Figure 10. For this test, the arc horn or the earthing rod will be replaced by a straight piece of same cross-section and shape and material than the horn or rod. The length of this test piece will be twice the one of the original horn or rod.

7.8.3 Procedure

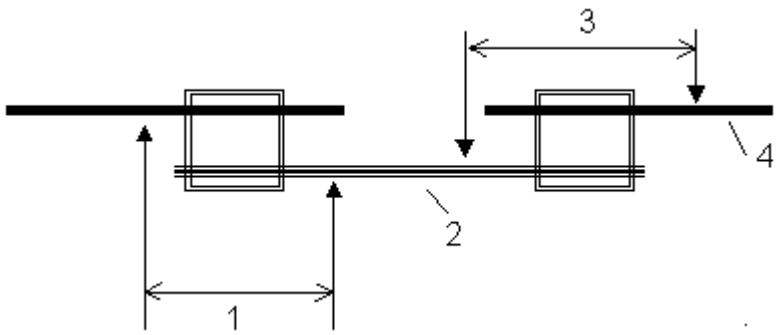
Two devices equipped of the test piece are tightened on a cable having the maximum cross-section for which the connectors are designed.

The electric resistances are measured before and after over-current according to the modalities described in (see electrical ageing test in 7.7).

The test arrangement shall be subjected to one pulse of over-current of 10 kA for 1 s.

7.8.4 Acceptance criteria

The change of resistance before and after short circuit shall be less than 50 %. No visible damage shall be observed on the connector or on the cable.



Key

1 Resistance measurement
2 Double rod or horn
3 Resistance measurement
4 Conductor of the max cross section

Figure 10 - Resistance measurement

7.9 Power arc test

7.9.1 Principle

The arc protection system shall be subjected to a power arc test circuit in order to ensure that they are capable of sustaining arcs without damaging of the conductor wires.

7.9.2 Test arrangement

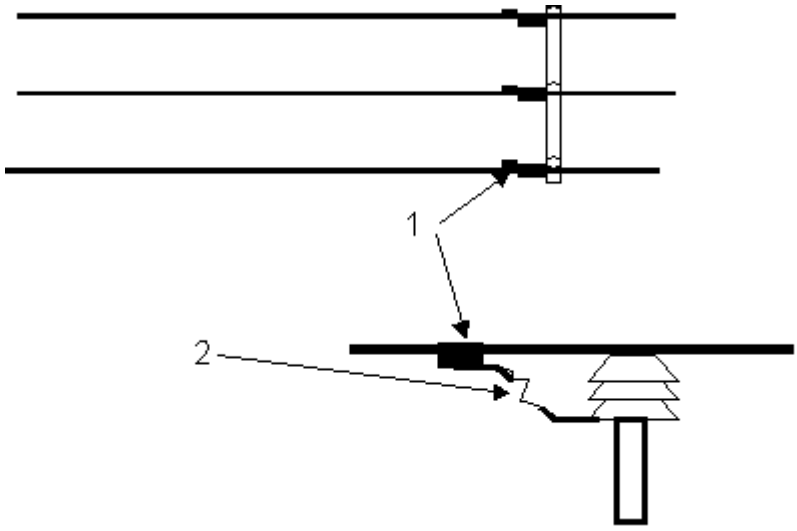
The arc protection device shall be assembled on to covered conductor in accordance with the manufacturer's instructions. One example is shown in Figure 11.

The arc horns and the bracket shall be connected to each other with a wire having approximately diameter of 1 mm.

The accessories used in the test shall be agreed between the supplier and the purchaser and they shall be installed as closely as possible to the service conditions.

The test shall be carried at normal service conditions.

Other arc protection devices shall be tested according to EN 61467.



Key

1 Arc protection device
2 1 mm wire to initiate short circuit

Figure 11 - Example of power arc test arrangement for arc protection system

7.9.3 Procedure

Two tests shall be done; one test with a rate of 1 kA and one with a rate of 10 kA. Duration of the short circuit shall be 1 s. The no-load voltage shall be between 7 kV and 10 kV.

7.9.4 Acceptance criteria

- No damage on the conductor wires shall occur.
- No failure or severe burning of the insulator shall occur.

NOTE Burning marks on the end of the insulator sheds or on the conductor covering are acceptable.

7.10 Environmental test for suspension and tension clamps

In order to meet the acceptance criteria of the type tests at least one of the three corrosion tests (detailed in 7.10.1) and one of two climatic tests (detailed in 7.10.2) shall be carried out. The choice of the test shall be agreed between the manufacturer and the customer.

7.10.1 Corrosion ageing test

7.10.1.1 Salt mist test

This test shall be carried out in accordance with EN 50483-6, 8.4.1.

7.10.1.1.1 Test arrangement

The following criteria shall be used during this test:

- number of suspension samples shall be 2;
- number of tension samples shall be 2;

- number of cycles shall be 4 (4 weeks);

- the samples shall be installed so that they are positioned in a manner, which is as close as possible to the orientation that would be expected in normal operation.

7.10.1.1.2 Acceptance criteria

Visual inspection shall be carried out and there shall be no significant trace of red rust.

NOTE Significant rusting would constitute more than 10% of the exposed surface area of the metallic parts.

Markings shall be legible.

No deterioration of the clamps shall occur which would impair the normal function of the clamp.

Tension clamps shall meet the acceptance criteria of the mechanical test in 7.4.1.

Suspension clamps shall meet the acceptance criteria of the mechanical test in 7.4.1.

7.10.1.2 Gas atmosphere test

This test shall be carried out accordance with EN 50483-6, 8.4.1.

7.10.1.2.1 Test criteria – Method 1

The following criteria shall be used during this test:

- number of suspension clamp shall be 2;
- number of tension samples shall be 2;
- there shall be 4 cycles of 14 days. This 14-day cycle consists of 7 days of salt mist and 7 days in SO_2 atmosphere as defined in 8.4.1 and 8.4.2 of EN 50483-6;
- the samples shall be installed so that they are positioned in a manner, which is as close as possible to the orientation that would be expected in normal operation.

7.10.1.2.2 Test criteria – Method 2

The following criteria shall be used during this test:

- number of suspension samples shall be 2;
- number of tension samples shall be 2;
- there shall be 500 cycles of 2 h (approximately 6 weeks);
- the samples shall be installed so that they are positioned in a manner, which is as close as possible to the orientation that would be expected in normal operation.

7.10.1.2.3 Acceptance criteria (Method 1 and Method 2)

Visual inspection shall be carried out and there shall be no significant trace of red rust.

NOTE Significant rusting would constitute more than 10 % of the exposed surface area of the metallic parts.

Markings shall be legible.

No deterioration of the clamps shall occur which would impair the normal function of the clamp.

Tension clamps shall meet the acceptance criteria of the mechanical test in 7.4.1.

Suspension clamps shall meet the acceptance criteria of the mechanical test in 7.4.1.

7.10.2 Climatic ageing test

This test shall be carried out in accordance with EN 50483-6, 8.5.

7.10.2.1 Test arrangement - Method 1

The following criteria shall be used during this test:

- number of suspension samples shall be 2;
- number of tension samples shall be 2;
- there shall be 6 cycles of 1 week;
- the temperature during periods A and C shall be 70 °C or otherwise, if agreed between the customer and the manufacturer;
- the samples shall be installed so that they are positioned that there is maximum exposure of the synthetic parts to the light source.

7.10.2.2 Test arrangement - Method 2

The following criteria shall be used during this test:

- number of suspension samples shall be 2;
- number of tension samples shall be 2;
- there shall be 56 cycles of 1 day (8 weeks);
- the samples shall be installed so that they are positioned that there is maximum exposure of the synthetic parts to the light source.

7.10.2.3 Acceptance criteria (Method 1 and Method 2)

Visual inspection shall be carried out to determine that there has been no degradation of the organic parts.

Markings shall be legible.

No deterioration of the clamps shall occur which would impair the normal function of the clamp.

Tension clamps shall meet the acceptance criteria of the mechanical test in 7.4.1.

Suspension clamps shall meet the acceptance criteria of the mechanical test in 7.4.1.

7.11 Environmental tests for connectors

The environmental tests shall be completed on all connectors. In this clause, connector means also arc protection device and earth parking device.

7.11.1 Corrosion tests

7.11.1.1 Principle

This test shall ensure that the IPC is not affected in corrosive atmospheres.

7.11.1.2 Test arrangement

For salt mist test and gas atmosphere test:

Two samples shall be tested in accordance with the following conductor combination:

Main	Branch
Min.	Min.

7.11.1.3 Procedure

For salt mist test and gas atmosphere test:

The connector shall be placed in the middle of the main core of length 0,5 m to 1,5 m. It shall be tightened to the minimum torque specified by the manufacturer. The tightening shall be carried out at a rate of approximately 1 full turn in 8 s or at the rate specified in the manufacturer's installation instructions.

7.11.1.3.1 Salt mist test

This test shall be carried out in accordance with EN 50483-6, 8.4.1.

Number of cycles shall be 4 (4 weeks).

7.11.1.3.2 Gas atmosphere test

This test shall be carried out in accordance with EN 50483-6, 8.4.2.

Method 1: Combined test. There shall be 4 cycles of 14 days. This 14-day cycle consists of 7 days of salt mist and 7 days in SO_2 atmosphere as defined in EN 50483-6, 8.4.1 and 8.4.2.

Method 2: There shall be 500 cycles of 2 h (approximately 6 weeks).

7.11.1.4 Acceptance criteria

Visual inspection shall be carried out and there shall be no significant trace of red rust.

NOTE Significant rusting would constitute more than 10 % of the exposed surface area of the metallic parts.

Markings shall be legible.

No deterioration of the connectors shall occur which would impair their normal function.

For a connector designed with a shear-head it shall be able to be removed with a torque below, or equal to, the manufacturer's specified maximum torque.

For a connector designed without a shear-head it shall be able to be removed with a torque below or equal to 1,1 x the manufacturer's specified nominal torque.

7.11.2 Climatic ageing test

7.11.2.1 Principle

This test shall ensure that the connector is not affected by climatic conditions.

7.11.2.2 Test arrangement

Two samples shall be tested. Where the IPC is designed to accept more than one size of conductor, two samples shall be tested in each of the following conductor combinations:

Main	**Branch**
Min.	Min.
Max.	Min.

In case of arc protection device or earth parking device, the branch conductor shall be replaced by the rod.

7.11.2.3 Procedure

7.11.2.3.1 Climatic ageing test – Method 1

This test shall be carried out in accordance with EN 50483-6, 8.5.1.

There shall be 6 cycles of 1 week.

The temperature during periods A and C shall be 70 °C.

NOTE The temperature may be lower if agreed between the customer and the manufacturer.

7.11.2.3.2 Climatic ageing test – Method 2

This test shall be carried out in accordance with EN 50483-6, 8.5.2.

There shall be 56 cycles of 1 day (8 weeks).

7.11.2.4 Acceptance criteria

After the climatic ageing cycles and after a period of at least 24 h but not exceeding 72 h at the laboratory atmosphere, the following tests shall be carried out.

The connector shall meet the acceptance criteria of the water tightness test in 7.8 but after an immersion time limited to 12 h.

Visual inspection shall be carried out to determine that there has been no degradation of the organic parts.

The sample’s identification marking shall be legible when examined with normal or corrected vision, without magnification.

Annex A
(normative)
Type tests, sample tests and routine tests

Table A.1

Clause		Tension fittings			Suspension fittings			Connectors			Arc protection device			Earth parking device		
		Type tests	Sample tests	Routine tests	Type tests	Sample tests	Routine tests	Type tests	Sample tests	Routine tests	Type tests	Sample tests	Routine tests	Type tests	Sample tests	Routine tests
7.1	Visual examination	x	a	b	x	a	b	x	a	b	x	a	b	x	a	b
7.2	Dimensional and material verification	x	x	b	x	x	b	x	x	b	x	x	b	x	x	b
7.3	Marking	x	x	b	x	x	b	x	x	b	x	x	b	x	x	b
7.4	Mechanical tests															
7.4.1	Damage and failure load test	x	x		x	x										
7.4.2	Slip test at ambient temperature				x	x										
7.4.3	Slip test at low temperature.				x											
7.4.4	Slip test at high temperature (optional)				x											
7.4.5	Lift and side load test				x	x	x									
7.4.6	Thermal test on helical fittings				x											
7.4.7	Tensile test at ambient temperature	x	x													
7.4.8	Tensile test at low temperature	x														
7.4.9	Tensile test at high temperature	x														
7.4.10	Clamp bolt tightening test	x	x		x	x		x	x		x	x		x	x	
7.4.11	Shear head function test	x	x		x	x		x	x		x	x		x	x	
7.4.12	Damage to the main conductor test							x	x		x	x		x	x	
7.4.13	Branch cable pull out test							x								
7.4.14	Low temperature assembly test							x			x			x		
7.4.15	Mechanical test on earth parking device													x	x	
7.5	Hot dip galvanizing test	x	x		x	x		x	x		x	x		x	x	
7.6	Watertightness test	x			x			x			x			x		
7.7	Electrical ageing test							x								
7.8	Short circuit test										x			x		
7.9	Power Arc test										c					
7.10	Environmental test for clamps															
7.10.1	Corrosion ageing test	x			x											
7.10.2	Climatic ageing test	x			x											
7.11	Environmental test for connectors															
7.11.1	Corrosion ageing test							x			x			x		
7.11.2	Climatic ageing test							x			x			x		

a: Inspection by attributes only b: By agreement between the purchaser and supplier c: Only in connection with complete insulator set

Annex B
(informative)

Example of sampling with inspection by attributes

An example of the procedure for inspection by attributes agreed between purchaser and supplier is as follows:

a) inspection level: S4;

b) sampling plan: single sampling plan for normal inspection;

c) Acceptance Quality Level (AQL):

   1) 0,1 for all items and characteristics which are vital for a safe and reliable service of the line;
   2) 1,0 for all other items and their pertinent characteristics.

The above procedure requires, for example:

– for lot or batch size = 100

  - Code letter D

  - Sample size 8

  - AQL 0,1 Acceptance: zero non-conformity

    Rejection: one (or more) non-conformity

  - AQL 1,0 Acceptance: zero non-conformity

    Rejection: one (or more) non-conformity

– for lot or batch size = 12 500

  - Code letter H

  - Sample size 50

  - AQL 0,1 Acceptance: zero non-conformity

    Rejection: one (or more) non-conformity

  - AQL 1,0 Acceptance: one non-conformity

    Rejection: two (or more) non-conformity

Annex C
(informative)

Example of sampling with inspection by variable

An example of the procedure for inspection by variables agreed between purchaser and supplier is as follows:

a) inspection level: S4;

b) type of method: s method;

c) Acceptance Quality Level (AQL):

   1) 0,1 for all items and characteristics which are vital for a safe and reliable service of the line;
   2) 1,0 for all other items and their pertinent characteristics.

The above procedure requires, for example:

– for lot or batch size = 100

  - Code letter C

  - Sample size 4

  - AQL 0,1 Acceptability constant k = 2,42

  - AQL 1,0 Acceptability constant k = 1,45

– for lot or batch size = 12 500

  - Code letter I

  - Sample size 25

  - AQL 0,1 Acceptability constant k = 2,50

  - AQL 1,0 Acceptability constant k = 1,85

Annex D
(normative)

Special national conditions

Special national condition: National characteristic or practice that cannot be changed even over a long period, e.g. climatic conditions, electrical earthing conditions.

NOTE If it affects harmonization, it forms part of the European Standard / Harmonization Document.

For the countries in which the relevant special national conditions apply these provisions are normative, for other countries they are informative.

Clause	Special national condition
General	**Finland, Iceland, Norway, Sweden and Switzerland**
	Due to climate conditions, the type tests at low temperature have to be performed at -25 °C instead of -10 °C.

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Bibliography

HD 474 *Dimensions of ball and socket couplings of string insulator units* (IEC 60120)

EN ISO 9000 *Quality management systems - Fundamentals and vocabulary* (ISO 9000)

IEC 60471 *Dimensions of clevis and tongue couplings of string insulator units*

IEC 60826 *Design criteria of overhead transmission lines*