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Edition 3.0 2021-10
COMMENTED VERSION

INTERNATIONAL STANDARD

colour inside

Cable cleats for electrical installations

IEC 61914:2021-10 CMV(en)

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Cable cleats for electrical installations

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CABLE CLEATS FOR ELECTRICAL INSTALLATIONS

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This commented version (CMV) of the official standard IEC 61914:2021 edition 3.0 allows the user to identify the changes made to the previous IEC 61914:2015 edition 2.0. Futhermore, comments from IEC SC 23A experts are provided to explain the reasons of the most relevant changes.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 61914 has been prepared by subcommittee 23A: Cable management systems, of IEC technical committee 23: Electrical accessories. It is an International Standard.

This third edition cancels and replaces the second edition published in 2015. This edition constitutes a technical revision.

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

a) requirements for mandrels used in testing rationalised and detailed in the general test requirements (Clause 5);
b) definition of liner added and test requirements where liners and other optional parts are used;
c) definitions for LV, MV and HV cables added and test requirements where MV & HV cable are used ;
d) new corrosion resistance classes for plated products added;
e) new requirements and test for durability and legibility of markings added;
f) new test requirements for axial load testing of cleats for more than one cable added;
g) lateral load test requirements for intermediate restraints added.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
23A/976/FDIS	23A/982/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

In this standard, the following print types are used:

– requirements proper: in roman type;
– *test specifications: in italic type*;
– notes: in smaller roman type.

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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

CABLE CLEATS FOR ELECTRICAL INSTALLATIONS

1 Scope

This International Standard specifies requirements and tests for cable cleats used for securing cables in electrical installations and for intermediate restraints used for ~~securing cable~~ holding cables together in formation in electrical installations. Cable cleats provide resistance to electromechanical forces where declared. This document includes cable cleats that rely on a mounting surface specified by the manufacturer for axial and/or lateral retention of cables.

Various types of cable cleats and intermediate restraints are shown in Annex A.

NOTE Requirements for manufacturers in this document also apply to importers and responsible vendors where appropriate.

This document does not apply to ~~cable glands,~~ cable ties.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60502-1, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV) – Part 1: Cables for rated voltages of 1 kV (U_m = 1,2 kV) and 3 kV (U_m = 3,6 kV)*

IEC 60695-11-5~~:2004~~, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

ISO 2081, *Metallic and other inorganic coatings – Electroplated coatings of zinc with supplementary treatments on iron or steel*

ISO 3575, *Continuous hot dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of commercial and drawing qualities*

ISO 4287~~:1997~~, *Geometrical Product Specifications (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters*

ISO 4892-2~~:2006~~, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 4998, *Continuous hot-dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of structural quality*

ISO 9227~~:2012~~, *Corrosion tests in artificial atmospheres – Salt spray tests*

ISO 14713-1, *Zinc coatings – Guidelines and recommendations for the protection against corrosion of iron and steel in structures – Part 1: General principles of design and corrosion resistance*

ISO 14713-2, *Zinc coatings – Guidelines and recommendations for the protection against corrosion of iron and steel in structures – Part 2: Hot dip galvanizing*

EN 10346, *Continuously hot-dip coated steel flat products for cold forming – Technical delivery conditions*

3 Terms, definitions and abbreviations

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
cable cleat
device provided with a means of attachment to a mounting surface and ~~designed to~~ that provides securing of cables when installed at intervals along the length of cables

Note 1 to entry: ~~A cable cleat is provided with a means of attachment to a mounting surface but does not rely on an unspecified mounting surface for the retention of the cables.~~ Examples of mounting surfaces that may be specified are ladder, tray, strut (see Figure A.8) or rail. ~~Where declared, cable cleats provide resistance to electromechanical forces.~~ Hardware, such as screws or bolts, needed to secure cable cleats to the mounting surface is not necessarily supplied with cable cleats.

Note 2 to entry: Some examples of cable cleats are shown in Annex A (see Figure A.1 to ~~Figure A.9~~ Figure A.10). These examples do not limit the use of other cable cleat designs that conform to the requirements of this document.

3.2
intermediate restraint
cable retaining device ~~designed~~ intended to be used with cable cleats, without being attached to a mounting surface, to hold cables together in ~~order~~ formation and/or to provide resistance to electromechanical forces

3.3
metallic
consisting of metal only

3.4
non-metallic
consisting of non-metallic material only

3.5
composite
consisting of metallic and non-metallic materials

Note 1 to entry: Fibre reinforced resin materials are not considered to be composite under this definition.

Note 2 to entry: Materials include any materials supplied by the manufacturer as part of a cable cleat or intermediate restraint or with a cable cleat or intermediate restraint in the same packaging. This may include fixings such as nuts, bolts, screws, washers, springs and pins. Fixings supplied by the installer are not considered in this document.

3.6
short-circuit current
overcurrent resulting from a circuit condition in which the current flows through an abnormal or unintended path of negligible impedance between live conductors, or between a live conductor and an earth, having a difference in potential under normal operating conditions

3.7
peak short-circuit current
i_p
maximum possible instantaneous value of the short-circuit current

SEE: Annex B

3.8
initial r.m.s. symmetrical short-circuit current
I''_k
r.m.s. value of the a.c. symmetrical component of a short-circuit current, applicable at the instant of the short circuit if the impedance remains at the zero-time value

SEE: Annex B

3.9
decaying ~~(~~aperiodic~~)~~ component of short-circuit current
$i_{d.c.}$
mean value between the top and bottom envelope of a short-circuit current decaying from an initial value to zero

SEE: Annex B

3.10
steady-state short-circuit current
I_k
r.m.s. value of the short-circuit current which remains after the decay of the transient phenomena

SEE: Annex B

3.11
trefoil formation
formation of three cables so laid as to be mutually equidistant

Note 1 to entry: Viewed in cross-section, the lines joining the cable centres form an equilateral triangle (see Figure 7).

~~Note 2 to entry: The formation is known as "close trefoil" formation when the cables are touching each other.~~

3.12
flat formation
formation of a number of cables laid in a plane, usually with equal spacing between adjacent cables (see Figure 8)

3.13
electromechanical forces
induced forces acting on current-carrying conductors

3.14
retention
limiting the lateral and/or axial movement of the cable

3.15
securing
fixing to or from a mounting surface ~~or another product~~

3.16
environmental influences
capacity for environmental factors to have an effect on the intended function of cable cleats and/or intermediate restraints (e.g. effect of corrosive substances or solar radiation, etc.)

3.17 1
LV cables
cables with a rated voltage of 1,0 kV ac, 1,5 kV dc or less

3.18 1
MV or HV cables
cables with a rated voltage of more than 1,0 kV ac or 1,5 kV dc

3.19 2
liner
polymeric component between the cable and the cable cleat or intermediate restraint

3.20 3
product type
group of cable cleats for which only the cable or bundle diameter may be changed

Note 1 to entry: For guidance in determining product types, cable cleats or intermediate restraints having material, design, construction characteristics, and classifications according to Clause 6 below, in common, are considered to be the same product type.

4 General requirements

Products covered by this document shall be so designed and constructed that, when assembled and installed as for normal use according to the manufacturer's instructions, they ensure securing and/or holding in formation of cables as declared in accordance with Clause 6 and shall not cause damage to the cable.

Compliance is checked by the relevant tests specified in this document.

5 General notes on tests

5.1 Tests according to this document are type tests.

– Products of all sizes shall comply with Clause 8 and 9.1 a).

– Where cleats or intermediate restraints may be supplied with optional extra parts (e.g. liners), all tests shall be performed on the product without any of the optional parts. Where the addition of any optional part affects the performance of the product (e.g. the axial load performance with the addition of a liner), the tests shall be repeated with the optional parts in place.

– For the requirements in 9.1 b), 9.1 c) and 9.1 d) where there are a number of cable cleats in a range, the range is divided into one or more product types. In this case, the smallest and the largest size of cable cleat of each type are tested.

– The test for compliance with 9.1 e) is performed on the set of samples selected as defined in 9.5.1.

~~NOTE For guidance in determining types, cable cleats or intermediate restraints having material, construction characteristics, and classifications according to Clause 6 below, in common, are considered to be the same type.~~

5.2 Unless otherwise specified, all tests shall be carried out on three new samples of each size selected as specified in 5.1, assembled and installed as for normal use according to the manufacturer's~~ or responsible vendor's~~ instructions. Where a cable cleat is designed to accommodate more than one cable the number, size and shape of the mandrels used in the test shall represent the number, size and shape of the cables for which the cable cleat is intended.

5.3 Tests on non-metallic and composite cable cleats and intermediate restraints and any test that includes a liner shall not commence earlier than 168 h after manufacture.

5.4 Unless otherwise specified, the tests shall be carried out at an ambient temperature of (23^{+5}_{-5}) °C.

When toxic or hazardous processes are used, due regard shall be taken of the safety of persons within the test area.

5.5 Metal mandrels used in testing shall be made from carbon steel, stainless steel, brass or aluminium. Where testing is performed at a temperature below 105 °C, mandrels may be made from polyamide or HDPE. All mandrels shall have a surface roughness less than or equal to 7 µm Ra in accordance with ISO 4287. **4**

5.6 Compliance with this document is satisfied if all the applicable test requirements are achieved. If only one of the samples does not satisfy a test due to a manufacturing fault, then that test and any preceding one which may have influenced the results of the test shall be repeated and also the tests which follow shall be made in the same required sequence on another full set of samples, all of which shall comply with the requirements.

The applicant, when submitting the first set of samples, may also submit an additional set of samples, which may be necessary should one sample fail. The test house should then, without further request, test the additional set of samples and should only reject if a further failure occurs. If the additional set of samples is not submitted at the same time, a failure of one sample would entail rejection.

6 Classification

6.1 Classification according to material

6.1.1 Metallic

See 3.3 and examples in Annex A.

6.1.2 Non-metallic

See 3.4 and examples in Annex A.

6.1.3 Composite

See 3.5 and examples in Annex A.

6.2 Classification according to maximum and minimum temperature

Table 1 – Maximum temperature for permanent application

A. Maximum temperature °C
+ 40
+ 60
+ 85
+ 105
+ 120

Table 2 – Minimum temperature for permanent application

B. Minimum temperature °C
+ 5
− 5
− 15
− 25
− 40
− 60

For temperature values above 120 °C and below −60 °C, the manufacturer ~~or responsible vendor~~ may declare temperatures outside the values provided in Table 1 and Table 2 above.

6.3 Classification according to resistance to impact

6.3.1 Very light

See Table 5.

6.3.2 Light

See Table 5.

6.3.3 Medium

See Table 5.

6.3.4 Heavy

See Table 5.

6.3.5 Very heavy

See Table 5.

6.4 Classification according to type of retention or resistance to electromechanical forces or both

6.4.1 General

Manufacturers of cable cleats shall declare a classification under 6.4.2 and may also declare a classification under 6.4.3. Manufacturers of cable cleats may also declare a classification under 6.4.4 or 6.4.5.

Manufacturers of intermediate restraints shall declare a classification under 6.4.2 and under 6.4.4 or 6.4.5 in association with cable cleats.

6.4.2 With lateral retention

Tested in accordance with 9.3.

6.4.3 With axial retention

Tested in accordance with 9.4.

NOTE ~~This value~~ The axial retention test result is for guidance purposes as it is not possible to replicate cables using mandrels.

6.4.4 Resistant to electromechanical forces, withstanding one short circuit

Tested in accordance with 9.5.2.

6.4.5 Resistant to electromechanical forces, withstanding more than one short circuit

Tested in accordance with 9.5.3.

NOTE The intent for cable cleats and intermediate restraints classified under 6.4.5 is that after one short-circuit application, the cable cleat and intermediate restraints, if used, will continue to perform as designed and tested according to this document. The physical condition of the cable cleats and intermediate restraints after short-circuit application has only been evaluated under laboratory conditions. The continued use of the cable cleats and intermediate restraints, if used, following an actual short-circuit incident, is solely at the discretion of the party responsible for the installation.

6.5 Classification according to environmental influences

6.5.1 ~~Resistant~~ Resistance to ultraviolet light for non-metallic and composite components

6.5.1.1 Not declared

No resistance to UV light is claimed.

6.5.1.2 Resistant to ultraviolet light

Tested in accordance with 11.1.

6.5.2 ~~Resistant~~ Resistance to corrosion ~~for metallic and composite components~~

~~6.5.2.1 Low~~

~~6.5.2.2 High~~

6.5.2.1 General

If components within the cable cleat or intermediate restraint have different classifications, then the manufacturer shall declare all relevant classifications.

6.5.2.2 Non-metallic components

Non-metallic components are considered to be inherently resistant to corrosion and do not require testing.

6.5.2.3 Components made of stainless steel

Resistance against corrosion is classified according to Table 3.

Table 3 – Classification for resistance against corrosion for stainless steel components

Class	Typical usage	Reference material
Indoor	Dry indoor locations	Stainless steel containing at least 13 % chromium
Outdoor	Wet outdoor unpolluted areas (IEC 60364-5-51 – AF1)	Stainless steel containing at least 16 % chromium

For use in any other environment, additional protection may be required and consideration should be given to the appropriate duration of test exposure or to the use of an alternative test method.

6.5.2.4 Components made of mild steel or cast-iron with coatings

Resistance against corrosion is classified according to Table 4. This table lists materials as references for classification purposes. The classification is an indication only and is used for comparison purposes and should not be used to determine life expectancy of the coating.

To indicate the life to first maintenance for zinc coated products, refer to ISO 14713-1 and ISO 14713-2.

Table 4 – Classification for resistance against corrosion for coated mild steel or cast-iron components

Class	Neutral salt spray (NSS) test duration h		Reference material and metallic coating
0	-		None [a]
2	96	or	Electroplated to a minimum thickness of 12 µm according to ISO 2081
3	155	or	Pre-galvanised with coating designation Z275 according to ISO 3575, ISO 4998 or EN 10346
8	850	or	Post-galvanised to a zinc mean coating thickness of not less than 85 µm according to ISO 1461 for zinc thickness only
NOTE The classes listed above have been selected from Table 1 of IEC 61537:2006.			
[a] For materials which have no declared corrosion resistance classification.			

- If a coating is referenced in Table 4, a classification without testing can be obtained from the table;
- For materials made of mild steel or cast-iron with a coating and not referenced in Table 4, a salt spray test is required. The classification obtained shall be the one corresponding to the duration of the salt spray test;
- The classification of coating referenced in Table 4 can be higher if it passes a salt spray test for a longer duration. The classification obtained shall be the one corresponding to the longer duration of the salt spray test. 5

EXAMPLE A sample electroplated to a minimum thickness of 12 µm according to ISO 2081 is classified as class 2 according to Table 4, equivalent to 96 h. If the sample is tested in accordance with 11.2.6 for a duration of 155 h and passes the test, then it can be classified as class 3.

6.5.2.5 Components made of non-ferrous alloys

Under consideration.

6.6 Classification according to electromagnetic compatibility

6.6.1 Liable to inductive heating

Capable of forming an electrically conductive and magnetically permeable loop around a cable.

6.6.2 Not liable to inductive heating

Not capable of forming an electrically conductive and magnetically permeable loop around a cable.

7 Marking and documentation

7.1 Marking

Each cable cleat and intermediate restraint shall be marked with

– the manufacturer's ~~or responsible vendor's~~ name or logo or trademark;
– the product identification or product type.

Where it is not possible to apply the marking directly onto the product, then the marking shall be placed on the smallest supplied package.

7.2 Durability and legibility

Marking ~~on the product~~ shall be easily legible ~~to normal or corrected vision~~, durable and indelible.

NOTE 1 Examples of methods for applying marking are by moulding, pressing, engraving, printing, adhesive labels, etc.

Compliance is checked by inspection ~~and by rubbing the marking 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~~, using normal or corrected vision, without additional magnification and, if necessary, by the test below.

~~After the test, the marking shall remain legible to normal or corrected vision.~~

~~Marking made by moulding, pressing or engraving is not subjected to the rubbing test.~~

Laser marking directly on the product and markings made by moulding, pressing or engraving are not subjected to the test below.

The test is made by rubbing the marking for 15 s with a piece of cotton cloth soaked with water and again for 15 s with a piece of cotton cloth soaked with n-hexane 95 % (Chemical Abstracts Service Registry Number, CAS RN, 110-54-3).

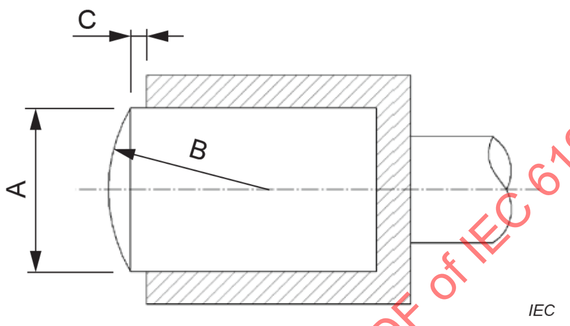
NOTE 2 n-hexane 95 % (Chemical Abstracts Service Registry Number, CAS RN, 110-54-3) is available from a variety of chemical suppliers as a high pressure liquid chromatography (HPLC) solvent.

When using the liquid specified for the test, precautions as stated in the relative material safety datasheet provided by the chemical supplier shall be taken to safeguard the laboratory technicians.

The marking surface to be tested shall be dried after the test with water.

Rubbing shall commence immediately after soaking the piece of cotton, applying a compression force of (5 ± 1) N at a rate of about one cycle per second (a cycle comprising a forward and backward movement along the length of the marking). For markings longer than 20 mm, rubbing can be limited to a part of the marking, over a path of at least 20 mm length.

The compression force is applied by means of a test piston, which is wrapped with cotton comprising cotton wool covered by a piece of cotton medical gauze.



Key

A piston diameter, $\left(20\,^{+2}_{-0}\right)$ *mm*

B piston head radius, $\left(20\,^{+0,5}_{-0,5}\right)$ *mm*

C gap between piston head and cylinder, $\left(2\,^{+1}_{-0}\right)$ *mm*

Figure 1 – Test piston dimensions

The test piston shall have the dimensions specified in Figure 1 and shall be made of an elastic material which is inert against the test liquids and has a Shore-A hardness of 47 ± 5 (for example synthetic rubber).

When it is not possible to carry out the test on the specimens due to the shape/size of the product, a suitable piece having the same characteristics as the product can be submitted to the test. **6**

7.3 Documentation

The manufacturers ~~or responsible vendor~~ shall provide in their literature:

- the classifications according to Clause 6;
- the maximum and minimum number of cables;
- the maximum and minimum cable or bundle ~~diameters~~ dimensions;
- the lateral load for cable cleats declared under 6.4.2;
- the axial load for cable cleats if declared under 6.4.3. Where the axial load test is performed using multiple mandrels, the number of mandrels, the axial load applied to all mandrels together and the lowest load applied to the individual mandrels shall be declared;

– the method of assembly and installation including tightening torques, where appropriate. Where overtightening of the cable cleat or intermediate restraint may cause damage to the cable, cable cleat or intermediate restraint, a warning shall be provided by the manufacturer in the installation instructions.
– any limitation on mounting orientation for lateral retention;
– any restriction on the cable rating and construction that may be used;

Additionally, for cable cleats and/or intermediate restraints declared under 6.4.4 or 6.4.5, the manufacturers~~ or responsible vendor~~ shall provide in their literature:

– the peak short-circuit current;
– the initial r.m.s. symmetrical short-circuit current;
– the cable outside diameter and the distance between cable centres, S, used in the test in 9.5. Where the test has used MV or HV cable, the data listed on the form shown in Annex C shall be provided;
– the maximum spacing, D, as shown in Figure 6.

Compliance is checked by inspection.

~~NOTE~~ Some or all of this information may also be required to be provided on packaging or instruction sheets supplied with the product.

8 Construction

The surfaces of cable cleats and intermediate restraints shall be free from sharp edges, burrs, flash, etc. that are likely to damage cables or inflict injury to the installer or user.

Compliance is checked by visual and manual inspection of the surface.

9 Mechanical properties

9.1 Requirements

Cable cleats and intermediate restraints shall be:

a) capable of accommodating the size or range of cable or cable bundle~~ diameter~~ dimensions declared by the manufacturer~~ or responsible vendor~~ without cracking or breaking, or stripping of the threads of screws or bolts;

   Compliance is checked by measurement and by visual and manual inspection.

b) resistant to impact at the minimum declared temperature;

   Compliance is checked by the test according to 9.2.

c) capable of withstanding the lateral load at the maximum declared temperature;

   Compliance is checked by the test according to 9.3

d) capable of withstanding the axial load at the maximum declared temperature, where declared in 6.4.3;

   Compliance is checked by the test in 9.4.

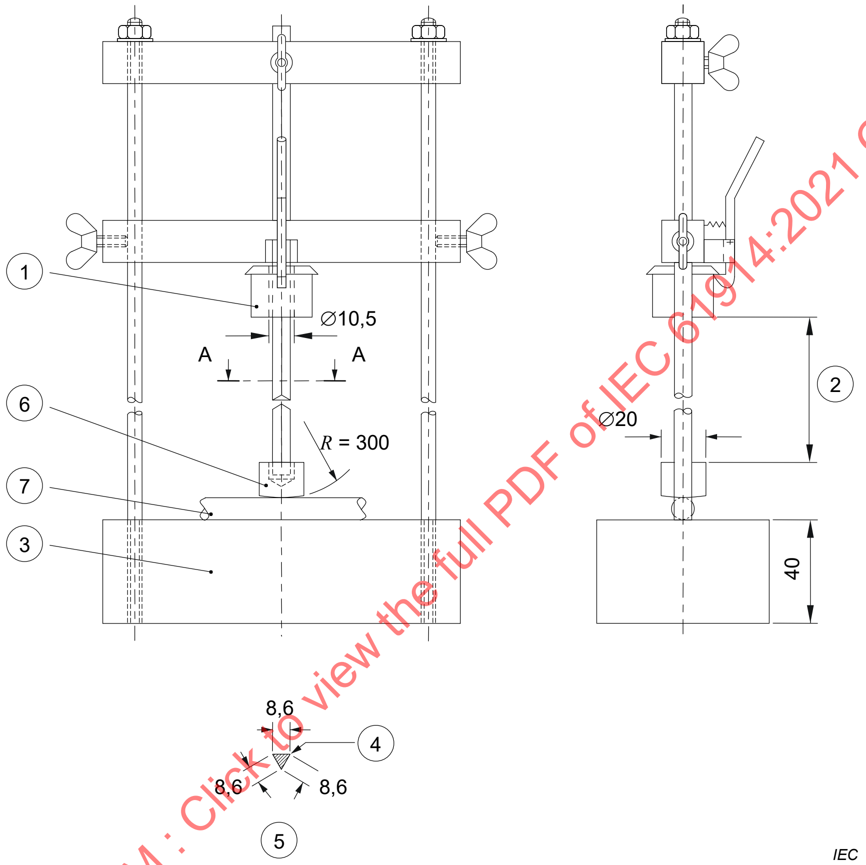
e) resistant to electromechanical forces, where declared in 6.4.4 or 6.4.5.

   Compliance is checked by the test in 9.5.

9.2 Impact test

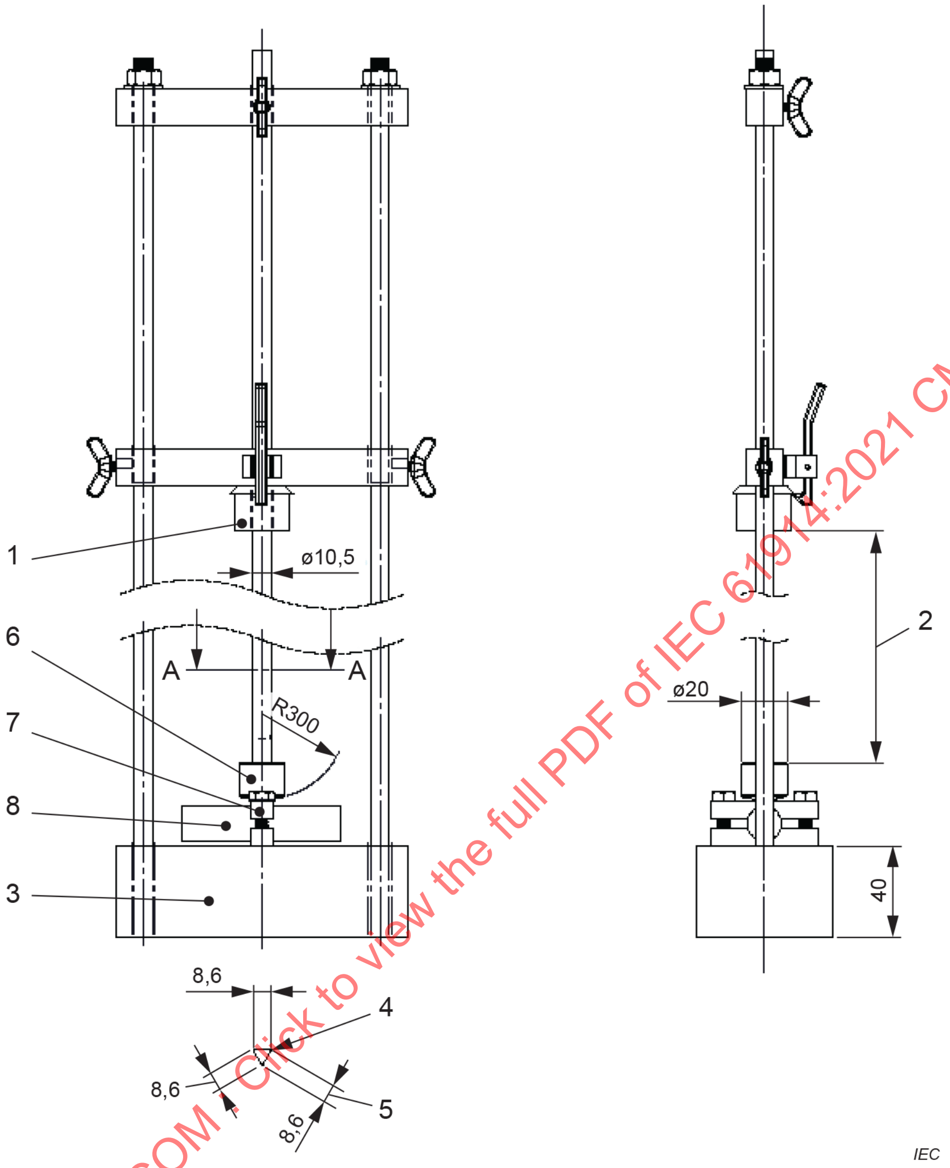
The impact test is carried out using a typical arrangement as shown in Figure 2. The component transmitting the impact to the cable cleat or intermediate restraint shall have a spherical radius of $\left(300^{+5}_{-5}\right)$ *mm at the point of contact. For cable cleats classified according to 6.5.1.2, the impact test is performed after the resistance to ultraviolet light test is successfully passed.*

~~*Dimensions in millimetres*~~



~~**Key**~~	
~~1~~	~~Hammer~~
~~2~~	~~fall height (see Table 3)~~
~~3~~	~~rigid steel base~~
~~4~~	~~slightly rounded edges~~
~~5~~	~~section A – A~~
~~6~~	~~steel intermediate piece~~
~~7~~	~~Sample~~

Dimensions in millimetres



Key

1 hammer

2 fall height (see Table 5)

3 rigid steel base

4 slightly rounded edges

5 section A – A

6 steel intermediate piece

7 cable cleat or intermediate restraint

8 mandrel

Figure 2 – Typical arrangement for impact test

Before the test, the samples are assembled onto a solid ~~polyamide or metal~~ test mandrel, as specified in 5.5, having ~~a diameter~~ dimensions equivalent to the maximum declared ~~diameter~~ dimensions for which the cable cleat is designed and mounted on a rigid support. Where a cable cleat or intermediate restraint is designed for non-circular cables, a solid mandrel corresponding to the shape and size of the largest cable shall be used.

For cable cleats and intermediate restraints taking more than one cable, the appropriate number of mandrels is used.

For metallic cable cleats and intermediate restraints where the material has a face-centre-cubic crystal structure (for example austenitic stainless steel and aluminium alloys), the test is carried out at ambient temperature.

For all other metallic, composite and non-metallic cable cleats and intermediate restraints, the samples are conditioned at the declared lowest temperature according to Table 2 with a tolerance of $\left({}^{+2}_{-2}\right)$ *°C for a period of* $\left(60\,{}^{+5}_{0}\right)$ *min. The impact is applied within a period of* $\left(10\,{}^{0}_{-2}\right)$ *s after removal from the refrigerator.*

Each sample is placed in position on the steel base as shown in Figure 2. The energy value of the hammer is as declared in Table 5.

The impact is applied at the weakest point of the cable cleat or intermediate restraint and the direction of impact is radial to the centre of the mandrel nearest to the point of impact.

After the test, the samples shall show no signs of disintegration nor shall there be any cracks or damage, visible to normal or corrected vision, that are likely to impair normal use. ~~In case of doubt, the samples are subjected to the test of 9.3.~~

Table 5 – Impact test values

Classification	Nominal Impact energy J	Equivalent mass kg (± 2%)	Height mm (± 1%)
Very light	0,5	0,25	200
Light	1,0	0,25	400
Medium	2,0	0,5	400
Heavy	5,0	1,7	300
Very heavy	20,0	5,0	400

NOTE The figures in Table 5 have been taken from IEC 60068-2-75.

9.3 Lateral load test

9.3.1 Lateral load test for cable cleats

The purpose of this test is to indicate the sustained static load that a cable cleat can withstand perpendicular to the mandrel axis. It does not predict the ability to withstand the dynamic forces generated during a short-circuit.

The cable cleat is mounted on a test rig as shown in Figure 3, or a similar arrangement. The mounting surface can be made of steel or aluminium plate, plywood or other material. For the purpose of applying the load, a rigid mandrel, as specified in 5.5, of circular, or other appropriate cross-section, is positioned within the cable cleat's aperture. For cable cleats ~~and intermediate restraints~~ taking more than one cable, the appropriate number of mandrels is used. Where more than one mandrel is used, the load shall be applied to a mandrel furthest from the mounting surface. Care is taken to ensure that the load acts through the centre line of the mandrel. The mandrel size is the minimum for which the cable cleat is designed.

Where cable cleats are provided with optional liners, the lateral load test performance of the cable cleat without a liner also applies to the same cable cleat with a liner.

For metallic cable cleats, the declared load is applied gradually and held for a period of $\left(60\ {}^{+5}_{\ 0}\right)$ *min.*

For non-metallic and composite cable cleats, the sample assembly is placed in a full draft air-circulating oven. The tests are carried out after the oven temperature has reached and maintained the declared maximum temperature from Table 1 with a tolerance of $\left({}^{+2}_{-2}\right)$ *°C. The load is applied gradually and then held for a period of* $\left(60\ {}^{+5}_{\ 0}\right)$ *min.*

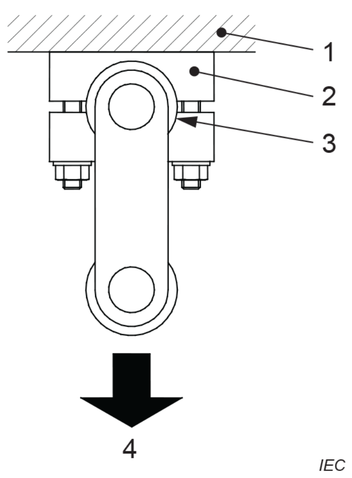
A cable cleat intended for a single mounting orientation shall be tested in that orientation and that orientation shall be declared in the published documentation of the manufacturer.

A cable cleat intended for multiple mounting orientations shall be tested in each mounting orientation using separate samples. The test load on one set of samples shall be applied perpendicular to the mounting surface (Figure 3 a) or Figure 3 b), and to the second set of samples parallel to the mounting surface (Figure 3 c) or Figure 3 d).

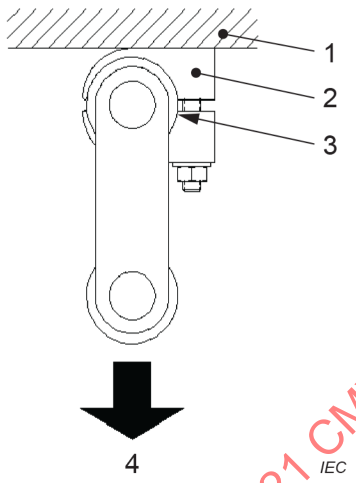
When it can be determined that a particular mounting orientation represents the most onerous condition, the results of the tests in that orientation may represent all mounting orientations for lateral loads.

Movement of the mandrel shall be less than 50 % of the mandrel diameter for circular mandrels. Where a non-circular mandrel is used to simulate non-circular cables, the movement of the mandrel shall be less than 50 % of the diameter of a circle that can be drawn inside the cross-section of the mandrel.

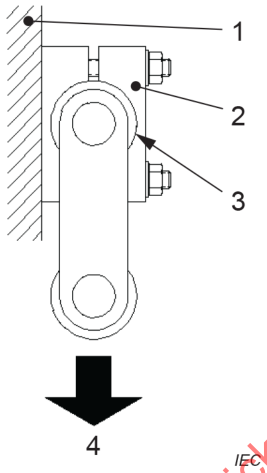
NOTE The intention of this test is to determine the lateral retention of the cable cleat and not the strength of the mounting surface.



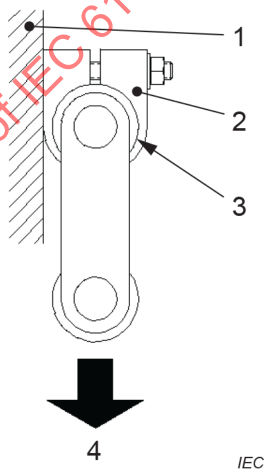
a) Lateral load test with load applied perpendicular to mounting surface on cable cleat with two fixings



b) Lateral load test with load applied perpendicular to mounting surface on cable cleat with single fixing



c) Lateral load test with load applied parallel to mounting surface on cable cleat with two fixings



d) Lateral load test with load applied parallel to mounting surface on cable cleat with single fixing

Key

1 mounting surface

2 cable cleat

3 mandrel

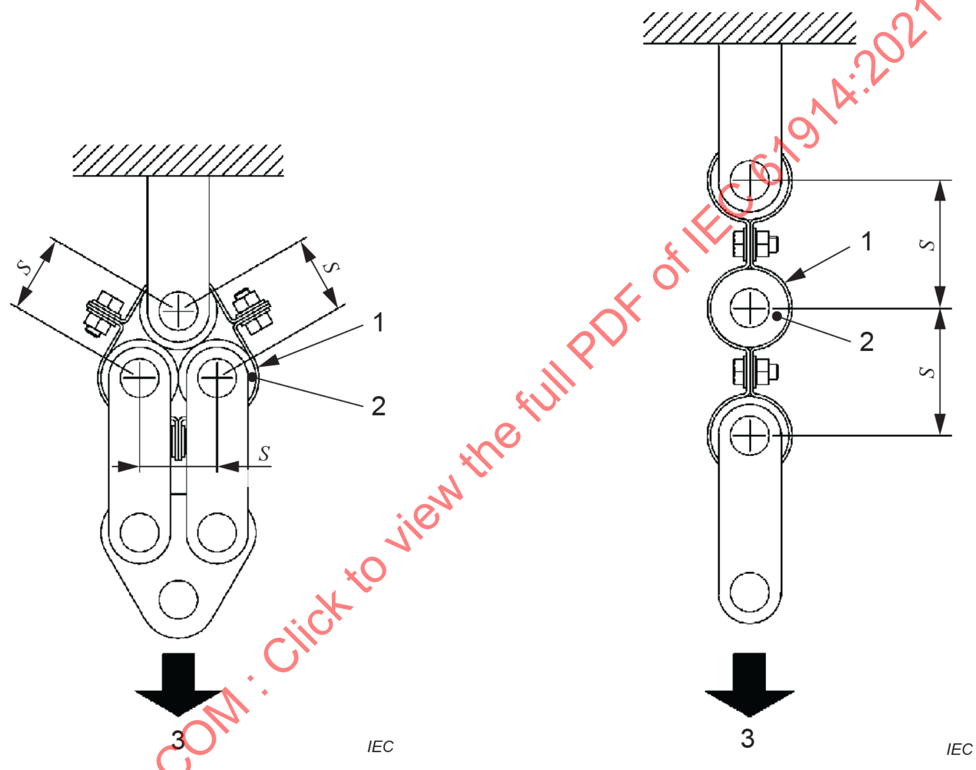
4 direction of load

Figure 3 – Typical arrangements for lateral load test for cable cleats

9.3.2 Lateral load test for intermediate restraints

The purpose of this test is to indicate the sustained static load that an intermediate restraint can withstand perpendicular to the mandrel axis. It does not predict the ability to withstand the dynamic forces generated during a short-circuit.

The intermediate restraint is mounted on a test rig as shown in Figure 4, or a similar arrangement. For the purpose of applying the load, rigid mandrels, as specified in 5.5, of circular, or other appropriate cross-section, are positioned within each of the intermediate restraint's apertures. Care is taken to ensure that the loads act through the centre lines of the mandrels. The mandrel size is the minimum for which the intermediate restraint is designed. Where intermediate restraints are provided with optional liners, the lateral load test performance of the intermediate restraint without a liner also applies to the same intermediate restraint with a liner.



a) Lateral load test for intermediate restraint for cables in trefoil formation

b) Lateral load test for intermediate restraint for cables in flat formation

Key

1 intermediate restraint

2 mandrel

3 direction of load

S mandrel centre spacing

Figure 4 – Typical arrangements for lateral load test for intermediate restraints

For metallic intermediate restraints, the declared load is applied gradually and held for a period of $\left(60\ ^{+5}_{\ 0}\right)$ *min.*

For non-metallic and composite intermediate restraints, the sample assembly is placed in a full draft air-circulating oven. The tests are carried out after the oven temperature has reached and maintained the declared maximum temperature from Table 1 with a tolerance of $\left(^{+2}_{-2}\right)$ °C. The load is applied gradually and then held for a period of $\left(60\ ^{+5}_{0}\right)$ min.

Movement of the mandrels shall not increase the mandrel centre spacing (S) by more than 50 % of the mandrel diameter for circular mandrels. Where a non-circular mandrel is used to simulate non-circular cables, the movement of the mandrel shall be less than 50 % of the diameter of a circle that can be drawn inside the cross-section of the mandrel. **7**

9.4 Axial load tests

~~*The test is carried out using a mandrel with an overall cross section equivalent to the minimum declared cable cross section for which the cleat is designed. The test mandrel shall have a diametrical tolerance of*~~ $\cancel{\left(^{+0,2}_{-0,2}\right)}$ ~~*mm for mandrels up to and including 16 mm diameter and of*~~ $\cancel{\left(^{+0,3}_{-0,3}\right)}$ ~~*mm for larger diameters. In the case of non-circular cables, a profile is to be used simulating the outer cable dimension, as declared by the manufacturer or responsible vendor. For cleats and intermediate restraints taking more than one cable, the appropriate number of mandrels is used. Where more than one mandrel is used the load shall be simultaneously applied to all mandrels.*~~

~~*All mandrels shall have a surface roughness less than or equal to 7 µm Ra in accordance with ISO 4287. For test temperatures below 105 °C, test mandrels may be solid polyamide or metal. Metallic mandrels shall be used for test temperatures 105 °C and higher.*~~

The purpose of these tests is to indicate the sustained static load that a cable cleat can withstand along the mandrel axis. It may not predict the ability to withstand the axial forces generated by a cable.

The test is carried out using a mandrel, as specified in 5.5, with an overall cross section equivalent to the most onerous size, taking into account the surface contact area between the mandrel and the cable cleat.

NOTE While the most onerous size will typically be the mandrel with an overall cross section equivalent to the minimum declared cable cross section, it is possible that a larger mandrel has less surface contact area between the mandrel and the cable cleat.

The test mandrel shall have a diametrical tolerance of $\left(^{+0,3}_{-0,3}\right)$ mm. In the case of non-circular cables, a profile shall be used simulating the outer cable dimension, as declared by the manufacturer. For cable cleats taking more than one cable, the appropriate number of mandrels is used. Where more than one mandrel is used, multiple tests are required.

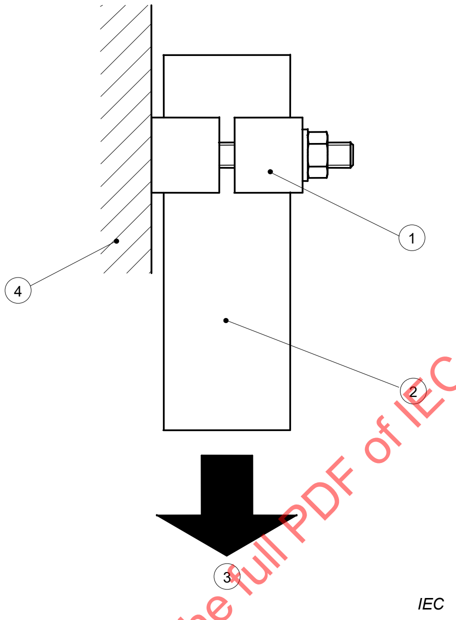
- *The first set of tests is carried out with the load applied to each mandrel in turn. When it can be determined that a particular mandrel represents the most onerous condition, the results of the test utilizing that mandrel may represent the other mandrels.*
- *The second test is carried out with the load simultaneously applied to all mandrels.* **8**

The cable cleat is mounted on a rigid mounting surface and assembled in the test rig as shown in Figure 5, or a similar arrangement. The mounting surface can be made of steel or aluminium plate, plywood or other material. Cable cleats with an optional liner are tested with and without the liner.

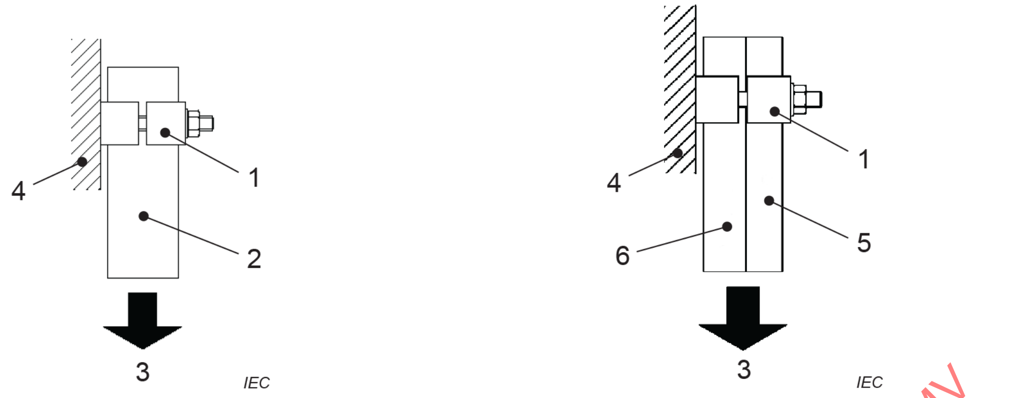
For metallic cable cleats, the declared load is applied gradually and held for a period of $\left(5\ ^{+1}_{0}\right)$ min.

For metallic with optional liner, non-metallic and composite cable cleats, the sample assembly is placed in a full draft air-circulating oven. The tests are carried out after the oven temperature has reached and maintained the declared maximum temperature from Table 1 with a tolerance of $\left(^{+2}_{-2}\right)$ *°C. The load is applied gradually and held for a period of* $\left(5\,^{+1}_{0}\right)$ *min.*

After the test, the displacement of the mandrel(s) with respect to the cable cleat shall not be more than 5 mm.



~~**Key**~~	
~~1~~	~~cleat~~
~~2~~	~~mandrel~~
~~3~~	~~direction of load~~
~~4~~	~~mounting surface~~



a) Axial load test on cable cleat taking one cable

b) Axial load test on cable cleat taking more than one cable

Key

1 cable cleat

2 single mandrel

3 direction of load

4 mounting surface

5 mandrel(s) farthest from mounting surface

6 mandrel(s) closest to mounting surface

Figure 5 – Typical arrangement for axial load test

9.5 Test for resistance to electromechanical forces

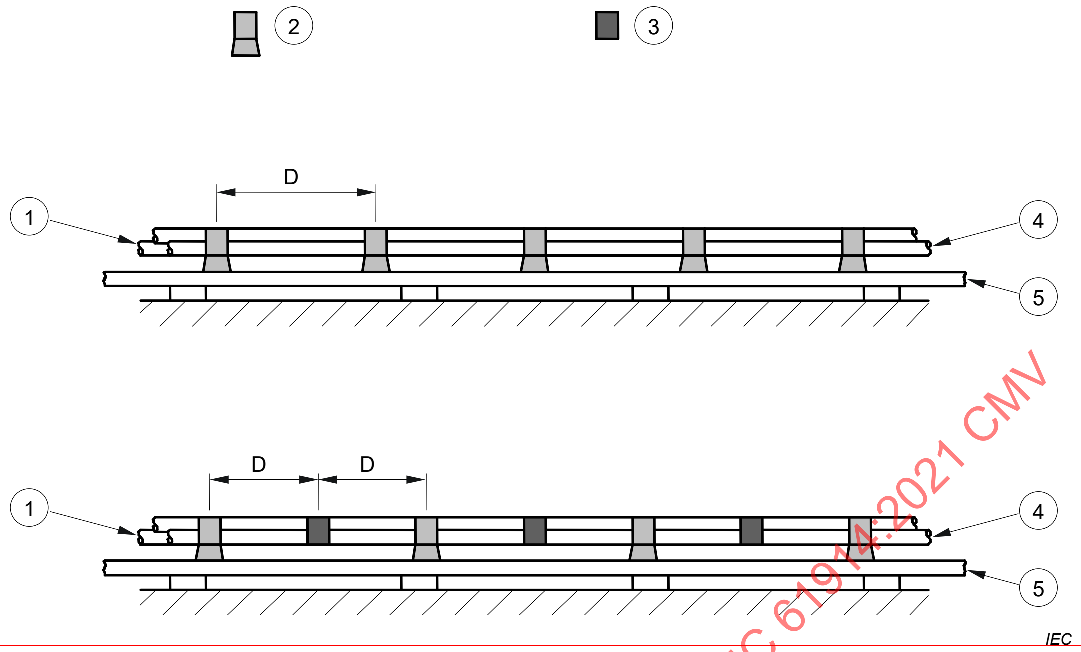
9.5.1 General

A short-circuit test is carried out as follows, using the manufacturer's ~~or responsible vendor's~~ declared values of peak short-circuit current (i_p) and initial r.m.s. symmetrical short-circuit current (I''_k). One set of cable cleats of each product type with intermediate restraints, where appropriate, and of a size suitable for the test cable shall be tested. The test is performed using unarmoured single core 600 V / 1 000 V class 2 stranded copper conductor cable in accordance with IEC 60502-1 of either $\left(35\,^{+5}_{-5}\right)$ *mm or* $\left(50\,^{+5}_{-5}\right)$ *mm diameter.*

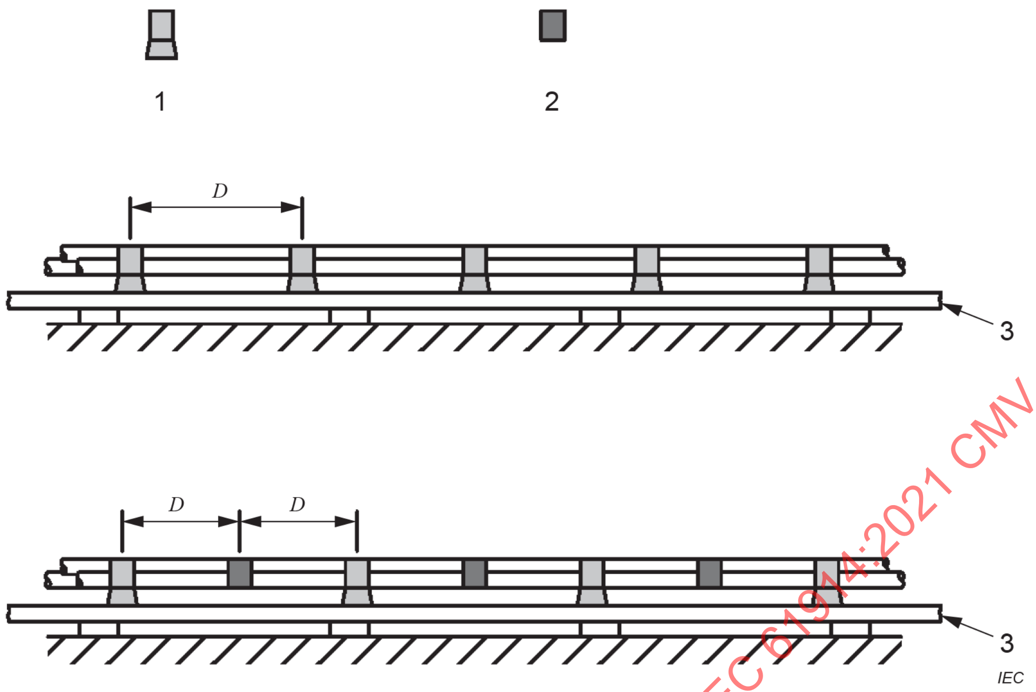
For larger cable cleats where the test cannot be performed on the cable described above, a medium or high voltage cable with a single screened core may be used. Details of the cable shall be recorded on the form given in Annex C.

Care should be taken in the design of the test to ensure that the deflection of the cables between the cleats is not excessive.

The temperature limits specified in 5.4 do not apply to this test. The test is carried out at the prevailing ambient temperature on the declared arrangement at the declared short-circuit level. The ambient temperature shall be recorded in the test report. Typical assemblies are shown in Figure 6.



~~Key~~	
~~1~~	~~supply end~~
~~2~~	~~Cable cleats~~
~~3~~	~~intermediate restraints~~
~~4~~	~~short-circuit busbar end~~
~~5~~	~~mounting surface~~
~~D~~	~~spacing~~



Key

1 cable cleats

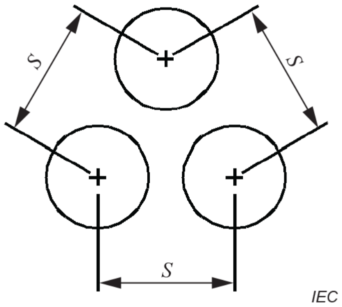
2 intermediate restraints

3 mounting surface

D lineal spacing

Figure 6 – Typical assemblies for test for resistance to electromechanical force

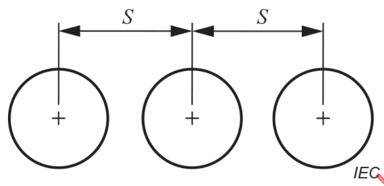
The arrangement of the cables is as shown in Figure 7 or Figure 8 with one cable per phase. One end of each cable is connected to a three-phase supply and the other end to a short-circuiting busbar with all three phases being connected. Where cables incorporating metallic screens, sheath or armour are used in the test, no connection shall be made to any screen, sheath or armour. The short-circuiting busbar shall be insulated from earth (ground). The cable is restrained at a minimum of 5 positions along the cable run. Where intermediate restraints are used, at least 4 cable cleats and at least 3 intermediate restraints shall be used. Cable cleats and intermediate restraints, where used, shall be equally spaced. The cable cleats are fixed to mounting surface which may be cable ladder, cable tray, wire mesh cable tray, framing channel or structural steel as defined by the manufacturer ~~(e.g. cable ladder) which shall be selected with regard to the forces likely to occur during the test~~. This mounting surface shall be secured before the test.



Key

S cable centre spacing

Figure 7 – Typical arrangement of three cables in trefoil formation



Key

S cable centre spacing

Figure 8 – Typical arrangement of cables in flat formation

Care is taken to ensure the cross-sectional area of the cable is adequate for the magnitude and duration of the test current which shall be chosen so that the I^2t (thermal stress) rating of the cable used is not exceeded.

The test report shall contain the following information:

– *the manufacturer's ~~or responsible vendor's~~ catalogue references of the cable cleat and intermediate restraint (where used);*

– *the assembly details showing:*

- *the number of cable cleats and ~~their~~ the lineal spacing, D (see Figure 6);*
- *the number of intermediate restraints (where used) and ~~their~~ the lineal spacing, D (see Figure 6);*
- *the cable centre spacing, S (see Figure 7 or Figure 8);*
- *a description of the mounting surface used*

– *cable conductor diameter, insulation thickness, external diameter and markings, where unarmoured single core 600 V / 1 000 V class 2 stranded copper conductor cable of either $\left(35\,^{+5}_{-5}\right)$ mm or $\left(50\,^{+5}_{-5}\right)$ mm diameter are used;*

– *full cable details recorded on the form in Annex C where MV or HV cables are used;*

– *a pre-test photograph of the test assembly and a post-test photograph documenting the condition of the cable cleats, and intermediate restraints if used. Where a second short-circuit is applied, photographs before and after each short-circuit application shall be supplied;*

– *the test duration;*

– *the ambient temperature during the test;*

– *the actual peak short-circuit current (i_p) and initial r.m.s. symmetrical short-circuit current, (I''_k) applied (in both tests where cable cleats and intermediate restraints classified under 6.4.5 are tested).*

If the test station has to undertake a calibration test, action is taken to ensure that the test installation is not affected.

The cables of the test arrangement are subjected to a three-phase short-circuit of duration of not less than ~~0,1 s~~ 5 cycles at a nominal frequency of 50 Hz or 60 Hz. The duration of the test is recorded.

~~Care must be taken to ensure~~ It shall be ensured that there is adequate restraint for the cables at each end of the cable run to be tested.

Annex B may be used to calculate the theoretical forces that may be created during short circuits in order to plan testing.

9.5.2 For cable cleats and intermediate restraints classified in 6.4.4

Cable cleats and intermediate restraints classified under 6.4.4 shall comply with the following requirements:

– *following the short-circuit, all cable cleats shall remain secured to the mounting surface;*

– *there shall be no failure that will affect the intended function of holding the cables ~~in place~~ within the confinement of the cable cleat;*

– *the cable cleats and the intermediate restraints, if used, shall be intact with no missing parts including all devices used to secure the cable cleats to the mounting surface;*

– *there shall be no cuts or damage visible to normal or corrected vision to the outer sheath of each cable caused by the cable cleats or by the intermediate restraints, if used;*

– *Where a test failure is caused by damage to the cable from parts of the mounting structure other than a cable cleat or intermediate restraint, the test shall be void without discrediting the cable cleats or intermediate restraints.*

9.5.3 For cable cleats and intermediate restraints classified in 6.4.5

Cable cleats and intermediate restraints classified under 6.4.5 shall comply with the inspection requirements of 9.5.2 after the first and after the second short-circuit applications.

After a second short-circuit application, a voltage withstand test is performed by applying a minimum test voltage of ~~2,8~~ 1,8 kV d.c. or 1,0 kV a.c. for a period of $\left(60\,^{+5}_{\ 0}\right)$ s according to the provisions of IEC 60060-1:2010, Clause 5, Tests with direct voltage or Clause 6, Tests with alternating voltage. Where LV cables have been used in the test, the voltage withstand test shall be administered between the cable cores, which should be connected together, and the mounting frame. Where MV or HV cables have been used in the test, the voltage withstand test shall be administered between the outermost cable screens, armours or metallic sheaths, which should be connected together, and the mounting frame. 9 The mounting frame shall be bonded to the earthing system. The cable ~~jackets~~ oversheaths and mounting frame shall be pre-wetted with sufficient water to facilitate a current leakage path along the outer jacket for ~~$(2^{+1}_{\ 0})$ min~~ a minimum of 1 min before the test begins.

The cables shall meet the requirements of the voltage withstand test without failure of the insulation.

The lower of the two short-circuit currents applied is the declared short-circuit current rating for cable cleats and intermediate restraints classified in 6.4.5. Where the first short-circuit current is higher, then it may be declared as the short-circuit current rating under 6.4.4.

10 Fire hazards

10.1 Flame propagation

Non-metallic and composite cable cleats and intermediate restraints shall have adequate resistance to flame propagation.

Compliance is checked by the following test.

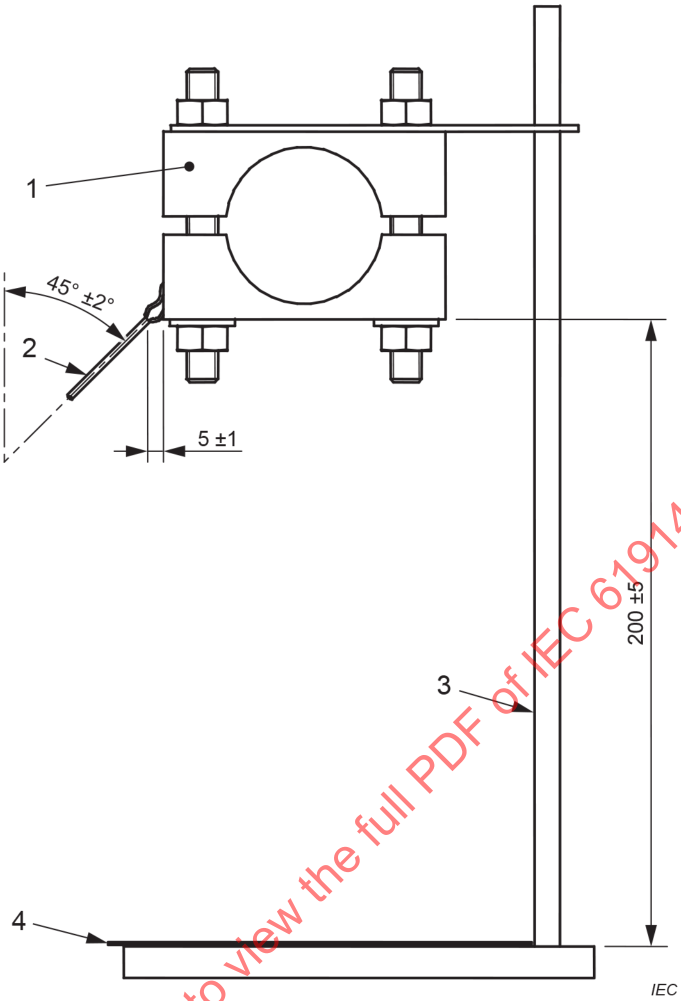
Using an arrangement as shown in Figure 9, the sample shall be submitted to the needle-flame test as specified in IEC 60695-11-5 with the following additional information:

- *the flame shall be applied to the outer surface of the sample;*
- *the time of application shall be* $\left(30\,^{+0}_{-1}\right)$ *s;*
- *the underlying layer shall consist of three layers of tissue paper;*
- *there shall be a single application of the flame.*

The sample shall be deemed to have passed the test if:

- *30 s after the test flame is removed, there is no flaming of the sample;*
- *there is no ignition of the tissue paper.*

Dimensions in millimetres



Key

1 cable cleat

2 burner

3 stand

4 tissue paper

Figure 9 – Typical arrangement of the needle-flame test

10.2 Smoke emission

The smoke emissions from cable cleats and intermediate restraints need not be considered because of their small size and quantity in normal use.

10.3 Smoke toxicity

The smoke toxicity from cable cleats and intermediate restraints need not be considered because of their small size and quantity in normal use.

11 Environmental influences

11.1 Resistance to ultraviolet light

Cable cleats and intermediate restraints classified according to 6.5.1.2 shall be subjected to ultraviolet light (UV) conditioning according to the following requirements. Liners for cable cleats have a limited area exposed to daylight, so do not need to be tested for UV exposure.

When the product is provided in more than one colour, the colour having the heaviest organic pigment loading shall be subjected to this test. The samples tested are considered representative of the entire colour range.

Samples shall be mounted in the ultraviolet light apparatus in a convenient manner suitable for the product to be tested and the test equipment and so that the samples do not touch each other.

The samples ~~are to~~ shall be exposed for a minimum of 700 h to Xenon-arc, Method A, Cycle 1 in accordance with ISO 4892-2~~:2006~~. If the geometry of the test specimens results in a higher UV exposure than required on the surface subjected to the impact test, the duration of exposure may be modified in order to achieve the intended exposure on that surface. There shall be continuous exposure to light and intermittent exposure to water spray. The cycle shall consist of 102 min without water spray and 18 min with water spray. The apparatus shall operate with a water-cooled xenon-arc lamp, borosilicate glass inner and outer optical filters, a spectral irradiance of $\left(0{,}51^{+0{,}02}_{-0{,}02}\right)$ *W/(m²•nm) at 340 nm and a black-standard temperature of* $\left(65^{+3}_{-3}\right)$ *°C. The temperature of the chamber shall be* $\left(38^{+3}_{-3}\right)$ *°C. The relative humidity in the chamber shall be* $\left(50^{+10}_{-10}\right)$ *% during the 102 min without water spray.*

Following the exposure, the samples shall be held for a minimum of 30 min under ambient conditions.

After UV exposure, the samples shall show no signs of disintegration nor shall there be any cracks or damage, visible to normal or corrected vision. The samples shall then be subjected to the impact test, as described in 9.2 and shall comply with the impact test requirements.

~~NOTE Cleats that comply with IEC 61914:2009 do not need to be re-tested.~~

11.2 Resistance to corrosion

11.2.1 General

~~Metallic or composite cleats and intermediate restraints shall have adequate resistance to corrosion.~~

~~Compliance is determined by the test in 11.2.2 unless otherwise specified below.~~

~~Metallic or composite cleats and intermediate restraints, including fixings such as nuts, bolts, screws and washers, made of non-ferrous metals, cast-iron, malleable-iron or stainless steel containing at least 16 % chromium need not be tested and are assumed to meet the classification for high resistance to corrosion. Stainless steel containing at least 13 % chromium is assumed to meet the classification for low resistance to corrosion and need only be tested where declared in accordance with 6.5.2.2 for high resistance. Where corrosion protection is provided by a layer of zinc equal to or greater than that specified in Table 4, measurement of the zinc layer is required without the need to carry out further testing.~~

~~The mean and minimum thickness shall be determined by taking five measurements over the plated surface.~~

~~Fixings, such as nuts, bolts, screws and washers, shall not be subjected to the test in 11.2.2, however, the presence of a protective coating is required.~~

~~*The presence of a coating on fixings shall be determined by inspection with normal or corrected vision.*~~

~~A cut edge, a punched hole and the threaded surface of a tapped hole of a part formed from galvanized stock of thickness 2,5 mm or less is not required to be coated.~~

~~Table 4 – Resistance to corrosion~~

~~Classification~~	~~Typical usage~~	~~Mean zinc layer thickness µm~~	~~Minimum zinc layer thickness µm~~	~~Salt spray duration h~~
~~Low~~	~~Indoor, dry locations~~	~~5~~	~~3,5~~	~~24~~
~~High~~	~~Outdoor, wet locations~~ [a]	~~25~~	~~18~~	~~192~~
[a] ~~For use in marine or other corrosive environments additional protection may be required and additional consideration should be given to the appropriate duration of test exposure or to the use of an alternative test method..~~				

All cable cleat and intermediate restraint components shall have adequate resistance against corrosion in accordance with Table 6.

Table 6 – Component compliance and classification for resistance against corrosion

Component material and coating(s)	Classification according to	Compliance	Subclause for compliance check
Non-metallic	6.5.2.2	Declaration	11.2.2
Stainless steel as in Table 3	6.5.2.3	Declaration	11.2.3
Mild steel or cast iron with zinc coating referenced in Table 4	6.5.2.4	Declaration or zinc coating measurement according to Table 7	11.2.4.2
Mild steel or cast iron with metallic coating not referenced in Table 4	6.5.2.4	By neutral salt spray test (NSS) according to Table 4	11.2.4.3
Non-ferrous alloys	6.5.2.5	Under consideration	11.2.5

11.2.2 Non-metallic components

Components classified according to 6.5.2.2 are considered to be inherently resistant to corrosion and do not require testing.

11.2.3 Components made of stainless steel

All stainless steel components shall have a class according to Table 3. Components declared according to 6.5.2.3 made of stainless steel shall conform to the declared class in Table 3.

Compliance is checked by a supplier's declaration based on the material composition.

11.2.4 Components made of mild steel or cast iron with metallic coating

11.2.4.1 General

Mild steel and cast-iron components with a metallic coating shall have a class according to Table 4.

11.2.4.2 Components made of mild steel with zinc coating referenced in Table 4

Components declared according to 6.5.2.4 made of mild steel with zinc coating and referenced in Table 4 shall conform to the relevant specification as detailed in Table 7.

Table 7 – Zinc coating thickness of reference materials

Class	Minimum thickness according to ISO 2081 µm	Minimum coating thickness as given in either ISO 3575 or EN 10346 µm	Mean coating thickness (minimum) to ISO 1461 µm
2	12	-	-
3	-	15	-
8	-	-	85

The zinc layer thickness shall comply with the following test:

– *For class 2, compliance is checked by:*

  measurement according to ISO 2081. For small parts such as screws, a supplier's declaration is sufficient.

– *For class 3, compliance is checked by:*

  measurement according to either ISO 3575 or EN 10346 or a supplier's declaration.

– *For class 8, compliance is checked by:*

  measurement according to ISO 1461. **10**

11.2.4.3 Components made of mild steel or cast-iron with coatings and not referenced in Table 4

Components declared according to 6.5.2.4 made of mild steel or cast-iron with a metallic coating and not referenced in Table 4 shall conform to the declared class and corresponding test duration as specified in Table 4.

Compliance is checked by the salt spray test in 11.2.6.

11.2.5 Components made of non-ferrous alloys

Under consideration.

11.2.6 Salt spray test

All grease shall be removed from the parts to be tested, by cleaning with white spirit. All parts shall then be dried. The samples shall then be assembled onto ~~a polyamide 66~~ polymeric mandrel(s) as specified in 5.5, with ~~a diameter~~ dimensions equal to the smallest cable ~~diameter~~ dimensions declared for the cable cleat or intermediate restraint in accordance with 5.2.

Samples shall be subjected to a neutral salt spray (NSS) test according to ISO 9227 for the duration specified in Table 4.

~~*Surfaces where a coating is not required under 11.2.1 shall be protected during the test in accordance with the directions in ISO 9227.*~~

After the parts have been dried for a minimum of 10 min in a heating cabinet at a temperature of $\left(100\,^{+5}_{-5}\right)$ °C, any traces of rust on sharp edges and a yellowish film may be removed by rubbing.

The sample shall have passed the test if there is no red rust visible to normal or corrected vision.

~~Zones that trap saltwater during the test are not considered for the test result.~~

12 Electromagnetic compatibility

12.1 Electromagnetic emission

Products covered by this document are, in normal use, passive in respect of electromagnetic emission.

12.2 Inductive heating

Ferromagnetic materials (e.g. cast-iron, mild steel) that surround single conductors in a.c. circuits are susceptible to heating from eddy currents. The manufacturer ~~or responsible vendor~~ of cable cleats and intermediate restraints made from ferromagnetic materials that may complete an electrical and magnetic circuit around the cable shall issue a warning that the cable cleats shall not be used on single core cables in a.c. circuits.

Annex A
(informative)

Examples of cable cleats and intermediate restraints

~~Figures A.1 to A.9 show examples of cable cleats.~~

~~Figure A.1 –~~

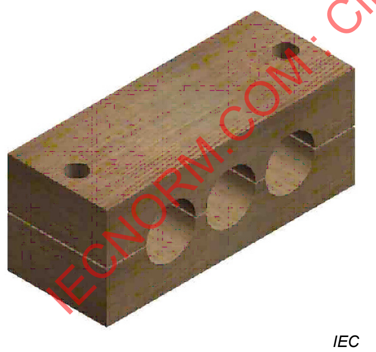
~~Figure A.2 –~~

~~Figure A.3 –~~

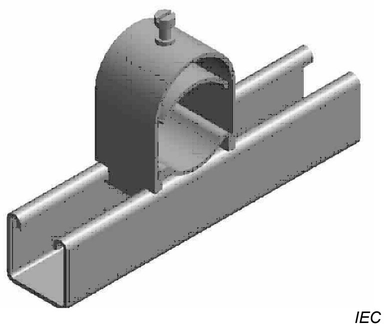
~~Figure A.4 –~~

~~Figure A.5 –~~

~~Figure A. 6 –~~



~~Figure A.7–~~



~~Figure A.8 –~~

~~Figure A.9 –~~

Figure A.1 to Figure A.10 show examples of cable cleats. Figure A.11 and Figure A.12 are examples of intermediate restraints.

Figure A.1 – Metallic strap cable cleat for single or bundled cables

Figure A.2 – Metallic single bolt cable cleat for single cable

Figure A.3 – Metallic two-bolt cable cleat for single cable

Figure A.4 – Composite cable cleat for three cables in trefoil formation

Figure A.5 – Non-metallic cable cleat for single cable

Figure A.6 – Metallic cable cleat for single cable with integral mounting stud

Figure A.7 – Non-metallic cable cleat for three cables in flat formation

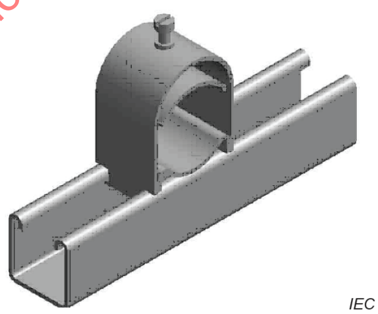


Figure A.8 – Metallic cable cleat for use with channel cable support system

Figure A.9 – Non-metallic cable cleat for three cables in trefoil formation

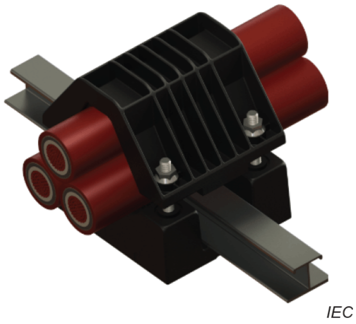


Figure A.10 – Non-metallic cable cleat for three cables in trefoil formation with integral ladder rung clamp

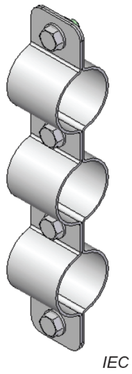


Figure A.11 – Metallic intermediate restraint for three cables in flat formation

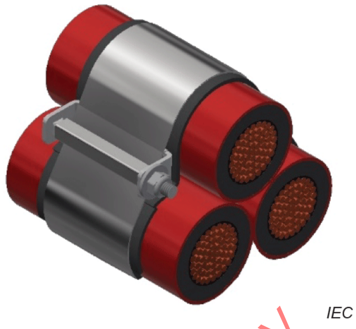


Figure A.12 – Composite intermediate restraint for bundled cables

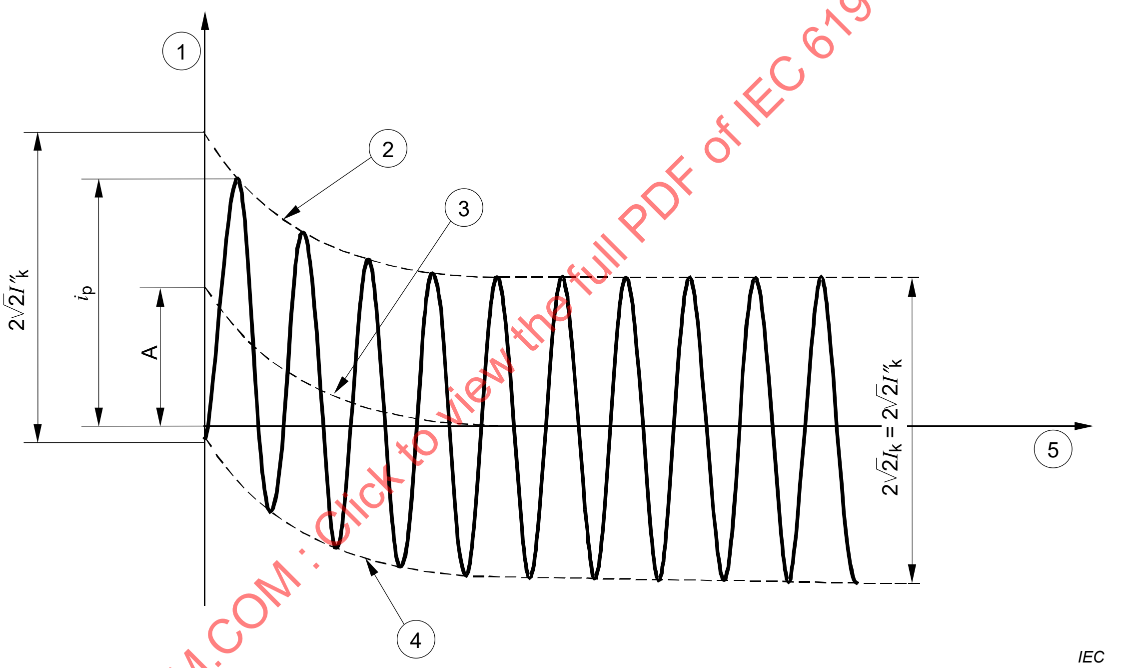
Annex B
(informative)

Calculation of forces caused by short-circuit currents

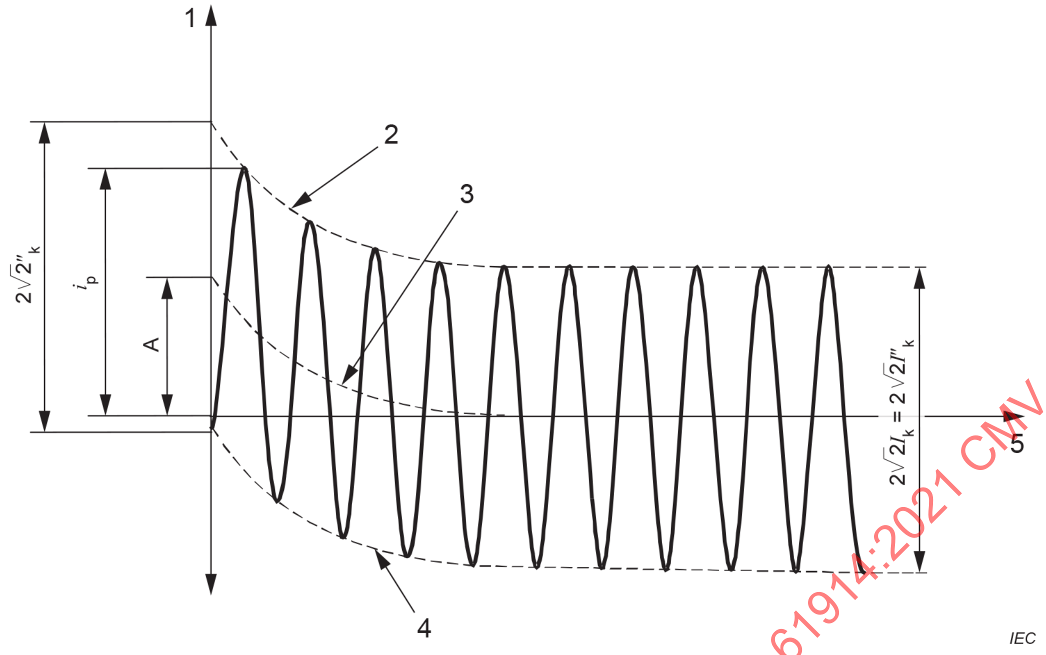
B.1 Characteristics

Recommendations for the calculation of short-circuit currents are given in IEC 60909 (all parts) and IEC 61363-1. The latter covers ships and offshore units. The information given in this annex is based on IEC 60909-0.

The characteristics of the current during a short circuit depend on a number of factors, including the electrical separation from the generator. Figure B.1 shows a current vs. time characteristic typical of a far-from-generator short circuit. The a.c. component in this case has a constant amplitude ($I''_k = I_k$) and is superimposed on a decaying d.c. component, $i_{d.c.}$. This falls from an initial value, A, to zero.



~~Key~~	
~~1~~	~~Current~~
2	~~top envelope~~
~~3~~	~~decaying d.c. component, $i_{d.c.}$ of the short-circuit current~~
4	~~bottom envelope~~
~~5~~	~~Time~~
A	~~initial value of the d.c. component, $i_{d.c.}$ of the short-circuit current~~



Key

1 current

2 top envelope

3 decaying d.c. component, $i_{d.c.}$ of the short-circuit current

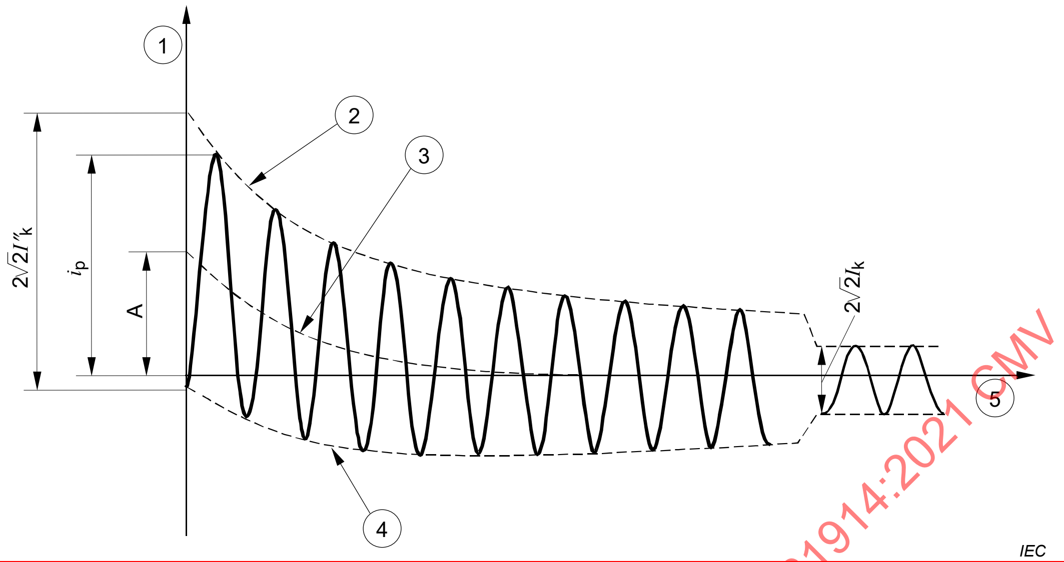
4 bottom envelope

5 time

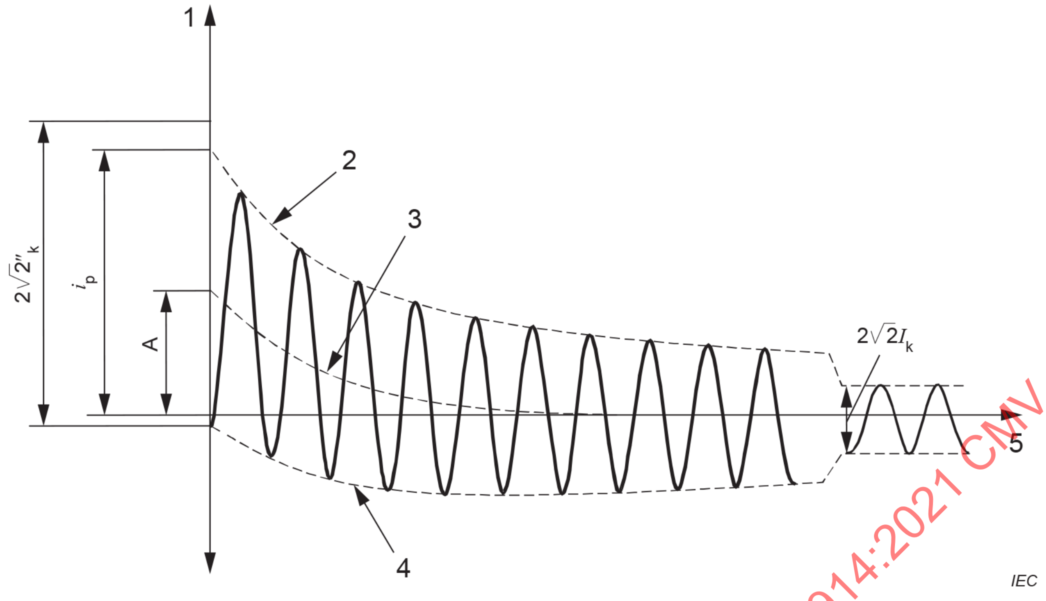
A initial value of the d.c. component, $i_{d.c.}$ of the short-circuit current

Figure B.1 – Short-circuit current of a far-from-generator short circuit with constant a.c. component

For near-to-generator short circuits, the a.c. component has a decaying amplitude ($I''_k > I_k$) and is also superimposed on a decaying d.c. component, $i_{d.c.}$ that falls from an initial value, A, to zero. Figure B.2 shows a typical current vs. time characteristic for a near-to-generator short circuit.



~~**Key**~~	
~~1~~	~~Current~~
~~2~~	~~top envelope~~
~~3~~	~~decaying d.c. component, $i_{d.c.}$ of the short-circuit current~~
~~4~~	~~bottom envelope~~
~~5~~	~~Time~~
~~A~~	~~initial value of the d.c. component, $i_{d.c.}$ of the short-circuit current~~



Key

1 current

2 top envelope

3 decaying d.c. component, $i_{d.c.}$ of the short-circuit current

4 bottom envelope

5 time

A initial value of the d.c. component, $i_{d.c.}$ of the short-circuit current

Figure B.2 – Short-circuit current of a near-to-generator short circuit with decaying a.c. component

B.2 Specification of the test current

A complete specification of short-circuit currents should give the currents as a function of time at the short-circuit location from the initiation of the short circuit up to its end. In most practical cases, this is not necessary. It is usually sufficient to know the peak current, i_p, and the values of the initial r.m.s. symmetrical, I''_k, and steady state, I_k, short-circuit currents.

In order to specify the current used in a short-circuit test, the following is quoted:

– the peak current, i_p;

– the initial r.m.s. symmetrical short-circuit current, I''_k;

– the short-circuit duration, t.

B.3 Calculation of the mechanical forces between conductors

The electromagnetic force acting on a conductor is determined by the current in the conductor and the magnetic field from the neighbouring conductors. In cable installations, the distances between the cables are normally small and hence the forces may be considerable.

To calculate the forces a cable cleat may be subjected to during a short-circuit, the equations derived in this Annex B may be used. These derivations assume that the cables are rigid and do not move in the test. The derivation of Equations (B.5), (B.6) and (B.7) is based on a symmetrical pure sine wave fault current with no d.c. component. For these reasons, these equations should not be used to extrapolate short circuit test results.

In the case of two parallel conductors, the electromagnetic force on a conductor can be derived from Equation (B.1):

$$F(t) = B(t) \cdot i(t) \cdot l \tag{B.1}$$

where

l is the length;

$F(t)$ is the momentary electromagnetic force on a conductor;

$B(t)$ is the momentary magnetic field from the neighbouring conductor;

$i(t)$ is the momentary current in the neighbouring conductor.

If the d.c. component of the short-circuit current is disregarded, the momentary force has a sinusoidal variation with a frequency twice the frequency of the currents [Equation (B.1)]. The d.c. component gives a decaying force-component with a frequency the same as the system frequency.

Key

B magnetic flux density

d conductor diameter

i_1 current in first conductor

i_2 current in second conductor

S distance between conductor centres

Figure B.3 – Two parallel conductors

For the two parallel conductors in Figure B.3., the magnetic field from current i_1, at the location of the other conductor is:

$$\cancel{B = \mu_0 \cdot H = \mu_0 \cdot i_1 / 2 \cdot \pi \cdot S}$$

$$B = \mu_0 \cdot H = (\mu_0 \cdot i_1)/(2 \cdot \pi \cdot S) \tag{B.2}$$

where

$\mu_0 = 4 \cdot \pi \cdot 10^{-7}$ ~~(~~H/m~~)~~

H = magnetic field strength

and the distributed mechanical force is:

$$\cancel{F = i_2 \times B = i_2 \cdot \mu_0 \cdot i_1 / 2 \cdot \pi \cdot S}$$

$$F = i_2 \times B = (i_2 \cdot \mu_0 \cdot i_1)/(2 \cdot \pi \cdot S) \tag{B.3}$$

This equation is usually written as:

$$F = 0{,}2 \cdot i_1 \cdot i_2 / S \tag{B.4}$$

In this equation, the distributed force is given in N/m, i in kA and S in metres.

In a three-phase system, the magnetic field in Equation (B.2) is the resulting momentary vector value from the other two phases.

The vector Equation (B.3) confirms that two parallel conductors are repelled if the two currents have a difference in phase angle of 180° and that the force is directed towards the other conductor for currents that have the same phase angle.

The evaluation of Equation (B.4) requires $S >> d$ but gives an acceptable accuracy when the current distribution is uniform (or symmetrical) within the conductors.

For a three-phase short circuit with the conductors in flat configuration, the forces on the two outer conductors are ~~always~~ primarily directed outwards from the central conductor. The force on the central conductor is oscillating. The maximum distributed force on the outer conductors in flat formation can be ~~calculated~~ approximated by

$$F_{fo} = 0{,}16 \cdot {i_p}^2 / S \tag{B.5}$$

The maximum distributed force on the middle conductor in flat formation can be ~~calculated~~ approximated by

$$F_{fm} = 0{,}17 \cdot {i_p}^2 / S \tag{B.6}$$

For a three-phase short circuit with the cables in a trefoil configuration, the maximum distributed force on the conductor ~~is~~ can be approximated by:

$$F_t = 0{,}17 \cdot {i_p}^2 / S \tag{B.7}$$

where

~~F_s is the maximum force on the cable conductor in flat formation for a single phase short circuit [N/m];~~

F is the maximum distributed force between two parallel conductors [N/m];

F_{fo} is the maximum distributed force on the outer cable conductors in flat formation for a three-phase short circuit [N/m];

F_{fm} is the maximum distributed force on the centre cable conductor in flat formation for a three-phase short circuit [N/m];

F_t is the maximum distributed force on the cable conductor in a trefoil configuration for a three-phase short circuit [N/m];

i_p is the peak short-circuit current [kA];

~~d is the external diameter of the conductor [m];~~

S is the centre to centre distance between two neighbouring conductors [m].

Annex C
(normative)

Identification of MV or HV cable used in short-circuit test

Cable manufacturer:	....			
Cable part number:	....			
Cable marking:	....			
Cable standard:	....			
Rated voltage U_0/U (U_m):	.... kV			
Number of conductors:	....			
Conductor type:	☐ Al	☐ Cu		
	☐ Class 1	☐ Class 2	☐ Class 5	☐ Class 6
	☐ Circular	☐ Shaped		
Conductor cross-section:	....mm^2 / kcmil			
Insulation:	☐ XLPE		☐ EPR	
	☐ HEPR		☐ other	....
Metallic screen:	☐ Wire		☐ Tape	
	☐ Laminated foil	☐ other		
	☐ Al	☐ Cu	☐ other	....
Armour:	☐ Wire	☐ Braid	☐ Tape	
	☐ Corrugated Al	☐ other		
Oversheath:	☐ PVC	☐ PE	☐ other	....
Actual diameters:	Conductor	.... mm		
	Insulation	.... mm		
	Insulation screen	.... mm		
	Oversheath	.... mm		

Cable datasheet attached (mandatory): ☐

Bibliography

IEC 60068-2-75, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60364-5-51, *Electrical installations of buildings – Part 5-51: Selection and erection of electrical equipment – Common rules*

IEC 60909 (all parts), *Short-circuit currents in three-phase a.c. systems*

IEC 60909-0, *Short-circuit currents in three-phase a.c. systems – Part 0: Calculation of currents*

IEC 61363-1, *Electrical installations of ships and mobile and fixed offshore units – Part 1: Procedures for calculating short-circuit currents in three-phase a.c.*

IEC 61537:2006, *Cable management – Cable tray systems and cable ladder systems*

List of comments

1 Cable definitions added so that the short-circuit test method can be extended to cable cleats that are too large for LV cables.

2 Definition added so that the performance of liners can be accounted for in the tests.

3 Definition added to aid selection of test sample sets.

4 Requirements for mandrels were specified differently in the different test methods. They have been rationalised and moved here so that the same mandrels can be used in all tests.

5 Classification for mild steel and cast iron components based on those used for cable tray and cable ladder to simplify product selection where these products are used together.

6 Test method for marking durability is now based on IEC TR 61916 as used for other cable management products.

7 New test requirements added to assess the performance of lateral restraints.

8 New test requirements added to assess the axial load performance of cable cleats designed for more than one cable.

9 New requirements added so that large cable cleats can be tested with the MV or HV cables that they are intended to be used with.

10 Test requirements for mild steel and cast iron components based on those used for cable tray and cable ladder to simplify product selection where these products are used together.

IEC 61914

Edition 3.0 2021-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Cable cleats for electrical installations

Brides de câbles pour installations électriques

IEC 61914:2021-10(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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CABLE CLEATS FOR ELECTRICAL INSTALLATIONS

FOREWORD

IEC 61914 has been prepared by subcommittee 23A: Cable management systems, of IEC technical committee 23: Electrical accessories. It is an International Standard.

This third edition cancels and replaces the second edition published in 2015. This edition constitutes a technical revision.

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

a) requirements for mandrels used in testing rationalised and detailed in the general test requirements (Clause 5);

b) definition of liner added and test requirements where liners and other optional parts are used;

c) definitions for LV, MV and HV cables added and test requirements where MV & HV cable are used ;

d) new corrosion resistance classes for plated products added;

e) new requirements and test for durability and legibility of markings added;

f) new test requirements for axial load testing of cleats for more than one cable added;

g) lateral load test requirements for intermediate restraints added.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
23A/976/FDIS	23A/982/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

In this standard, the following print types are used:

– requirements proper: in roman type;
– *test specifications: in italic type*;
– notes: in smaller roman type.

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

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

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

CABLE CLEATS FOR ELECTRICAL INSTALLATIONS

1 Scope

This International Standard specifies requirements and tests for cable cleats used for securing cables in electrical installations and for intermediate restraints used for holding cables together in formation in electrical installations. Cable cleats provide resistance to electromechanical forces where declared. This document includes cable cleats that rely on a mounting surface specified by the manufacturer for axial and/or lateral retention of cables.

Various types of cable cleats and intermediate restraints are shown in Annex A.

NOTE Requirements for manufacturers in this document also apply to importers and responsible vendors where appropriate.

This document does not apply to cable ties.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60502-1, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV) – Part 1: Cables for rated voltages of 1 kV (U_m = 1,2 kV) and 3 kV (U_m = 3,6 kV)*

IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

ISO 2081, *Metallic and other inorganic coatings – Electroplated coatings of zinc with supplementary treatments on iron or steel*

ISO 3575, *Continuous hot dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of commercial and drawing qualities*

ISO 4287, *Geometrical Product Specifications (GPS) – Surface texture: Profile method –Terms, definitions and surface texture parameters*

ISO 4892-2, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 4998, *Continuous hot-dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of structural quality*

ISO 9227, *Corrosion tests in artificial atmospheres – Salt spray tests*

ISO 14713-1, *Zinc coatings – Guidelines and recommendations for the protection against corrosion of iron and steel in structures – Part 1: General principles of design and corrosion resistance*

ISO 14713-2, *Zinc coatings – Guidelines and recommendations for the protection against corrosion of iron and steel in structures – Part 2: Hot dip galvanizing*

EN 10346, *Continuously hot-dip coated steel flat products for cold forming – Technical delivery conditions*

3 Terms, definitions and abbreviations

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
cable cleat
device provided with a means of attachment to a mounting surface and that provides securing of cables when installed at intervals along the length of cables

Note 1 to entry: Examples of mounting surfaces that may be specified are ladder, tray, strut (see Figure A.8) or rail. Hardware, such as screws or bolts, needed to secure cable cleats to the mounting surface is not necessarily supplied with cable cleats.

Note 2 to entry: Some examples of cable cleats are shown in Annex A (see Figure A.1 to Figure A.10). These examples do not limit the use of other cable cleat designs that conform to the requirements of this document.

3.2
intermediate restraint
cable retaining device intended to be used with cable cleats, without being attached to a mounting surface, to hold cables together in formation and/or to provide resistance to electromechanical forces

3.3
metallic
consisting of metal only

3.4
non-metallic
consisting of non-metallic material only

3.5
composite
consisting of metallic and non-metallic materials

Note 1 to entry: Fibre reinforced resin materials are not considered to be composite under this definition.

Note 2 to entry: Materials include any materials supplied by the manufacturer as part of a cable cleat or intermediate restraint or with a cable cleat or intermediate restraint in the same packaging. This may include fixings such as nuts, bolts, screws, washers, springs and pins. Fixings supplied by the installer are not considered in this document.

3.6
short-circuit current
overcurrent resulting from a circuit condition in which the current flows through an abnormal or unintended path of negligible impedance between live conductors, or between a live conductor and an earth, having a difference in potential under normal operating conditions

3.7
peak short-circuit current
i_p
maximum possible instantaneous value of the short-circuit current

SEE: Annex B

3.8
initial r.m.s. symmetrical short-circuit current
I''_k
r.m.s. value of the a.c. symmetrical component of a short-circuit current, applicable at the instant of the short circuit if the impedance remains at the zero-time value

SEE: Annex B

3.9
decaying aperiodic component of short-circuit current
$i_{d.c.}$
mean value between the top and bottom envelope of a short-circuit current decaying from an initial value to zero

SEE: Annex B

3.10
steady-state short-circuit current
I_k
r.m.s. value of the short-circuit current which remains after the decay of the transient phenomena

SEE: Annex B

3.11
trefoil formation
formation of three cables so laid as to be mutually equidistant

Note 1 to entry: Viewed in cross-section, the lines joining the cable centres form an equilateral triangle (see Figure 7).

3.12
flat formation
formation of a number of cables laid in a plane, usually with equal spacing between adjacent cables (see Figure 8)

3.13
electromechanical forces
induced forces acting on current-carrying conductors

3.14
retention
limiting the lateral and/or axial movement of the cable

3.15
securing
fixing to or from a mounting surface

3.16
environmental influences
capacity for environmental factors to have an effect on the intended function of cable cleats and/or intermediate restraints (e.g. effect of corrosive substances or solar radiation, etc.)

3.17
LV cables
cables with a rated voltage of 1,0 kV ac, 1,5 kV dc or less

3.18
MV or HV cables
cables with a rated voltage of more than 1,0 kV ac or 1,5 kV dc

3.19
liner
polymeric component between the cable and the cable cleat or intermediate restraint

3.20
product type
group of cable cleats for which only the cable or bundle diameter may be changed

Note 1 to entry: For guidance in determining product types, cable cleats or intermediate restraints having material, design, construction characteristics, and classifications according to Clause 6 below, in common, are considered to be the same product type.

4 General requirements

Products covered by this document shall be so designed and constructed that, when assembled and installed as for normal use according to the manufacturer's instructions, they ensure securing and/or holding in formation of cables as declared in accordance with Clause 6 and shall not cause damage to the cable.

Compliance is checked by the relevant tests specified in this document.

5 General notes on tests

5.1 Tests according to this document are type tests.

– Products of all sizes shall comply with Clause 8 and 9.1 a).

– Where cleats or intermediate restraints may be supplied with optional extra parts (e.g. liners), all tests shall be performed on the product without any of the optional parts. Where the addition of any optional part affects the performance of the product (e.g. the axial load performance with the addition of a liner), the tests shall be repeated with the optional parts in place.

– For the requirements in 9.1 b), 9.1 c) and 9.1 d) where there are a number of cable cleats in a range, the range is divided into one or more product types. In this case, the smallest and the largest size of cable cleat of each type are tested.

– The test for compliance with 9.1 e) is performed on the set of samples selected as defined in 9.5.1.

5.2 Unless otherwise specified, all tests shall be carried out on three new samples of each size selected as specified in 5.1, assembled and installed as for normal use according to the manufacturer’s instructions. Where a cable cleat is designed to accommodate more than one cable the number, size and shape of the mandrels used in the test shall represent the number, size and shape of the cables for which the cable cleat is intended.

5.3 Tests on non-metallic and composite cable cleats and intermediate restraints and any test that includes a liner shall not commence earlier than 168 h after manufacture.

5.4 Unless otherwise specified, the tests shall be carried out at an ambient temperature of (23^{+5}_{-5}) °C.

When toxic or hazardous processes are used, due regard shall be taken of the safety of persons within the test area.

5.5 Metal mandrels used in testing shall be made from carbon steel, stainless steel, brass or aluminium. Where testing is performed at a temperature below 105 °C, mandrels may be made from polyamide or HDPE. All mandrels shall have a surface roughness less than or equal to 7 µm Ra in accordance with ISO 4287.

5.6 Compliance with this document is satisfied if all the applicable test requirements are achieved. If only one of the samples does not satisfy a test due to a manufacturing fault, then that test and any preceding one which may have influenced the results of the test shall be repeated and also the tests which follow shall be made in the same required sequence on another full set of samples, all of which shall comply with the requirements.

The applicant, when submitting the first set of samples, may also submit an additional set of samples, which may be necessary should one sample fail. The test house should then, without further request, test the additional set of samples and should only reject if a further failure occurs. If the additional set of samples is not submitted at the same time, a failure of one sample would entail rejection.

6 Classification

6.1 Classification according to material

6.1.1 Metallic

See 3.3 and examples in Annex A.

6.1.2 Non-metallic

See 3.4 and examples in Annex A.

6.1.3 Composite

See 3.5 and examples in Annex A.

6.2 Classification according to maximum and minimum temperature

Table 1 – Maximum temperature for permanent application

A. Maximum temperature °C
+ 40
+ 60
+ 85
+ 105
+ 120

Table 2 – Minimum temperature for permanent application

B. Minimum temperature °C
+ 5
− 5
− 15
− 25
− 40
− 60

For temperature values above 120 °C and below −60 °C, the manufacturer may declare temperatures outside the values provided in Table 1 and Table 2 above.

6.3 Classification according to resistance to impact

6.3.1 Very light

See Table 5.

6.3.2 Light

See Table 5.

6.3.3 Medium

See Table 5.

6.3.4 Heavy

See Table 5.

6.3.5 Very heavy

See Table 5.

6.4 Classification according to type of retention or resistance to electromechanical forces or both

6.4.1 General

Manufacturers of cable cleats shall declare a classification under 6.4.2 and may also declare a classification under 6.4.3. Manufacturers of cable cleats may also declare a classification under 6.4.4 or 6.4.5.

Manufacturers of intermediate restraints shall declare a classification under 6.4.2 and under 6.4.4 or 6.4.5 in association with cable cleats.

6.4.2 With lateral retention

Tested in accordance with 9.3.

6.4.3 With axial retention

Tested in accordance with 9.4.

NOTE The axial retention test result is for guidance purposes as it is not possible to replicate cables using mandrels.

6.4.4 Resistant to electromechanical forces, withstanding one short circuit

Tested in accordance with 9.5.2.

6.4.5 Resistant to electromechanical forces, withstanding more than one short circuit

Tested in accordance with 9.5.3.

NOTE The intent for cable cleats and intermediate restraints classified under 6.4.5 is that after one short-circuit application, the cable cleat and intermediate restraints, if used, will continue to perform as designed and tested according to this document. The physical condition of the cable cleats and intermediate restraints after short-circuit application has only been evaluated under laboratory conditions. The continued use of the cable cleats and intermediate restraints, if used, following an actual short-circuit incident, is solely at the discretion of the party responsible for the installation.

6.5 Classification according to environmental influences

6.5.1 Resistance to ultraviolet light for non-metallic and composite components

6.5.1.1 Not declared

No resistance to UV light is claimed.

6.5.1.2 Resistant to ultraviolet light

Tested in accordance with 11.1.

6.5.2 Resistance to corrosion

6.5.2.1 General

If components within the cable cleat or intermediate restraint have different classifications, then the manufacturer shall declare all relevant classifications.

6.5.2.2 Non-metallic components

Non-metallic components are considered to be inherently resistant to corrosion and do not require testing.

6.5.2.3 Components made of stainless steel

Resistance against corrosion is classified according to Table 3.

Table 3 – Classification for resistance against corrosion for stainless steel components

Class	Typical usage	Reference material
Indoor	Dry indoor locations	Stainless steel containing at least 13 % chromium
Outdoor	Wet outdoor unpolluted areas (IEC 60364-5-51 – AF1)	Stainless steel containing at least 16 % chromium

For use in any other environment, additional protection may be required and consideration should be given to the appropriate duration of test exposure or to the use of an alternative test method.

6.5.2.4 Components made of mild steel or cast-iron with coatings

Resistance against corrosion is classified according to Table 4. This table lists materials as references for classification purposes. The classification is an indication only and is used for comparison purposes and should not be used to determine life expectancy of the coating.

To indicate the life to first maintenance for zinc coated products, refer to ISO 14713-1 and ISO 14713-2.

Table 4 – Classification for resistance against corrosion for coated mild steel or cast-iron components

Class	Neutral salt spray (NSS) test duration h		Reference material and metallic coating
0	-		None [a]
2	96	or	Electroplated to a minimum thickness of 12 μm according to ISO 2081
3	155	or	Pre-galvanised with coating designation Z275 according to ISO 3575, ISO 4998 or EN 10346
8	850	or	Post-galvanised to a zinc mean coating thickness of not less than 85 μm according to ISO 1461 for zinc thickness only
NOTE The classes listed above have been selected from Table 1 of IEC 61537:2006.			
[a] For materials which have no declared corrosion resistance classification.			

– If a coating is referenced in Table 4, a classification without testing can be obtained from the table;

– For materials made of mild steel or cast-iron with a coating and not referenced in Table 4, a salt spray test is required. The classification obtained shall be the one corresponding to the duration of the salt spray test;

– The classification of coating referenced in Table 4 can be higher if it passes a salt spray test for a longer duration. The classification obtained shall be the one corresponding to the longer duration of the salt spray test.

EXAMPLE A sample electroplated to a minimum thickness of 12 μm according to ISO 2081 is classified as class 2 according to Table 4, equivalent to 96 h. If the sample is tested in accordance with 11.2.6 for a duration of 155 h and passes the test, then it can be classified as class 3.

6.5.2.5 Components made of non-ferrous alloys

Under consideration.

6.6 Classification according to electromagnetic compatibility

6.6.1 Liable to inductive heating

Capable of forming an electrically conductive and magnetically permeable loop around a cable.

6.6.2 Not liable to inductive heating

Not capable of forming an electrically conductive and magnetically permeable loop around a cable.

7 Marking and documentation

7.1 Marking

Each cable cleat and intermediate restraint shall be marked with

– the manufacturer's name or logo or trademark;
– the product identification or product type.

Where it is not possible to apply the marking directly onto the product, then the marking shall be placed on the smallest supplied package.

7.2 Durability and legibility

Marking shall be easily legible, durable and indelible.

NOTE 1 Examples of methods for applying marking are by moulding, pressing, engraving, printing, adhesive labels, etc.

Compliance is checked by inspection, using normal or corrected vision, without additional magnification and, if necessary, by the test below.

Laser marking directly on the product and markings made by moulding, pressing or engraving are not subjected to the test below.

The test is made by rubbing the marking for 15 s with a piece of cotton cloth soaked with water and again for 15 s with a piece of cotton cloth soaked with n-hexane 95 % (Chemical Abstracts Service Registry Number, CAS RN, 110-54-3).

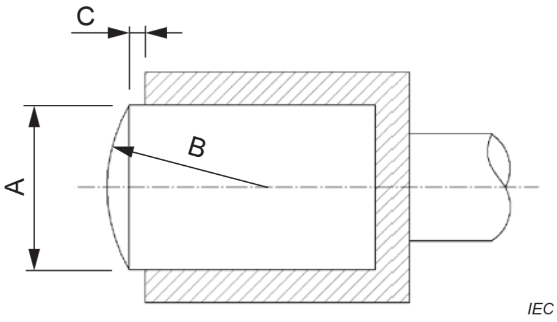
NOTE 2 n-hexane 95 % (Chemical Abstracts Service Registry Number, CAS RN, 110-54-3) is available from a variety of chemical suppliers as a high pressure liquid chromatography (HPLC) solvent.

When using the liquid specified for the test, precautions as stated in the relative material safety datasheet provided by the chemical supplier shall be taken to safeguard the laboratory technicians.

The marking surface to be tested shall be dried after the test with water.

Rubbing shall commence immediately after soaking the piece of cotton, applying a compression force of (5 ± 1) N at a rate of about one cycle per second (a cycle comprising a forward and backward movement along the length of the marking). For markings longer than 20 mm, rubbing can be limited to a part of the marking, over a path of at least 20 mm length.

The compression force is applied by means of a test piston, which is wrapped with cotton comprising cotton wool covered by a piece of cotton medical gauze.



Key

A piston diameter, $\left(20^{+2}_{-0}\right)$ mm

B piston head radius, $\left(20^{+0,5}_{-0,5}\right)$ mm

C gap between piston head and cylinder, $\left(2^{+1}_{-0}\right)$ mm

Figure 1 – Test piston dimensions

The test piston shall have the dimensions specified in Figure 1 and shall be made of an elastic material which is inert against the test liquids and has a Shore-A hardness of 47 ± 5 (for example synthetic rubber).

When it is not possible to carry out the test on the specimens due to the shape/size of the product, a suitable piece having the same characteristics as the product can be submitted to the test.

7.3 Documentation

The manufacturers shall provide in their literature:

– the classifications according to Clause 6;

– the maximum and minimum number of cables;

– the maximum and minimum cable or bundle dimensions;

– the lateral load for cable cleats declared under 6.4.2;

– the axial load for cable cleats if declared under 6.4.3. Where the axial load test is performed using multiple mandrels, the number of mandrels, the axial load applied to all mandrels together and the lowest load applied to the individual mandrels shall be declared;

– the method of assembly and installation including tightening torques, where appropriate. Where overtightening of the cable cleat or intermediate restraint may cause damage to the cable, cable cleat or intermediate restraint, a warning shall be provided by the manufacturer in the installation instructions.

– any limitation on mounting orientation for lateral retention;

– any restriction on the cable rating and construction that may be used;

Additionally, for cable cleats and/or intermediate restraints declared under 6.4.4 or 6.4.5, the manufacturers shall provide in their literature:

– the peak short-circuit current;

– the initial r.m.s. symmetrical short-circuit current;

– the cable outside diameter and the distance between cable centres, S, used in the test in 9.5. Where the test has used MV or HV cable, the data listed on the form shown in Annex C shall be provided;

– the maximum spacing, D, as shown in Figure 6.

Compliance is checked by inspection.

Some or all of this information may also be required to be provided on packaging or instruction sheets supplied with the product.

8 Construction

The surfaces of cable cleats and intermediate restraints shall be free from sharp edges, burrs, flash, etc. that are likely to damage cables or inflict injury to the installer or user.

Compliance is checked by visual and manual inspection of the surface.

9 Mechanical properties

9.1 Requirements

Cable cleats and intermediate restraints shall be:

a) capable of accommodating the size or range of cable or cable bundle dimensions declared by the manufacturer without cracking or breaking, or stripping of the threads of screws or bolts;

   Compliance is checked by measurement and by visual and manual inspection.

b) resistant to impact at the minimum declared temperature;

   Compliance is checked by the test according to 9.2.

c) capable of withstanding the lateral load at the maximum declared temperature;

   Compliance is checked by the test according to 9.3

d) capable of withstanding the axial load at the maximum declared temperature, where declared in 6.4.3;

   Compliance is checked by the test in 9.4.

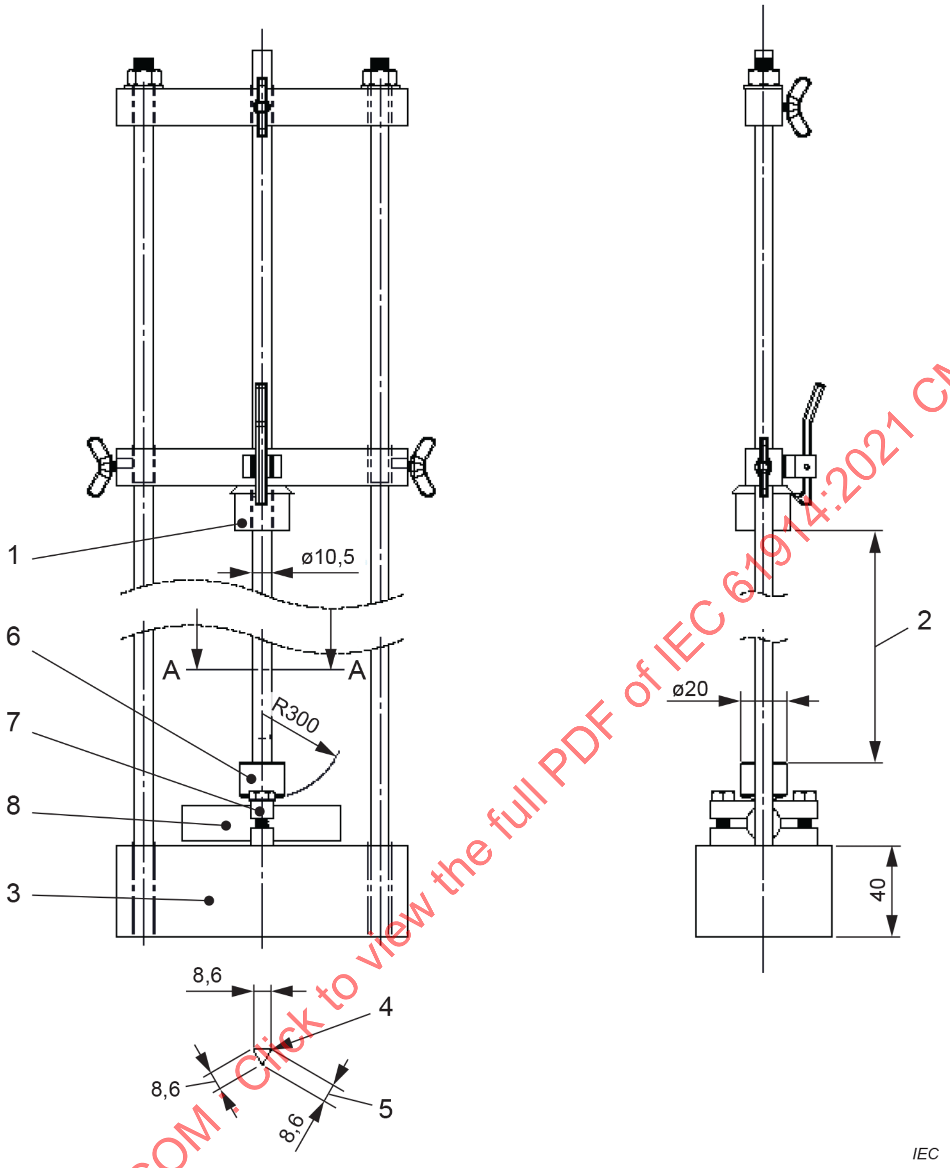
e) resistant to electromechanical forces, where declared in 6.4.4 or 6.4.5.

   Compliance is checked by the test in 9.5.

9.2 Impact test

The impact test is carried out using a typical arrangement as shown in Figure 2. The component transmitting the impact to the cable cleat or intermediate restraint shall have a spherical radius of $\left(300^{+5}_{-5}\right)$ *mm at the point of contact. For cable cleats classified according to 6.5.1.2, the impact test is performed after the resistance to ultraviolet light test is successfully passed.*

Dimensions in millimetres



Key

1 hammer

2 fall height (see Table 5)

3 rigid steel base

4 slightly rounded edges

5 section A – A

6 steel intermediate piece

7 cable cleat or intermediate restraint

8 mandrel

Figure 2 – Typical arrangement for impact test

Before the test, the samples are assembled onto a solid test mandrel, as specified in 5.5, having dimensions equivalent to the maximum declared dimensions for which the cable cleat is designed and mounted on a rigid support. Where a cable cleat or intermediate restraint is designed for non-circular cables, a solid mandrel corresponding to the shape and size of the largest cable shall be used.

For cable cleats and intermediate restraints taking more than one cable, the appropriate number of mandrels is used.

For metallic cable cleats and intermediate restraints where the material has a face-centre-cubic crystal structure (for example austenitic stainless steel and aluminium alloys), the test is carried out at ambient temperature.

For all other metallic, composite and non-metallic cable cleats and intermediate restraints, the samples are conditioned at the declared lowest temperature according to Table 2 with a tolerance of $\left({}^{+2}_{-2}\right)$ *°C for a period of* $\left(60\,{}^{+5}_{0}\right)$ *min. The impact is applied within a period of* $\left(10\,{}^{0}_{-2}\right)$ *s after removal from the refrigerator.*

Each sample is placed in position on the steel base as shown in Figure 2. The energy value of the hammer is as declared in Table 5.

The impact is applied at the weakest point of the cable cleat or intermediate restraint and the direction of impact is radial to the centre of the mandrel nearest to the point of impact.

After the test, the samples shall show no signs of disintegration nor shall there be any cracks or damage, visible to normal or corrected vision, that are likely to impair normal use.

Table 5 – Impact test values

Classification	Nominal Impact energy J	Equivalent mass kg (± 2%)	Height mm (± 1%)
Very light	0,5	0,25	200
Light	1,0	0,25	400
Medium	2,0	0,5	400
Heavy	5,0	1,7	300
Very heavy	20,0	5,0	400

NOTE The figures in Table 5 have been taken from IEC 60068-2-75.

9.3 Lateral load test

9.3.1 Lateral load test for cable cleats

The purpose of this test is to indicate the sustained static load that a cable cleat can withstand perpendicular to the mandrel axis. It does not predict the ability to withstand the dynamic forces generated during a short-circuit.

The cable cleat is mounted on a test rig as shown in Figure 3, or a similar arrangement. The mounting surface can be made of steel or aluminium plate, plywood or other material. For the purpose of applying the load, a rigid mandrel, as specified in 5.5, of circular, or other appropriate cross-section, is positioned within the cable cleat's aperture. For cable cleats taking more than one cable, the appropriate number of mandrels is used. Where more than one mandrel is used, the load shall be applied to a mandrel furthest from the mounting surface. Care is taken to ensure that the load acts through the centre line of the mandrel. The mandrel size is the minimum for which the cable cleat is designed.

Where cable cleats are provided with optional liners, the lateral load test performance of the cable cleat without a liner also applies to the same cable cleat with a liner.

For metallic cable cleats, the declared load is applied gradually and held for a period of $\left(60\,^{+5}_{\ 0}\right)$ *min.*

For non-metallic and composite cable cleats, the sample assembly is placed in a full draft air-circulating oven. The tests are carried out after the oven temperature has reached and maintained the declared maximum temperature from Table 1 with a tolerance of $\left(^{+2}_{-2}\right)$ *°C. The load is applied gradually and then held for a period of* $\left(60\,^{+5}_{\ 0}\right)$ *min.*

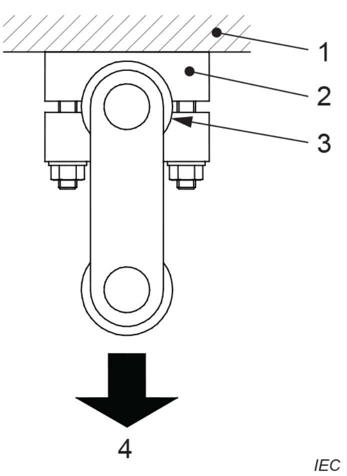
A cable cleat intended for a single mounting orientation shall be tested in that orientation and that orientation shall be declared in the published documentation of the manufacturer.

A cable cleat intended for multiple mounting orientations shall be tested in each mounting orientation using separate samples. The test load on one set of samples shall be applied perpendicular to the mounting surface (Figure 3 a) or Figure 3 b), and to the second set of samples parallel to the mounting surface (Figure 3 c) or Figure 3 d).

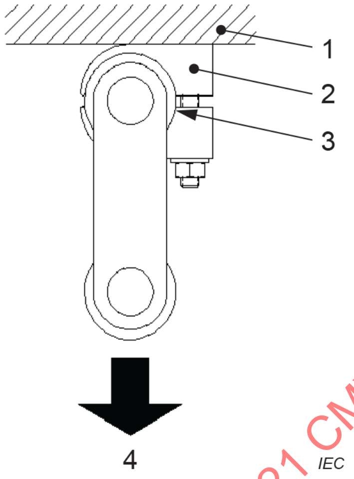
When it can be determined that a particular mounting orientation represents the most onerous condition, the results of the tests in that orientation may represent all mounting orientations for lateral loads.

Movement of the mandrel shall be less than 50 % of the mandrel diameter for circular mandrels. Where a non-circular mandrel is used to simulate non-circular cables, the movement of the mandrel shall be less than 50 % of the diameter of a circle that can be drawn inside the cross-section of the mandrel.

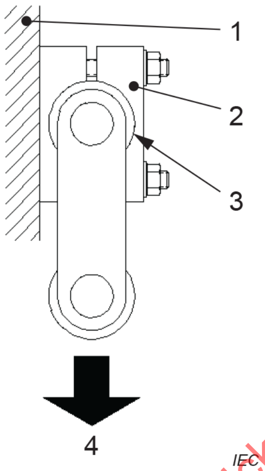
NOTE The intention of this test is to determine the lateral retention of the cable cleat and not the strength of the mounting surface.



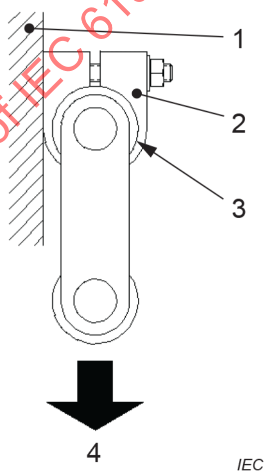
a) Lateral load test with load applied perpendicular to mounting surface on cable cleat with two fixings



b) Lateral load test with load applied perpendicular to mounting surface on cable cleat with single fixing



c) Lateral load test with load applied parallel to mounting surface on cable cleat with two fixings



d) Lateral load test with load applied parallel to mounting surface on cable cleat with single fixing

Key

1 mounting surface

2 cable cleat

3 mandrel

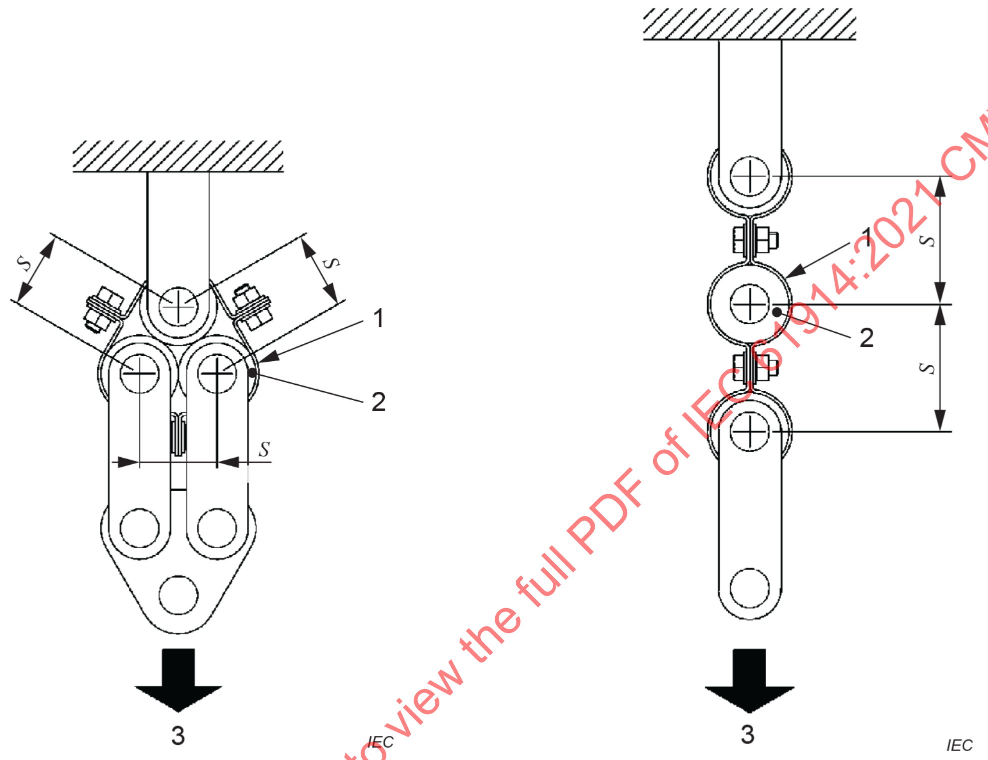
4 direction of load

Figure 3 – Typical arrangements for lateral load test for cable cleats

9.3.2 Lateral load test for intermediate restraints

The purpose of this test is to indicate the sustained static load that an intermediate restraint can withstand perpendicular to the mandrel axis. It does not predict the ability to withstand the dynamic forces generated during a short-circuit.

The intermediate restraint is mounted on a test rig as shown in Figure 4, or a similar arrangement. For the purpose of applying the load, rigid mandrels, as specified in 5.5, of circular, or other appropriate cross-section, are positioned within each of the intermediate restraint's apertures. Care is taken to ensure that the loads act through the centre lines of the mandrels. The mandrel size is the minimum for which the intermediate restraint is designed. Where intermediate restraints are provided with optional liners, the lateral load test performance of the intermediate restraint without a liner also applies to the same intermediate restraint with a liner.



a) Lateral load test for intermediate restraint for cables in trefoil formation

b) Lateral load test for intermediate restraint for cables in flat formation

Key

1 intermediate restraint

2 mandrel

3 direction of load

S mandrel centre spacing

Figure 4 – Typical arrangements for lateral load test for intermediate restraints

For metallic intermediate restraints, the declared load is applied gradually and held for a period of $\left(60\,^{+5}_{\ 0}\right)$ *min.*

For non-metallic and composite intermediate restraints, the sample assembly is placed in a full draft air-circulating oven. The tests are carried out after the oven temperature has reached and maintained the declared maximum temperature from Table 1 with a tolerance of $\left(^{+2}_{-2}\right)$ *°C. The load is applied gradually and then held for a period of* $\left(60\,^{+5}_{\ 0}\right)$ *min.*

Movement of the mandrels shall not increase the mandrel centre spacing (S) by more than 50 % of the mandrel diameter for circular mandrels. Where a non-circular mandrel is used to simulate non-circular cables, the movement of the mandrel shall be less than 50 % of the diameter of a circle that can be drawn inside the cross-section of the mandrel.

9.4 Axial load tests

The purpose of these tests is to indicate the sustained static load that a cable cleat can withstand along the mandrel axis. It may not predict the ability to withstand the axial forces generated by a cable.

The test is carried out using a mandrel, as specified in 5.5, with an overall cross section equivalent to the most onerous size, taking into account the surface contact area between the mandrel and the cable cleat.

NOTE While the most onerous size will typically be the mandrel with an overall cross section equivalent to the minimum declared cable cross section, it is possible that a larger mandrel has less surface contact area between the mandrel and the cable cleat.

The test mandrel shall have a diametrical tolerance of $\left(\begin{smallmatrix}+0,3\\-0,3\end{smallmatrix}\right)$ *mm. In the case of non-circular cables, a profile shall be used simulating the outer cable dimension, as declared by the manufacturer. For cable cleats taking more than one cable, the appropriate number of mandrels is used. Where more than one mandrel is used, multiple tests are required.*

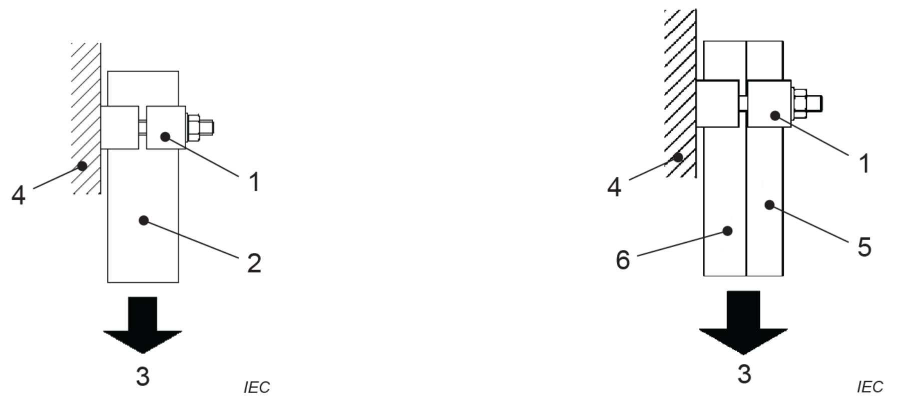
- *The first set of tests is carried out with the load applied to each mandrel in turn. When it can be determined that a particular mandrel represents the most onerous condition, the results of the test utilizing that mandrel may represent the other mandrels.*
- *The second test is carried out with the load simultaneously applied to all mandrels.*

The cable cleat is mounted on a rigid mounting surface and assembled in the test rig as shown in Figure 5, or a similar arrangement. The mounting surface can be made of steel or aluminium plate, plywood or other material. Cable cleats with an optional liner are tested with and without the liner.

For metallic cable cleats, the declared load is applied gradually and held for a period of $\left(5\,^{+1}_{\;\,0}\right)$ *min.*

For metallic with optional liner, non-metallic and composite cable cleats, the sample assembly is placed in a full draft air-circulating oven. The tests are carried out after the oven temperature has reached and maintained the declared maximum temperature from Table 1 with a tolerance of $\left(\begin{smallmatrix}+2\\-2\end{smallmatrix}\right)$ *°C. The load is applied gradually and held for a period of* $\left(5\,^{+1}_{\;\,0}\right)$ *min.*

After the test, the displacement of the mandrel(s) with respect to the cable cleat shall not be more than 5 mm.



a) **Axial load test on cable cleat taking one cable**

b) **Axial load test on cable cleat taking more than one cable**

Key

1 cable cleat

2 single mandrel

3 direction of load

4 mounting surface

5 mandrel(s) farthest from mounting surface

6 mandrel(s) closest to mounting surface

Figure 5 – Typical arrangement for axial load test

9.5 Test for resistance to electromechanical forces

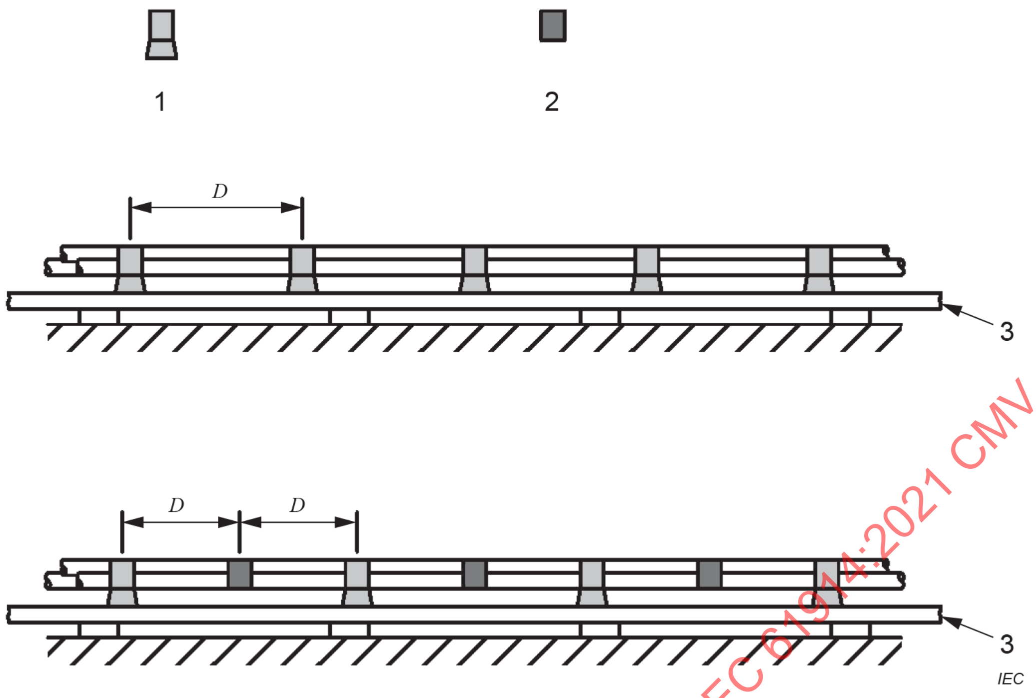
9.5.1 General

A short-circuit test is carried out as follows, using the manufacturer's declared values of peak short-circuit current (i_p) and initial r.m.s. symmetrical short-circuit current (I''_k). One set of cable cleats of each product type with intermediate restraints, where appropriate, and of a size suitable for the test cable shall be tested. The test is performed using unarmoured single core 600 V / 1 000 V class 2 stranded copper conductor cable in accordance with IEC 60502-1 of either $\left(35\,^{+5}_{-5}\right)$ mm or $\left(50\,^{+5}_{-5}\right)$ mm diameter.

For larger cable cleats where the test cannot be performed on the cable described above, a medium or high voltage cable with a single screened core may be used. Details of the cable shall be recorded on the form given in Annex C.

Care should be taken in the design of the test to ensure that the deflection of the cables between the cleats is not excessive.

The temperature limits specified in 5.4 do not apply to this test. The test is carried out at the prevailing ambient temperature on the declared arrangement at the declared short-circuit level. The ambient temperature shall be recorded in the test report. Typical assemblies are shown in Figure 6.



Key

1 cable cleats

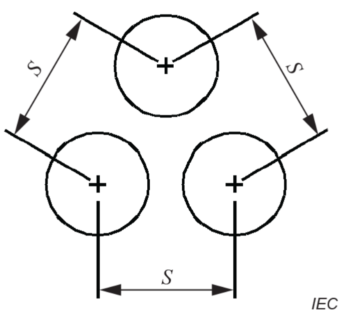
2 intermediate restraints

3 mounting surface

D lineal spacing

Figure 6 – Typical assemblies for test for resistance to electromechanical force

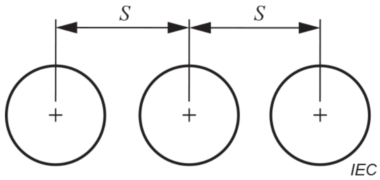
The arrangement of the cables is as shown in Figure 7 or Figure 8 with one cable per phase. One end of each cable is connected to a three-phase supply and the other end to a short-circuiting busbar with all three phases being connected. Where cables incorporating metallic screens, sheath or armour are used in the test, no connection shall be made to any screen, sheath or armour. The short-circuiting busbar shall be insulated from earth (ground). The cable is restrained at a minimum of 5 positions along the cable run. Where intermediate restraints are used, at least 4 cable cleats and at least 3 intermediate restraints shall be used. Cable cleats and intermediate restraints, where used, shall be equally spaced. The cable cleats are fixed to mounting surface which may be cable ladder, cable tray, wire mesh cable tray, framing channel or structural steel as defined by the manufacturer. This mounting surface shall be secured before the test.



Key

S cable centre spacing

Figure 7 – Typical arrangement of three cables in trefoil formation



Key

S cable centre spacing

Figure 8 – Typical arrangement of cables in flat formation

Care is taken to ensure the cross-sectional area of the cable is adequate for the magnitude and duration of the test current which shall be chosen so that the I^2t (thermal stress) rating of the cable used is not exceeded.

The test report shall contain the following information:

- *the manufacturer's catalogue references of the cable cleat and intermediate restraint (where used);*
- *the assembly details showing:*
  - *the number of cable cleats and the lineal spacing, D (see Figure 6);*
  - *the number of intermediate restraints (where used) and the lineal spacing, D (see Figure 6);*
  - *the cable centre spacing, S (see Figure 7 or Figure 8);*
  - *a description of the mounting surface used*
- *cable conductor diameter, insulation thickness, external diameter and markings, where unarmoured single core 600 V / 1 000 V class 2 stranded copper conductor cable of either $\left(35\,^{+5}_{-5}\right)$ mm or $\left(50\,^{+5}_{-5}\right)$ mm diameter are used;*
- *full cable details recorded on the form in Annex C where MV or HV cables are used;*
- *a pre-test photograph of the test assembly and a post-test photograph documenting the condition of the cable cleats, and intermediate restraints if used. Where a second short-circuit is applied, photographs before and after each short-circuit application shall be supplied;*
- *the test duration;*
- *the ambient temperature during the test;*
- *the actual peak short-circuit current (i_p) and initial r.m.s. symmetrical short-circuit current, (I''_k) applied (in both tests where cable cleats and intermediate restraints classified under 6.4.5 are tested).*

If the test station has to undertake a calibration test, action is taken to ensure that the test installation is not affected.

The cables of the test arrangement are subjected to a three-phase short-circuit of duration of not less than 5 cycles at a nominal frequency of 50 Hz or 60 Hz. The duration of the test is recorded.

It shall be ensured that there is adequate restraint for the cables at each end of the cable run to be tested.

Annex B may be used to calculate the theoretical forces that may be created during short circuits in order to plan testing.

9.5.2 For cable cleats and intermediate restraints classified in 6.4.4

Cable cleats and intermediate restraints classified under 6.4.4 shall comply with the following requirements:

– *following the short-circuit, all cable cleats shall remain secured to the mounting surface;*

– *there shall be no failure that will affect the intended function of holding the cables within the confinement of the cable cleat;*

– *the cable cleats and the intermediate restraints, if used, shall be intact with no missing parts including all devices used to secure the cable cleats to the mounting surface;*

– *there shall be no cuts or damage visible to normal or corrected vision to the outer sheath of each cable caused by the cable cleats or by the intermediate restraints, if used;*

– *Where a test failure is caused by damage to the cable from parts of the mounting structure other than a cable cleat or intermediate restraint, the test shall be void without discrediting the cable cleats or intermediate restraints.*

9.5.3 For cable cleats and intermediate restraints classified in 6.4.5

Cable cleats and intermediate restraints classified under 6.4.5 shall comply with the inspection requirements of 9.5.2 after the first and after the second short-circuit applications.

After a second short-circuit application, a voltage withstand test is performed by applying a minimum test voltage of 1,8 kV d.c. or 1,0 kV a.c. for a period of $\left(60\ ^{+5}_{\ 0}\right)$ *s according to the provisions of IEC 60060-1:2010, Clause 5, Tests with direct voltage or Clause 6, Tests with alternating voltage. Where LV cables have been used in the test, the voltage withstand test shall be administered between the cable cores, which should be connected together, and the mounting frame. Where MV or HV cables have been used in the test, the voltage withstand test shall be administered between the outermost cable screens, armours or metallic sheaths, which should be connected together, and the mounting frame. The mounting frame shall be bonded to the earthing system. The cable oversheaths and mounting frame shall be pre-wetted with sufficient water to facilitate a current leakage path along the outer jacket for a minimum of 1 min before the test begins.*

The cables shall meet the requirements of the voltage withstand test without failure of the insulation.

The lower of the two short-circuit currents applied is the declared short-circuit current rating for cable cleats and intermediate restraints classified in 6.4.5. Where the first short-circuit current is higher, then it may be declared as the short-circuit current rating under 6.4.4.

10 Fire hazards

10.1 Flame propagation

Non-metallic and composite cable cleats and intermediate restraints shall have adequate resistance to flame propagation.

Compliance is checked by the following test.

Using an arrangement as shown in Figure 9, the sample shall be submitted to the needle-flame test as specified in IEC 60695-11-5 with the following additional information:

– *the flame shall be applied to the outer surface of the sample;*

– *the time of application shall be* $\left(30\ ^{+0}_{-1}\right)$ *s;*

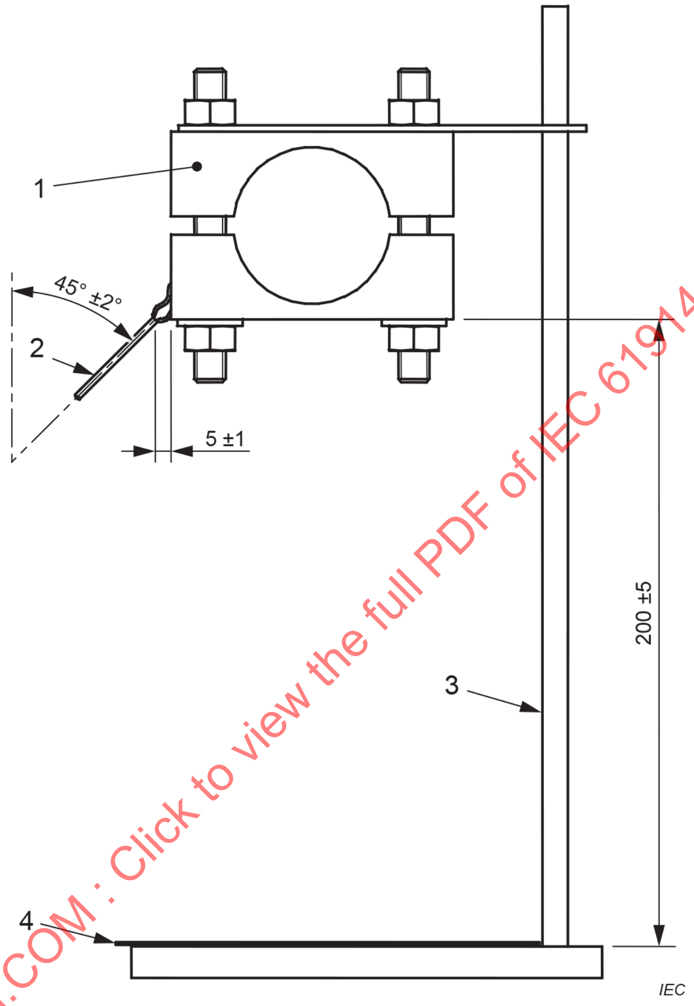
– *the underlying layer shall consist of three layers of tissue paper;*

– *there shall be a single application of the flame.*

The sample shall be deemed to have passed the test if:

– *30 s after the test flame is removed, there is no flaming of the sample;*
– *there is no ignition of the tissue paper.*

Dimensions in millimetres



Key

1 cable cleat

2 burner

3 stand

4 tissue paper

Figure 9 – Typical arrangement of the needle-flame test

10.2 Smoke emission

The smoke emissions from cable cleats and intermediate restraints need not be considered because of their small size and quantity in normal use.

10.3 Smoke toxicity

The smoke toxicity from cable cleats and intermediate restraints need not be considered because of their small size and quantity in normal use.

11 Environmental influences

11.1 Resistance to ultraviolet light

Cable cleats and intermediate restraints classified according to 6.5.1.2 shall be subjected to ultraviolet light (UV) conditioning according to the following requirements. Liners for cable cleats have a limited area exposed to daylight, so do not need to be tested for UV exposure.

When the product is provided in more than one colour, the colour having the heaviest organic pigment loading shall be subjected to this test. The samples tested are considered representative of the entire colour range.

Samples shall be mounted in the ultraviolet light apparatus in a convenient manner suitable for the product to be tested and the test equipment and so that the samples do not touch each other.

The samples shall be exposed for a minimum of 700 h to Xenon-arc, Method A, Cycle 1 in accordance with ISO 4892-2. If the geometry of the test specimens results in a higher UV exposure than required on the surface subjected to the impact test, the duration of exposure may be modified in order to achieve the intended exposure on that surface. There shall be continuous exposure to light and intermittent exposure to water spray. The cycle shall consist of 102 min without water spray and 18 min with water spray. The apparatus shall operate with a water-cooled xenon-arc lamp, borosilicate glass inner and outer optical filters, a spectral irradiance of $\left(0{,}51^{+0{,}02}_{-0{,}02}\right)$ *W/(m²•nm) at 340 nm and a black-standard temperature of* $\left(65^{+3}_{-3}\right)$ *°C. The temperature of the chamber shall be* $\left(38^{+3}_{-3}\right)$ *°C. The relative humidity in the chamber shall be* $\left(50^{+10}_{-10}\right)$ *% during the 102 min without water spray.*

Following the exposure, the samples shall be held for a minimum of 30 min under ambient conditions.

After UV exposure, the samples shall show no signs of disintegration nor shall there be any cracks or damage, visible to normal or corrected vision. The samples shall then be subjected to the impact test, as described in 9.2 and shall comply with the impact test requirements.

11.2 Resistance to corrosion

11.2.1 General

All cable cleat and intermediate restraint components shall have adequate resistance against corrosion in accordance with Table 6.

Table 6 – Component compliance and classification for resistance against corrosion

Component material and coating(s)	Classification according to	Compliance	Subclause for compliance check
Non-metallic	6.5.2.2	Declaration	11.2.2
Stainless steel as in Table 3	6.5.2.3	Declaration	11.2.3
Mild steel or cast iron with zinc coating referenced in Table 4	6.5.2.4	Declaration or zinc coating measurement according to Table 7	11.2.4.2
Mild steel or cast iron with metallic coating not referenced in Table 4	6.5.2.4	By neutral salt spray test (NSS) according to Table 4	11.2.4.3
Non-ferrous alloys	6.5.2.5	Under consideration	11.2.5

11.2.2 Non-metallic components

Components classified according to 6.5.2.2 are considered to be inherently resistant to corrosion and do not require testing.

11.2.3 Components made of stainless steel

All stainless steel components shall have a class according to Table 3. Components declared according to 6.5.2.3 made of stainless steel shall conform to the declared class in Table 3.

Compliance is checked by a supplier's declaration based on the material composition.

11.2.4 Components made of mild steel or cast iron with metallic coating

11.2.4.1 General

Mild steel and cast-iron components with a metallic coating shall have a class according to Table 4.

11.2.4.2 Components made of mild steel with zinc coating referenced in Table 4

Components declared according to 6.5.2.4 made of mild steel with zinc coating and referenced in Table 4 shall conform to the relevant specification as detailed in Table 7.

Table 7 – Zinc coating thickness of reference materials

Class	Minimum thickness according to ISO 2081 µm	Minimum coating thickness as given in either ISO 3575 or EN 10346 µm	Mean coating thickness (minimum) to ISO 1461 µm
2	12	-	-
3	-	15	-
8	-	-	85

The zinc layer thickness shall comply with the following test:

– *For class 2, compliance is checked by:*

  measurement according to ISO 2081. For small parts such as screws, a supplier's declaration is sufficient.

– *For class 3, compliance is checked by:*

  measurement according to either ISO 3575 or EN 10346 or a supplier's declaration.

– *For class 8, compliance is checked by:*

  measurement according to ISO 1461.

11.2.4.3 Components made of mild steel or cast-iron with coatings and not referenced in Table 4

Components declared according to 6.5.2.4 made of mild steel or cast-iron with a metallic coating and not referenced in Table 4 shall conform to the declared class and corresponding test duration as specified in Table 4.

Compliance is checked by the salt spray test in 11.2.6.

11.2.5 Components made of non-ferrous alloys

Under consideration.

11.2.6 Salt spray test

All grease shall be removed from the parts to be tested, by cleaning with white spirit. All parts shall then be dried. The samples shall then be assembled onto polymeric mandrel(s) as specified in 5.5, with dimensions equal to the smallest cable dimensions declared for the cable cleat or intermediate restraint in accordance with 5.2.

Samples shall be subjected to a neutral salt spray (NSS) test according to ISO 9227 for the duration specified in Table 4.

After the parts have been dried for a minimum of 10 min in a heating cabinet at a temperature of $\left(100^{+5}_{-5}\right)$ *°C, any traces of rust on sharp edges and a yellowish film may be removed by rubbing.*

The sample shall have passed the test if there is no red rust visible to normal or corrected vision.

12 Electromagnetic compatibility

12.1 Electromagnetic emission

Products covered by this document are, in normal use, passive in respect of electromagnetic emission.

12.2 Inductive heating

Ferromagnetic materials (e.g. cast-iron, mild steel) that surround single conductors in a.c. circuits are susceptible to heating from eddy currents. The manufacturer of cable cleats and intermediate restraints made from ferromagnetic materials that may complete an electrical and magnetic circuit around the cable shall issue a warning that the cable cleats shall not be used on single core cables in a.c. circuits.

Annex A
(informative)

Examples of cable cleats and intermediate restraints

Figure A.1 to Figure A.10 show examples of cable cleats. Figure A.11 and Figure A.12 are examples of intermediate restraints.

Figure A.1 – Metallic strap cable cleat for single or bundled cables

Figure A.2 – Metallic single bolt cable cleat for single cable

Figure A.3 – Metallic two-bolt cable cleat for single cable

Figure A.4 – Composite cable cleat for three cables in trefoil formation

Figure A.5 – Non-metallic cable cleat for single cable

Figure A.6 – Metallic cable cleat for single cable with integral mounting stud

Figure A.7 – Non-metallic cable cleat for three cables in flat formation

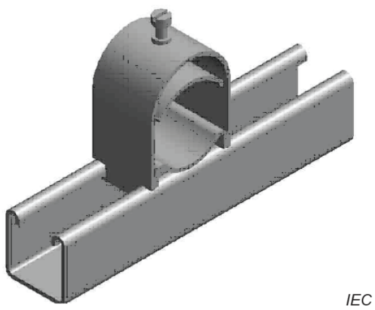


Figure A.8 – Metallic cable cleat for use with channel cable support system

Figure A.9 – Non-metallic cable cleat for three cables in trefoil formation

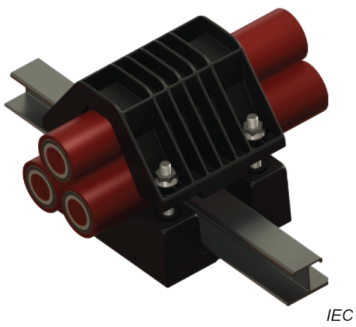


Figure A.10 – Non-metallic cable cleat for three cables in trefoil formation with integral ladder rung clamp

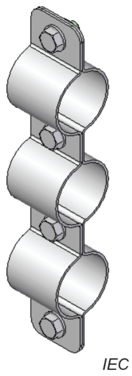


Figure A.11 – Metallic intermediate restraint for three cables in flat formation

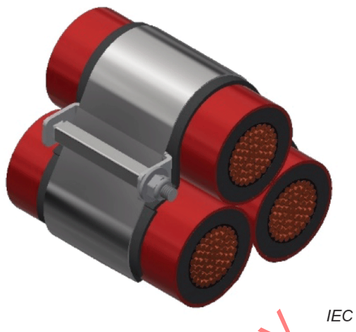


Figure A.12 – Composite intermediate restraint for bundled cables

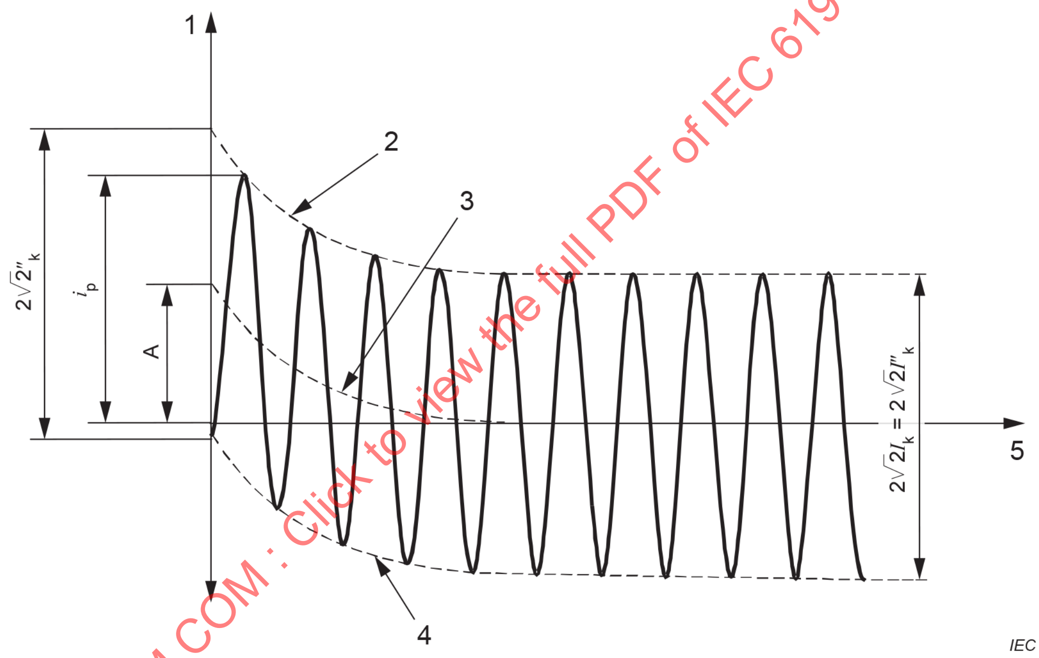
Annex B
(informative)

Calculation of forces caused by short-circuit currents

B.1 Characteristics

Recommendations for the calculation of short-circuit currents are given in IEC 60909 (all parts) and IEC 61363-1. The latter covers ships and offshore units. The information given in this annex is based on IEC 60909-0.

The characteristics of the current during a short circuit depend on a number of factors, including the electrical separation from the generator. Figure B.1 shows a current vs. time characteristic typical of a far-from-generator short circuit. The a.c. component in this case has a constant amplitude ($I''_k = I_k$) and is superimposed on a decaying d.c. component, $i_{d.c.}$ This falls from an initial value, A, to zero.



Key

1 current

2 top envelope

3 decaying d.c. component, $i_{d.c.}$ of the short-circuit current

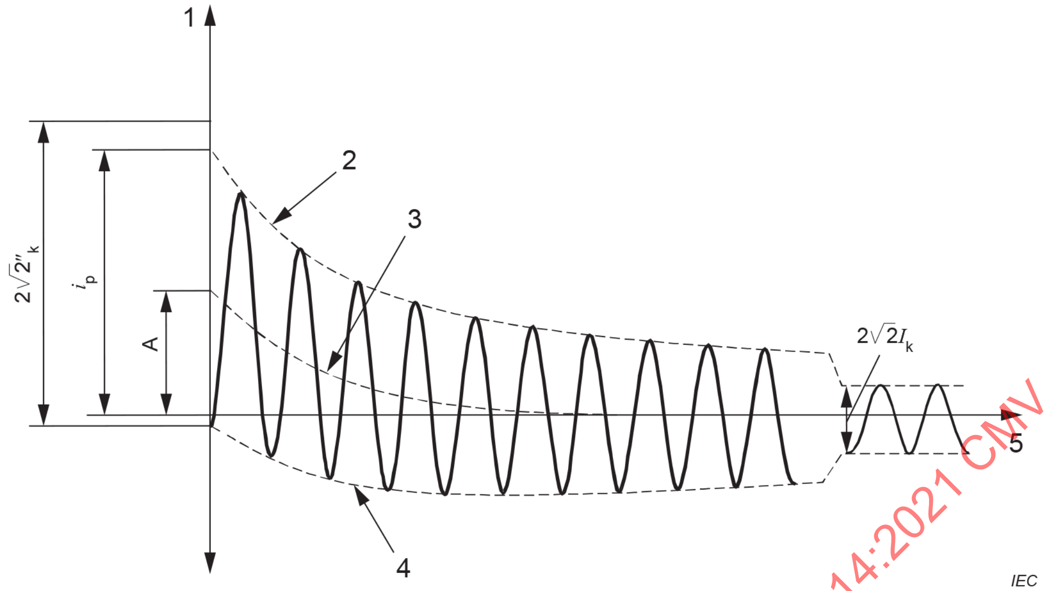
4 bottom envelope

5 time

A initial value of the d.c. component, $i_{d.c.}$ of the short-circuit current

Figure B.1 – Short-circuit current of a far-from-generator short circuit with constant a.c. component

For near-to-generator short circuits, the a.c. component has a decaying amplitude ($I''_k > I_k$) and is also superimposed on a decaying d.c. component, $i_{d.c.}$ that falls from an initial value, A, to zero. Figure B.2 shows a typical current vs. time characteristic for a near-to-generator short circuit.



Key

1 current

2 top envelope

3 decaying d.c. component, $i_{d.c.}$ of the short-circuit current

4 bottom envelope

5 time

A initial value of the d.c. component, $i_{d.c.}$ of the short-circuit current

Figure B.2 – Short-circuit current of a near-to-generator short circuit with decaying a.c. component

B.2 Specification of the test current

A complete specification of short-circuit currents should give the currents as a function of time at the short-circuit location from the initiation of the short circuit up to its end. In most practical cases, this is not necessary. It is usually sufficient to know the peak current, i_p, and the values of the initial r.m.s. symmetrical, I''_k, and steady state, I_k, short-circuit currents.

In order to specify the current used in a short-circuit test, the following is quoted:

– the peak current, i_p;

– the initial r.m.s. symmetrical short-circuit current, I''_k;

– the short-circuit duration, t.

B.3 Calculation of the mechanical forces between conductors

The electromagnetic force acting on a conductor is determined by the current in the conductor and the magnetic field from the neighbouring conductors. In cable installations, the distances between the cables are normally small and hence the forces may be considerable.

To calculate the forces a cable cleat may be subjected to during a short-circuit, the equations derived in this Annex B may be used. These derivations assume that the cables are rigid and do not move in the test. The derivation of Equations (B.5), (B.6) and (B.7) is based on a symmetrical pure sine wave fault current with no d.c. component. For these reasons, these equations should not be used to extrapolate short circuit test results.

In the case of two parallel conductors, the electromagnetic force on a conductor can be derived from Equation (B.1):

$$F(t) = B(t) \cdot i(t) \cdot l \tag{B.1}$$

where

l is the length;

$F(t)$ is the momentary electromagnetic force on a conductor;

$B(t)$ is the momentary magnetic field from the neighbouring conductor;

$i(t)$ is the momentary current in the neighbouring conductor.

If the d.c. component of the short-circuit current is disregarded, the momentary force has a sinusoidal variation with a frequency twice the frequency of the currents [Equation (B.1)]. The d.c. component gives a decaying force-component with a frequency the same as the system frequency.

Key

B magnetic flux density

d conductor diameter

i_1 current in first conductor

i_2 current in second conductor

S distance between conductor centres

Figure B.3 – Two parallel conductors

For the two parallel conductors in Figure B.3., the magnetic field from current i_1, at the location of the other conductor is:

$$B = \mu_0 \cdot H = (\mu_0 \cdot i_1)/(2 \cdot \pi \cdot S) \tag{B.2}$$

where

$\mu_o = 4 \cdot \pi \cdot 10^{-7}$ H/m

H = magnetic field strength

and the distributed mechanical force is:

$$F = i_2 \times B = (i_2 \cdot \mu_0 \cdot i_1)/(2 \cdot \pi \cdot S) \tag{B.3}$$

This equation is usually written as:

$$F = 0{,}2 \cdot i_1 \cdot i_2 / S \tag{B.4}$$

In this equation, the distributed force is given in N/m, i in kA and S in metres.

In a three-phase system, the magnetic field in Equation (B.2) is the resulting momentary vector value from the other two phases.

The vector Equation (B.3) confirms that two parallel conductors are repelled if the two currents have a difference in phase angle of 180° and that the force is directed towards the other conductor for currents that have the same phase angle.

The evaluation of Equation (B.4) requires $S >> d$ but gives an acceptable accuracy when the current distribution is uniform (or symmetrical) within the conductors.

For a three-phase short circuit with the conductors in flat configuration, the forces on the two outer conductors are primarily directed outwards from the central conductor. The force on the central conductor is oscillating. The maximum distributed force on the outer conductors in flat formation can be approximated by

$$F_{\text{fo}} = 0{,}16 \cdot {i_{\text{p}}}^2 / S \tag{B.5}$$

The maximum distributed force on the middle conductor in flat formation can be approximated by

$$F_{\text{fm}} = 0{,}17 \cdot {i_{\text{p}}}^2 / S \tag{B.6}$$

For a three-phase short circuit with the cables in a trefoil configuration, the maximum distributed force on the conductor can be approximated by:

$$F_{\text{t}} = 0{,}17 \cdot {i_{\text{p}}}^2 / S \tag{B.7}$$

where

F is the maximum distributed force between two parallel conductors [N/m];

F_{fo} is the maximum distributed force on the outer cable conductors in flat formation for a three-phase short circuit [N/m];

F_{fm} is the maximum distributed force on the centre cable conductor in flat formation for a three-phase short circuit [N/m];

F_{t} is the maximum distributed force on the cable conductor in a trefoil configuration for a three-phase short circuit [N/m];

i_{p} is the peak short-circuit current [kA];

S is the centre to centre distance between two neighbouring conductors [m].

Annex C
(normative)

Identification of MV or HV cable used in short-circuit test

Cable manufacturer: ....

Cable part number: ....

Cable marking: ....

Cable standard: ....

Rated voltage U_0/U (U_m): .... kV

Number of conductors: ....

Conductor type:
☐ Al ☐ Cu
☐ Class 1 ☐ Class 2 ☐ Class 5 ☐ Class 6
☐ Circular ☐ Shaped

Conductor cross-section: ....mm^2 / kcmil

Insulation:
☐ XLPE ☐ EPR
☐ HEPR ☐ other ....

Metallic screen:
☐ Wire ☐ Tape
☐ Laminated foil ☐ other
☐ Al ☐ Cu ☐ other ....

Armour:
☐ Wire ☐ Braid ☐ Tape
☐ Corrugated Al ☐ other

Oversheath:
☐ PVC ☐ PE ☐ other ....

Actual diameters:
Conductor .... mm
Insulation .... mm
Insulation screen .... mm
Oversheath .... mm

Cable datasheet attached (mandatory): ☐

Bibliography

IEC 60068-2-75, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60364-5-51, *Electrical installations of buildings – Part 5-51: Selection and erection of electrical equipment – Common rules*

IEC 60909 (all parts), *Short-circuit currents in three-phase a.c. systems*

IEC 60909-0, *Short-circuit currents in three-phase a.c. systems – Part 0: Calculation of currents*

IEC 61363-1, *Electrical installations of ships and mobile and fixed offshore units – Part 1: Procedures for calculating short-circuit currents in three-phase a.c.*

IEC 61537:2006, *Cable management – Cable tray systems and cable ladder systems*

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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BRIDES DE CÂBLES POUR INSTALLATIONS ÉLECTRIQUES

AVANT-PROPOS

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L'IEC 61914 a été établie par le sous-comité 23A: Systèmes de câblage, du comité d'études 23 de l'IEC: Petit appareillage. Il s'agit d'une Norme internationale.

Cette troisième édition annule et remplace la deuxième édition parue en 2015. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) rationalisation des exigences relatives aux mandrins d'essai, détaillées dans la section Généralités sur les essais (Article 5);
b) ajout de la définition de la fourrure et définition des exigences d'essai dans lesquelles les fourrures et autres accessoires sont utilisés;
c) ajout des définitions BT, MT et HT pour les câbles et définition des exigences d'essai en cas d'utilisation de câbles MT et HT;
d) ajout de nouvelles classes de tenue à la corrosion pour les produits revêtus;

e) ajout de nouvelles exigences et d'un essai de durabilité et de lisibilité des marquages;

f) ajout de nouvelles exigences d'essai pour les essais de tenue à la charge axiale des brides pour plusieurs câbles;

g) ajout d'exigences d'essai de tenue à la charge latérale pour les dispositifs intermédiaires de tenue.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
23A/976/FDIS	23A/982/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Dans la présente norme, les caractères d'imprimerie suivants sont utilisés:

– exigences proprement dites: caractères romains;
– *modalités d'essai: caractères italiques*;
– notes: petits caractères romains.

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BRIDES DE CÂBLES POUR INSTALLATIONS ÉLECTRIQUES

1 Domaine d'application

La présente Norme internationale spécifie les exigences et les essais relatifs aux brides de câbles utilisées pour la fixation des câbles dans les installations électriques et aux dispositifs intermédiaires de tenue utilisés pour le maintien des câbles en formation dans des installations électriques. Les brides de câbles fournissent une résistance aux forces électromécaniques lorsque cela est déclaré. Le présent document inclut les brides de câbles qui reposent sur une surface de montage spécifiée par le fabricant pour le maintien axial et/ou latéral des câbles.

Plusieurs types de brides de câbles et de dispositifs intermédiaires de tenue sont présentés à l'Annexe A.

NOTE Les exigences pour les fabricants qui figurent dans le présent document s'appliquent également aux importateurs et aux fournisseurs responsables, le cas échéant.

Le présent document ne couvre pas les colliers.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60060-1:2010, *Technique des essais à haute tension – Partie 1: Définitions et exigences générales*

IEC 60502-1, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV) – Part 1: Cables for rated voltages of 1 kV (U_m = 1,2 kV) and 3 kV (U_m = 3,6 kV)* (disponible en anglais seulement)

IEC 60695-11-5, *Essais relatifs aux risques du feu – Partie 11-5: Flammes d'essai – Méthode d'essai au brûleur-aiguille – Appareillage, dispositif d'essai de vérification et lignes directrices*

ISO 1461, *Revêtements par galvanisation à chaud sur produits finis en fonte et en acier – Spécifications et méthodes d'essai*

ISO 2081, *Revêtements métalliques et autres revêtements inorganiques – Dépôts électrolytiques de zinc avec traitements supplémentaires sur fer ou acier*

ISO 3575, *Continuous hot dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of commercial and drawing qualities* (disponible en anglais seulement)

ISO 4287, *Spécification géométrique des produits (GPS) – État de surface: Méthode du profil – Termes, définitions et paramètres d'état de surface*

ISO 4892-2, *Plastiques – Méthodes d'exposition à des sources lumineuses de laboratoire – Partie 2: Lampes à arc au xénon*

ISO 4998, *Continuous hot-dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of structural quality* (disponible en anglais seulement)

ISO 9227:2017, *Essais de corrosion en atmosphères artificielles – Essais aux brouillards salins*

ISO 14713-1, *Revêtements de zinc – Lignes directrices et recommandations pour la protection contre la corrosion du fer et de l'acier dans les constructions – Partie 1: Principes généraux de conception et résistance à la corrosion*

ISO 14713-2, *Revêtements de zinc – Lignes directrices et recommandations pour la protection contre la corrosion du fer et de l'acier dans les constructions – Partie 2: Galvanisation à chaud*

EN 10346:2015, *Produits plats en acier revêtus en continu par immersion à chaud pour formage à froid – Conditions techniques de livraison*

3 Termes, définitions et abréviations

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
bride de câbles
dispositif équipé d'un moyen de fixation à une surface de montage et qui permet la fixation des câbles dès lors qu'il est installé par intervalle le long des câbles

Note 1 à l'article: Une échelle, une tablette, une cornière (voir la Figure A.8) ou un rail sont des exemples de surfaces de montage qui peuvent être spécifiés. Le matériel, tel que les vis ou les boulons, nécessaire pour fixer les brides de câbles à la surface de montage n'est pas nécessairement fourni avec les brides de câbles.

Note 2 à l'article: Les Figure A.1 à Figure A.10 (voir Annexe A) représentent des exemples de brides de câbles. D'autres conceptions de brides de câbles, conformes aux exigences du présent document, peuvent également être utilisées.

3.2
dispositif intermédiaire de tenue
dispositif de tenue des câbles prévu pour être utilisé avec des brides de câbles, sans être attaché à une surface de montage, pour maintenir les câbles ensemble en formation et/ou afin de fournir une résistance aux forces électromécaniques

3.3
métallique, adj
constitué de métal uniquement

3.4
non métallique, adj
constitué de matériau uniquement non métallique

3.5
composite, adj
constitué de matériaux métallique et non métallique

Note 1 à l'article: Les matériaux en résine renforcée par des fibres ne sont pas considérés comme des composites selon cette définition.

Note 2 à l'article: Les matériaux comprennent tous les matériaux fournis par le fabricant faisant partie d'une bride de câbles ou d'un dispositif intermédiaire de tenue ou avec une bride de câbles ou un dispositif intermédiaire de tenue dans le même emballage. Il peut s'agir de fixations telles que des écrous, des boulons, des vis, des rondelles, des ressorts et des goupilles. Les fixations fournies par l'installateur ne sont pas prises en considération dans le présent document.

3.6
courant de court-circuit
surintensité résultant d'un état du circuit dans lequel le courant circule à travers un chemin, anormal ou non prévu, d'impédance négligeable entre les conducteurs actifs ou entre un conducteur actif et la terre, ayant une différence de potentiel dans des conditions normales de fonctionnement

3.7
valeur de crête du courant de court-circuit
i_{p}
valeur instantanée maximale du courant de court-circuit

VOIR: Annexe B

3.8
valeur efficace du courant de court-circuit symétrique initial
I''_{k}
valeur efficace de la composante symétrique alternative d'un courant de court-circuit, applicable à l'instant d'apparition du court-circuit si l'impédance conserve sa valeur au temps zéro

VOIR: Annexe B

3.9
composante apériodique décroissante du courant de court-circuit
$i_{\mathrm{d.c.}}$
valeur moyenne des enveloppes inférieure et supérieure d'un courant de court-circuit décroissant de sa valeur initiale à zéro

VOIR: Annexe B

3.10
courant de court-circuit permanent
I_{k}
valeur efficace du courant de court-circuit qui se maintient après extinction du phénomène transitoire

VOIR: Annexe B

3.11
disposition en trèfle
configuration géométrique de trois câbles mutuellement équidistants

Note 1 à l'article: Vues en section nominale, les droites joignant leurs centres forment un triangle équilatéral dans un plan perpendiculaire à leur axe (voir la Figure 7).

3.12
disposition en nappe
configuration géométrique de plusieurs câbles posés dans un plan, généralement avec des distances égales entre câbles adjacents (voir la Figure 8)

3.13
forces électromécaniques
forces d'induction agissant sur les conducteurs sous tension

3.14
maintien
limitation du mouvement latéral et/ou axial du câble

3.15
fixation
fixation à ou à partir d'une surface de montage

3.16
influences liées à l'environnement
capacité des facteurs environnementaux à avoir un effet sur la fonction prévue des brides de câbles et/ou des dispositifs intermédiaires de tenue (par exemple, effet des substances corrosives ou du rayonnement solaire, etc.)

3.17
câbles BT
câbles ayant une tension assignée de 1,0 kV en courant alternatif ou inférieure ou égale à 1,5 kV en courant continu

3.18
câbles MT ou HT
câbles ayant une tension assignée supérieure à 1,0 kV en courant alternatif ou à 1,5 kV en courant continu

3.19
fourrure
composant polymérique entre le câble et la bride de câbles ou le dispositif intermédiaire de tenue

3.20
produit type
groupe de brides de câbles pour lesquelles seul le diamètre du câble ou du toron peut être modifié

Note 1 à l'article: À titre de recommandations pour déterminer les produits types, les brides de câbles ou les dispositifs intermédiaires de tenue de câbles dont le matériau, la conception, les caractéristiques de construction et les classifications sont conformes à l'Article 6 ci-dessous, sont considérés comme étant du même produit type.

4 Exigences générales

Les produits couverts par le présent document doivent être conçus et construits de sorte que, lorsqu'ils sont assemblés et installés comme en utilisation normale selon les instructions du fabricant, ils assurent la fixation et/ou le maintien en formation des câbles déclarés selon l'Article 6 et ne doivent pas endommager le câble.

La vérification est effectuée au moyen des essais applicables spécifiés dans le présent document.

5 Généralités sur les essais

5.1 Les essais mentionnés dans le présent document sont des essais de type.

– Les produits de toutes les tailles doivent être conformes à l'Article 8 et au 9.1 a).
– Lorsque des brides ou des dispositifs intermédiaires de tenue peuvent être fournis avec des accessoires supplémentaires (par exemple, des fourrures), tous les essais doivent être effectués sur le produit sans ces accessoires. Lorsque l'ajout d'un accessoire affecte les performances du produit (par exemple, la performance de la charge axiale avec l'ajout d'une fourrure), les essais doivent être répétés avec les accessoires en place.

– Pour les exigences de 9.1 b), 9.1 c) et 9.1 d), lorsqu'il y a un certain nombre de brides de câbles dans une gamme, la gamme est divisée en un ou plusieurs produits types. Dans ce cas, la plus petite taille et la plus grande taille de bride de câbles de chaque type sont soumises aux essais.
– L'essai de conformité à 9.1 e) est réalisé sur le lot d'échantillons choisis, comme cela est défini en 9.5.1.

5.2 Sauf spécification contraire, tous les essais doivent être réalisés sur trois échantillons neufs de chaque taille choisis comme cela est spécifié en 5.1, assemblés et installés comme en usage normal selon les instructions du fabricant. Lorsqu'une bride de câbles est conçue pour recevoir plusieurs câbles, le nombre, la taille et la forme des mandrins utilisés dans l'essai doivent correspondent au nombre, à la taille et à la forme des câbles pour lesquels la bride de câbles est prévue.

5.3 Les essais sur les brides de câbles et les dispositifs intermédiaires de tenue non métalliques et composites, et tout essai qui comprend une fourrure, ne doivent pas être commencés moins de 168 h après leur fabrication.

5.4 Sauf spécification contraire, les essais doivent être réalisés à une température ambiante de (23^{+5}_{-5}) °C.

Lorsque des procédés toxiques ou dangereux sont utilisés, la sécurité des personnes doit être assurée à l'intérieur de la zone d'essai.

5.5 Les mandrins métalliques utilisés pour les essais doivent être en acier au carbone, en acier inoxydable, en laiton ou en aluminium. Lorsque les essais sont effectués à une température inférieure à 105 °C, les mandrins peuvent être en polyamide ou en HDPE. Tous les mandrins doivent avoir une rugosité de surface inférieure ou égale à 7 µm Ra selon l'ISO 4287.

5.6 La conformité au présent document est satisfaite si toutes les exigences d'essai applicables sont satisfaites. Si seulement un des échantillons ne satisfait pas à un essai en raison d'un défaut de fabrication, cet essai et tous les essais précédents qui peuvent avoir influencé les résultats de l'essai doivent alors être répétés et les essais suivants doivent être effectués dans le même ordre exigé sur un autre lot d'échantillons qui doivent tous satisfaire aux exigences.

Le demandeur, lorsqu'il soumet le premier lot d'échantillons, peut aussi fournir un lot supplémentaire d'échantillons qui peut être nécessaire en cas d'échec d'un des échantillons. Il convient que le laboratoire d'essai, sans autre avis, soumette le lot supplémentaire d'échantillons aux essais, et il convient qu'il rejette le lot uniquement par suite d'une nouvelle défaillance. Si le lot supplémentaire d'échantillons n'est pas fourni au même moment, la défaillance d'un échantillon entraîne le rejet.

6 Classification

6.1 Classification selon le matériau

6.1.1 Métallique

Voir 3.3 et des exemples à l'Annexe A.

6.1.2 Non métallique

Voir 3.4 et des exemples à l'Annexe A.

6.1.3 Composite

Voir 3.5 et des exemples à l’Annexe A.

6.2 Classification selon les températures maximale et minimale

Tableau 1– Température maximale en utilisation permanente

A. Température maximale °C
+ 40
+ 60
+ 85
+ 105
+ 120

Tableau 2 – Température minimale en utilisation permanente

B. Température minimale °C
+ 5
− 5
− 15
− 25
− 40
− 60

Pour des valeurs de température supérieures à 120 °C et inférieures à −60 °C, le fabricant peut déclarer des températures en dehors des valeurs du Tableau 1 et du Tableau 2 ci-dessus.

6.3 Classification selon la tenue aux chocs

6.3.1 Très légère

Voir Tableau 5.

6.3.2 Légère

Voir Tableau 5.

6.3.3 Moyenne

Voir Tableau 5.

6.3.4 Lourde

Voir Tableau 5.

6.3.5 Très lourde

Voir Tableau 5.

6.4 Classification selon le type de maintien ou la tenue aux forces électromécaniques ou les deux

6.4.1 Généralités

Les fabricants de brides de câbles doivent déclarer une classification selon 6.4.2 et peuvent aussi déclarer une classification selon 6.4.3. Les fabricants de brides de câbles peuvent aussi déclarer une classification selon 6.4.4 ou 6.4.5.

Les fabricants de dispositifs intermédiaires de tenue doivent déclarer une classification selon 6.4.2 et selon 6.4.4 ou 6.4.5 en association avec des brides de câbles.

6.4.2 Avec un maintien latéral

Maintien soumis à l'essai selon 9.3.

6.4.3 Avec un maintien axial

Maintien soumis à l'essai selon 9.4.

NOTE Le résultat de l'essai de maintien axial est donné à titre de recommandation car il n'est pas possible de reproduire des câbles en utilisant des mandrins.

6.4.4 Tenue aux forces électromécaniques, supportant un court-circuit

Soumise à l'essai selon 9.5.2.

6.4.5 Tenue aux forces électromécaniques, supportant plus d'un court-circuit

Soumise à l'essai selon 9.5.3.

NOTE L'objectif des brides de câbles et des dispositifs intermédiaires de tenue classés selon 6.4.5 est qu'après l'application d'un court-circuit, les brides de câbles et les dispositifs intermédiaires de tenue, le cas échéant, continuent de fonctionner conformément à la conception et aux essais du présent document. L'état physique des brides de câbles et des dispositifs intermédiaires de tenue après l'application d'un court-circuit est uniquement évalué dans des conditions de laboratoire. L'utilisation des brides de câbles et des dispositifs intermédiaires de tenue, le cas échéant, après un court-circuit réel, est laissée à la discrétion de l'entité responsable de l'installation.

6.5 Classification selon les influences liées à l'environnement

6.5.1 Tenue aux rayonnements lumineux ultraviolets pour les composants composites et les composants non métalliques

6.5.1.1 Non déclarée

Aucune tenue aux rayonnements lumineux UV n'est demandée.

6.5.1.2 Tenue aux rayonnements lumineux ultraviolets

Soumise à l'essai selon 11.1.

6.5.2 Tenue à la corrosion

6.5.2.1 Généralités

Si les composants de la bride de câbles ou du dispositif intermédiaire de tenue ont des classifications différentes, le fabricant doit alors déclarer toutes les classifications pertinentes.

6.5.2.2 Composants non métalliques

Les composants non métalliques sont considérés comme étant intrinsèquement résistants à la corrosion et ne nécessitent pas d'essais.

6.5.2.3 Composants en acier inoxydable

La tenue à la corrosion est classée selon le Tableau 3.

Tableau 3 – Classification pour la tenue à la corrosion des composants en acier inoxydable

Classe	Utilisation type	Matériau de référence
Intérieur	Endroits intérieurs secs	Acier inoxydable contenant au moins 13 % de chrome
Extérieur	Zones extérieures humides non polluées (IEC 60364-5-51 – AF1)	Acier inoxydable contenant au moins 16 % de chrome

Pour une utilisation dans tout autre environnement, une protection supplémentaire peut être exigée et il convient de prendre en considération la durée appropriée de l'exposition d'essai ou l'utilisation d'une méthode d'essai alternative.

6.5.2.4 Composants en acier doux ou en fonte revêtus

La tenue à la corrosion est classée selon le Tableau 4. Ce tableau répertorie les matériaux comme références pour la classification. La classification est uniquement indicative et sert à des fins de comparaison. Il convient de ne pas l'utiliser pour déterminer la durée de vie du revêtement.

Pour indiquer la durée de vie jusqu'à la première maintenance pour les produits revêtus de zinc, se référer aux normes ISO 14713-1 et ISO 14713-2.

Tableau 4 – Classification pour la tenue à la corrosion des composants revêtus en acier doux ou en fonte

Classe	Durée de l'essai au brouillard salin neutre (NSS- neutral salt spray) h		Matériau de référence et revêtement métallique
0	-		Aucun[a]
2	96	ou	Électrodéposé avec une épaisseur minimale de 12 µm selon l'ISO 2081
3	155	ou	Pré-galvanisé avec la désignation de revêtement Z275 selon l'ISO 3575, l'ISO 4998 ou l'EN 10346
8	850	ou	Post-galvanisé à une épaisseur moyenne de zinc non inférieure à 85 µm selon l'ISO 1461 pour l'épaisseur de zinc uniquement
NOTE Les classes répertoriées ci-dessus ont été tirées du Tableau 1 de l'IEC 61537:2006.			
[a] Pour les matériaux qui n'ont pas de classification déclarée de tenue à la corrosion.			

– Si un revêtement est référencé dans le Tableau 4, une classification sans essai peut être obtenue à partir du tableau;

– Pour les matériaux revêtus en acier doux ou en fonte et non référencés dans le Tableau 4, un essai au brouillard salin est exigé. La classification obtenue doit être celle qui correspond à la durée de l'essai au brouillard salin;

– La classification du revêtement référencé dans le Tableau 4 peut être plus élevée s'il satisfait à un essai au brouillard salin pendant une durée plus longue. La classification obtenue doit être celle qui correspond à la plus longue durée de l'essai au brouillard salin.

EXEMPLE Un échantillon électrodéposé avec une épaisseur minimale de 12 µm selon l'ISO 2081 est classé dans la classe 2 selon le Tableau 4, ce qui équivaut à 96 h. Si l'échantillon est soumis à l'essai conformément à 11.2.6 pendant une durée de 155 h et qu'il satisfait à l'essai, il peut alors être classé dans la classe 3.

6.5.2.5 Composants en alliages non ferreux

À l'étude.

6.6 Classification selon la compatibilité électromagnétique

6.6.1 Sujet à l'échauffement par induction

Capable de former une boucle électriquement conductrice et magnétiquement perméable autour d'un câble.

6.6.2 Non sujet à l'échauffement par induction

Incapable de former une boucle électriquement conductrice et magnétiquement perméable autour d'un câble.

7 Marquage et documentation

7.1 Marquage

Chaque bride de câbles et chaque dispositif intermédiaire de tenue de câbles doivent être marqués

– avec le nom du fabricant ou le logo ou la marque commerciale;
– avec l'identification du produit ou du produit type.

Lorsqu'il n'est pas possible d'apposer ce marquage directement sur le produit, alors ce marquage doit figurer sur le plus petit emballage fourni.

7.2 Durabilité et lisibilité

Le marquage doit être facilement lisible, durable et indélébile.

NOTE 1 Des exemples de méthodes d'application du marquage sont: le moulage, l'estampage, la gravure, l'impression, les étiquettes adhésives, etc.

La vérification est effectuée par examen, en utilisant une vision normale ou corrigée, sans grossissement supplémentaire et, si nécessaire, par l'essai ci-dessous.

Le marquage au laser directement sur le produit et les marquages réalisés par moulage, estampage ou gravure ne sont pas soumis à l'essai ci-dessous.

L'essai est réalisé en frottant le marquage pendant 15 s avec un morceau de tissu de coton imbibé d'eau et de nouveau pendant 15 s avec un morceau de tissu de coton imbibé de n-hexane à 95 % (numéro de registre du Chemical Abstracts Service, CAS RN, 110-54-3).

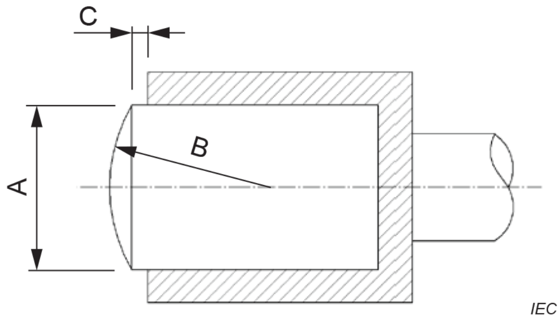
NOTE 2 Le n-hexane 95 % (numéro de registre du Chemical Abstracts Service, CAS RN, 110-54-3) est disponible auprès de plusieurs fournisseurs de produits chimiques sous forme de solvant pour la chromatographie liquide à haute pression (CLHP).

Lors de l'utilisation du liquide spécifié pour l'essai, les précautions indiquées dans la fiche de données de sécurité relative aux matériaux fournie par le fournisseur de produits chimiques doivent être prises pour protéger les techniciens de laboratoire.

La surface de marquage à soumettre à l'essai doit être séchée après l'essai à l'eau.

Le frottement doit commencer immédiatement après le trempage du morceau de coton, en appliquant une force de compression de (5 ± 1) N à raison d'environ un cycle par seconde (un cycle qui comprend un mouvement d'avant en arrière sur la longueur du marquage). Pour les *marquages de plus de 20 mm de longueur, le frottement peut être limité à une partie du marquage, sur un trajet d'au moins 20 mm de longueur.*

La force de compression est appliquée au moyen d'un piston d'essai, qui est enveloppé d'un coton composé d'ouate recouverte d'un morceau de gaze médicale en coton.



Légende

A diamètre du piston, $\left(20^{+2}_{-0}\right)$ mm

B rayon de la tête du piston, $\left(20^{+0,5}_{-0,5}\right)$ mm

C espace entre la tête du piston et le cylindre, $\left(2^{+1}_{-0}\right)$ mm

Figure 1 – Dimensions du piston d'essai

Le piston d'essai doit avoir les dimensions spécifiées à la Figure 1 et doit être constitué d'un matériau élastique inerte contre les liquides d'essai et d'une dureté Shore-A de 47 ± 5 (par exemple, du caoutchouc synthétique).

Lorsqu'il n'est pas possible de réaliser l'essai sur les échantillons en raison de la forme/taille du produit, une pièce appropriée qui détient les mêmes caractéristiques que le produit peut être soumise à l'essai.

7.3 Documentation

Le fabricant doit fournir dans sa documentation:

– les classifications selon l'Article 6;
– le nombre maximal et minimal de câbles;
– les dimensions minimales et maximales du câble ou du toron;
– la charge latérale pour les brides de câbles déclarées selon 6.4.2;
– la charge axiale pour les brides de câbles déclarées selon 6.4.3. Lorsque l'essai de tenue à la charge axiale est effectué à l'aide de plusieurs mandrins, le nombre de mandrins, la charge axiale appliquée à tous les mandrins collectivement et la charge la plus faible appliquée aux mandrins individuellement doivent être déclarés;
– la méthode de montage et d'installation, y compris les couples de serrage, le cas échéant. Lorsqu'un serrage excessif de la bride de câbles ou du dispositif intermédiaire de tenue peut endommager le câble, la bride de câbles ou le dispositif intermédiaire de tenue, un avertissement doit être fourni par le fabricant dans les instructions d'installation;
– toute limitation sur l'orientation de montage pour le maintien latéral;
– toute restriction sur les caractéristiques assignées et la construction du câble qui peut être utilisé;