# IEC 62561-1

Edition 3.0 2023-03
REDLINE VERSION

# INTERNATIONAL STANDARD

colour inside

## Lightning protection system components (LPSC) – Part 1: Requirements for connection components



IEC 62561-1:2023-03 RLV(en)



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## Lightning protection system components (LPSC) – Part 1: Requirements for connection components

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.020; 91.120.40

ISBN 978-2-8322-6744-8

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# LIGHTNING PROTECTION SYSTEM COMPONENTS (LPSC) –

## Part 1: Requirements for connection components

## FOREWORD

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**This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62561-1:2017. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.**

IEC 62561-1 has been prepared by IEC technical committee 81: Lightning protection. It is an International Standard.

This third edition cancels and replaces the second edition published in 2017. This edition constitutes a technical revision.

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

a) definitions of connection types mentioned in the scope have been added;
b) location classification has been expanded in detail;
c) the document has been updated in line with the new edition of ISO 22479:2019 on humid sulphurous atmosphere treatment;
d) a new normative Annex E for reduced test procedures has been introduced.

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

| Draft | Report on voting |
|---|---|
| 81/721/FDIS | 81/724/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/publications.

A list of all parts in the IEC 62561 series, published under the general title *Lightning protection system components (LPSC),* can be found on the IEC website.

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.

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# INTRODUCTION

This part of IEC 62561 deals with the requirements and tests for lightning protection system components (LPSC) used for the installation of a lightning protection system (LPS) designed and implemented according to the IEC 62305 series.

# LIGHTNING PROTECTION SYSTEM COMPONENTS (LPSC) –

# Part 1: Requirements for connection components

## 1 Scope

This part of IEC 62561 specifies the requirements and tests for metallic connection components that form part of a lightning protection system (LPS). Typically, these can be connectors, clamps, bonding and bridging components, expansion pieces and test joints.

For the purposes of this document the following connection types are considered as connection components: exothermic, brazing, welding, clamping, crimping, seaming, screwing or bolting.

Testing of components for an explosive atmosphere is not covered by this document.

## 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 60068-2-52:~~1996~~2017, *Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 62561-2, *Lightning protection system components (LPSC) – Part 2: Requirements for conductors and earth electrodes*

ISO 6957:1988, *Copper alloys – Ammonia test for stress corrosion resistance*

~~ISO 6988:1985, *Metallic and other non-organic coatings – Sulphur dioxide test with general condensation of moisture*~~

ISO 22479:2019, *Corrosion of metals and alloys – Sulfur dioxide test in a humid atmosphere (fixed gas method)*

## 3 Terms and definitions

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

ISO and IEC maintain terminology 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**
**connection component**
part of an external LPS which is used for the connection of conductors to each other or to ~~metallic~~ metal installations

~~Note 1 to entry: connection components include connectors, clamps, bridging components, expansion pieces and test joints.~~

EXAMPLE Examples of connection components are given in Clause 1.

**3.2**
**metal installation**
extended metal items in the structure to be protected which ~~may~~ can form a path for lightning current

EXAMPLE Pipes, staircases, elevator guide rails, ventilation, heating and air conditioning ducts, and interconnected reinforcing steel.

**3.3**
**conductor**
element intended to carry electric current

Note 1 to entry: A metal installation is not intended to carry electrical current.

[SOURCE: IEC 60050-151:2001, 151-12-05, modified – The notes have been replaced with a new Note 1 to entry.]

**3.4**
**bridging component**
connection component for the connection of metal installations

**3.5**
**expansion piece**
connection component designed to compensate for changes in length in conductors ~~and/~~or metal installations or both caused by temperature changes

**3.6**
**connector**
connection component to interconnect two or more conductors

**3.7**
**clamp**
connection component for the connection of conductors to metal installations

**3.8**
**pipe clamp**
clamp for the connection of conductors to metal pipes

**3.9**
**test joint**
~~joint~~ connection component designed to facilitate electrical testing and measurement of LPS components

**3.10**
**connection range**
minimum to maximum range for which a specific connection component is designed to be used

**3.11**
**bonding**
technique for joining one object to another

[SOURCE: IEC 60050-523:2018, 523-06-01, modified – The example has been deleted.]

**3.12**
**bonding bar**
connection component such as a metal bar on which metal installations, external conductive parts, electric power and telecommunication lines and other cables can be connected to an LPS

**3.13**
**type test**
test ~~required to be~~ made before supplying a type of material covered by IEC 62561-1 on a general commercial basis, in order to demonstrate satisfactory performance characteristics to meet the intended application

~~Note 1 to entry: These tests are of such a nature that, after they have been made, they need not be repeated unless changes are made to the accessory materials, design or type of manufacturing process which might change the performance characteristics.~~

**3.14**
**permanent connection**
connection that cannot or is not intended to be dismantled

**3.15**
**non-permanent connection**
connection that can or is intended to be dismantled

**3.16**
**exothermic connection**
welding process that employs molten metal to permanently join the conductors

Note 1 to entry: The electrical connection suitability and electrical durability of the exothermic connection is tested using a lightning current test.

**3.17**
**brazed connection**
metal-joining process in which two or more metal items are joined together by melting and flowing a filler metal into the joint

Note 1 to entry: The electrical connection suitability and electrical durability of the brazed connection is tested using a lightning current test.

**3.18**
**welded connection**
fabrication process that joins materials, usually metals

Note 1 to entry: The electrical connection suitability and electrical durability of the welded connection is tested using a lightning current test.

**3.19**
**force-locked connection**
connection between two metal parts which does not allow any relative movement due to thermal expansion and to environmental load, for example snow, ice, wind

EXAMPLE Connection by means of crimping, clamping, bolting or screwing.

Note 1 to entry: The electrical connection suitability and electrical durability of the force-locked connection is tested using a lightning current test.

**3.20**
**form-locked connection**

connection between two metal parts which allows a small relative movement of metal parts due to thermal expansion and to environmental load, for example snow, ice, wind

EXAMPLE Connection by means of seaming, overlapping and zipping, locked overlapping or hooking.

Note 1 to entry: The electrical connection suitability and electrical durability of the form-locked connection is tested using a lightning current test.

**3.21**
**clamped connection**
force-locked connection, which can usually be disassembled, between two components

Note 1 to entry: The electrical connection suitability and electrical durability of the clamped connection is tested using a lightning current test.

**3.22**
**crimped connection**
connection method of permanently attaching a termination to a conductor by pressure deformation or by reshaping the barrel around the conductor to establish good electrical and mechanical connection

Note 1 to entry: Crimping as a means of achieving a connection between two conductors may not always require an additional component to achieve the final connection.

Note 2 to entry: The electrical connection suitability and electrical durability of the crimped connection is tested using a lightning current test.

[SOURCE: IEC 60050-581:2008, 581-23-10, modified – The term "crimping" has been replaced with "crimped connection", in the definition "method" has been replaced with "connection method" and the notes to entry have been added.]

**3.23**
**seamed connection**
form-locked connection created by bending of the edges of two adjacent metal sheets bringing them into intimate contact in a way that they cannot be separated by natural action

Note 1 to entry: The electrical connection suitability and electrical durability of the seamed connection is tested using a lightning current test.

**3.24**
**screwed connection**
force-locked connection, which can be disassembled, between two components which have threads of their own and can be bolted directly

Note 1 to entry: The electrical connection suitability and electrical durability of the screwed connection is tested using a lightning current test.

**3.25**
**bolted connection**
force-locked connection, which can be disassembled, between two components which can be bolted indirectly by means of third components (bolts and nuts)

Note 1 to entry: The electrical connection suitability and electrical durability of the bolted connection is tested using a lightning current test.

**3.26**
**stranded conductor**
conductor consisting of a number of individual wires or strands all or some of which generally have helical form

Note 1 to entry: The cross-section of a stranded conductor can be circular or otherwise shaped.

Note 2 to entry: The term "strand" is also used to designate a single wire.

[SOURCE: IEC 60050-461:2008, 461-01-07]

**3.27**
**rope lay conductor**
conductor composed of a central core surrounded by one or more layers of helically laid groups of wires

**3.28**
**smooth weave stranded conductor**
conductor constructed of multi-strand soft drawn wire, interwoven in a basket weave configuration so as to avoid fraying in application

## 4 Classification

### 4.1 According to the ability to withstand lightning current

a) class H for heavy duty;

b) class N for normal duty.

The selection of classes H ~~and~~ or N should be performed by the manufacturer in accordance with the test parameters identified in Table 1.

### 4.2 According to the installation location

~~a) general use;~~

a) outdoors;

b) indoors;

c) buried in ground;

d) embedded in concrete;

e) embedded in materials with thermal insulation.

The manufacturer's declaration of installation location shall determine whether it is necessary to carry out the conditioning and ageing test as identified in 6.5.

### 4.3 According to the mechanical behaviour of connection components

a) intended to withstand a static mechanical ~~load~~ stress;

b) not intended to withstand a static mechanical ~~load~~ stress.

The manufacturer's declaration of ability to withstand a static mechanical load shall determine ~~the need or otherwise~~ whether it is necessary to carry out the static mechanical test as identified in 6.7.

### 4.4 According to whether or not a connection is permanent

a) permanent connection such as exothermic process, brazing, welding, crimping, seaming;

b) non-permanent connection such as screwing or bolting.

## 5 Requirements

### 5.1 General

Connection components shall be designed in such a manner that, when they are installed in accordance with the manufacturer's instructions, their performance shall be reliable, stable and safe to persons and surrounding equipment.

~~NOTE~~ A summary of the requirements and their corresponding tests is given in Annex A.

### 5.2 Documentation and installation instructions

The manufacturer of the connection component shall provide adequate instructions in their literature to ensure that the installer of the connection component can select and install the components in a suitable and safe manner, containing at least the following information:

~~a) the classification of the component;~~

~~b) the recommended tightening torque;~~

a) classification and lightning current capability ($I_{imp}$);

b) classification according to the installation location;

c) classification according to the mechanical behaviour;

d) classification according to whether or not the connection is permanent;

e) the range of conductor sizes and materials;

f) the connection configuration;

g) assembly instructions for permanent or non-permanent connection components (e.g. whether special tools are necessary, tightening torque, etc.).

Compliance is checked ~~by inspection~~ in accordance with 6.2.

### 5.3 Marking

#### 5.3.1 Content of marking

The connection components shall be marked at least with the following:

a) the manufacturer's or responsible vendor's name or trademark;

b) identifying symbol (picture, product number, etc.);

c) classification, i.e. class N or H;

d) classification according to the installation location.

Compliance is checked by review in accordance with 6.3.1, a).

Where this proves to be impractical the marking in accordance with b), c) and d) may be given on the smallest packing unit label or on the accompanying documentation.

NOTE 1 Marking can be applied for example by moulding, pressing, engraving, printing and environmental stress adhesive labels.

NOTE 2 Marking can be applied by water slide transfers only for components classified as indoors.

#### 5.3.2 Durability and legibility

The marking shall be durable and legible.

~~NOTE Marking can be applied for example by moulding, pressing, engraving, printing adhesive labels or water slide transfers.~~

Compliance is checked by test in accordance with 6.3.1 b).

### 5.4 Lightning current carrying capability

Connection components shall have sufficient lightning current carrying capability.

Compliance is checked in accordance with 6.6 following the manufacturer's declaration for the class (H or N) of the connection components in accordance with 4.1.

### 5.5 Static mechanical ~~stress~~ withstand capability

Connection components classified according to 4.3 a) shall have a sufficient withstand capability against static mechanical stresses.

Equipotential bonding bars and connections made by seaming are excluded from this requirement.

Compliance is checked in accordance with 6.7.

### 5.6 Permanent connection

Where exothermic process, brazing, welding, crimping or seaming are used for connection, the design shall be such that the conductor and~~/or~~ the metal installation is always securely bonded.

Compliance is checked by inspection and in accordance with 6.6.2 a), b) and g).

### 5.7 Non-permanent connection

Where screws ~~and/~~or nuts are used as the clamping connection, the design shall be such that the conductor and~~/or~~ the metal installation is always securely fastened by the screw ~~and/~~or nut application.

Compliance is checked by inspection and in accordance with 6.6.2 a), b), d) and f).

Compliance of connection components classified according to 4.2 d) is checked by inspection according to 6.6.2 a), d) and g).

### 5.8 Dismantling of test joints

It shall be possible to dismantle the test joints after lightning current stress.

Compliance is checked by inspection and in accordance with 6.6.2 a), b), d) and f).

~~**5.8 Damage to conductors and metal installations**~~

~~Connection components shall be so designed that they connect the conductors and/or the metal installations without undue damage to the conductors, the metal installations and/or the connection components.~~

~~Compliance is checked by inspection.~~

~~**5.9 Reliable connection**~~

~~Connection components shall guarantee safe connection within the connection range declared by the manufacturer.~~

~~Compliance is checked by inspection and in accordance with 0.~~

~~**5.10 Terminals of bonding bars**~~

~~The input terminals of bonding bars used for lightning protection installations shall have a diameter of connection equal to or greater than 6 mm.~~

~~Compliance is checked by inspection.~~

### 5.9 Expansion piece

In addition to the requirements of this document, the expansion piece (E of Figure 7) shall fulfil the requirements of IEC 62561-2 for air termination conductors.

## 6 Tests

### 6.1 General test conditions

a) The tests in accordance with this document are type tests (see 3.13), performed in a sequence according to Annex C. Type tests are of such a nature that, after they have been made, unless changes are made to the accessory materials, design or type of manufacturing process which can change the performance characteristics, repeated testing is not required.

b) Unless otherwise specified, tests are carried out with the specimens assembled and installed as in normal use according to the manufacturer's or supplier's installation instructions with the recommended conductor materials, sizes and tightening torques. ~~If the connection component is suitable for various conductors' materials, then it shall be tested on each material combination.~~

c) All tests are carried out on new specimens.

d) Unless otherwise specified, three specimens are subjected to the tests and the requirements are satisfied if all the tests are met.

e) If only one of the specimens does not satisfy a test due to an assembly or a manufacturing fault, that test and any preceding one which ~~may have influenced~~ can influence the results of the test shall be repeated and also the tests which follow shall be carried out in the required sequence on another full set of specimens, all of which shall comply with the requirements.

f) The electrical test shall be carried out in the order given, after conditioning~~/~~ and ageing of the arrangement of the specimen in accordance with 6.5.

The applicant, when submitting the sets of specimens, ~~may~~ can also submit an additional set of specimens which ~~may~~ can be ~~necessary~~ used, should one specimen fail. The ~~testing station~~ laboratory will then, without further request, test the additional set of specimens and will reject it only if a further failure occurs. If the additional set of specimens is not submitted at the same time, the failure of one specimen will entail rejection.

For components already tested according to IEC 62561-1:2017, the reduced test procedure according to Annex E can be applied.

For new components complete type tests and samples according to Clause 6 are required.

### 6.2 Documentation and installation instructions

#### 6.2.1 General test conditions

The content of the installation instructions is checked as per its completeness by review.

#### 6.2.2 Acceptance criteria

Documentation or installation instructions are deemed to be acceptable if they contain at least the information specified in 5.2.

### 6.3 Marking test

#### 6.3.1 General test conditions

The marking is checked:

a) as per its completeness in accordance with 5.3.1 by review and

b) as per its durability and legibility by rubbing it 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 white spirit or mineral spirit.

Marking made by moulding, pressing or engraving is not subjected to this test.

### 6.3.2 Acceptance criteria

The specimen is deemed to have passed the test if:

a) the marking contains all the information of 5.3.1;

b) after the test according to 6.3.1, b) the marking remains durable and legible.

## 6.4 Preparation of the specimen

a) If not otherwise specified by the manufacturer, the conductors and the specimens shall be cleaned by using a suitable degreasing agent followed by cleaning in demineralized water and drying. They shall then be assembled in accordance with the manufacturer's instructions, for example with the recommended conductors and tightening torques.

b) The conductors and rods used for this test shall fulfil the requirements of IEC 62561-2.

c) The connection component shall be tested in all the connection configurations declared by the manufacturer. Typical connection configurations for various LPSC are illustrated in Annex B.

d) If the connection component is suitable for various conductors' materials, then it shall be tested on each material combination declared by the manufacturer.

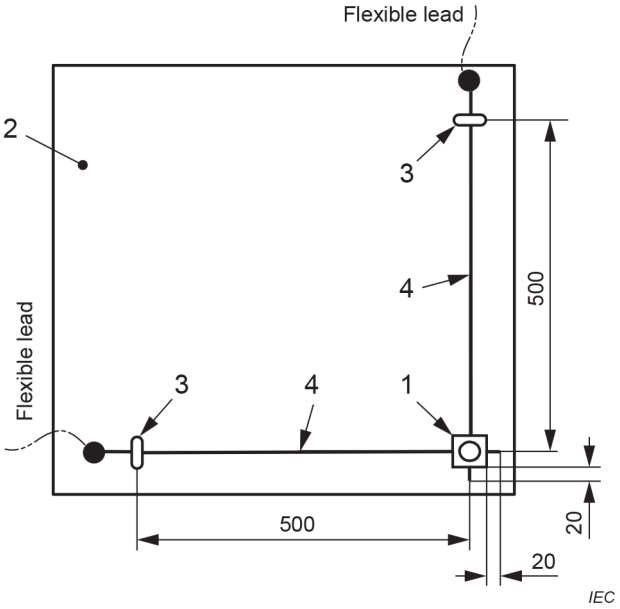
e) Any connection components accommodating a range of conductors with a variation on any dimension equal to or less than 2 mm shall be tested using the minimum conductor size recommended. If the range of conductor sizes is greater than 2 mm, it shall be tested using the minimum and maximum size of conductors recommended.

f) The basic arrangement of the specimen with cross-connection component, parallel connection component, bridging component and equipotential bonding bar is shown in Figure 1, Figure 2, Figure 3 and Figure 4, respectively. Terminals of bonding bars are only tested if the connection size is equal to or greater than 16 $mm^2$. The test is carried out using the smallest conductor size within the range of the terminal with a minimum of 16 $mm^2$ conductor. Typical arrangements for various LPSC are shown in Annex B.

g) Prorated section of an installation to be embedded in concrete, including connection components such as connectors, clamps, crimping connections, shall be arranged as connections, shown in Figure 5 a) Figure 5 b), Figure 5 c), and shall be assembled according to the manufacturer's instructions.

h) Prorated section of an installation to be embedded in concrete, including connection components such as brazed, welded, exothermically welded, etc., shall be arranged as shown in Figure 6 a), Figure 6 b), Figure 6 c) and shall be prepared according to the designer's or installer's instructions and supervision of the installer.

*Dimension in millimetres*




**Key**

1 Cross-connection component

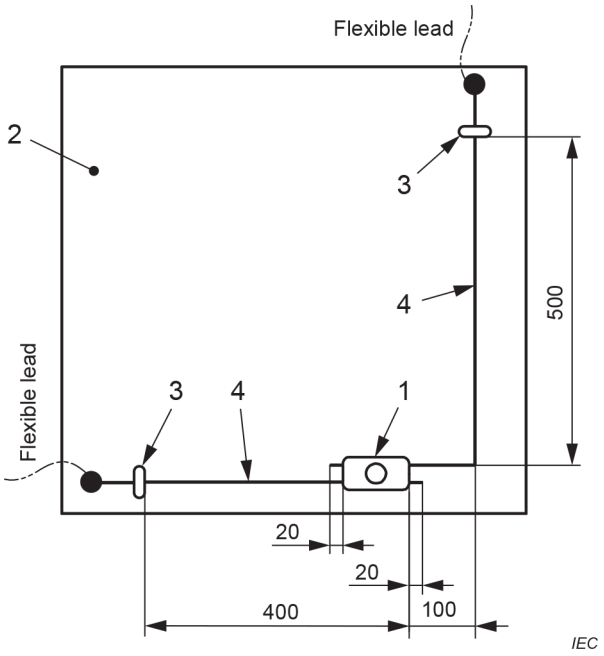
2 Plate made of insulating material

3 Rigid fastener

4 Conductor and~~/or~~ metal installation ~~in accordance with Annex C~~

**Figure 1 – Basic arrangement of specimen with cross-connection component**

*Dimension in millimetres*




**Key**

1 Parallel connection component

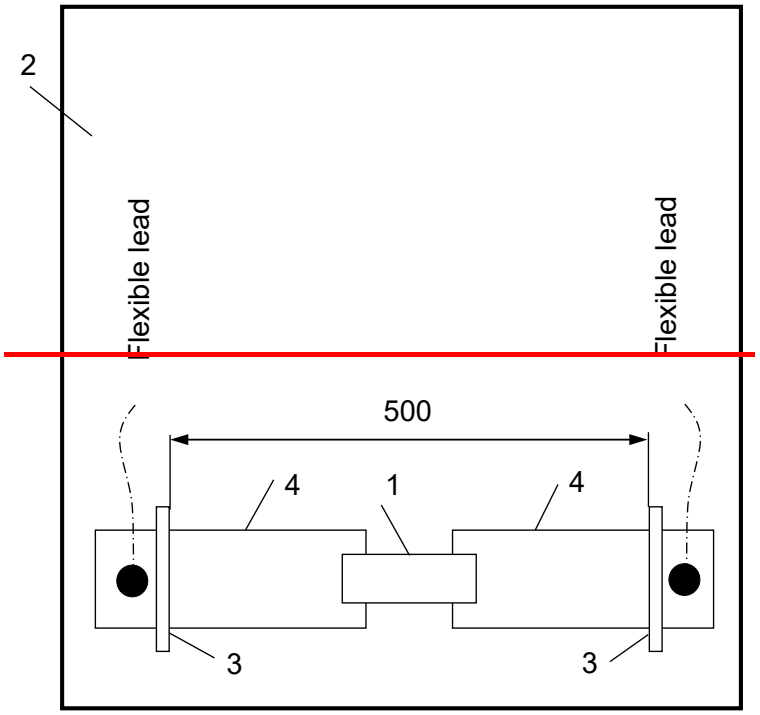
2 Plate made of insulating material

3 Rigid fastener

4 Conductor and~~/or~~ metal installation ~~in accordance with Annex C~~

**Figure 2 – Basic arrangement of specimen with parallel connection component**

*Dimension in millimetres*




*IEC*

**Key**

1 Bridging component

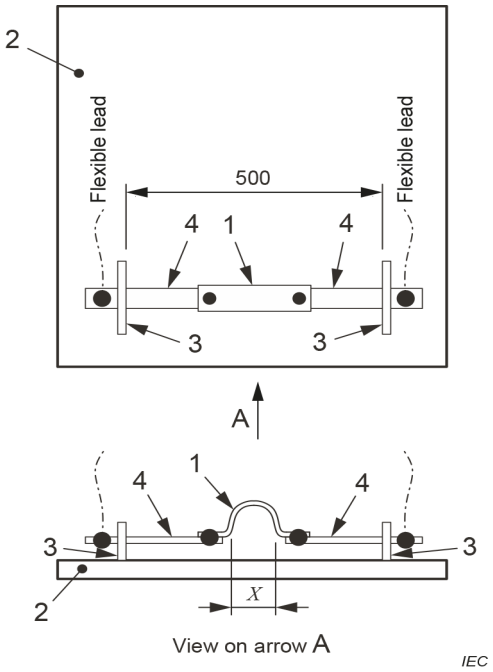
2 Plate made of insulating material

3 Rigid fastener

4 Metal installation in accordance with Annex C

**Figure 3 – Basic arrangement of specimen with bridging component**

*Dimension in millimetres*




**Key**

1 Expansion piece or bridging component

2 Plate made of insulating material

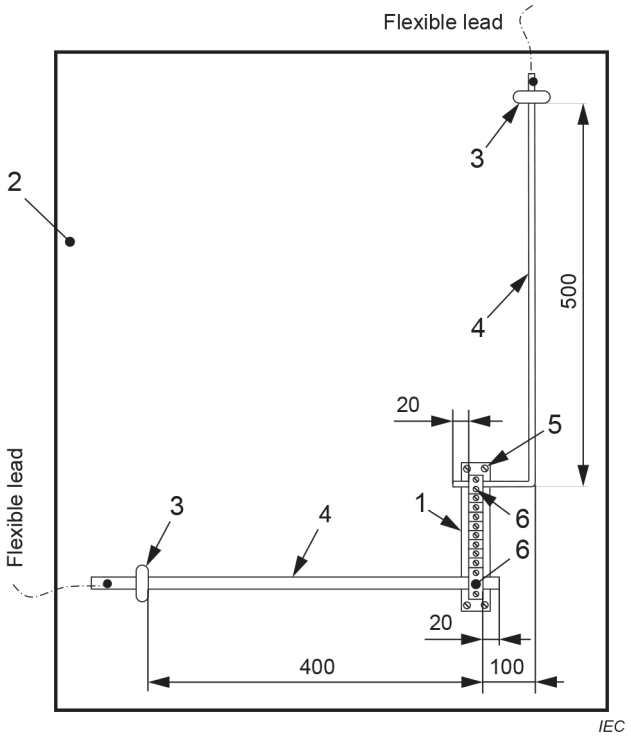
3 Rigid fastener

4 Conductor or metal installation

*X* Distance indicating position of maximum allowable expansion as declared by the manufacturer. Only applicable in case of expansion conductor or bridging component allowing for expansion

**Figure 3 – Basic arrangement of specimen with expansion piece or bridging component**

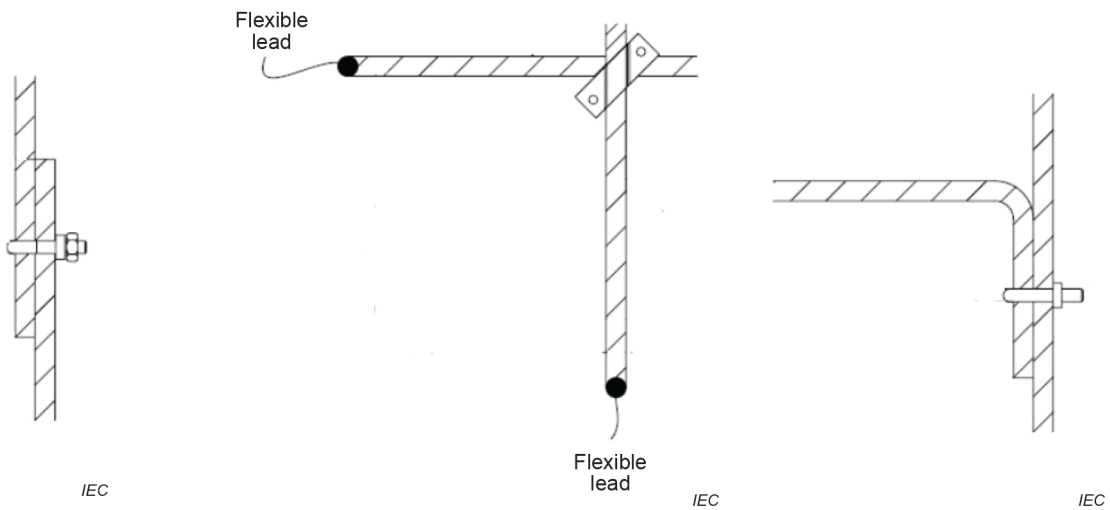
*Dimension in millimetres*




**Key**

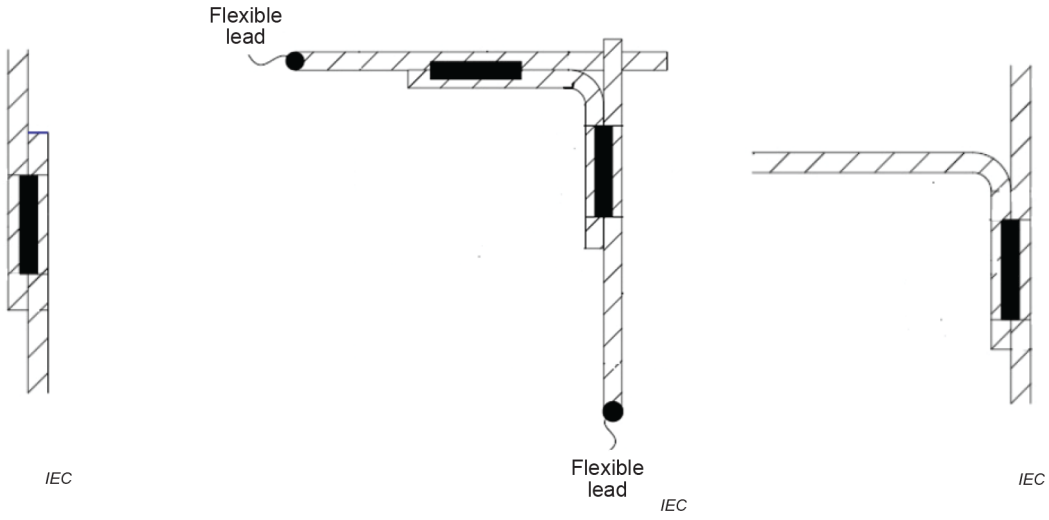
1 Equipotential bonding bar
2 Plate made of insulating material
3 Rigid fastener
4 Conductor
5 Fixing points of equipotential bonding bar
6 Connection to be tested

**Figure 4 – Basic arrangement of specimen with equipotential bonding bar**




**a) In-line connection** **b) Cross connection** **c) "T" connection**

**Figure 5 – Basic arrangement of specimen with clamped connection of reinforcing rods**




a) In-line connection b) Cross connection c) "T" connection

**Figure 6 – Basic arrangement of specimen with welded, brazed or exothermic connections of reinforcing rods**

## 6.5 Conditioning~~/~~ and ageing

~~**6.3.1 Connection components not embedded in concrete**~~

Following the manufacturer's declaration in accordance with 4.2 but before the electrical tests of 6.6, the arrangement of the specimen shall be subjected to a conditioning~~/~~ and ageing treatment in accordance with Annex D.

The manufacturer shall provide proof of the copper content of any part of the assembly made from an alloy having a copper content ≥ 80 %.

After the treatment, the arrangement is fixed on an insulated plate, taking care to avoid any damage to the specimen ~~due to~~ during handling.

~~**6.3.2 Connection components embedded in concrete**~~

~~This treatment is not necessary for connection components designed to be completely embedded in concrete.~~

This treatment is not necessary for connection components designed for installation locations:

a) indoors;

b) completely embedded in concrete.

Connection components designed to be partially embedded in concrete shall be subjected to the conditioning~~/~~ and ageing test in accordance with 6.5.

~~Bonding bars designed for indoor applications only are tested without conditioning/ageing.~~

## 6.6 Electrical test

### 6.6.1 General test conditions

After 6.5 and without cleaning the arrangement, the specimen shall be stressed three times by a test current as given in Table 1. The time interval between individual shots shall allow the arrangement of the specimen to cool down to approximately ambient temperature.

The impulse discharge current passing through the device under test is defined by the ~~crest~~ current peak value $I_{imp}$, and the specific energy $W/R$. The impulse current shall show no reversal and reach $I_{imp}$ within 50 µs. The transfer of the specific energy $W/R$ shall be dissipated within 5 ms.

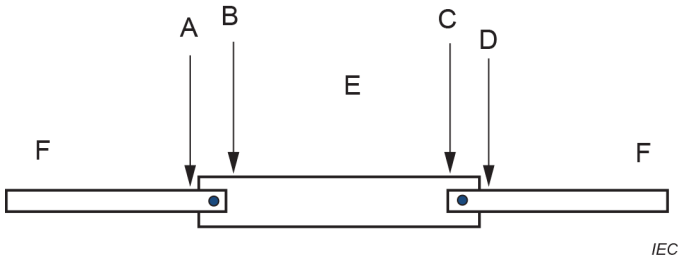
**Table 1 – Lightning impulse current ( $I_{Imp}$ ) parameters**

| Classification | $I_{imp}$<br>kA<br>±10 % | $W/R$<br>kJ/Ω ~~±35~~<br>$^{+45}_{-10}$ % |
|---|---|---|
| H | 100 | 2 500 |
| N | 50 | 625 |
| NOTE The parameters specified in this Table 1 can typically be achieved by an exponentially decaying lightning impulse current having a time to half value in the range of 350 µs according to IEC 62305-1. | | |

### 6.6.2 Acceptance criteria

The connection component is deemed to have passed the test if:

a) the contact resistance, measured with a source of at least ~~10~~ 5 A as close as possible to the connection component is equal to or less than ~~1~~ 3 mΩ. ~~In the case where the connection component or the conductor(s) is of stainless steel, a value of 3 mΩ is allowed~~ The measurement of the contact resistance of the expansion components (E) and the connected conductors (F) is performed between the clamped ends A-B and C-D, as close as possible to the expansion component (see Figure 7). Acceptance criteria for seaming are under consideration;




**Key**

| | |
|---|---|
| A-B, C-D | Measuring points to verify the clamp contact resistances |
| E | Solid material or stranded material according to IEC 62561-2 |
| F | ~~Lightning protection system conductor according to IEC 62561-2~~ Conductor or metal installation |

**Figure 7 – Basic arrangement for contact measurement of expansion piece or bridging component**

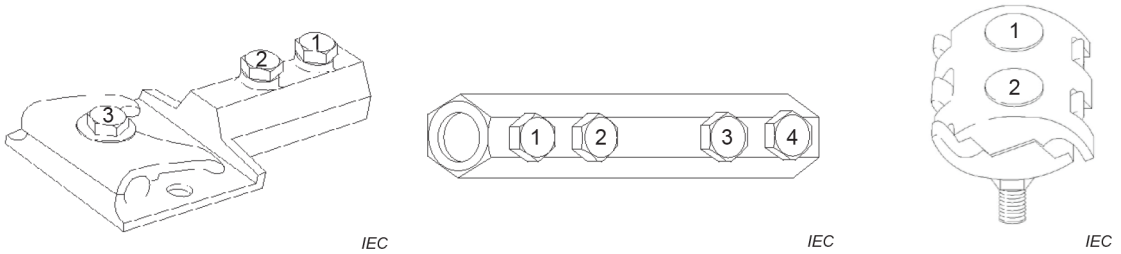
b) it does not exhibit any crack to normal or corrected vision without magnification nor does it have any loose parts or deformation impairing its normal use;

c) for connection components classified according to 4.3 a) or connection components classified according to 4.4 a), except for connections made by seaming, where each conductor of specimen assembly shall be tested independently for multiple conductor connectors, there is less than 1 mm movement of the conductor during the test and no damage to the connection component or conductor. This requirement is not applied to connection components classified according to 4.3 b) and permanent connections made by seaming;

d) for a non-permanent connection component, in accordance with 4.4 b), utilizing screws, the loosening torque is greater than 0,25 and less than 1,5 times the tightening torque. In the case of connectors with more than one screw, only the loosening torque of the first screw is relevant to this test which shall be different each time. For connection components with multiple bolts and screws the manufacturer shall declare the sequence of loosening of bolts and screws to measure the first loosening torque which will be considered. The loosening torques of the remaining bolts and screws can be measured without any loosening torque requirement (see examples in Figure 8). The torque shall be measured at the nut. The screw should be fixed with a wrench and thus secured against turning;

e) for a connection made by bolting where the bolt is secured by a securing nut, the securing nut shall be removed prior to the measurement of the loosening torque. During the removal of the securing nut, the nut underneath the securing nut shall be fixed with a wrench and thus secured against turning. It shall be possible to completely dismantle test joints classified according to 3.9.

Acceptance criteria for connection components designed for connecting rope lay conductors and smooth weave stranded conductors are under consideration.




| a) Example 1 | b) Example 2 | c) Example 3 |
|---|---|---|
| Sequence for tests: | Sequence for tests: | Sequence for tests: |
| Test A: Loosen bolts 1 and 3 | Test A: Loosen bolts 1 and 3 | Test A: Loosen bolt 1 |
| Test B: Loosen bolts 2 and 3 | Test B: Loosen bolts 2 and 4 | Test B: Loosen bolt 2 |
| Test C: Loosen bolts (1 or 2) and 3 | Test C: Loosen either bolt (1 or 2) or (2 or 4) | Test C: Loosen bolt 1 or 2 |

**Figure 8 – Examples of sequence of loosening of bolts and screws**

f) for a non-permanent connection component, in accordance with 4.4 b), the 20 mm length of conductor from the connector (see Figure 1, Figure 2, Figure 4), prior to the test, is not less than 3 mm after completion of the test. For connection configurations where at least one conductor terminates within the connector (see connection arrangements B3, B4, B6 and B8 in Figure B.1), the length of the conductor movement shall not be greater than 20 % of the original length of conductor engagement within the component;

g) for screw-less or permanent connection components, in accordance with 4.4 a), where each conductor of the specimen assemblies shall be subjected independently to a mechanical tensile force of 900 N ± 20 N, for 1 min and where each conductor shall be tested independently for multiple conductor connectors~~. The connection component is deemed to have passed the test if~~, there is less than 1 mm movement of the conductor during the test and no damage to the connection component or conductor.

~~NOTE 1 For the examples B3 and B6 as shown in Figure B.1, the requirement of not less than 3 mm is not applicable.~~

~~NOTE 2 The measurement of the contact resistance of the expansion components (E) and the connected conductors (F) is performed between the clamped ends A-B and C-D, as close as possible to the expansion component (see Figure 5);~~

~~The expansion conductor (E, see Figure 5), shall be tested according to IEC 62561-2 and shall fulfill the requirements for air termination conductors.~~

### 6.7 Static mechanical withstand-capability test

Connection components classified according to 4.3 a) shall have a sufficient withstand-capability against static mechanical stresses. Verification is performed with the test according to 6.6.2 g).

~~**6.5.1 General**~~

~~The test shall be performed with all conductor materials permitted according to the manufacturer's declaration.~~

~~Alternatively, to minimize the number of tests, connection components that are used with several different conductor materials may be tested using stainless steel only.~~

~~Any connection components with a connection range equal to or less than 2 mm shall be tested on the minimum conductor size recommended. If the connection range is greater than 2 mm it shall be tested on the minimum and maximum size of conductor recommended.~~

~~**6.5.2 Test procedure**~~

~~A second set of 3 new connection components shall be arranged according to the manufacturer's or supplier's installation instructions with the recommended conductor materials, sizes and tightening torques.~~

~~Each conductor of the specimen assemblies shall be subjected independently to a mechanical tensile force of 900 N ± 20 N for 1 min.~~

~~The connection component is deemed to have passed the test if there is less than 1 mm movement of the conductor during the test and no damage to the connection component or conductor.~~

~~**6.6 Marking test**~~

~~The marking is checked by inspection and by rubbing it 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 white spirit/mineral spirit.~~

~~Markings made by moulding, pressing or engraving are not subjected to this test.~~

~~The specimen is deemed to have passed the test if the marking remains legible.~~

## 7 Electromagnetic compatibility (EMC)

Products covered by this document are, in normal use, passive in respect of electromagnetic influences (emission and immunity).

## 8 Structure and content of the test report

### 8.1 General

The purpose of this Clause 8 is to provide general requirements for laboratory test reports. It is intended to promote clear, complete reporting procedures for laboratories submitting test reports.

The results of each test carried out by the laboratory shall be reported accurately, clearly, unambiguously and objectively, in accordance with any instructions in the test methods. The

results shall be reported in a test report and shall include all the information necessary for the interpretation of the test results and all information required by the method used.

~~Particular care and attention shall be paid to the arrangement of the report, especially with regard to presentation of the test data and ease of assimilation by the reader.~~ The report shall be arranged and presented in such a way that it is easily assimilated by the reader. The format shall be ~~carefully and~~ specifically designed for each type of test carried out, but the headings shall be standardized as indicated below.

The structure of each report shall include at least the information according to 8.2 to 8.10.

### 8.2 Report identification

The following information shall be included.

a) a title or the subject of the report;

b) name, address and email or telephone number of the test laboratory;

c) name, address and email or telephone number of the sub test laboratory where the test was carried out if different from the company which has been assigned to perform the test;

d) unique identification number (or serial number) of the test report;

e) name and address of the vendor;

f) page numbers, including the total number of pages;

g) date of issue of report;

h) date(s) of performance of test(s);

i) signature and title, or an equivalent identification of the person(s) authorized to sign for the testing laboratory for the content of the report;

j) signature and title of person(s) conducting the test;

k) the following declaration in order to avoid misuse: "This type test report shall not be reproduced other than in full, except with the prior written approval of the issuing testing laboratory. This type test report only covers the samples submitted for test and does not produce evidence of the quality for series production."

### 8.3 Specimen description

a) sample description: classification as per Clause 4;

b) detailed description such as basic materials of the sample, screws, nuts, parts, external dimensions, shape, protective or aesthetic coating and unambiguous identification of the test sample ~~and/~~or test assembly;

c) characterization and condition of the test sample ~~and/~~or test assembly;

d) sampling procedure, where relevant;

e) date of receipt of test items;

f) photographs, drawings or any other visual documentation, if available.

### 8.4 Conductor

a) conductor material;

b) nominal cross-sectional area, dimensions and shape. It is recommended that the actual cross-sectional area ~~should~~ also be given.

### 8.5 Standards and references

a) identification of the test standard used and the date of issue of the standard;

b) other relevant documentation with the documentation date.

### 8.6 Test procedure

a) description of the test procedure;

b) justification for any deviations from, additions to or exclusions from the referenced standard;

c) any other information relevant to a specific test such as environmental conditions;

d) configuration of testing assembly;

e) location of the arrangement in the testing area and measuring techniques.

### 8.7 Testing equipment description

Description of equipment used for every test conducted, i.e. generator, conditioning~~/~~ or ageing device.

### 8.8 Measuring instruments description

Characteristics and calibration date of all instruments used for measuring the values specified in the standard i.e. radius gauge, shunts, tensile testing machine, extensometer, ohmmeter, torque meter, thickness calliper gauge, etc.

### 8.9 Results and parameters recorded

The measured, observed or derived results shall be clearly identified at least for:

a) current peak value;

~~b) charge;~~

b) specific energy;

c) front time of the impulse;

~~e) duration of the impulse;~~

d) time to half value;

e) ~~ohmic~~ resistance;

f) tightening torque;

g) loosening torque.

The above shall be presented by means of tables, graphs, drawings, photographs or other documentation of visual observations as appropriate.

### 8.10 Statement of pass~~/~~ or fail

A statement that the specimen passed or failed the tests shall be reported. If the specimen has failed, a description of the failure is necessary.

# Annex A
(normative)

## Summary of the requirements and corresponding tests

See Table A.1.

**Table A.1 – Requirements and corresponding tests**

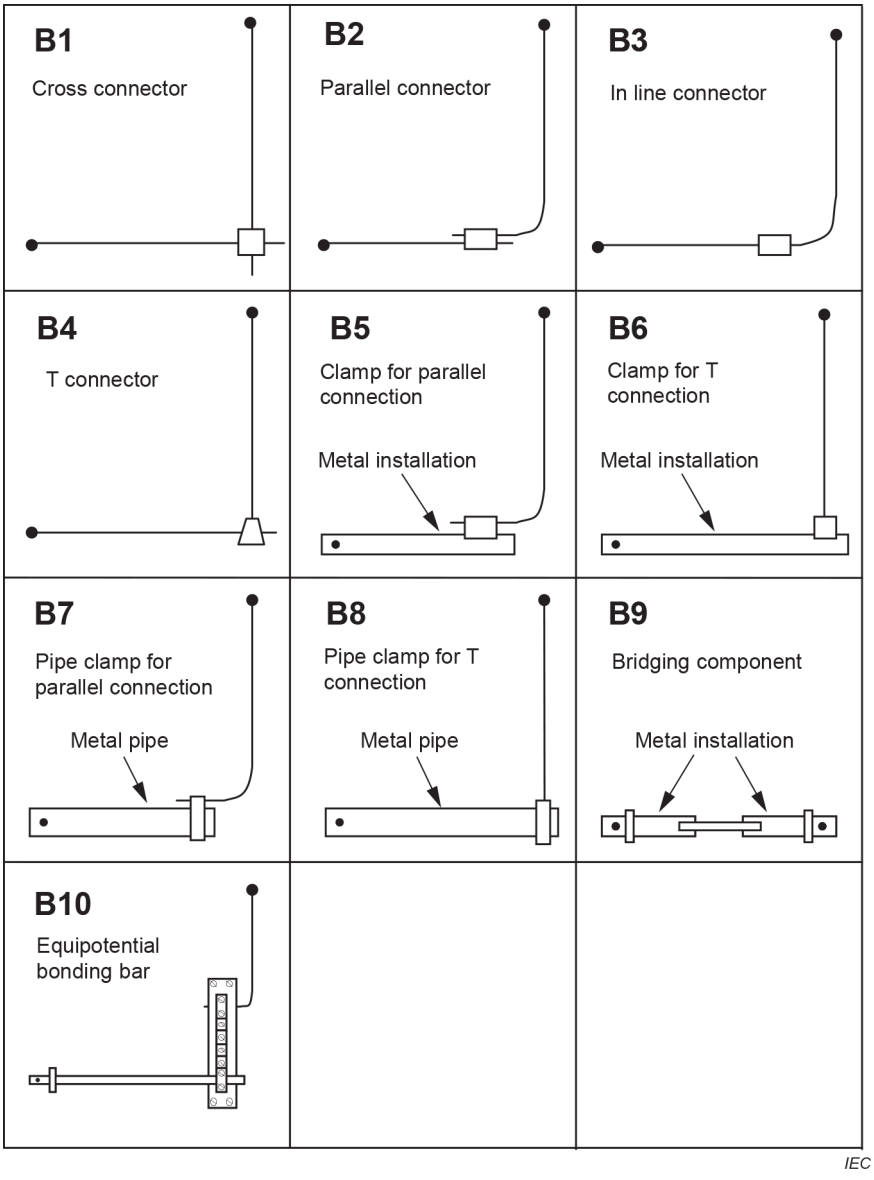
| ~~Test sequence~~ | ~~Requirements~~ | ~~Requirements in accordance with~~ | ~~Compliance is checked by~~ |
|---|---|---|---|
| ~~1~~ | ~~Installation instructions~~ | ~~5.2~~ | ~~Inspection~~ |
| ~~2~~ | ~~Lightning current carrying capability for non-permanent connection~~ | ~~5.3 and 5.6~~ | ~~6.4 a),b),c),d)~~ |
| ~~3~~ | ~~Lightning current carrying capability for permanent connection~~ | ~~5.3 and 5.5~~ | ~~6.4 a),b),e)~~ |
| ~~4~~ | ~~Dismantling of test joints~~ | ~~5.7~~ | ~~Inspection and 6.4 a),b),c),d)~~ |
| ~~5~~ | ~~Damage to conductors and metal installations~~ | ~~5.8~~ | ~~Inspection~~ |
| ~~6~~ | ~~Reliable connection~~ | ~~5.9~~ | ~~Inspection and 6.4~~ |
| ~~7~~ | ~~Marking~~ | ~~5.11~~ | ~~Inspection and 6.6~~ |
| ~~8~~ | ~~Static mechanical test~~ | ~~5.4~~ | ~~6.5~~ |
| ~~9~~ | ~~Terminals of bonding bars~~ | ~~5.10~~ | ~~Inspection~~ |

| Test sequence | Requirements | Requirements in accordance with | Compliance is checked by |
|---|---|---|---|
| 1 | Installation instructions | 5.2 | Inspection and test 6.6.2 |
| 2 | Marking | 5.3 | Inspection and test 6.3 |
| 3 | Lightning current carrying capability for permanent connection | 5.4 and 5.6 | 6.6.2, a), b) and g) |
| 4 | Lightning current carrying capability for non-permanent connection | 5.4 and 5.7 | 6.6.2 a), b), d) and f) |
| 5 | Static mechanical withstand capability | 5.5 | 6.6.2 g) |
| 6 | Dismantling of test joints | 5.8 | 6.6.2 a), b), d) and f) |
| 7 | Expansion piece | 5.9 | E of Figure 7 |

# Annex B
(informative)

## Typical connection ~~configurations~~ arrangements for various LPSC

See Figure B.1.




NOTE 1 B1, B4, B6 and B8 – for more information see Figure 1.

NOTE 2 B2, B3, B5 and B7 – for more information see Figure 2.

NOTE 3 B9 – for more information see Figure 3.

NOTE 4 B10 – for more information see Figure 4.

**Figure B.1 – Typical arrangements for various LPSC**

# Annex C
(normative)

## Flowchart of tests for connection components

See Figure C.1.

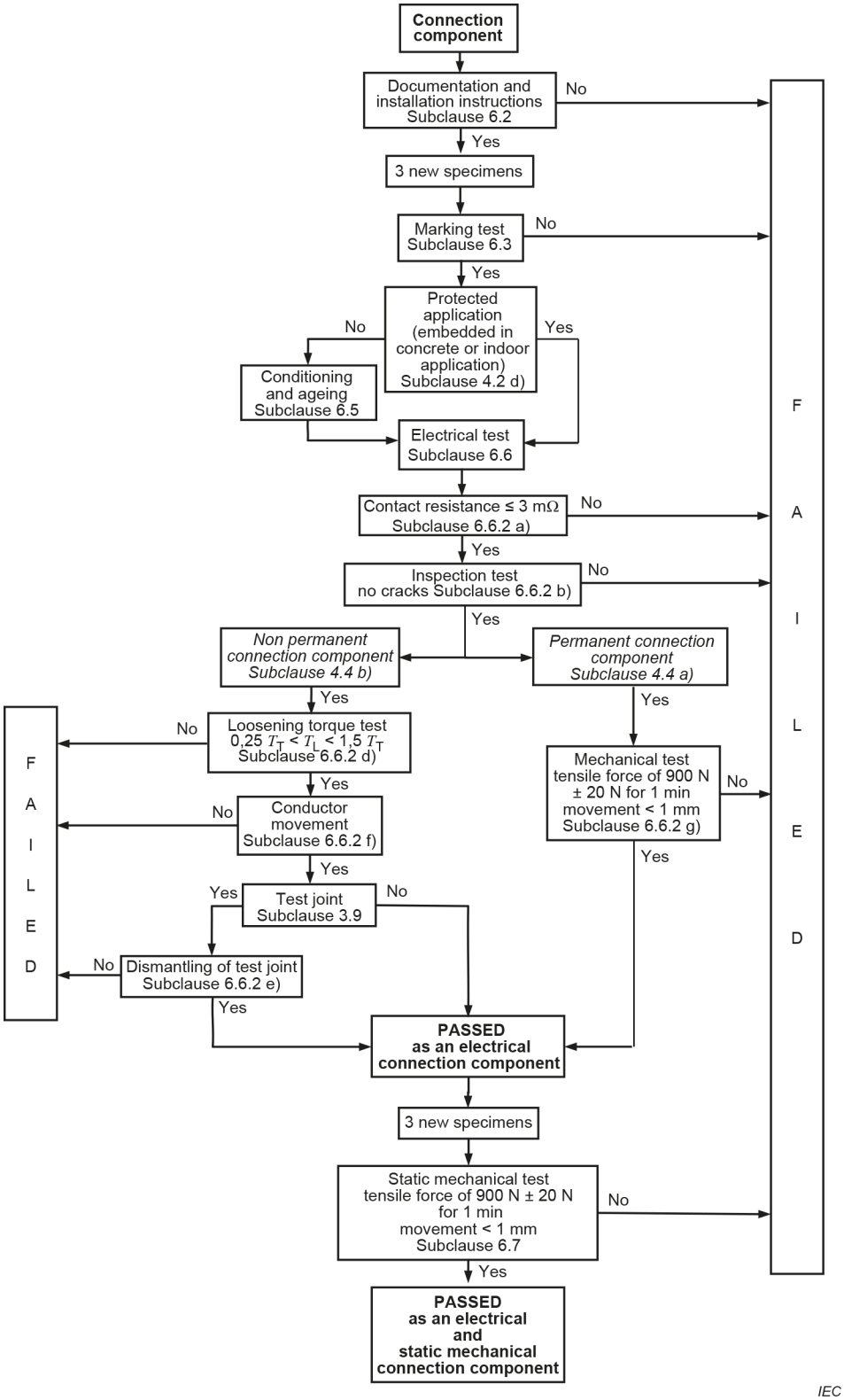



**Figure C.1 – Flowchart of tests for connection components**

# Annex D
(normative)

# Conditioning~~/~~ and ageing for connection components

## D.1 General

The conditioning~~/~~ and ageing test consists of a salt mist treatment as specified in Clause D.2 followed by a humid sulphurous atmosphere treatment as specified in Clause D.3 and an additional ammonia atmosphere treatment for specimens where any component part is made of copper alloy with a copper content less than 80 %, as specified in Clause D.4.

The manufacturer or supplier shall provide proof of the copper content of any part of the assembly made from a copper alloy.

## D.2 Salt mist treatment

The salt mist treatment shall be in accordance with IEC 60068-2-52:~~1996~~2017 except for Clause 7, Clause 10 and Clause 11 which are not applicable. The test is carried out using severity (2).

If the salt mist chamber maintains the temperature conditions as specified in IEC 60068-2-52:~~1996~~2017, 9.3 and a relative humidity of not less than 90 % then the specimen can remain in the chamber for the humidity storage period.

## D.3 Humid sulphurous atmosphere treatment

The humid sulphurous atmosphere treatment shall be in accordance with ~~ISO 6988:1985~~ ISO 22479:2019 Method B with 7 cycles with a volume concentration of sulphur dioxide of $667 \times 10^{-6} \pm 25 \times 10^{-6}$, except for Clause 9 and Clause 10 which are not applicable.

Each cycle which has a duration of 24 h is composed of a heating period of 8 h at a temperature of 40 °C ± 3 °C in the humid saturated atmosphere which is followed by a rest period of 16 h. After that, the humid sulphurous atmosphere is replaced.

If the test chamber maintains the temperature conditions as specified in ~~ISO 6988:1985~~ ISO 22479:2019, 8.5 then the specimen can remain in the chamber for the storage period.

## D.4 Ammonia atmosphere treatment

The ammonia atmosphere treatment shall be in accordance with ISO 6957:1988 for a moderate atmosphere with the pH value of 10, except for 8.4 and Clause 9 of the ISO document which are not applicable.

# Annex E
(normative)

## Reduced test procedures

The reduced test procedures apply to the number of samples to be submitted and the test sequence to be applied for verification of conformity.

For products already tested according to IEC 62561-1:2017 or IEC 62561-1:2012, the simplified test procedure according to Table E.1 can be applied.

For new products, complete type tests and samples according to Clause 6 are required.

**Table E.1 – Reduced test procedures for connection components complying with IEC 62561-1:2017 or IEC 62561-1:2012**

| Test description | Subclause in this document | Testing required |
|---|---|---|
| Lightning impulse current ($I_{imp}$) parameters (tolerances) | Table 1 | No |
| Conditioning and ageing | 6.5, Clause D.3 | No |
| Sequence of loosening torques of connection components with multiple bolts and screws | 6.6.2 d) | No |
| Measurement of conductor's displacement | 6.6.2 f) | No |

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[2] IEC 60050-461, *International Electrotechnical Vocabulary (IEV) – Part 461: Electric cables,* available at http://www.electropedia.org

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[4] IEC 62305 (all parts), *Protection against lightning*

~~IEC 62305-1, *Protection against lightning – Part 1: General principles*~~

~~EN 50164-1:2008[1], *Lightning Protection Components (LPC) – Part 1: Requirements for connection components*~~

_____

~~[1] Withdrawn.~~

IEC 62561-1

Edition 3.0 2023-03

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

## Lightning protection system components (LPSC) – Part 1: Requirements for connection components

## Composants des systèmes de protection contre la foudre (CSPF) – Partie 1: Exigences pour les composants de connexion



IEC 62561-1:2023-03(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

# LIGHTNING PROTECTION SYSTEM COMPONENTS (LPSC) –

## Part 1: Requirements for connection components

## FOREWORD

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IEC 62561-1has been prepared by IEC technical committee 81: Lightning protection. It is an International Standard.

This third edition cancels and replaces the second edition published in 2017. This edition constitutes a technical revision.

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

a) definitions of connection types mentioned in the scope have been added;
b) location classification has been expanded in detail;
c) the document has been updated in line with the new edition of ISO 22479:2019 on humid sulphurous atmosphere treatment;
d) a new normative Annex E for reduced test procedures has been introduced.

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

| Draft | Report on voting |
|---|---|
| 81/721/FDIS | 81/724/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/publications.

A list of all parts in the IEC 62561 series, published under the general title *Lightning protection system components (LPSC),* can be found on the IEC website.

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.

# INTRODUCTION

This part of IEC 62561 deals with the requirements and tests for lightning protection system components (LPSC) used for the installation of a lightning protection system (LPS) designed and implemented according to the IEC 62305 series.

# LIGHTNING PROTECTION SYSTEM COMPONENTS (LPSC) –

# Part 1: Requirements for connection components

## 1 Scope

This part of IEC 62561 specifies the requirements and tests for metallic connection components that form part of a lightning protection system (LPS). Typically, these can be connectors, clamps, bonding and bridging components, expansion pieces and test joints.

For the purposes of this document the following connection types are considered as connection components: exothermic, brazing, welding, clamping, crimping, seaming, screwing or bolting.

Testing of components for an explosive atmosphere is not covered by this document.

## 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 60068-2-52:2017, *Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 62561-2, *Lightning protection system components (LPSC) – Part 2: Requirements for conductors and earth electrodes*

ISO 6957:1988, *Copper alloys – Ammonia test for stress corrosion resistance*

ISO 22479:2019, *Corrosion of metals and alloys – Sulfur dioxide test in a humid atmosphere (fixed gas method)*

## 3 Terms and definitions

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

ISO and IEC maintain terminology 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**
**connection component**
part of an external LPS which is used for the connection of conductors to each other or to metal installations

EXAMPLE Examples of connection components are given in Clause 1.

**3.2**
**metal installation**
extended metal items in the structure to be protected which can form a path for lightning current

EXAMPLE Pipes, staircases, elevator guide rails, ventilation, heating and air conditioning ducts, and interconnected reinforcing steel.

**3.3**
**conductor**
element intended to carry electric current

Note 1 to entry: A metal installation is not intended to carry electrical current.

[SOURCE: IEC 60050-151:2001, 151-12-05, modified – The notes have been replaced with a new Note 1 to entry.]

**3.4**
**bridging component**
connection component for the connection of metal installations

**3.5**
**expansion piece**
connection component designed to compensate for changes in length in conductors or metal installations or both caused by temperature changes

**3.6**
**connector**
connection component to interconnect two or more conductors

**3.7**
**clamp**
connection component for the connection of conductors to metal installations

**3.8**
**pipe clamp**
clamp for the connection of conductors to metal pipes

**3.9**
**test joint**
connection component designed to facilitate electrical testing and measurement of LPS components

**3.10**
**connection range**
minimum to maximum range for which a specific connection component is designed to be used

**3.11**
**bonding**
technique for joining one object to another

[SOURCE: IEC 60050-523:2018, 523-06-01, modified – The example has been deleted.]

**3.12**
**bonding bar**
connection component such as a metal bar on which metal installations, external conductive parts, electric power and telecommunication lines and other cables can be connected to an LPS

**3.13**
**type test**
test made before supplying a type of material covered by IEC 62561-1 on a general commercial basis, in order to demonstrate satisfactory performance characteristics to meet the intended application

**3.14**
**permanent connection**
connection that cannot or is not intended to be dismantled

**3.15**
**non-permanent connection**
connection that can or is intended to be dismantled

**3.16**
**exothermic connection**
welding process that employs molten metal to permanently join the conductors

Note 1 to entry: The electrical connection suitability and electrical durability of the exothermic connection is tested using a lightning current test.

**3.17**
**brazed connection**
metal-joining process in which two or more metal items are joined together by melting and flowing a filler metal into the joint

Note 1 to entry: The electrical connection suitability and electrical durability of the brazed connection is tested using a lightning current test.

**3.18**
**welded connection**
fabrication process that joins materials, usually metals

Note 1 to entry: The electrical connection suitability and electrical durability of the welded connection is tested using a lightning current test.

**3.19**
**force-locked connection**
connection between two metal parts which does not allow any relative movement due to thermal expansion and to environmental load, for example snow, ice, wind

EXAMPLE Connection by means of crimping, clamping, bolting or screwing.

Note 1 to entry: The electrical connection suitability and electrical durability of the force-locked connection is tested using a lightning current test.

**3.20**
**form-locked connection**

connection between two metal parts which allows a small relative movement of metal parts due to thermal expansion and to environmental load, for example snow, ice, wind

EXAMPLE Connection by means of seaming, overlapping and zipping, locked overlapping or hooking.

Note 1 to entry: The electrical connection suitability and electrical durability of the form-locked connection is tested using a lightning current test.

**3.21**
**clamped connection**
force-locked connection, which can usually be disassembled, between two components

Note 1 to entry: The electrical connection suitability and electrical durability of the clamped connection is tested using a lightning current test.

**3.22**
**crimped connection**
connection method of permanently attaching a termination to a conductor by pressure deformation or by reshaping the barrel around the conductor to establish good electrical and mechanical connection

Note 1 to entry: Crimping as a means of achieving a connection between two conductors may not always require an additional component to achieve the final connection.

Note 2 to entry: The electrical connection suitability and electrical durability of the crimped connection is tested using a lightning current test.

[SOURCE: IEC 60050-581:2008, 581-23-10, modified – The term "crimping" has been replaced with "crimped connection", in the definition "method" has been replaced with "connection method" and the notes to entry have been added.]

**3.23**
**seamed connection**
form-locked connection created by bending of the edges of two adjacent metal sheets bringing them into intimate contact in a way that they cannot be separated by natural action

Note 1 to entry: The electrical connection suitability and electrical durability of the seamed connection is tested using a lightning current test.

**3.24**
**screwed connection**
force-locked connection, which can be disassembled, between two components which have threads of their own and can be bolted directly

Note 1 to entry: The electrical connection suitability and electrical durability of the screwed connection is tested using a lightning current test.

**3.25**
**bolted connection**
force-locked connection, which can be disassembled, between two components which can be bolted indirectly by means of third components (bolts and nuts)

Note 1 to entry: The electrical connection suitability and electrical durability of the bolted connection is tested using a lightning current test.

**3.26**
**stranded conductor**
conductor consisting of a number of individual wires or strands all or some of which generally have helical form

Note 1 to entry: The cross-section of a stranded conductor can be circular or otherwise shaped.

Note 2 to entry: The term "strand" is also used to designate a single wire.

[SOURCE: IEC 60050-461:2008, 461-01-07]

**3.27**
**rope lay conductor**
conductor composed of a central core surrounded by one or more layers of helically laid groups of wires

**3.28**
**smooth weave stranded conductor**
conductor constructed of multi-strand soft drawn wire, interwoven in a basket weave configuration so as to avoid fraying in application

## 4 Classification

### 4.1 According to the ability to withstand lightning current

a) class H for heavy duty;

b) class N for normal duty.

The selection of classes H or N should be performed by the manufacturer in accordance with the test parameters identified in Table 1.

### 4.2 According to the installation location

a) outdoors;

b) indoors;

c) buried in ground;

d) embedded in concrete;

e) embedded in materials with thermal insulation.

The manufacturer's declaration of installation location shall determine whether it is necessary to carry out the conditioning and ageing test as identified in 6.5.

### 4.3 According to the mechanical behaviour of connection components

a) intended to withstand a static mechanical stress;

b) not intended to withstand a static mechanical stress.

The manufacturer's declaration of ability to withstand a static mechanical load shall determine whether it is necessary to carry out the static mechanical test as identified in 6.7.

### 4.4 According to whether or not a connection is permanent

a) permanent connection such as exothermic process, brazing, welding, crimping, seaming;

b) non-permanent connection such as screwing or bolting.

## 5 Requirements

### 5.1 General

Connection components shall be designed in such a manner that, when they are installed in accordance with the manufacturer's instructions, their performance shall be reliable, stable and safe to persons and surrounding equipment.

A summary of the requirements and their corresponding tests is given in Annex A.

### 5.2 Documentation and installation instructions

The manufacturer of the connection component shall provide adequate instructions in their literature to ensure that the installer of the connection component can select and install the components in a suitable and safe manner, containing at least the following information:

a) classification and lightning current capability ($I_{\text{imp}}$);

b) classification according to the installation location;

c) classification according to the mechanical behaviour;

d) classification according to whether or not the connection is permanent;

e) the range of conductor sizes and materials;

f) the connection configuration;

g) assembly instructions for permanent or non-permanent connection components (e.g. whether special tools are necessary, tightening torque, etc.).

Compliance is checked in accordance with 6.2.

### 5.3 Marking

#### 5.3.1 Content of marking

The connection components shall be marked at least with the following:

a) the manufacturer's or responsible vendor's name or trademark;

b) identifying symbol (picture, product number, etc.);

c) classification, i.e. class N or H;

d) classification according to the installation location.

Compliance is checked by review in accordance with 6.3.1, a).

Where this proves to be impractical the marking in accordance with b), c) and d) may be given on the smallest packing unit label or on the accompanying documentation.

NOTE 1 Marking can be applied for example by moulding, pressing, engraving, printing and environmental stress adhesive labels.

NOTE 2 Marking can be applied by water slide transfers only for components classified as indoors.

#### 5.3.2 Durability and legibility

The marking shall be durable and legible.

Compliance is checked by test in accordance with 6.3.1 b).

### 5.4 Lightning current carrying capability

Connection components shall have sufficient lightning current carrying capability.

Compliance is checked in accordance with 6.6 following the manufacturer's declaration for the class (H or N) of the connection components in accordance with 4.1.

### 5.5 Static mechanical withstand capability

Connection components classified according to 4.3 a) shall have a sufficient withstand capability against static mechanical stresses.

Equipotential bonding bars and connections made by seaming are excluded from this requirement.

Compliance is checked in accordance with 6.7.

### 5.6 Permanent connection

Where exothermic process, brazing, welding, crimping or seaming are used for connection, the design shall be such that the conductor and the metal installation is always securely bonded.

Compliance is checked by inspection and in accordance with 6.6.2 a), b) and g).

### 5.7 Non-permanent connection

Where screws or nuts are used as the clamping connection, the design shall be such that the conductor and the metal installation is always securely fastened by the screw or nut application.

Compliance is checked by inspection and in accordance with 6.6.2 a), b), d) and f).

Compliance of connection components classified according to 4.2 d) is checked by inspection according to 6.6.2 a), d) and g).

### 5.8 Dismantling of test joints

It shall be possible to dismantle the test joints after lightning current stress.

Compliance is checked by inspection and in accordance with 6.6.2 a), b), d) and f).

### 5.9 Expansion piece

In addition to the requirements of this document, the expansion piece (E of Figure 7) shall fulfil the requirements of IEC 62561-2 for air termination conductors.

## 6 Tests

### 6.1 General test conditions

a) The tests in accordance with this document are type tests (see 3.13), performed in a sequence according to Annex C. Type tests are of such a nature that, after they have been made, unless changes are made to the accessory materials, design or type of manufacturing process which can change the performance characteristics, repeated testing is not required.

b) Unless otherwise specified, tests are carried out with the specimens assembled and installed as in normal use according to the manufacturer's or supplier's installation instructions with the recommended conductor materials, sizes and tightening torques.

c) All tests are carried out on new specimens.

d) Unless otherwise specified, three specimens are subjected to the tests and the requirements are satisfied if all the tests are met.

e) If only one of the specimens does not satisfy a test due to an assembly or a manufacturing fault, that test and any preceding one which can influence the results of the test shall be repeated and also the tests which follow shall be carried out in the required sequence on another full set of specimens, all of which shall comply with the requirements.

f) The electrical test shall be carried out in the order given, after conditioning and ageing of the arrangement of the specimen in accordance with 6.5.

The applicant, when submitting the sets of specimens, can also submit an additional set of specimens which can be used, should one specimen fail. The laboratory will then, without further request, test the additional set of specimens and will reject it only if a further failure occurs. If the additional set of specimens is not submitted at the same time, the failure of one specimen will entail rejection.

For components already tested according to IEC 62561-1:2017, the reduced test procedure according to Annex E can be applied.

For new components complete type tests and samples according to Clause 6 are required.

### 6.2 Documentation and installation instructions

#### 6.2.1 General test conditions

The content of the installation instructions is checked as per its completeness by review.

#### 6.2.2 Acceptance criteria

Documentation or installation instructions are deemed to be acceptable if they contain at least the information specified in 5.2.

### 6.3 Marking test

#### 6.3.1 General test conditions

The marking is checked:

a) as per its completeness in accordance with 5.3.1 by review and

b) as per its durability and legibility by rubbing it 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 white spirit or mineral spirit.

Marking made by moulding, pressing or engraving is not subjected to this test.

#### 6.3.2 Acceptance criteria

The specimen is deemed to have passed the test if:

a) the marking contains all the information of 5.3.1;

b) after the test according to 6.3.1, b) the marking remains durable and legible.

### 6.4 Preparation of the specimen

a) If not otherwise specified by the manufacturer, the conductors and the specimens shall be cleaned by using a suitable degreasing agent followed by cleaning in demineralized water and drying. They shall then be assembled in accordance with the manufacturer's instructions, for example with the recommended conductors and tightening torques.

b) The conductors and rods used for this test shall fulfil the requirements of IEC 62561-2.

c) The connection component shall be tested in all the connection configurations declared by the manufacturer. Typical connection configurations for various LPSC are illustrated in Annex B.

d) If the connection component is suitable for various conductors' materials, then it shall be tested on each material combination declared by the manufacturer.

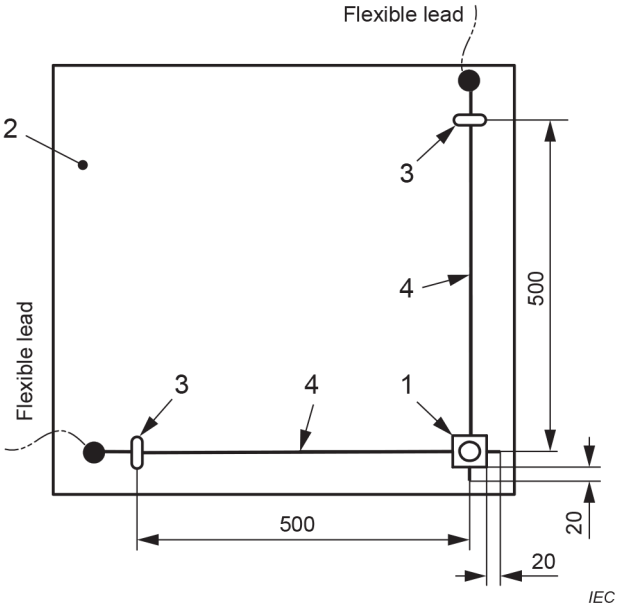
e) Any connection components accommodating a range of conductors with a variation on any dimension equal to or less than 2 mm shall be tested using the minimum conductor size recommended. If the range of conductor sizes is greater than 2 mm, it shall be tested using the minimum and maximum size of conductors recommended.

f) The basic arrangement of the specimen with cross-connection component, parallel connection component, bridging component and equipotential bonding bar is shown in Figure 1, Figure 2, Figure 3 and Figure 4, respectively. Terminals of bonding bars are only tested if the connection size is equal to or greater than 16 $mm^2$. The test is carried out using the smallest conductor size within the range of the terminal with a minimum of 16 $mm^2$ conductor. Typical arrangements for various LPSC are shown in Annex B.

g) Prorated section of an installation to be embedded in concrete, including connection components such as connectors, clamps, crimping connections, shall be arranged as connections, shown in Figure 5 a) Figure 5 b), Figure 5 c), and shall be assembled according to the manufacturer's instructions.

h) Prorated section of an installation to be embedded in concrete, including connection components such as brazed, welded, exothermically welded, etc., shall be arranged as shown in Figure 6 a), Figure 6 b), Figure 6 c) and shall be prepared according to the designer's or installer's instructions and supervision of the installer.

*Dimension in millimetres*




**Key**

1 Cross-connection component

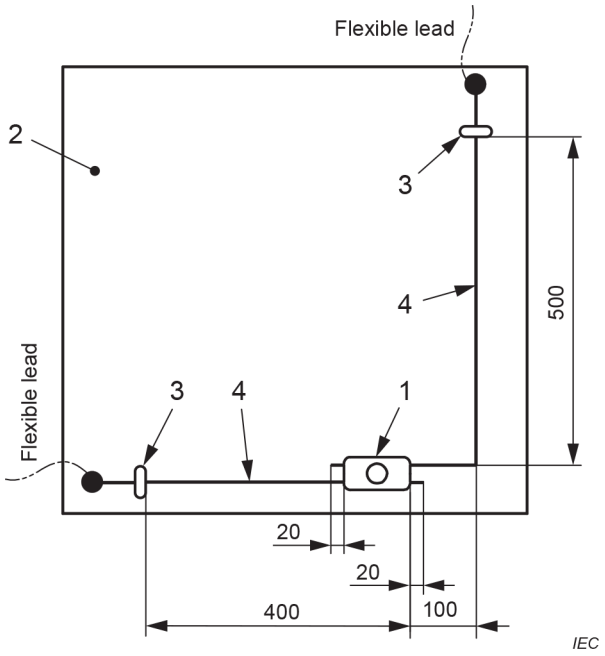
2 Plate made of insulating material

3 Rigid fastener

4 Conductor and metal installation

**Figure 1 – Basic arrangement of specimen with cross-connection component**

*Dimension in millimetres*




**Key**

1 Parallel connection component

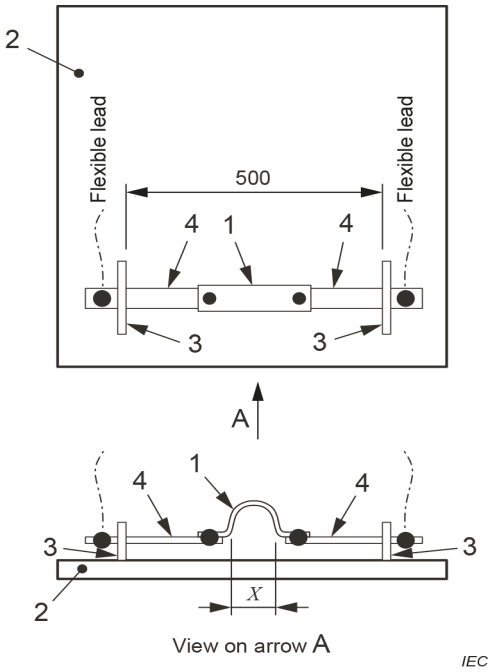
2 Plate made of insulating material

3 Rigid fastener

4 Conductor and metal installation

**Figure 2 – Basic arrangement of specimen with parallel connection component**

*Dimension in millimetres*




**Key**

1 Expansion piece or bridging component

2 Plate made of insulating material

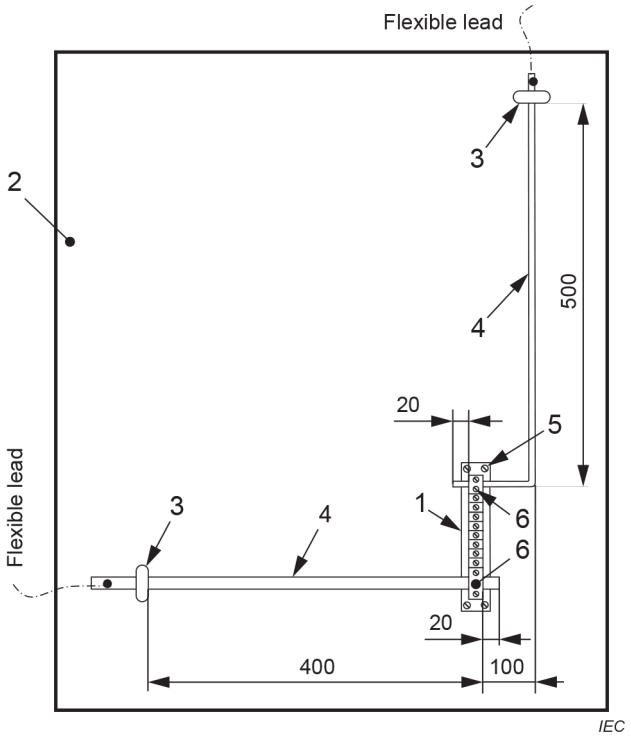
3 Rigid fastener

4 Conductor or metal installation

*X* Distance indicating position of maximum allowable expansion as declared by the manufacturer. Only applicable in case of expansion conductor or bridging component allowing for expansion

**Figure 3 – Basic arrangement of specimen with expansion piece or bridging component**

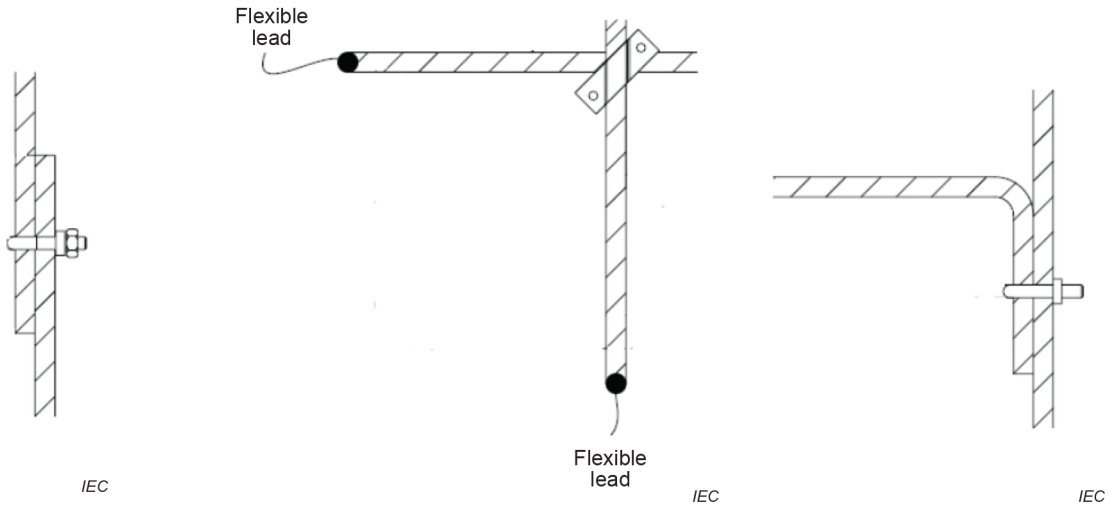
*Dimension in millimetres*




**Key**

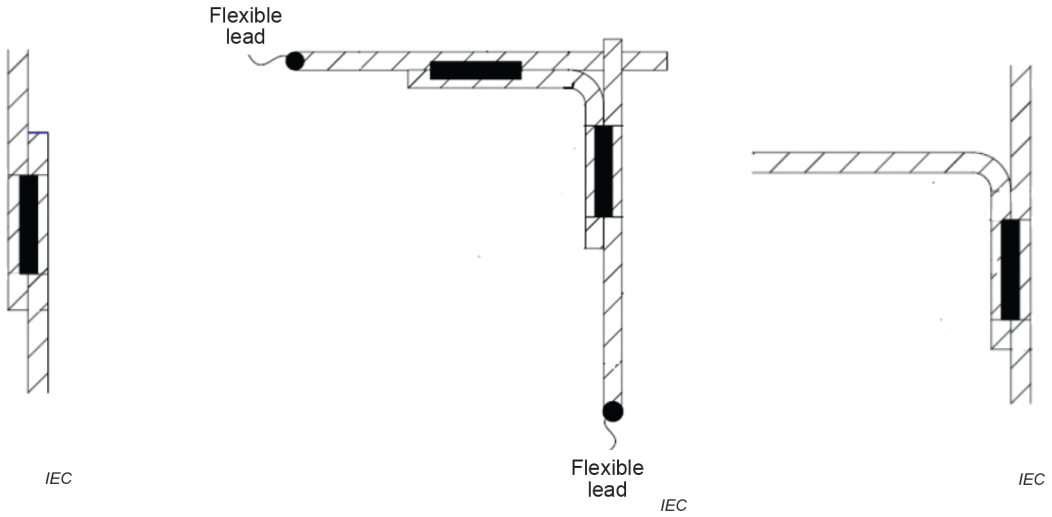
1 Equipotential bonding bar
2 Plate made of insulating material
3 Rigid fastener
4 Conductor
5 Fixing points of equipotential bonding bar
6 Connection to be tested

**Figure 4 – Basic arrangement of specimen with equipotential bonding bar**




**a) In-line connection** **b) Cross connection** **c) "T" connection**

**Figure 5 – Basic arrangement of specimen with clamped connection of reinforcing rods**




**a) In-line connection** **b) Cross connection** **c) "T" connection**

**Figure 6 – Basic arrangement of specimen with welded, brazed or exothermic connections of reinforcing rods**

### 6.5 Conditioning and ageing

Following the manufacturer's declaration in accordance with 4.2 but before the electrical tests of 6.6, the arrangement of the specimen shall be subjected to a conditioning and ageing treatment in accordance with Annex D.

The manufacturer shall provide proof of the copper content of any part of the assembly made from an alloy having a copper content ≥ 80 %.

After the treatment, the arrangement is fixed on an insulated plate, taking care to avoid any damage to the specimen during handling.

This treatment is not necessary for connection components designed for installation locations:

a) indoors;

b) completely embedded in concrete.

Connection components designed to be partially embedded in concrete shall be subjected to the conditioning and ageing test in accordance with 6.5.

### 6.6 Electrical test

#### 6.6.1 General test conditions

After 6.5 and without cleaning the arrangement, the specimen shall be stressed three times by a test current as given in Table 1. The time interval between individual shots shall allow the arrangement of the specimen to cool down to approximately ambient temperature.

The impulse discharge current passing through the device under test is defined by the current peak value $I_{imp}$, and the specific energy $W/R$. The impulse current shall show no reversal and reach $I_{imp}$ within 50 µs. The transfer of the specific energy $W/R$ shall be dissipated within 5 ms.

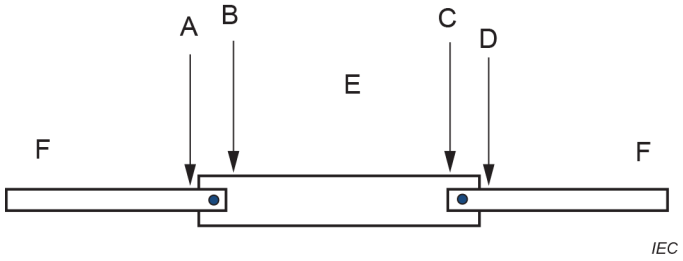
**Table 1 – Lightning impulse current ( $I_{Imp}$ ) parameters**

| Classification | $I_{imp}$<br>kA<br>±10 % | $W/R$<br>kJ/Ω<br>$^{+45}_{-10}$ % |
|---|---|---|
| H | 100 | 2 500 |
| N | 50 | 625 |
| NOTE The parameters specified in this Table 1 can typically be achieved by an exponentially decaying lightning impulse current having a time to half value in the range of 350 µs according to IEC 62305-1. | | |

### 6.6.2 Acceptance criteria

The connection component is deemed to have passed the test if:

a) the contact resistance, measured with a source of at least 5 A as close as possible to the connection component is equal to or less than 3 mΩ. The measurement of the contact resistance of the expansion components (E) and the connected conductors (F) is performed between the clamped ends A-B and C-D, as close as possible to the expansion component (see Figure 7). Acceptance criteria for seaming are under consideration;




**Key**

A-B, C-D Measuring points to verify the clamp contact resistances

E Solid material or stranded material according to IEC 62561-2

F Conductor or metal installation

**Figure 7 – Basic arrangement for contact measurement of expansion piece or bridging component**

b) it does not exhibit any crack to normal or corrected vision without magnification nor does it have any loose parts or deformation impairing its normal use;

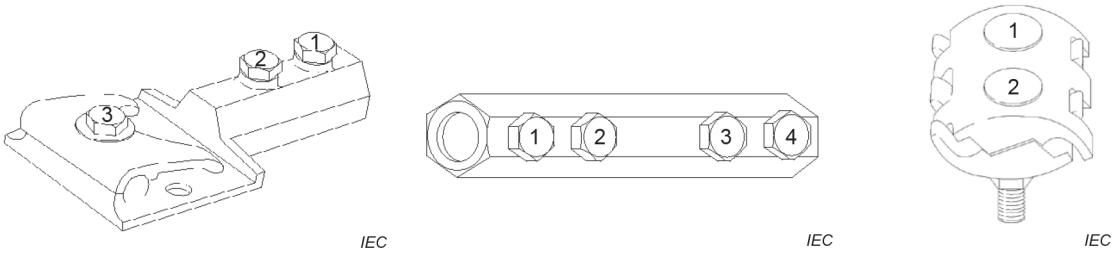
c) for connection components classified according to 4.3 a) or connection components classified according to 4.4 a), except for connections made by seaming, where each conductor of specimen assembly shall be tested independently for multiple conductor connectors, there is less than 1 mm movement of the conductor during the test and no damage to the connection component or conductor. This requirement is not applied to connection components classified according to 4.3 b) and permanent connections made by seaming;

d) for a non-permanent connection component, in accordance with 4.4 b), utilizing screws, the loosening torque is greater than 0,25 and less than 1,5 times the tightening torque. In the case of connectors with more than one screw, only the loosening torque of the first screw is relevant to this test which shall be different each time. For connection components with multiple bolts and screws the manufacturer shall declare the sequence of loosening of bolts and screws to measure the first loosening torque which will be considered. The loosening torques of the remaining bolts and screws can be measured without any loosening torque requirement (see examples in Figure 8). The torque shall be

measured at the nut. The screw should be fixed with a wrench and thus secured against turning;

e) for a connection made by bolting where the bolt is secured by a securing nut, the securing nut shall be removed prior to the measurement of the loosening torque. During the removal of the securing nut, the nut underneath the securing nut shall be fixed with a wrench and thus secured against turning. It shall be possible to completely dismantle test joints classified according to 3.9.

Acceptance criteria for connection components designed for connecting rope lay conductors and smooth weave stranded conductors are under consideration.




| a) Example 1 | b) Example 2 | c) Example 3 |
|---|---|---|
| Sequence for tests: | Sequence for tests: | Sequence for tests: |
| Test A: Loosen bolts 1 and 3 | Test A: Loosen bolts 1 and 3 | Test A: Loosen bolt 1 |
| Test B: Loosen bolts 2 and 3 | Test B: Loosen bolts 2 and 4 | Test B: Loosen bolt 2 |
| Test C: Loosen bolts (1 or 2) and 3 | Test C: Loosen either bolt (1 or 2) or (2 or 4) | Test C: Loosen bolt 1 or 2 |

**Figure 8 – Examples of sequence of loosening of bolts and screws**

f) for a non-permanent connection component, in accordance with 4.4 b), the 20 mm length of conductor from the connector (see Figure 1, Figure 2, Figure 4), prior to the test, is not less than 3 mm after completion of the test. For connection configurations where at least one conductor terminates within the connector (see connection arrangements B3, B4, B6 and B8 in Figure B.1), the length of the conductor movement shall not be greater than 20 % of the original length of conductor engagement within the component;

g) for screw-less or permanent connection components, in accordance with 4.4 a), where each conductor of the specimen assemblies shall be subjected independently to a mechanical tensile force of 900 N ± 20 N, for 1 min and where each conductor shall be tested independently for multiple conductor connectors, there is less than 1 mm movement of the conductor during the test and no damage to the connection component or conductor.

### 6.7 Static mechanical withstand-capability test

Connection components classified according to 4.3 a) shall have a sufficient withstand-capability against static mechanical stresses. Verification is performed with the test according to 6.6.2 g).

## 7 Electromagnetic compatibility (EMC)

Products covered by this document are, in normal use, passive in respect of electromagnetic influences (emission and immunity).

# 8 Structure and content of the test report

## 8.1 General

The purpose of this Clause 8 is to provide general requirements for laboratory test reports. It is intended to promote clear, complete reporting procedures for laboratories submitting test reports.

The results of each test carried out by the laboratory shall be reported accurately, clearly, unambiguously and objectively, in accordance with any instructions in the test methods. The results shall be reported in a test report and shall include all the information necessary for the interpretation of the test results and all information required by the method used.

The report shall be arranged and presented in such a way that it is easily assimilated by the reader. The format shall be specifically designed for each type of test carried out, but the headings shall be standardized as indicated below.

The structure of each report shall include at least the information according to 8.2 to 8.10.

## 8.2 Report identification

The following information shall be included.

a) a title or the subject of the report;

b) name, address and email or telephone number of the test laboratory;

c) name, address and email or telephone number of the sub test laboratory where the test was carried out if different from the company which has been assigned to perform the test;

d) unique identification number (or serial number) of the test report;

e) name and address of the vendor;

f) page numbers, including the total number of pages;

g) date of issue of report;

h) date(s) of performance of test(s);

i) signature and title, or an equivalent identification of the person(s) authorized to sign for the testing laboratory for the content of the report;

j) signature and title of person(s) conducting the test;

k) the following declaration in order to avoid misuse: "This type test report shall not be reproduced other than in full, except with the prior written approval of the issuing testing laboratory. This type test report only covers the samples submitted for test and does not produce evidence of the quality for series production."

## 8.3 Specimen description

a) sample description: classification as per Clause 4;

b) detailed description such as basic materials of the sample, screws, nuts, parts, external dimensions, shape, protective or aesthetic coating and unambiguous identification of the test sample or test assembly;

c) characterization and condition of the test sample or test assembly;

d) sampling procedure, where relevant;

e) date of receipt of test items;

f) photographs, drawings or any other visual documentation, if available.

## 8.4 Conductor

a) conductor material;

b) nominal cross-sectional area, dimensions and shape. It is recommended that the actual cross-sectional area also be given.

### 8.5 Standards and references

a) identification of the test standard used and the date of issue of the standard;

b) other relevant documentation with the documentation date.

### 8.6 Test procedure

a) description of the test procedure;

b) justification for any deviations from, additions to or exclusions from the referenced standard;

c) any other information relevant to a specific test such as environmental conditions;

d) configuration of testing assembly;

e) location of the arrangement in the testing area and measuring techniques.

### 8.7 Testing equipment description

Description of equipment used for every test conducted, i.e. generator, conditioning or ageing device.

### 8.8 Measuring instruments description

Characteristics and calibration date of all instruments used for measuring the values specified in the standard i.e. radius gauge, shunts, tensile testing machine, extensometer, ohmmeter, torque meter, thickness calliper gauge, etc.

### 8.9 Results and parameters recorded

The measured, observed or derived results shall be clearly identified at least for:

a) current peak value;

b) specific energy;

c) front time of the impulse;

d) time to half value;

e) resistance;

f) tightening torque;

g) loosening torque.

The above shall be presented by means of tables, graphs, drawings, photographs or other documentation of visual observations as appropriate.

### 8.10 Statement of pass or fail

A statement that the specimen passed or failed the tests shall be reported. If the specimen has failed, a description of the failure is necessary.

# Annex A
(normative)

## Summary of the requirements and corresponding tests

See Table A.1.

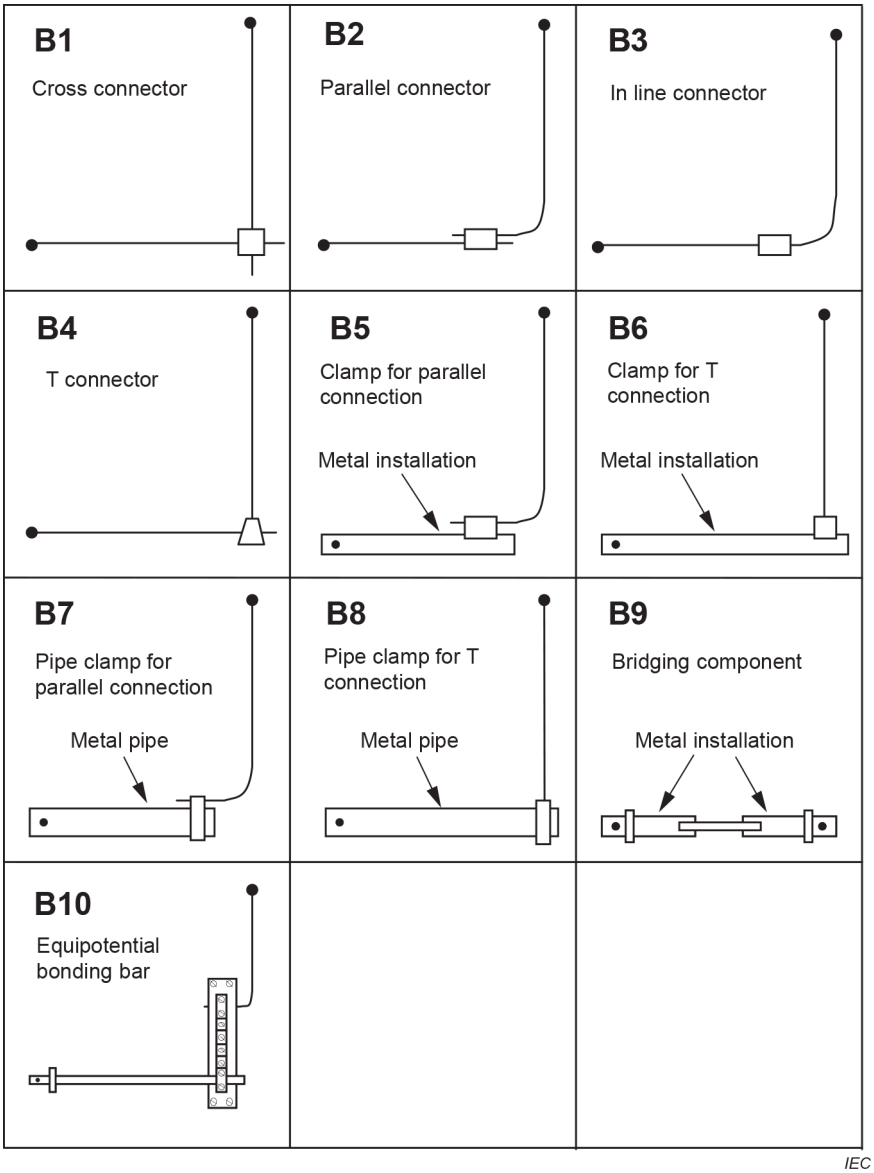
**Table A.1 – Requirements and corresponding tests**

| Test sequence | Requirements | Requirements in accordance with | Compliance is checked by |
|---|---|---|---|
| 1 | Installation instructions | 5.2 | Inspection and test 6.6.2 |
| 2 | Marking | 5.3 | Inspection and test 6.3 |
| 3 | Lightning current carrying capability for permanent connection | 5.4 and 5.6 | 6.6.2, a), b) and g) |
| 4 | Lightning current carrying capability for non-permanent connection | 5.4 and 5.7 | 6.6.2 a), b), d) and f) |
| 5 | Static mechanical withstand capability | 5.5 | 6.6.2 g) |
| 6 | Dismantling of test joints | 5.8 | 6.6.2 a), b), d) and f) |
| 7 | Expansion piece | 5.9 | E of Figure 7 |

# Annex B
(informative)

## Typical connection arrangements for various LPSC

See Figure B.1.




NOTE 1 B1, B4, B6 and B8 – for more information see Figure 1.

NOTE 2 B2, B3, B5 and B7 – for more information see Figure 2.

NOTE 3 B9 – for more information see Figure 3.

NOTE 4 B10 – for more information see Figure 4.

**Figure B.1 – Typical arrangements for various LPSC**

# Annex C
(normative)

## Flowchart of tests for connection components

See Figure C.1.

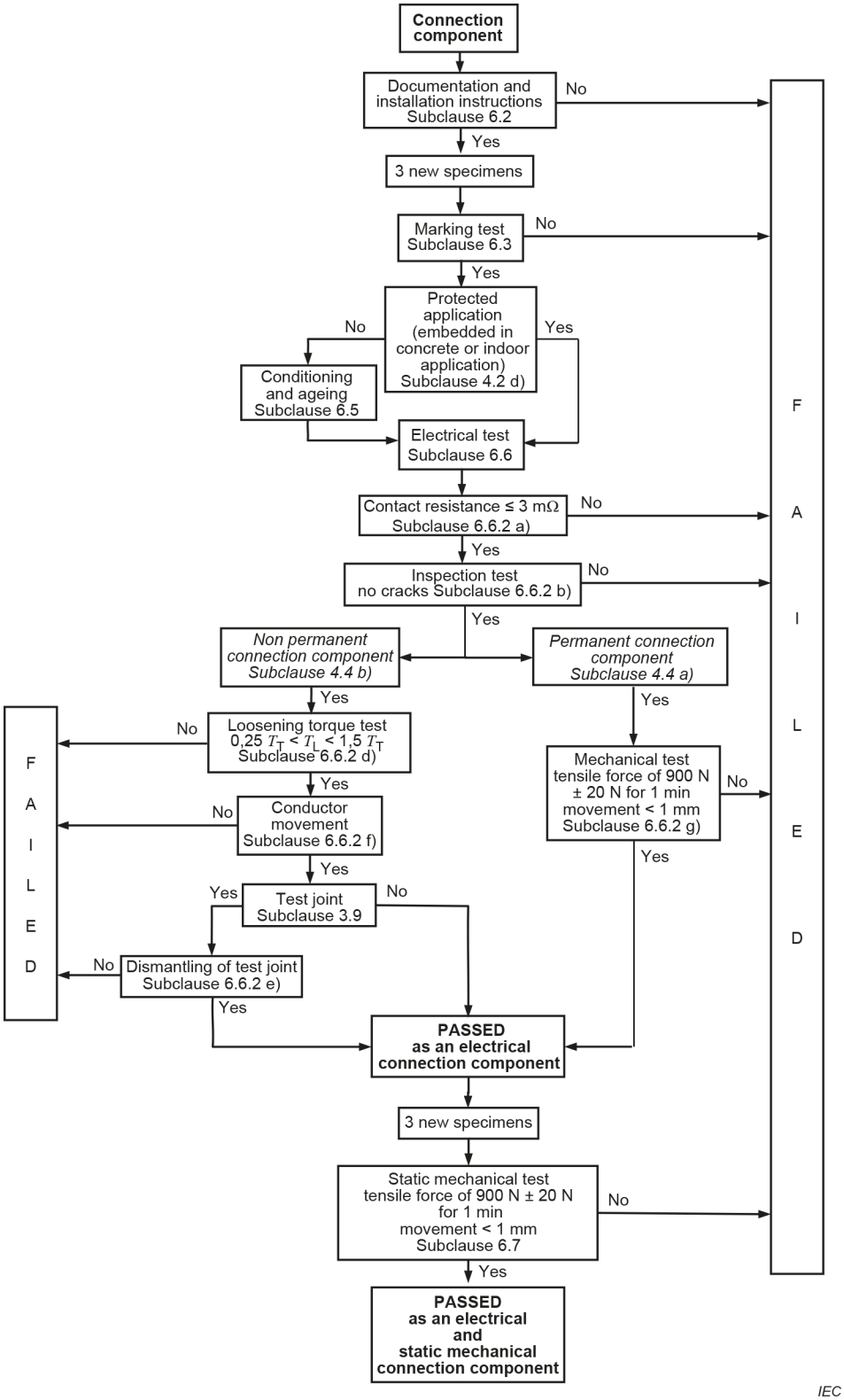



**Figure C.1 – Flowchart of tests for connection components**

# Annex D
(normative)

# Conditioning and ageing for connection components

## D.1 General

The conditioning and ageing test consists of a salt mist treatment as specified in Clause D.2 followed by a humid sulphurous atmosphere treatment as specified in Clause D.3 and an additional ammonia atmosphere treatment for specimens where any component part is made of copper alloy with a copper content less than 80 %, as specified in Clause D.4.

The manufacturer or supplier shall provide proof of the copper content of any part of the assembly made from a copper alloy.

## D.2 Salt mist treatment

The salt mist treatment shall be in accordance with IEC 60068-2-52:2017 except for Clause 7, Clause 10 and Clause 11 which are not applicable. The test is carried out using severity (2).

If the salt mist chamber maintains the temperature conditions as specified in IEC 60068-2-52:2017, 9.3 and a relative humidity of not less than 90 % then the specimen can remain in the chamber for the humidity storage period.

## D.3 Humid sulphurous atmosphere treatment

The humid sulphurous atmosphere treatment shall be in accordance with ISO 22479:2019 Method B with 7 cycles with a volume concentration of sulphur dioxide of $667 \times 10^{-6} \pm 25 \times 10^{-6}$, except for Clause 9 and Clause 10 which are not applicable.

Each cycle which has a duration of 24 h is composed of a heating period of 8 h at a temperature of 40 °C ± 3 °C in the humid saturated atmosphere which is followed by a rest period of 16 h. After that, the humid sulphurous atmosphere is replaced.

If the test chamber maintains the temperature conditions as specified in ISO 22479:2019, 8.5 then the specimen can remain in the chamber for the storage period.

## D.4 Ammonia atmosphere treatment

The ammonia atmosphere treatment shall be in accordance with ISO 6957:1988 for a moderate atmosphere with the pH value of 10, except for 8.4 and Clause 9 of the ISO document which are not applicable.

# Annex E
(normative)

## Reduced test procedures

The reduced test procedures apply to the number of samples to be submitted and the test sequence to be applied for verification of conformity.

For products already tested according to IEC 62561-1:2017 or IEC 62561-1:2012, the simplified test procedure according to Table E.1 can be applied.

For new products, complete type tests and samples according to Clause 6 are required.

**Table E.1 – Reduced test procedures for connection components complying with IEC 62561-1:2017 or IEC 62561-1:2012**

| Test description | Subclause in this document | Testing required |
|---|---|---|
| Lightning impulse current ($I_{imp}$) parameters (tolerances) | Table 1 | No |
| Conditioning and ageing | 6.5, Clause D.3 | No |
| Sequence of loosening torques of connection components with multiple bolts and screws | 6.6.2 d) | No |
| Measurement of conductor's displacement | 6.6.2 f) | No |

# Bibliography

[1] IEC 60050-151, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices,* available at http://www.electropedia.org

[2] IEC 60050-461, *International Electrotechnical Vocabulary (IEV) – Part 461: Electric cables,* available at http://www.electropedia.org

[3] IEC 60050-523, *International Electrotechnical Vocabulary (IEV) – Part 523: Micro-electromechanical devices,* available at http://www.electropedia.org

[4] IEC 62305 (all parts), *Protection against lightning*

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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# COMPOSANTS DES SYSTÈMES DE PROTECTION CONTRE LA FOUDRE (CSPF) –

## Partie 1: Exigences pour les composants de connexion

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L'IEC 62561-1 a été établie par le comité d'études 81: Protection contre la foudre. Il s'agit d'une Norme internationale.

Cette troisième édition annule et remplace la deuxième édition parue en 2017. Cette édition constitue une révision technique.

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

a) les définitions des types de connexions mentionnés dans le domaine d'application du document ont été ajoutées;
b) la classification des emplacements a été développée de façon détaillée;

c) le document a été mis à jour conformément à la nouvelle édition de l'ISO 22479:2019 concernant le traitement en atmosphère humide sulfureuse;

d) la nouvelle Annexe E normative concernant les procédures d'essai simplifiées a été introduite.

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

| Projet | Rapport de vote |
|---|---|
| 81/721/FDIS | 81/724/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/publications.

Une liste de toutes les parties de la série IEC 62561, publiée sous le titre général *Composants des systèmes de protection contre la foudre (CSPF)*, se trouve sur le site web de l'IEC.

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- reconduit,
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- remplacé par une édition révisée, ou
- amendé.

# INTRODUCTION

La présente partie de l'IEC 62561 traite des exigences et des essais pour les composants des systèmes de protection contre la foudre (CSPF) utilisés pour l'installation d'un système de protection contre la foudre (SPF) conçu et mis en œuvre conformément à la série IEC 62305.

# COMPOSANTS DES SYSTÈMES DE PROTECTION CONTRE LA FOUDRE (CSPF) –

# Partie 1: Exigences pour les composants de connexion

## 1 Domaine d'application

La présente partie de l'IEC 62561 spécifie les exigences et les essais applicables aux composants métalliques de connexion qui font partie d'un système de protection contre la foudre (SPF). Il peut s'agir, en général, des connecteurs, des colliers de serrage, des composants de collage et de pontage, des pièces de dilatation et des joints de contrôle.

Pour les besoins du présent document, les types de connexions suivants sont considérés comme des composants de connexion: la soudure exothermique, le brasage, le soudage, le serrage, le sertissage, l'agrafage, le vissage et le boulonnage.

Les essais de composants pour atmosphère explosive ne sont pas concernés par le présent document.

## 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 60068-2-52:2017, *Essais d'environnement – Partie 2-52: Essais – Essai Kb: Brouillard salin, essai cyclique (solution de chlorure de sodium)*

IEC 62561-2, *Composants des systèmes de protection contre la foudre (CSPF) – Partie 2: Exigences pour les conducteurs et les électrodes de terre*

ISO 6957:1988, *Alliages de cuivre – Essai à l'ammoniaque pour la résistance à la corrosion sous contrainte*

ISO 22479:2019, *Corrosion des métaux et alliages – Essai au dioxyde de soufre en atmosphère humide (méthode avec volume fixe de gaz)*

## 3 Termes et définitions

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**
**composant de connexion**
partie d'un SPF externe qui est utilisée pour la connexion des conducteurs entre eux ou aux installations métalliques

EXEMPLE Des exemples de composants de connexion sont donnés à l'Article 1.

**3.2**
**installation métallique**

ensemble des éléments métalliques de la structure à protéger qui peut constituer un chemin pour le courant de foudre

EXEMPLE Tuyaux, escaliers, guides d'ascenseurs, conduits de ventilation, de chauffage et de conditionnement d'air, ainsi que les armatures interconnectées en acier.

**3.3**
**conducteur**
élément destiné à assurer le passage d'un courant électrique

Note 1 à l'article: Une installation métallique n'est pas conçue pour transporter du courant électrique.

[SOURCE: IEC 60050-151:2001, 151-12-05, modifié – Les notes ont été remplacées par une nouvelle Note 1 à l'article.]

**3.4**
**composant de pontage**
composant de connexion pour le raccordement des installations métalliques

**3.5**
**pièce de dilatation**
composant de connexion destiné à compenser les variations de longueur des conducteurs et/ou des installations métalliques dues à des variations de température

**3.6**
**connecteur**
composant de connexion pour le raccordement de deux conducteurs ou plus

**3.7**
**collier de serrage**
composant de connexion pour le raccordement des conducteurs aux installations métalliques

**3.8**
**collier de serrage pour tuyau**
collier de serrage pour le raccordement des conducteurs aux tuyaux métalliques

**3.9**
**joint de contrôle**
composant de connexion conçu pour faciliter les essais et les mesurages électriques des composants des SPF

**3.10**
**plage de connexion**
plage minimale à maximale sur laquelle un composant de connexion spécifique est destiné à être utilisé

**3.11**
**collage**
technique pour joindre un objet à un autre

[SOURCE: IEC 60050-523:2018, 523-06-01, modifié – L'exemple a été supprimé.]

**3.12**
**barre d'équipotentialité**
composant de connexion tel qu'une barre métallique sur laquelle les installations métalliques, les parties conductrices externes, les réseaux de puissance et de communication et autres câbles peuvent être connectés à un SPF

**3.13**
**essai de type**
essai réalisé avant la livraison d'un type de matériau concerné par l'IEC 62561-1, sur une base commerciale générale, afin de démontrer que ses caractéristiques de performance satisfont à l'application prévue

**3.14**
**connexion permanente**
connexion qui ne peut pas ou n'est pas destinée à être démontée

**3.15**
**connexion non permanente**
connexion qui peut être ou est destinée à être démontée

**3.16**
**connexion exothermique**
procédé de soudage qui utilise du métal en fusion pour joindre de façon permanente les conducteurs

Note 1 à l'article: L'aptitude à la connexion électrique et la durabilité électrique de la connexion exothermique sont soumises à l'essai de courant de foudre.

**3.17**
**connexion par brasage**
procédé d'assemblage d'éléments métalliques qui consiste à joindre deux éléments métalliques ou plus en faisant fondre un métal d'apport qui est ensuite coulé dans le joint

Note 1 à l'article: L'aptitude à la connexion électrique et la durabilité électrique de la connexion par brasage sont soumises à l'essai de courant de foudre.

**3.18**
**connexion par soudage**
procédé de fabrication destiné à joindre des matériaux, généralement des métaux

Note 1 à l'article: L'aptitude à la connexion électrique et la durabilité électrique de la connexion par soudage sont soumises à l'essai de courant de foudre.

**3.19**
**assemblage en force**
connexion entre deux pièces métalliques qui ne permet aucun mouvement relatif dû à la dilatation thermique et à la charge environnementale, par exemple la neige, la glace ou le vent

EXEMPLE Connexion par sertissage, serrage, boulonnage ou vissage.

Note 1 à l'article: L'aptitude à la connexion électrique et la durabilité électrique de l'assemblage en force sont soumises à l'essai de courant de foudre.

**3.20**
**assemblage par complémentarité de formes**
connexion entre deux pièces métalliques qui permet un faible mouvement relatif des pièces métalliques dû à la dilatation thermique et à la charge environnementale, par exemple la neige, la glace ou le vent

EXEMPLE Connexion par agrafage, recouvrement et compression, recouvrement avec verrouillage ou accrochage.

Note 1 à l'article: L'aptitude à la connexion électrique et la durabilité électrique de l'assemblage par complémentarité de formes sont soumises à l'essai de courant de foudre.

**3.21**
**connexion par serrage**
assemblage en force, qui peut généralement être désassemblé, entre deux composants

Note 1 à l'article: L'aptitude à la connexion électrique et la durabilité électrique de la connexion par serrage sont soumises à l'essai de courant de foudre.

**3.22**
**connexion par sertissage**
méthode de connexion de fixation permanente d'un raccordement à un conducteur par une pression entraînant la déformation ou la mise en forme du fût autour du conducteur afin d'établir une bonne connexion électrique et mécanique

Note 1 à l'article: Le sertissage comme moyen de connexion entre deux conducteurs peut ne pas toujours exiger un composant supplémentaire pour finaliser la connexion.

Note 2 à l'article: L'aptitude à la connexion électrique et la durabilité électrique de la connexion par sertissage sont soumises à l'essai de courant de foudre.

[SOURCE: IEC 60050-581:2008, 581-23-10, modifié – Le terme "sertissage" a été remplacé par "connexion par sertissage", dans la définition "méthode" a été remplacé par "méthode de connexion" et les notes à l'article ont été ajoutée.]

**3.23**
**connexion par agrafage**
assemblage par complémentarité de formes créé en pliant les bords de deux feuilles métalliques adjacentes pour les mettre en contact étroit de sorte qu'ils ne puissent pas être séparés par une action naturelle

Note 1 à l'article: L'aptitude à la connexion électrique et la durabilité électrique de la connexion par agrafage sont soumises à l'essai de courant de foudre.

**3.24**
**connexion par vissage**
assemblage en force, qui peut être désassemblé, entre deux composants qui possèdent leurs propres filetages et qui peuvent être boulonnés directement

Note 1 à l'article: L'aptitude à la connexion électrique et la durabilité électrique de la connexion par vissage sont soumises à l'essai de courant de foudre.

**3.25**
**connexion par boulonnage**
assemblage en force, qui peut être désassemblé, entre deux composants qui peuvent être boulonnés de manière indirecte au moyen de composants tiers (boulons et écrous)

Note 1 à l'article: L'aptitude à la connexion électrique et la durabilité électrique de la connexion par boulonnage sont soumises à l'essai de courant de foudre.

**3.26**
**âme câblée**
âme constituée d'un ensemble de fils dont généralement la plupart ont la forme d'une hélice

Note 1 à l'article: L'âme câblée peut être circulaire ou profilée.

Note 2 à l'article: Le terme anglais "strand" est également utilisé pour désigner un fil unique.

[SOURCE: IEC 60050-461:2008, 461-01-07]

**3.27**
**conducteur multibrin tressé**
conducteur composé d'un noyau central entouré d'une ou de plusieurs couches d'ensembles de fils enroulés en hélice

**3.28**
**conducteur multibrin à tresse lisse**
conducteur composé d'un fil multibrin étiré et souple, entrelacé par tressage de façon à éviter un effilochage lors de l'application

## 4 Classification

### 4.1 En fonction de leur tenue aux courants de foudre

a) classe H pour une tenue élevée;

b) classe N pour une tenue normale.

Il convient que le choix de la classe H ou de la classe N soit réalisé par le fabricant conformément aux paramètres d'essai identifiés dans le Tableau 1.

### 4.2 En fonction de leur emplacement d'installation

a) à l'extérieur;

b) à l'intérieur;

c) enfouis dans le sol;

d) incorporés dans le béton;

e) incorporés dans des matériaux avec isolation thermique.

La déclaration d'emplacement d'installation émise par le fabricant doit déterminer s'il est nécessaire d'effectuer l'essai de conditionnement et de vieillissement indiqué en 6.5.

### 4.3 En fonction de leur comportement mécanique

a) prévus pour supporter une contrainte mécanique statique;

b) non prévus pour supporter une contrainte mécanique statique.

La déclaration d'aptitude à supporter une charge mécanique statique émise par le fabricant doit déterminer s'il est nécessaire d'effectuer l'essai mécanique statique indiqué en 6.7.

### 4.4 En fonction du caractère permanent ou non de la connexion

a) connexion permanente, par exemple soudure exothermique, brasage, soudage, sertissage ou agrafage;

b) connexion non permanente, par exemple vissage ou boulonnage.

## 5 Exigences

### 5.1 Généralités

Les composants de connexion doivent être conçus de manière telle que, lorsqu'ils sont installés conformément aux instructions du fabricant, leurs performances doivent être fiables, stables et sûres pour les personnes et les matériels environnants.

Une synthèse des exigences et des essais correspondants est fournie à l'Annexe A.

### 5.2 Documentation et instructions d'installation

Le fabricant du composant de connexion doit fournir des instructions pertinentes dans sa documentation pour s'assurer que l'installateur du composant de connexion puisse le choisir et l'installer d'une manière sûre et adéquate, qui contiennent au moins les informations suivantes:

a) la classification et la capacité à supporter les courants de foudre ($I_{imp}$);

b) la classification en fonction de l'emplacement d'installation;

c) la classification en fonction du comportement mécanique;

d) la classification en fonction du caractère permanent ou non de la connexion;

e) la gamme de matériaux et de tailles de conducteurs;

f) la configuration de connexion;

g) des instructions d'assemblage pour les composants de connexion permanente ou non permanente (par exemple, si des outils spéciaux sont nécessaires, couple de serrage, etc.).

La conformité est vérifiée selon 6.2.

### 5.3 Marquage

#### 5.3.1 Contenu du marquage

Les composants de connexion doivent porter au moins les informations suivantes:

a) le nom ou la marque du fabricant ou du fournisseur responsable;

b) le symbole d'identification (photo, numéro de produit, etc.);

c) la classification, c'est-à-dire classe N ou H;

d) la classification en fonction de l'emplacement d'installation.

La conformité est vérifiée par examen selon 6.3.1, a).

Lorsque cela n'est pas possible, les marquages b), c) et d) peuvent être inscrits sur l'étiquette de l'emballage le plus petit ou sur la documentation jointe.

NOTE 1 Le marquage peut être réalisé, par exemple, par moulage, emboutissage, gravure, impression et au moyen d'étiquettes adhésives adaptées aux contraintes environnementales.

NOTE 2 Le marquage peut être réalisé au moyen de décalcomanies uniquement pour les composants classés pour une utilisation à l'intérieur.

#### 5.3.2 Durabilité et lisibilité

Le marquage doit être durable et lisible.

La conformité est vérifiée par essai selon 6.3.1 b).

### 5.4 Capacité de tenue au courant de foudre

Les composants de connexion doivent avoir une capacité suffisante de tenue au courant de foudre.

La conformité est vérifiée conformément au 6.6, selon les déclarations du fabricant concernant la classe (H ou N) des composants de connexion conformément au 4.1.

### 5.5 Capacité de tenue aux contraintes mécaniques statiques

Les composants de connexion classés conformément au 4.3 a) doivent avoir une capacité suffisante de tenue aux contraintes mécaniques statiques.

Les barres d'équipotentialité et les connexions réalisées par agrafage sont exclues de cette exigence.

La conformité est vérifiée selon 6.7.

### 5.6 Connexion permanente

Lorsque la soudure exothermique, le brasage, le soudage, le sertissage ou l'agrafage est utilisé pour réaliser la connexion, la conception doit être telle que le conducteur et l'installation métallique soient toujours fixés de manière sûre.

La conformité est vérifiée par examen, selon 6.6.2 a), b) et g).

### 5.7 Connexion non permanente

Lorsque des vis ou des écrous sont utilisés comme fixations du collier, leur conception doit être telle que le conducteur et l'installation métallique soient toujours serrés de manière sûre par la vis ou l'écrou.

La conformité est vérifiée par examen, selon 6.6.2, a), b), d) et f).

La conformité des composants de connexion classés conformément au 4.2 d) est vérifiée par examen selon 6.6.2 a), d) et g).

### 5.8 Démontage des joints de contrôle

Il doit être possible de démonter les joints de contrôle après le passage de la contrainte de courant de foudre.

La conformité est vérifiée par examen, selon 6.6.2, a), b), d) et f).

### 5.9 Pièce de dilatation

En plus des exigences du présent document, la pièce de dilatation (E sur la Figure 7) doit satisfaire aux exigences de l'IEC 62561-2 concernant les conducteurs de capture.

## 6 Essais

### 6.1 Conditions générales d'essais

a) Les essais conformes au présent document sont des essais de type (voir 3.13), réalisés dans l'ordre indiqué à l'Annexe C. Les essais de type sont de telle nature qu'après avoir été effectués, à moins que des modifications n'aient été introduites dans les matériaux des accessoires, dans la conception ou dans le type de procédé de fabrication, qui peuvent en modifier les caractéristiques de performance, il n'est pas nécessaire de procéder à des répétitions d'essais.

b) Sauf spécification contraire, les essais sont effectués sur des échantillons assemblés et installés comme en usage normal conformément aux instructions d'installation du fabricant ou du fournisseur, qui présentent les matériaux et tailles de conducteurs recommandés, ainsi que les couples de serrage recommandés.

c) Tous les essais sont effectués sur des échantillons neufs.

d) Sauf spécification contraire, trois échantillons sont soumis aux essais, et les exigences sont remplies si tous les essais sont réalisés avec succès.

e) Si un seul des échantillons ne satisfait pas à un essai à cause d'un défaut d'assemblage ou de fabrication, cet essai et tout essai préalable qui peut avoir une influence sur les résultats de l'essai doivent être répétés, et les essais qui suivent doivent être effectués dans l'ordre exigé sur un autre lot complet d'échantillons, qui doivent tous satisfaire aux exigences.

f) L'essai électrique doit être effectué selon l'ordre indiqué, après le conditionnement et le vieillissement du montage de l'échantillon conformément au 6.5.

Le demandeur, lorsqu'il soumet les jeux d'échantillons, peut aussi soumettre un jeu supplémentaire qui peut être utilisé si un échantillon ne satisfait pas à l'essai. Le laboratoire soumet alors aux essais, sans demande complémentaire, le lot supplémentaire d'échantillons, et ne le refuse que si une nouvelle défaillance se produit. Si le lot supplémentaire d'échantillons n'est pas soumis au même moment, la défaillance d'un échantillon entraîne un refus.

Pour les composants déjà soumis à l'essai conformément à l'IEC 62561-1:2017, la procédure d'essai simplifiée selon l'Annexe E peut être appliquée.

Pour les nouveaux composants, des essais de type complets et des échantillons conformes à l'Article 6 sont exigés.

### 6.2 Documentation et instructions d'installation

#### 6.2.1 Conditions générales d'essais

L'exhaustivité du contenu des instructions d'installation est vérifiée par examen.

#### 6.2.2 Critères d'acceptation

La documentation ou les instructions d'installation sont considérées comme étant acceptables si elles contiennent au moins les informations spécifiées en 5.2.

### 6.3 Essai du marquage

#### 6.3.1 Conditions générales d'essais

Le marquage est vérifié:

a) en ce qui concerne son exhaustivité selon 5.3.1, par examen; et

b) en ce qui concerne sa durabilité et sa lisibilité, par frottement à la main pendant 15 s à l'aide d'un morceau de tissu imbibé d'eau, puis à nouveau pendant 15 s avec un morceau de tissu imbibé de white-spirit ou d'essence minérale.

Le marquage réalisé par moulage, impression ou gravure n'est pas soumis à cet essai.

#### 6.3.2 Critères d'acceptation

L'échantillon est considéré comme ayant satisfait à l'essai si:

a) le marquage contient toutes les informations indiquées en 5.3.1;

b) après l'essai selon 6.3.1, b), le marquage ne se dégrade pas et reste lisible.

### 6.4 Préparation de l'échantillon

a) Sauf spécification contraire du fabricant, les conducteurs et les échantillons doivent être nettoyés à l'aide d'un dégraissant approprié, puis rincés dans une eau déminéralisée et séchés. Ils doivent ensuite être assemblés conformément aux instructions du fabricant, par exemple avec les conducteurs et les couples de serrage recommandés.

b) Les conducteurs et les pointes utilisés pour cet essai doivent satisfaire aux exigences de l'IEC 62561-2.

c) Le composant de connexion doit être soumis à l'essai dans toutes les configurations de connexion déclarées par le fabricant. Les configurations de connexion types pour différents CSPF sont représentées à l'Annexe B.

d) Si le composant de connexion est adapté à différents matériaux des conducteurs, un essai doit être effectué pour chaque combinaison de matériaux déclarée par le fabricant.

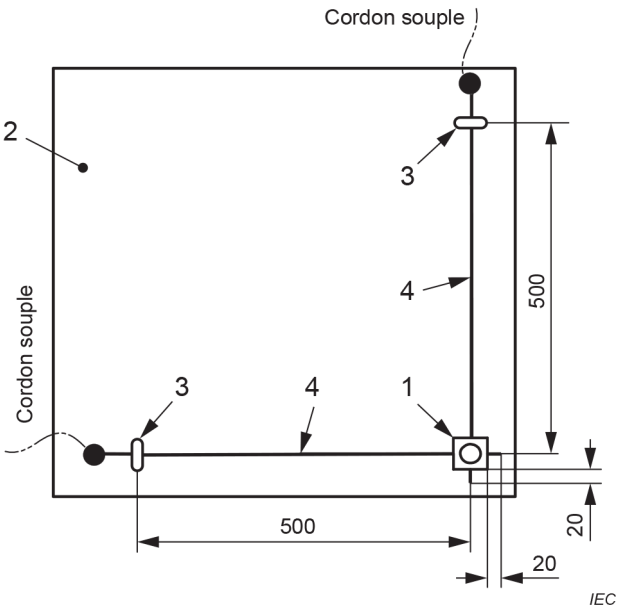
e) Tout composant de connexion compatible avec une gamme de conducteurs qui présentent une variation de dimension inférieure ou égale à 2 mm doit être soumis à l'essai en utilisant la taille de conducteur minimale recommandée. Si la plage des tailles de conducteurs est supérieure à 2 mm, le composant de connexion doit être soumis à l'essai en utilisant les tailles de conducteurs minimale et maximale recommandées.

f) Les montages de base des échantillons avec composant à connexion croisée, composant à connexion parallèle, composant de pontage et barre d'équipotentialité sont respectivement représentés à la Figure 1, à la Figure 2, à la Figure 3 et à la Figure 4. Les bornes des barres d'équipotentialité ne sont soumises à l'essai que si la dimension du raccordement est supérieure ou égale à 16 $mm^2$. L'essai est effectué en utilisant la taille la plus faible de conducteur comprise dans la plage de la borne, avec un minimum de 16 $mm^2$. Des montages types pour différents CSPF sont représentés à l'Annexe B.

g) La partie constituée d'une installation à incorporer dans le béton, notamment de composants de connexion tels que des connecteurs, des colliers de serrage et des connexions par sertissage, doit être disposée conformément à la Figure 5 a), à la Figure 5 b) et à la Figure 5 c), et doit être assemblée conformément aux instructions du fabricant.

h) La partie constituée d'une installation à incorporer dans le béton, notamment de composants de connexion par brasage, soudage, soudure exothermique, etc. doit être disposée conformément à la Figure 6 a), à la Figure 6 b) et à la Figure 6 c), et doit être préparée conformément aux instructions du concepteur ou de l'installateur et sous la supervision de l'installateur.

*Dimensions en millimètres*




**Légende**

1 composant à connexion croisée

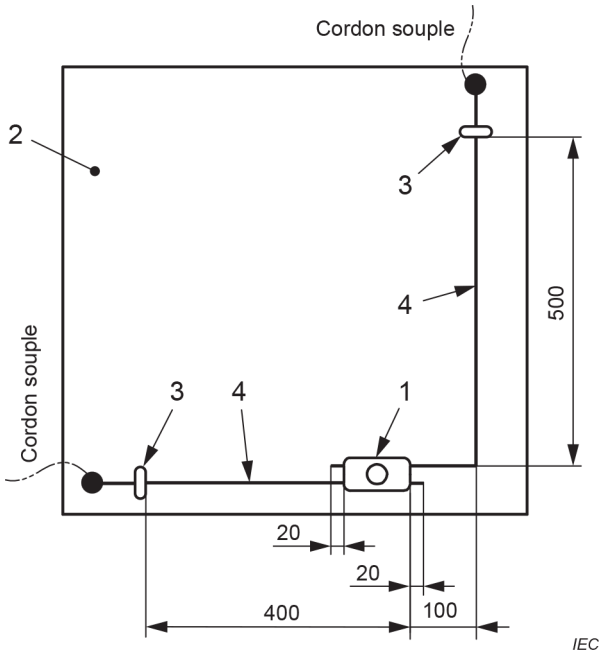
2 plateau en matériau isolant

3 pièce de fixation rigide

4 conducteur et installation métallique

**Figure 1 – Montage de base des échantillons avec composant à connexion croisée**

*Dimensions en millimètres*




**Légende**

1 composant à connexion parallèle

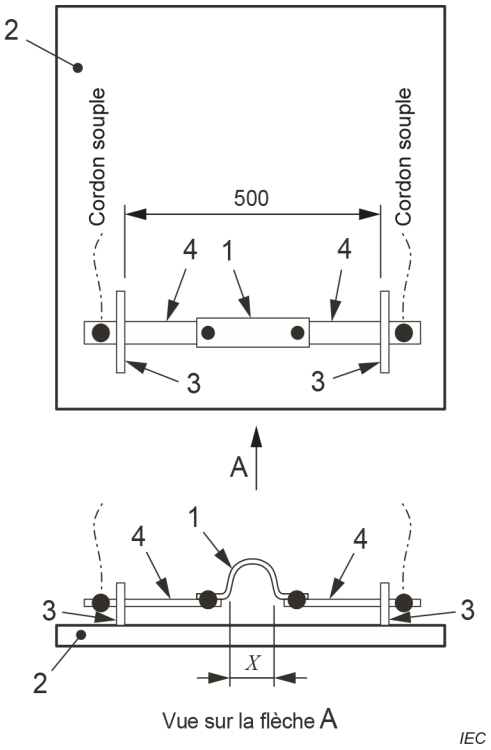
2 plateau en matériau isolant

3 pièce de fixation rigide

4 conducteur et installation métallique

**Figure 2 – Montage de base des échantillons avec composant à connexion parallèle**

*Dimensions en millimètres*




**Légende**

1 pièce de dilatation ou composant de pontage

2 plateau en matériau isolant

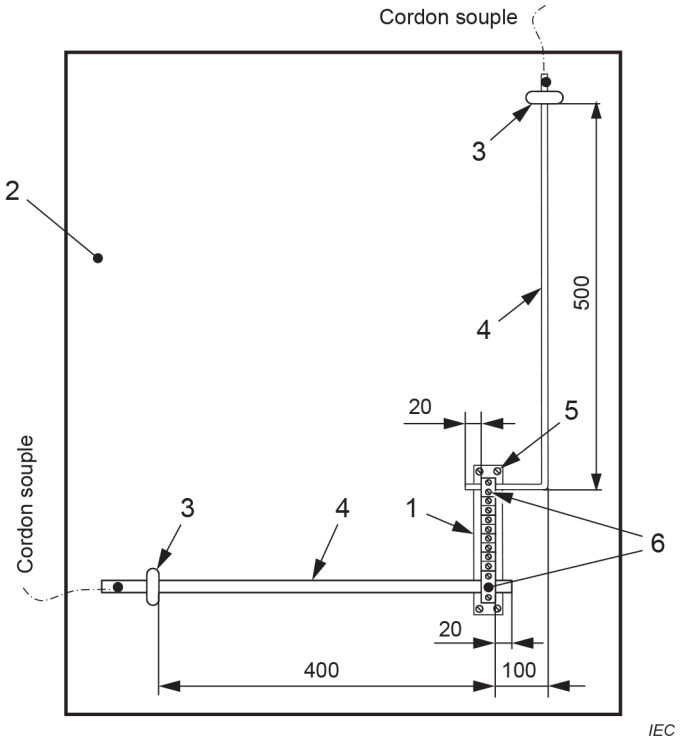
3 pièce de fixation rigide

4 conducteur ou installation métallique

*X* distance qui indique la position de la dilatation maximale admissible déclarée par le fabricant. Applicable uniquement pour les conducteurs de dilatation ou les composants de pontage qui permettent la dilatation

**Figure 3 – Montage de base des échantillons avec pièce de dilatation ou composant de pontage**

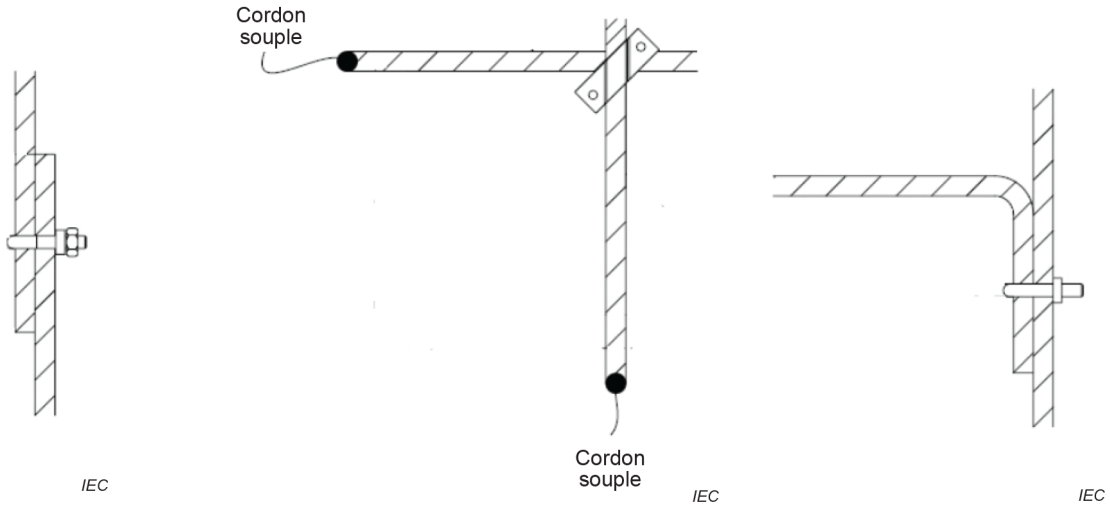
*Dimensions en millimètres*




**Légende**

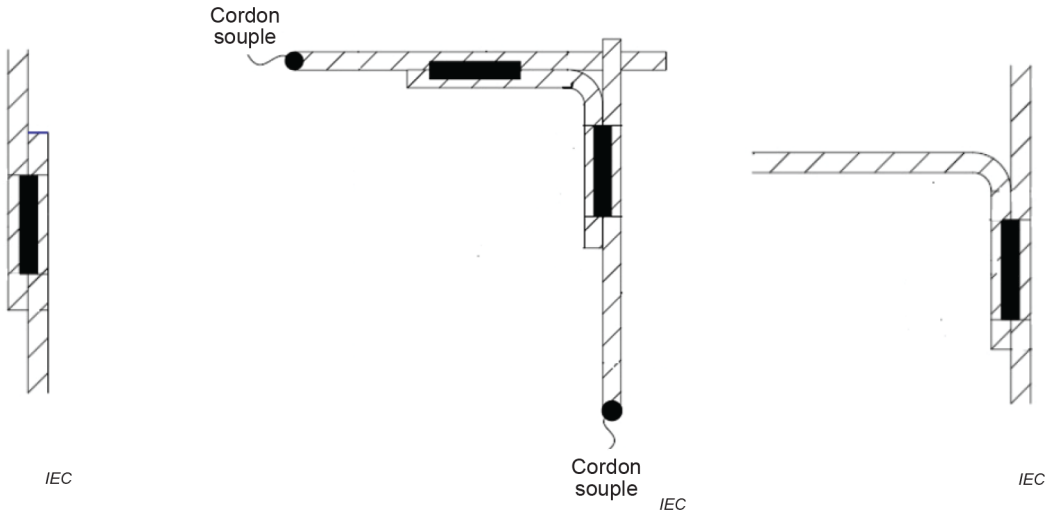
1 barre d'équipotentialité
2 plateau en matériau isolant
3 pièce de fixation rigide
4 conducteur
5 points de fixation de la barre d'équipotentialité
6 connexion à soumettre à l'essai

**Figure 4 – Montage de base des échantillons avec barre d'équipotentialité**




**a) Connexion en ligne** **b) Connexion croisée** **c) Connexion en "T"**

**Figure 5 – Montage de base des échantillons avec connexion par serrage de tiges de renfort**




**a) Connexion en ligne** **b) Connexion croisée** **c) Connexion en "T"**

**Figure 6 – Montage de base des échantillons avec connexion par brasage, soudage ou soudure exothermique de tiges de renfort**

### 6.5 Conditionnement et vieillissement

Selon la déclaration du fabricant conformément au 4.2, mais avant les essais électriques du 6.6, le montage de l'échantillon doit être soumis à un traitement de conditionnement et de vieillissement conformément à l'Annexe D.

Le fabricant doit fournir la preuve que le taux de cuivre de chaque partie de l'assemblage en alliage de cuivre est ≥ 80 %.

Après le traitement, le montage est fixé sur une plaque isolante, en veillant à ne pas endommager l'échantillon lors de la manipulation.

Ce traitement n'est pas nécessaire pour les composants de connexion conçus pour les emplacements d'installation:

a) à l'intérieur;

b) entièrement incorporés dans le béton.

Les composants de connexion conçus pour être partiellement incorporés dans le béton doivent être soumis à l'essai de conditionnement et de vieillissement conformément au 6.5.

### 6.6 Essai électrique

#### 6.6.1 Conditions générales d'essais

Après l'essai décrit en 6.5 et sans nettoyage, l'échantillon doit être soumis trois fois à un courant d'essai conformément au Tableau 1. L'intervalle de temps entre chaque essai doit permettre à l'échantillon de se refroidir approximativement à la température ambiante.

Le courant de décharge de choc qui passe par le dispositif en essai est défini par la valeur de crête du courant $I_{imp}$ et par l'énergie spécifique $W/R$. Le courant de choc ne doit présenter aucune inversion et atteindre $I_{imp}$ en 50 µs. Le transfert de l'énergie spécifique $W/R$ doit être dissipé dans un délai de 5 ms.

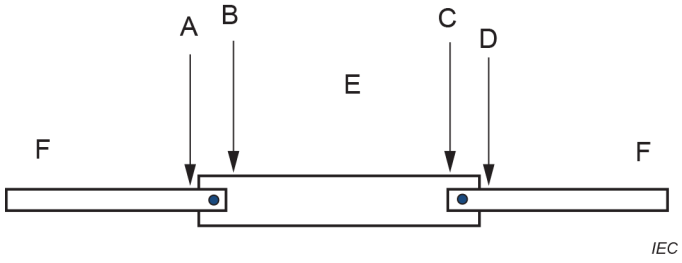
**Tableau 1 – Paramètres du courant de foudre ($I_{Imp}$)**

| Classification | $I_{imp}$<br>kA<br>±10 % | $W/R$<br>kJ/Ω<br>$^{+45}_{-10}$ % |
|---|---|---|
| H | 100 | 2 500 |
| N | 50 | 625 |
| NOTE Les paramètres spécifiés dans le présent Tableau 1 peuvent généralement être obtenus par un courant de foudre qui décroît de manière exponentielle et qui présente une durée à mi-hauteur comprise dans la plage des 350 µs conformément à l'IEC 62305-1. | | |

### 6.6.2 Critères d'acceptation

Le composant de connexion est considéré comme ayant satisfait à l'essai si:

a) la résistance de contact mesurée avec une source d'au moins 5 A, le plus près possible du composant de connexion, est inférieure ou égale à 3 mΩ. Le mesurage de la résistance de contact des composants d'expansion (E) et des conducteurs de connexion (F) est effectué entre les extrémités fixées A-B et C-D, le plus près possible du composant d'expansion (voir Figure 7). Les critères d'acceptation pour l'agrafage sont à l'étude;




**Légende**

A-B, C-D points de mesure en vue de vérifier les résistances de contact des colliers de serrage

E matériau massif ou matériau multibrin, conformément à l'IEC 62561-2

F conducteur ou installation métallique

**Figure 7 – Montage de base pour le mesurage du contact de la pièce de dilatation ou du composant de pontage**

b) il ne présente pas de craquelures en contrôle visuel normal ou corrigé sans grossissement, aucune partie ne se détache et aucune déformation n'altère son fonctionnement normal;

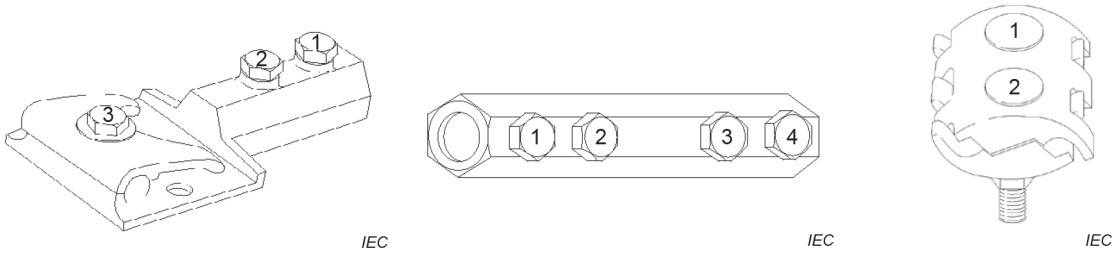
c) pour les composants de connexion classés conformément au 4.3 a) ou les composants de connexion classés conformément au 4.4 a), à l'exception des connexions réalisées par agrafage, où les échantillons doivent être soumis à l'essai de façon indépendante dans chacune des configurations applicables, le mouvement du conducteur au cours de l'essai est inférieur à 1 mm et le composant de connexion ou le conducteur n'a subi aucun dommage. Cette exigence ne s'applique pas aux composants de connexion classés conformément au 4.3 b) ni aux connexions permanentes réalisées par agrafage;

d) pour un composant de connexion non permanente, 4.4 b), qui utilise des vis, le couple de desserrage est supérieur à 0,25 fois le couple de serrage et inférieur à 1,5 fois ce couple. Dans le cas de connecteurs qui comportent plusieurs vis, seul le couple de desserrage de la première vis est concerné par l'essai, qui doit être différent à chaque fois. Pour les composants de connexion à plusieurs boulons et vis, le fabricant doit déclarer l'ordre de desserrage des boulons et des vis afin de mesurer le premier couple de desserrage, qui est pris en compte. Les couples de desserrage des boulons et vis restants peuvent être

mesurés sans aucune exigence relative au couple de desserrage (voir les exemples de la Figure 8). Le couple doit être mesuré au niveau de l'écrou. Il convient de fixer la vis à l'aide d'une clé afin d'empêcher sa rotation;

e) pour une connexion réalisée par boulonnage où l'écrou est fixé au moyen d'un écrou de serrage, ce dernier doit être retiré avant le mesurage du couple de desserrage. Lors du retrait de l'écrou de serrage, l'écrou situé sous l'écrou de serrage doit être fixé à l'aide d'une clé afin d'empêcher sa rotation. Il doit être possible de démonter complètement les joints de contrôle classés conformément au 3.9.

Les critères d'acceptation pour les composants de connexion conçus pour relier les conducteurs multibrins tressés et les conducteurs multibrins à tresse lisse sont à l'étude;




| a) Exemple 1 | b) Exemple 2 | c) Exemple 3 |
|---|---|---|
| Séquence pour essais | Séquence pour essais | Séquence pour essais |
| Essai A: Desserrer les boulons 1 et 3 | Essai A: Desserrer les boulons 1 et 3 | Essai A: Desserrer le boulon 1 |
| Essai B: Desserrer les boulons 2 et 3 | Essai B: Desserrer les boulons 2 et 4 | Essai B: Desserrer le boulon 2 |
| Essai C: Desserrer les boulons (1 ou 2) et 3 | Essai C: Desserrer le boulon (1 ou 2) ou (2 ou 4) | Essai C: Desserrer le boulon 1 ou 2 |

**Figure 8 – Exemples de séquences de desserrage des boulons et vis**

f) pour un composant de connexion non permanente, conformément au 4.4 b), la longueur de conducteur de 20 mm à partir du connecteur (voir Figure 1, Figure 2, Figure 4) avant l'essai n'est pas inférieure à 3 mm après la réalisation de l'essai. Pour les configurations de connexion dans lesquelles au moins un conducteur aboutit dans le connecteur (voir les configurations de connexion B3, B4, B6 et B8 sur la Figure B.1), la longueur du mouvement du conducteur ne doit pas être supérieure à 20 % de la longueur d'origine d'engagement du conducteur dans le composant;

g) pour les composants de connexion sans vis ou permanente, conformément au 4.4 a), où chaque conducteur des assemblages d'échantillons doit être soumis indépendamment à une force de traction mécanique de 900 N ± 20 N, pendant 1 min, et où chaque conducteur doit être soumis à l'essai indépendamment en cas de connecteurs à conducteurs multiples, le mouvement du conducteur au cours de l'essai est inférieur à 1 mm et le composant de connexion ou le conducteur n'a subi aucun dommage.

### 6.7 Essai de capacité de tenue aux contraintes mécaniques statiques

Les composants de connexion classés conformément au 4.3, a) doivent avoir une capacité suffisante de tenue aux contraintes mécaniques statiques. La vérification est effectuée par l'essai selon 6.6.2 g).

## 7 Compatibilité électromagnétique (CEM)

Dans des conditions d'utilisation normale, les produits concernés par le présent document sont passifs en ce qui concerne les perturbations électromagnétiques (émission et immunité).

# 8 Structure et contenu du rapport d'essai

## 8.1 Généralités

Le présent Article 8 a pour objet d'indiquer les exigences générales pour les rapports d'essai des laboratoires. Il est destiné à élaborer des procédures de rapports claires et complètes pour les laboratoires qui rédigent les rapports d'essai.

Les résultats de chaque essai effectué par le laboratoire doivent être consignés de manière précise, claire, non ambiguë et objective, conformément à toutes les instructions des méthodes d'essai. Les résultats doivent être consignés dans un rapport d'essai et doivent comprendre toutes les informations nécessaires pour l'interprétation de ces résultats d'essai, ainsi que toutes les informations exigées par la méthode d'essai employée.

Le rapport doit être articulé et présenté de manière à être facilement compris par le lecteur. Le format doit être spécialement conçu et adapté à chaque type d'essai, mais le sommaire doit être normalisé comme cela est indiqué ci-après.

La structure de chaque rapport doit inclure au moins les informations indiquées du 8.2 au 8.10.

## 8.2 Identification du rapport

Les informations suivantes doivent être incluses dans le rapport.

a) un titre ou le sujet du rapport;

b) nom, adresse et adresse électronique ou numéro de téléphone du laboratoire d'essai;

c) nom, adresse et adresse électronique ou numéro de téléphone du laboratoire d'essai sous-traitant dans lequel les essais ont été effectués, si celui-ci est différent de la société désignée pour réaliser les essais;

d) numéro d'identification unique (ou numéro de série) du rapport d'essai;

e) nom et adresse du fournisseur;

f) numéros de page et nombre total de pages;

g) date de parution du rapport;

h) date(s) de réalisation de l'essai (ou des essais);

i) signature et titre, ou une identification équivalente de la personne ou des personnes autorisées à signer le contenu du rapport pour le compte du laboratoire d'essai;

j) signature et titre de la personne ou des personnes qui ont conduit l'essai;

k) la déclaration suivante, afin d'en éviter un usage abusif: "Ce rapport d'essai de type ne doit pas être reproduit autrement qu'intégralement, sauf avec l'accord écrit préalable du laboratoire d'essai exécutant. Ce rapport d'essai de type couvre uniquement les échantillons soumis aux essais et ne prouve pas la qualité d'une production en série."

## 8.3 Description de l'échantillon

a) description de l'échantillon: classification selon l'Article 4;

b) description détaillée, par exemple les matériaux de base de l'échantillon, les vis, les écrous, les pièces, les dimensions externes, la forme, le revêtement à des fins esthétiques ou de protection, et identification non ambiguë de l'échantillon d'essai ou de l'assemblage d'essai;

c) caractérisation et état de l'échantillon d'essai ou de l'assemblage d'essai;

d) procédure d'échantillonnage, le cas échéant;

e) date de réception des éléments d'essai;

f) photos, dessins ou tout autre document visuel, si disponible.

### 8.4 Conducteur

a) matériau du conducteur;

b) section nominale, dimensions et forme. Il est recommandé d'indiquer également la section réelle.

### 8.5 Normes et références

a) identification de la norme d'essai employée et de sa date de publication;

b) tout autre document utile avec sa date de publication.

### 8.6 Procédure d'essai

a) description de la procédure d'essai;

b) justification de tout écart, ajout ou exclusion par rapport à la norme de référence;

c) toute autre information utile pour un essai spécifique, telle que les conditions d'environnement;

d) configuration de l'assemblage d'essai;

e) emplacement du montage dans l'espace d'essai et techniques de mesure.

### 8.7 Description des équipements d'essai

Description des équipements utilisés pour chacun des essais effectués, à savoir générateurs, dispositifs de conditionnement ou de vieillissement.

### 8.8 Description des instruments de mesure

Caractéristiques et date d'étalonnage de tous les instruments utilisés pour le mesurage des valeurs spécifiées dans la norme, à savoir calibre de rayon, shunts, appareil d'essai de résistance à la traction, extensomètre, ohmmètre, mesureur de couple, pied à coulisse, etc.

### 8.9 Résultats et paramètres enregistrés

Les mesures, observations ou résultats annexes doivent être clairement identifiés au moins en ce qui concerne:

a) la valeur de crête du courant;

b) l'énergie spécifique;

c) le temps de montée du choc;

d) la durée à mi-hauteur;

e) la résistance;

f) le couple de serrage;

g) le couple de desserrage.

Les valeurs ci-dessus doivent être présentées sous forme de tableaux, graphiques, dessins, photographies ou tout autre document visuel approprié.

### 8.10 Déclaration d'acceptation ou de refus

Une déclaration selon laquelle l'échantillon a satisfait ou échoué aux essais doit être consignée. Si l'échantillon a échoué à un essai, une description de la défaillance est nécessaire.

# Annexe A
(normative)

## Récapitulatif des exigences et des essais correspondants

Voir Tableau A.1.

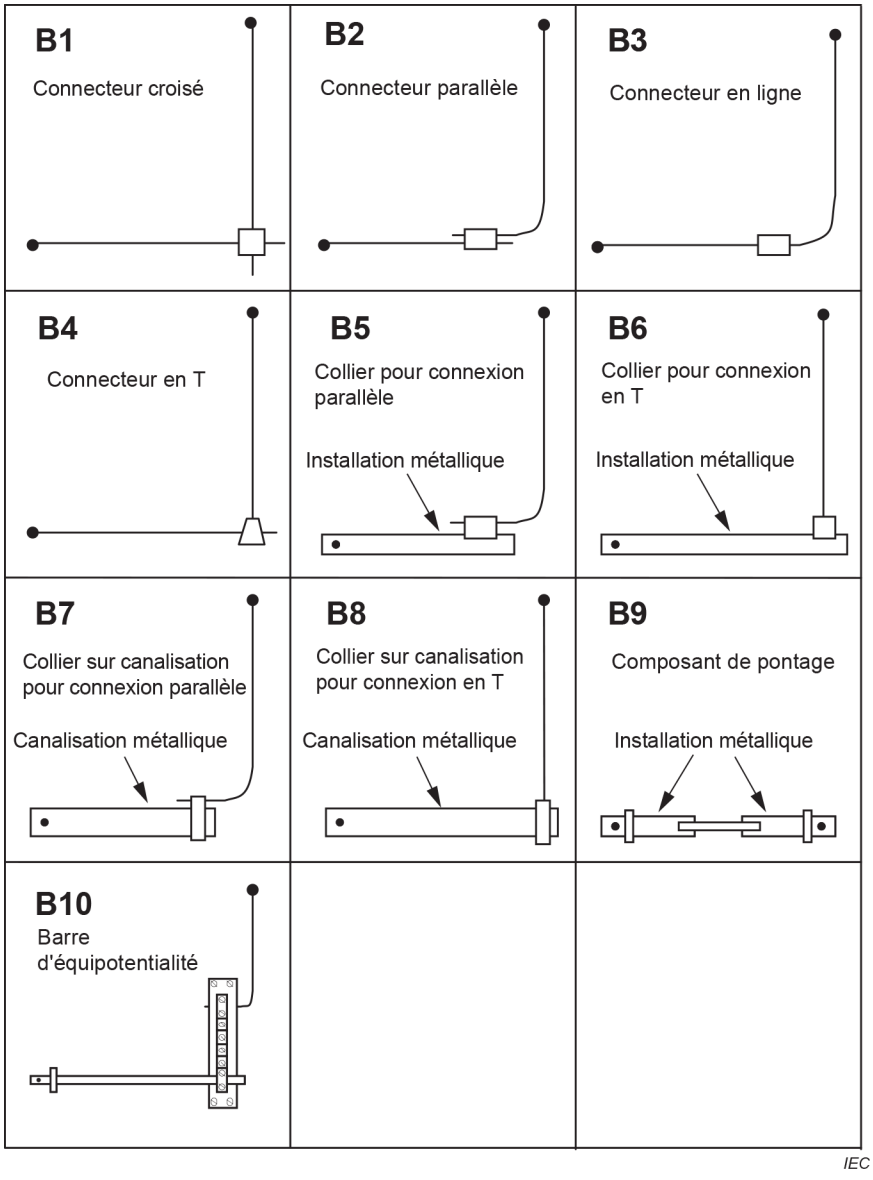
**Tableau A.1 – Exigences et essais correspondants**

| Séquence d'essai | Exigences | Exigences selon | Conformité vérifiée par |
|---|---|---|---|
| 1 | Instructions d'installation | 5.2 | Examen et essai 6.6.2 |
| 2 | Marquage | 5.3 | Examen et essai 6.3 |
| 3 | Capacité de tenue au courant de foudre des connexions permanentes | 5.4 et 5.6 | 6.6.2, a), b) et g) |
| 4 | Capacité de tenue au courant de foudre des connexions non permanentes | 5.4 et 5.7 | 6.6.2 a), b), d) et f) |
| 5 | Capacité de tenue aux contraintes mécaniques statiques | 5.5 | 6.6.2 g) |
| 6 | Démontage des joints de contrôle | 5.8 | 6.6.2 a), b), d) et f) |
| 7 | Pièce de dilatation | 5.9 | E sur la Figure 7 |

# Annexe B
(informative)

## Configurations de connexion types pour différents CSPF

Voir Figure B.1.




NOTE 1 B1, B4, B6 et B8 – pour plus d'informations, voir Figure 1.

NOTE 2 B2, B3, B5 et B7 – pour plus d'informations, voir Figure 2.

NOTE 3 B9 – pour plus d'informations, voir Figure 3.

NOTE 4 B10 – pour plus d'informations, voir Figure 4.

**Figure B.1 – Montages types pour différents CSPF**

# Annexe C
(normative)

## Logigramme des essais destinés aux composants de connexion

Voir Figure C.1.

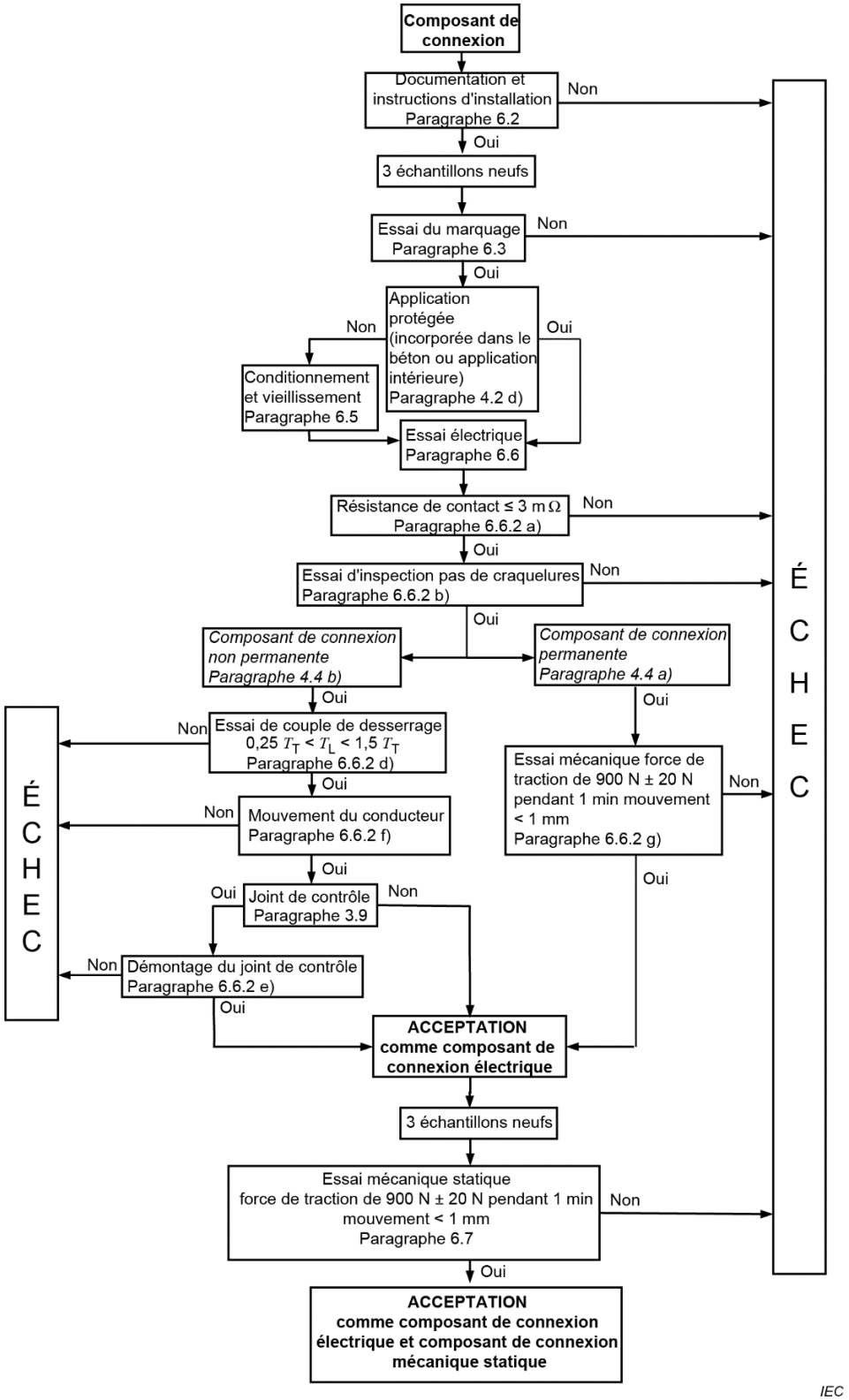



**Figure C.1 – Logigramme des essais destinés aux composants de connexion**

# Annexe D
(normative)

# Conditionnement et vieillissement pour les composants de connexion

## D.1 Généralités

L'essai de conditionnement et de vieillissement consiste en un traitement au brouillard salin spécifié à l'Article D.2, suivi d'un traitement en atmosphère humide sulfureuse spécifié à l'Article D.3, puis d'un traitement en atmosphère ammoniacale spécifié à l'Article D.4 pour les échantillons dont les composants en alliage de cuivre présentent un taux de cuivre inférieur à 80 %.

Le fabricant ou le fournisseur doit fournir la preuve du taux de cuivre de chaque partie de l'assemblage en alliage de cuivre.

## D.2 Traitement au brouillard salin

Le traitement au brouillard salin doit être réalisé conformément à l'IEC 60068-2-52:2017, à l'exception des Article 7, Article 10 et Article 11 qui ne s'appliquent pas. L'essai est effectué avec la sévérité (2).

Si l'enceinte qui contient le brouillard salin maintient les conditions de température spécifiées en 9.3 de l'IEC 60068-2-52:2017 et une humidité relative supérieure ou égale à 90 %, alors l'échantillon peut rester dans cette enceinte pendant la période de stockage en milieu humide.

## D.3 Traitement en atmosphère humide sulfureuse

Le traitement en atmosphère humide sulfureuse doit être conforme à l'ISO 22479:2019 Méthode B, avec 7 cycles, à une concentration en dioxyde de soufre de $667 \times 0^{-6} \pm 25 \times 10^{-6}$, à l'exception des Article 9 et Article 10 qui ne s'appliquent pas.

Chaque cycle, d'une durée de 24 h, se compose d'une période de chauffage de 8 h à une température de 40 °C ± 3 °C en atmosphère humide saturée, suivie d'une période de repos de 16 h. Ensuite, l'atmosphère humide sulfureuse est remplacée.

Si l'enceinte d'essai maintient les conditions de température spécifiées en 8.5 de l'ISO 22479:2019, alors l'échantillon peut rester dans cette enceinte pendant la période de stockage.

## D.4 Traitement en atmosphère ammoniacale

Le traitement en atmosphère ammoniacale doit être conforme à l'ISO 6957:1988 pour une atmosphère modérée, avec une valeur de pH de 10, à l'exception du 8.4 et de l'Article 9 du document ISO, qui ne sont pas applicables.

# Annexe E
(normative)

# Procédures d'essai simplifiées

Les procédures d'essai simplifiées s'appliquent au nombre d'échantillons à soumettre et à la séquence des essais à appliquer pour la vérification de la conformité.

Pour les produits qui ont déjà été soumis à l'essai conformément à l'IEC 62561-1:2017 ou à l'IEC 62561-1:2012, la procédure d'essai simplifiée selon le Tableau E.1 peut être appliquée.

Pour les nouveaux produits, des essais de type complets et des échantillons conformes à l'Article 6 sont exigés.

**Tableau E.1 – Procédures d'essai simplifiées pour les composants de connexion conformes à l'IEC 62561-1:2017 ou l'IEC 62561-1:2012**

| Description de l'essai | Paragraphe du présent document | Essai exigé |
|---|---|---|
| Paramètres du courant de foudre ($I_{imp}$) (tolérances) | Tableau 1 | Non |
| Conditionnement et vieillissement | 6.5, Article D.3 | Non |
| Ordre des couples de desserrage des composants de connexion à plusieurs boulons et vis | 6.6.2 d) | Non |
| Mesurage du déplacement du conducteur | 6.6.2 f) | Non |

# Bibliographie

[1] IEC 60050-151, *Vocabulaire Electrotechnique International (IEV) – Partie 151: Dispositifs électriques et magnétiques*, disponible à l'adresse http://www.electropedia.org

[2] IEC 60050-461, *Vocabulaire Electrotechnique International (IEV) – Partie 461: Câbles électriques*, disponible à l'adresse http://www.electropedia.org

[3] IEC 60050-523, *Vocabulaire Electrotechnique International (IEV) – Partie 523: Dispositifs microélectromécaniques*, disponible à l'adresse http://www.electropedia.org

[4] IEC 62305 (toutes les parties), *Protection contre la foudre*

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