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

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

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IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LIGHTNING PROTECTION SYSTEM COMPONENTS (LPSC) –

Part 1: Requirements for connection components

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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.

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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.

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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

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~~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.]

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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.

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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]

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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.

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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.

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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.~~

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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:

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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.

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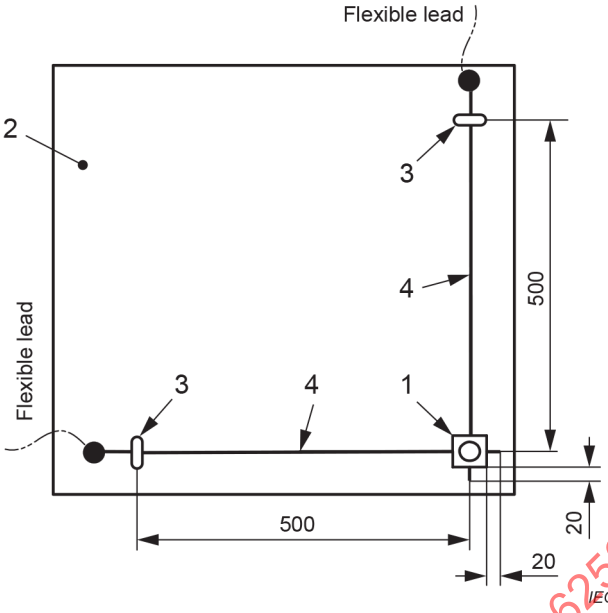
Dimension in millimetres



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

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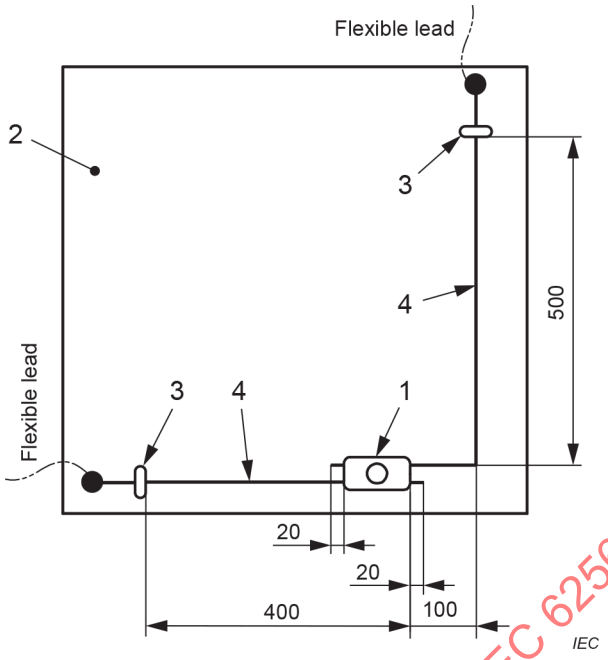
Dimension in millimetres



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

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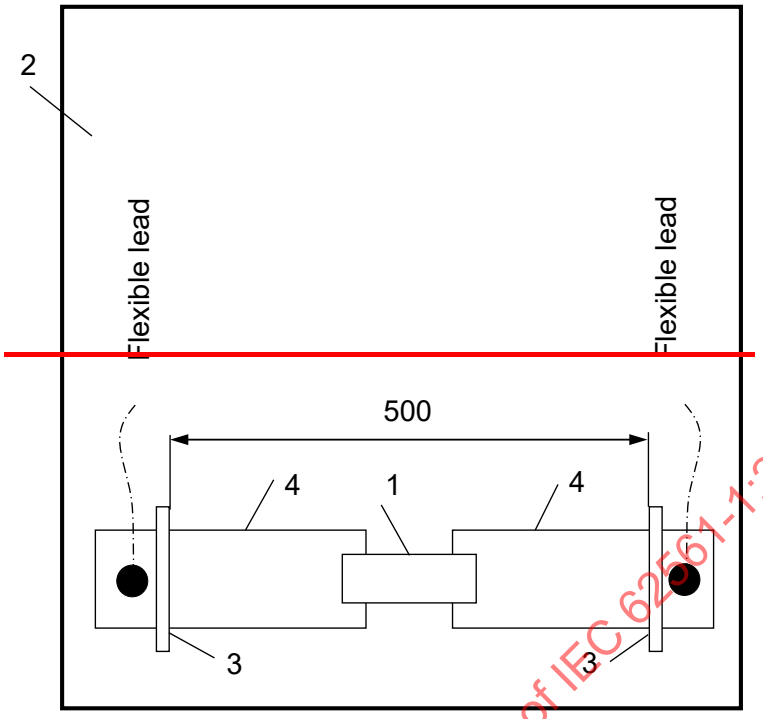
Dimension in millimetres



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

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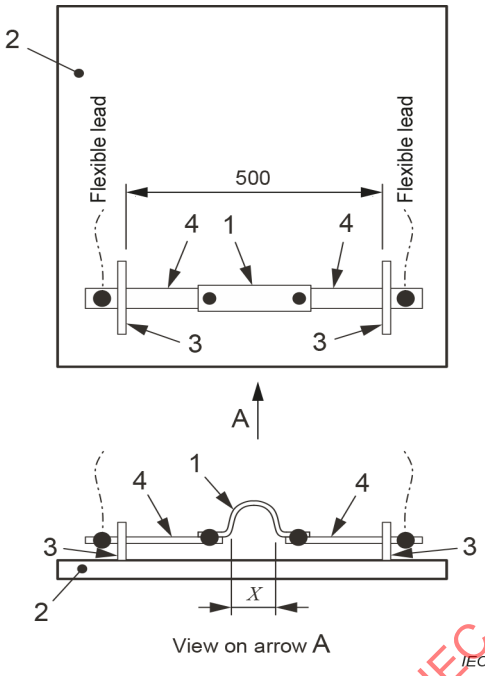
Dimension in millimetres



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

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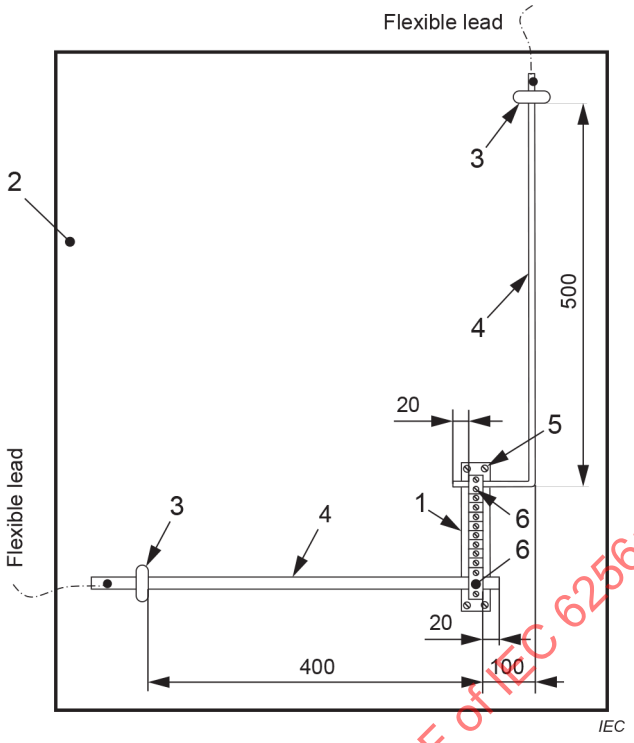
Dimension in millimetres



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

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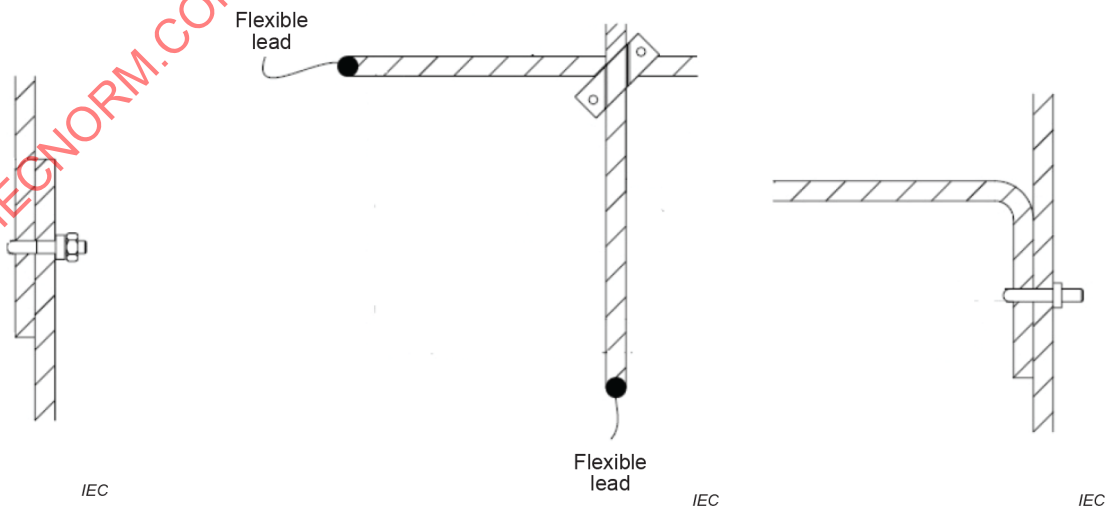
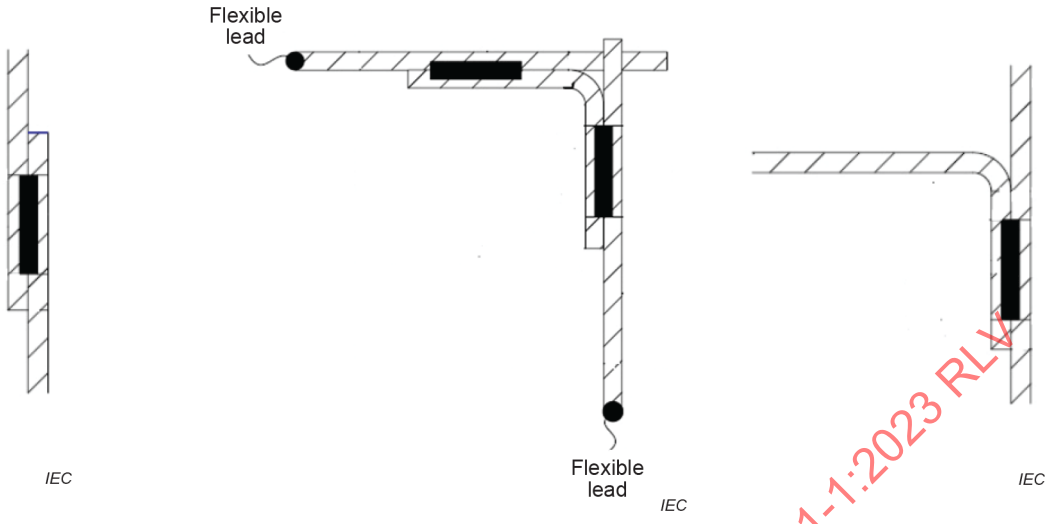


a) In-line connection **b) Cross connection** **c) "T" connection**

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.

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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.

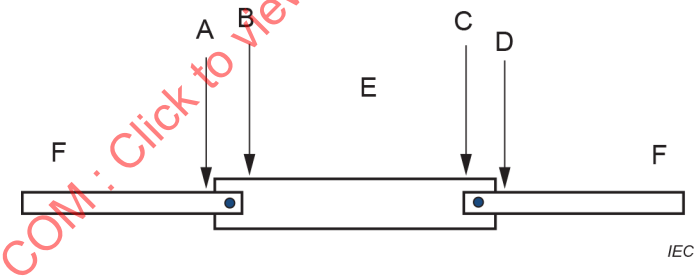
Table 1 – Lightning impulse current (I_{imp}) parameters

Classification	I_{imp} kA ±10 %	W/R kJ/Ω ~~±35~~ $^{+45}_{-10}$ %
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;

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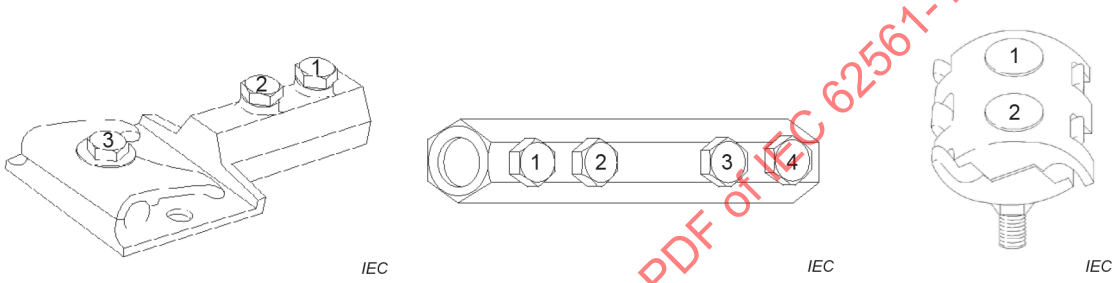
d) for a non-permanent connection component, in accordance with 4.4 b), utilizing screws, the loosening torque is greater than 0,25 and less than 1,5 times the tightening torque. In the case of connectors with more than one screw, only the loosening torque of the first screw is relevant to this test 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.~~

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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.~~

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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.

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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.

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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

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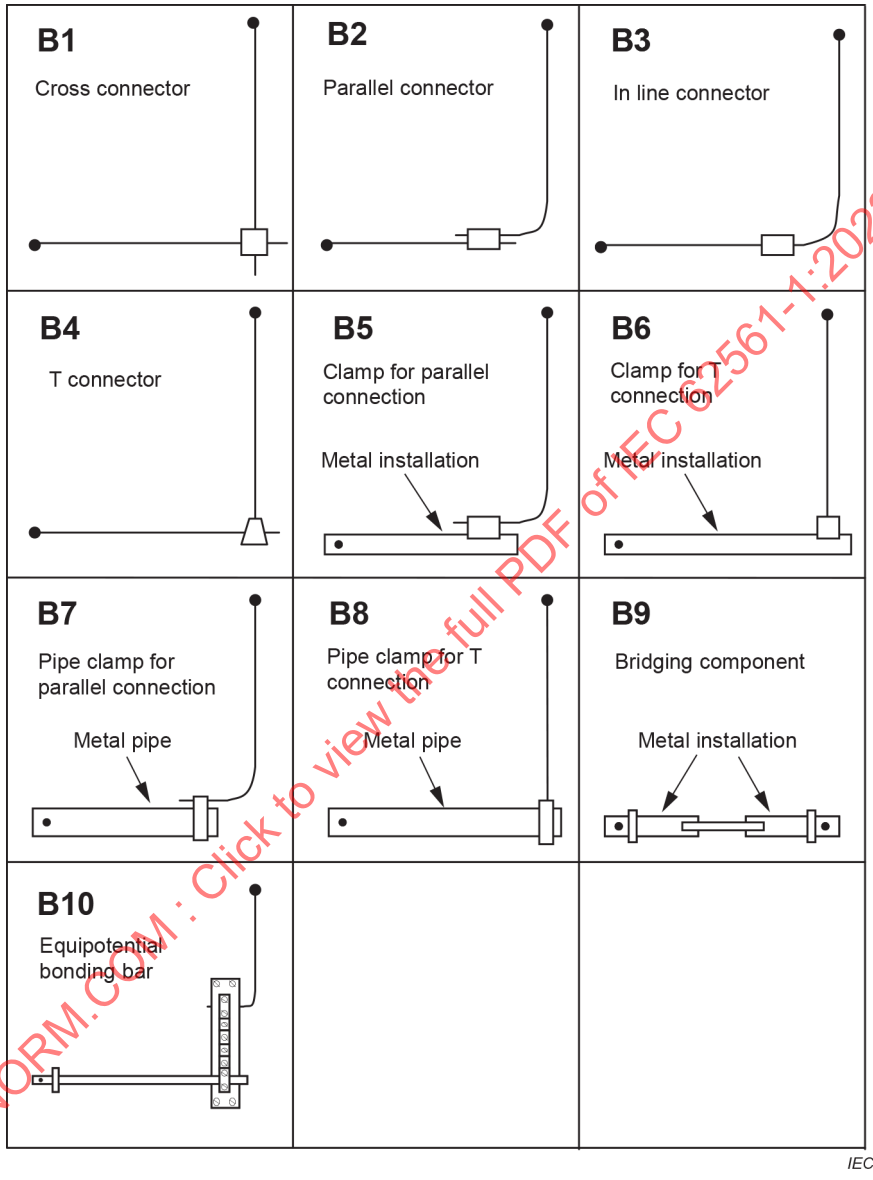
Annex B
(informative)

Typical connection ~~configurations~~ arrangements for various LPSC

See Figure B.1.



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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.

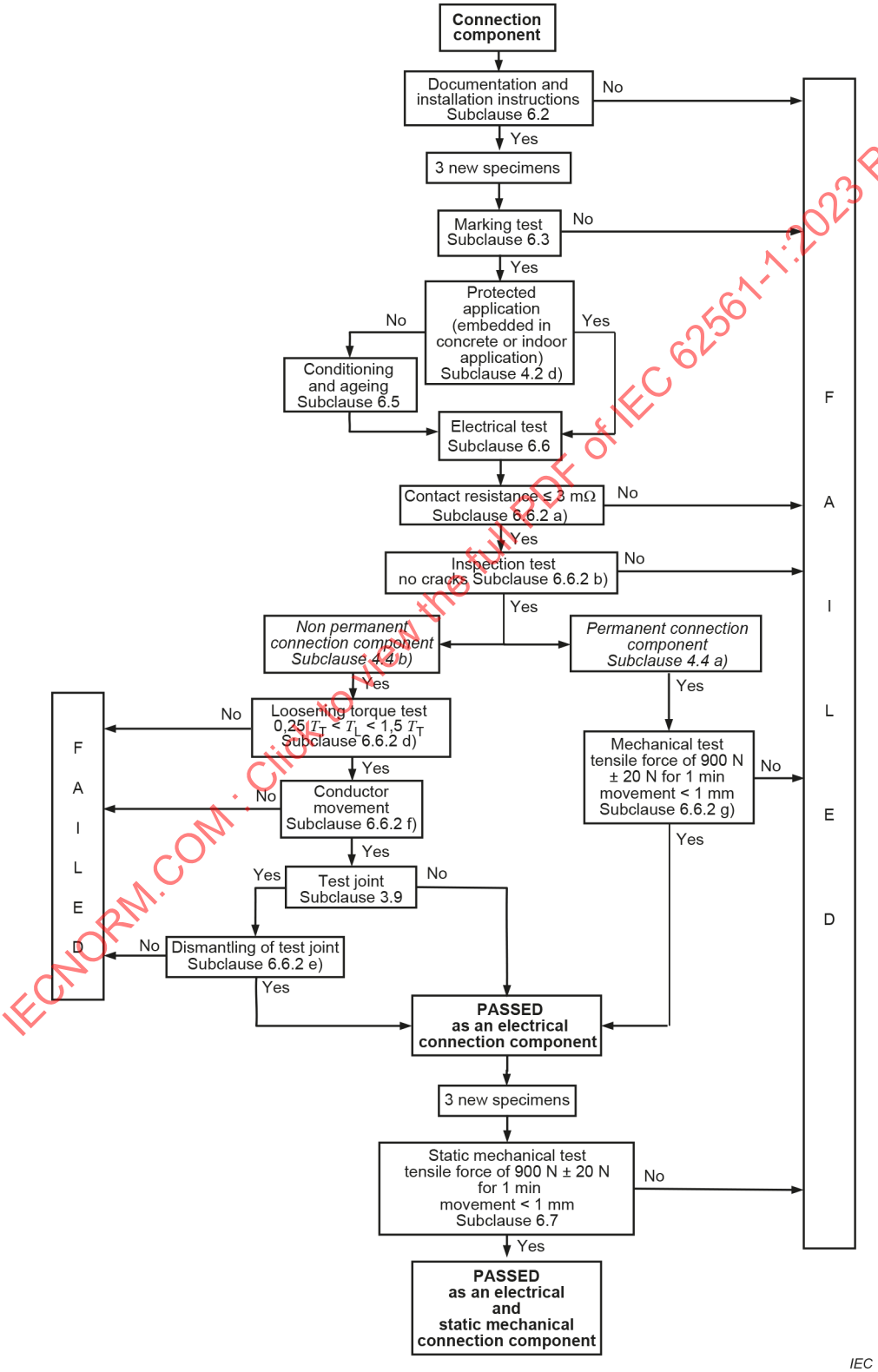

Figure C.1 – Flowchart of tests for connection components

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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.

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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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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*

~~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*~~

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~~[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

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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

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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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.

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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.

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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.

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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.]

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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.

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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

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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_{imp});

b) classification according to the installation location;

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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.

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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.

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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.

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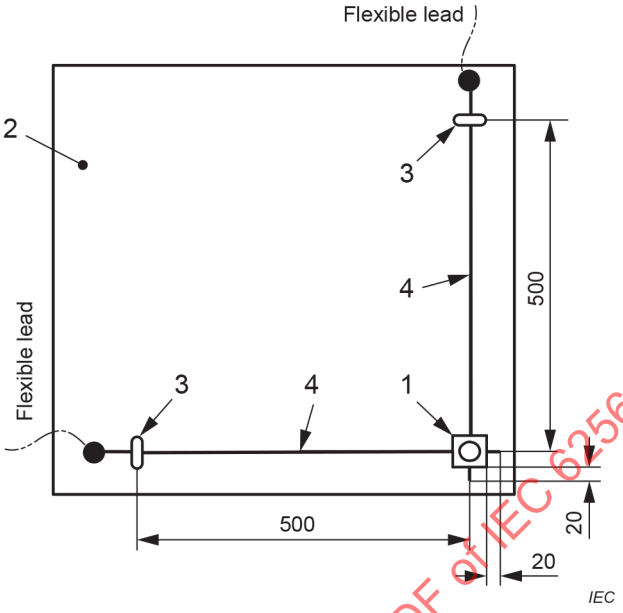
h) Prorated section of an installation to be embedded in concrete, including connection components such as brazed, welded, exothermically welded, etc., shall be arranged as shown in Figure 6 a), Figure 6 b), Figure 6 c) and shall be prepared according to the designer's or installer's instructions and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

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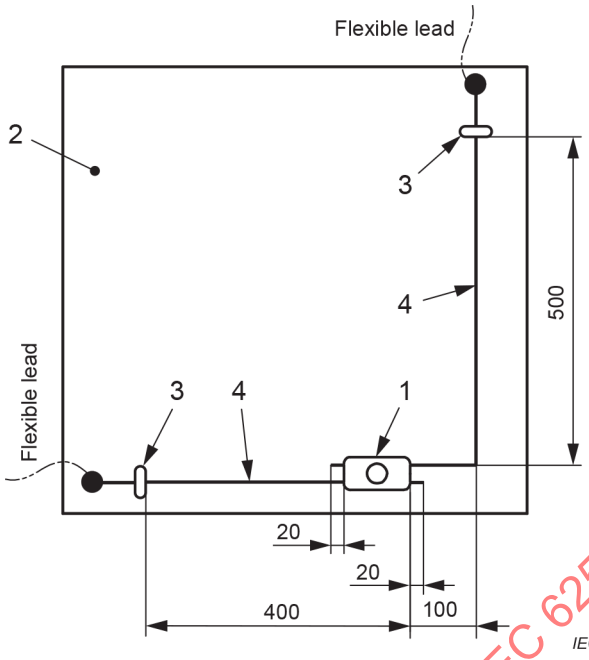
Dimension in millimetres



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

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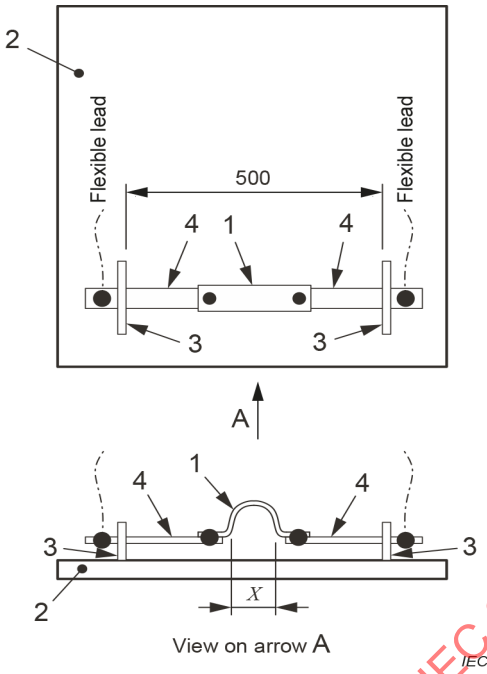
Dimension in millimetres



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

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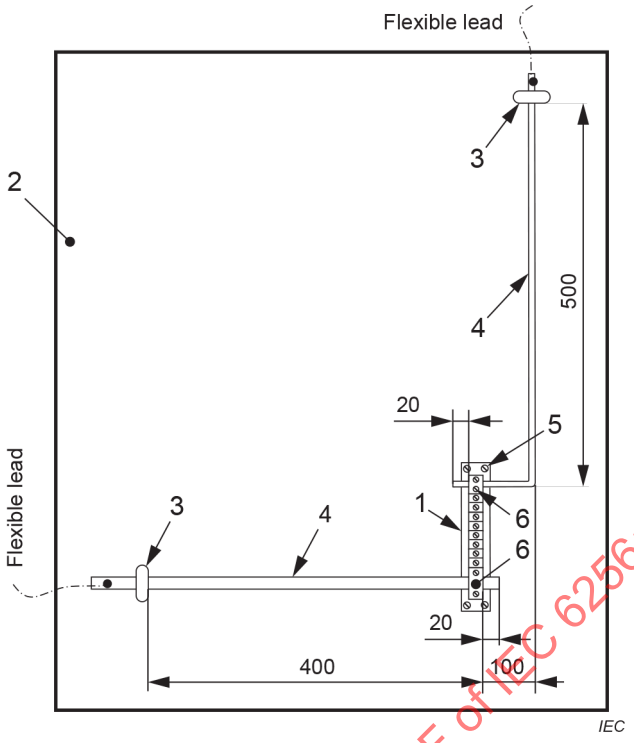
Dimension in millimetres



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

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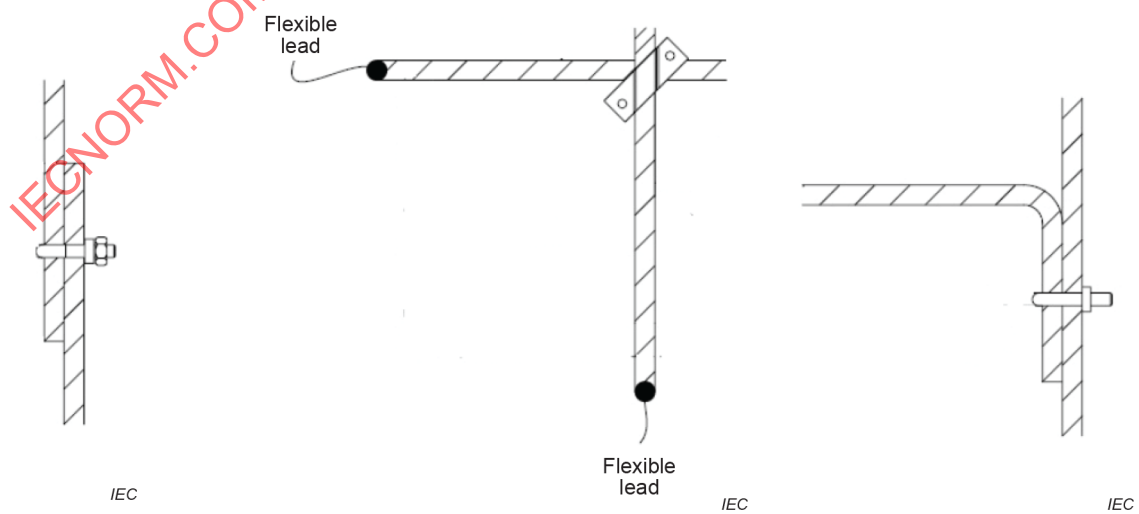
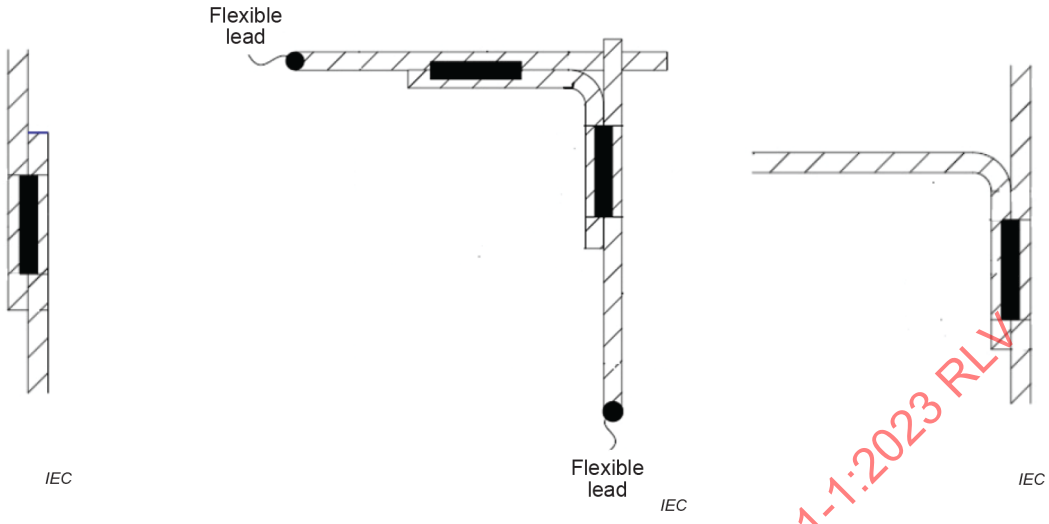


a) In-line connection **b) Cross connection** **c) "T" connection**

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.

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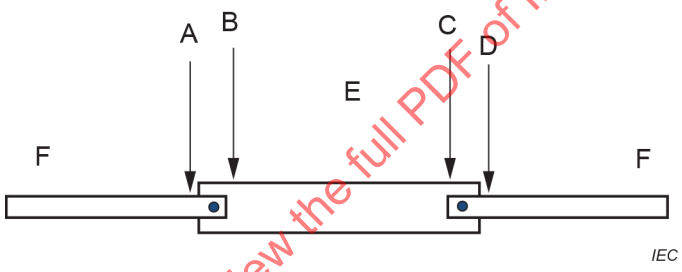
Table 1 – Lightning impulse current (I_{Imp}) parameters

Classification	I_{imp} kA ±10 %	W/R kJ/Ω $^{+45}_{-10}$ %
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

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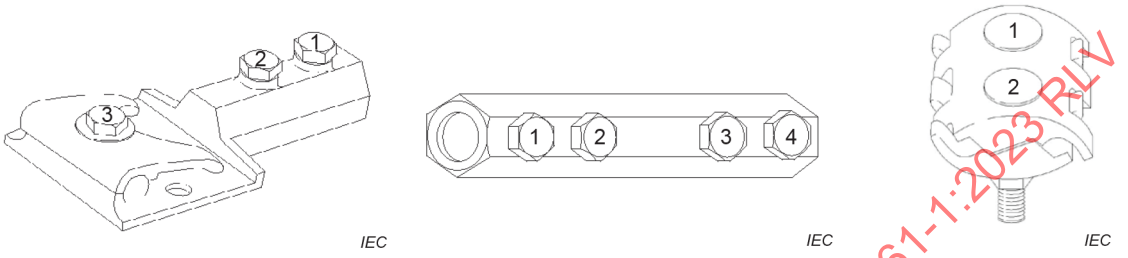
measured at the nut. The screw should be fixed with a wrench and thus secured against turning;

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).

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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;

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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.

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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

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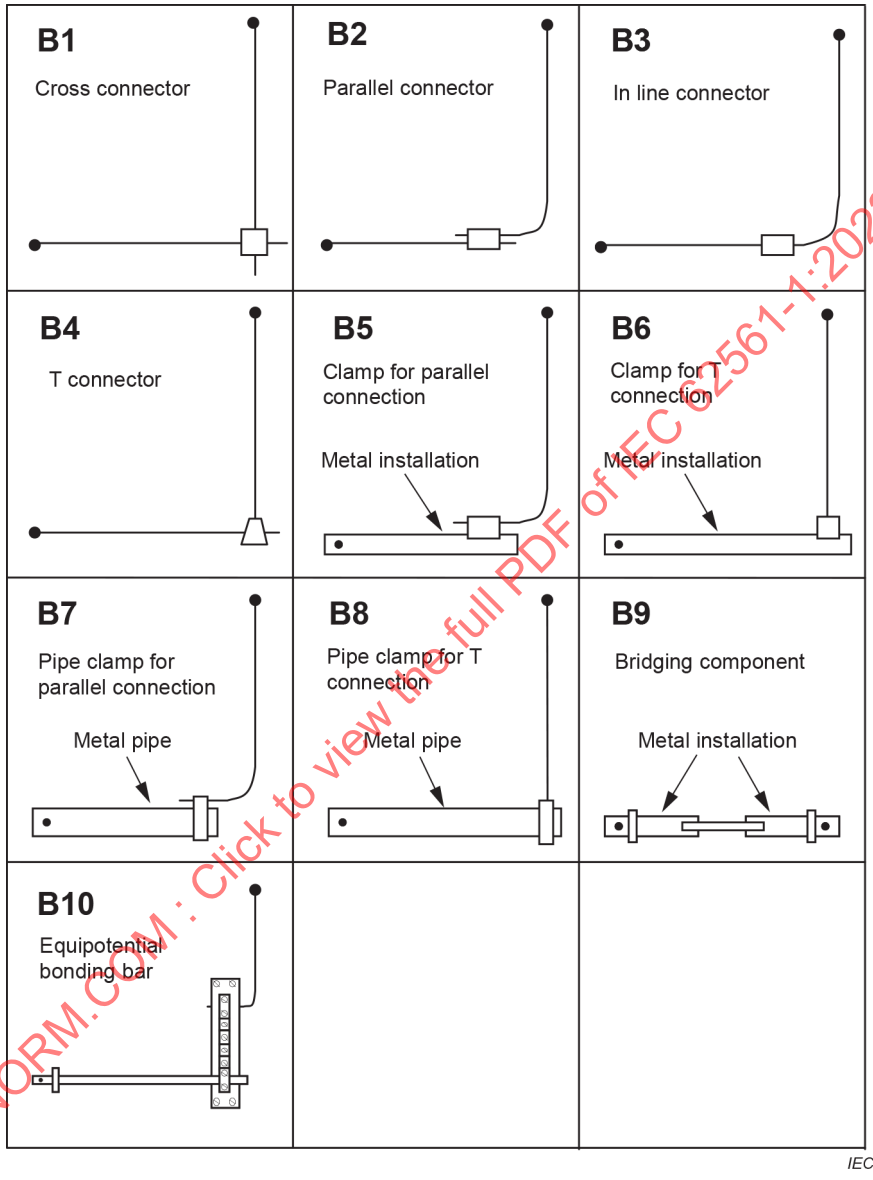
Annex B
(informative)

Typical connection arrangements for various LPSC

See Figure B.1.



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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.

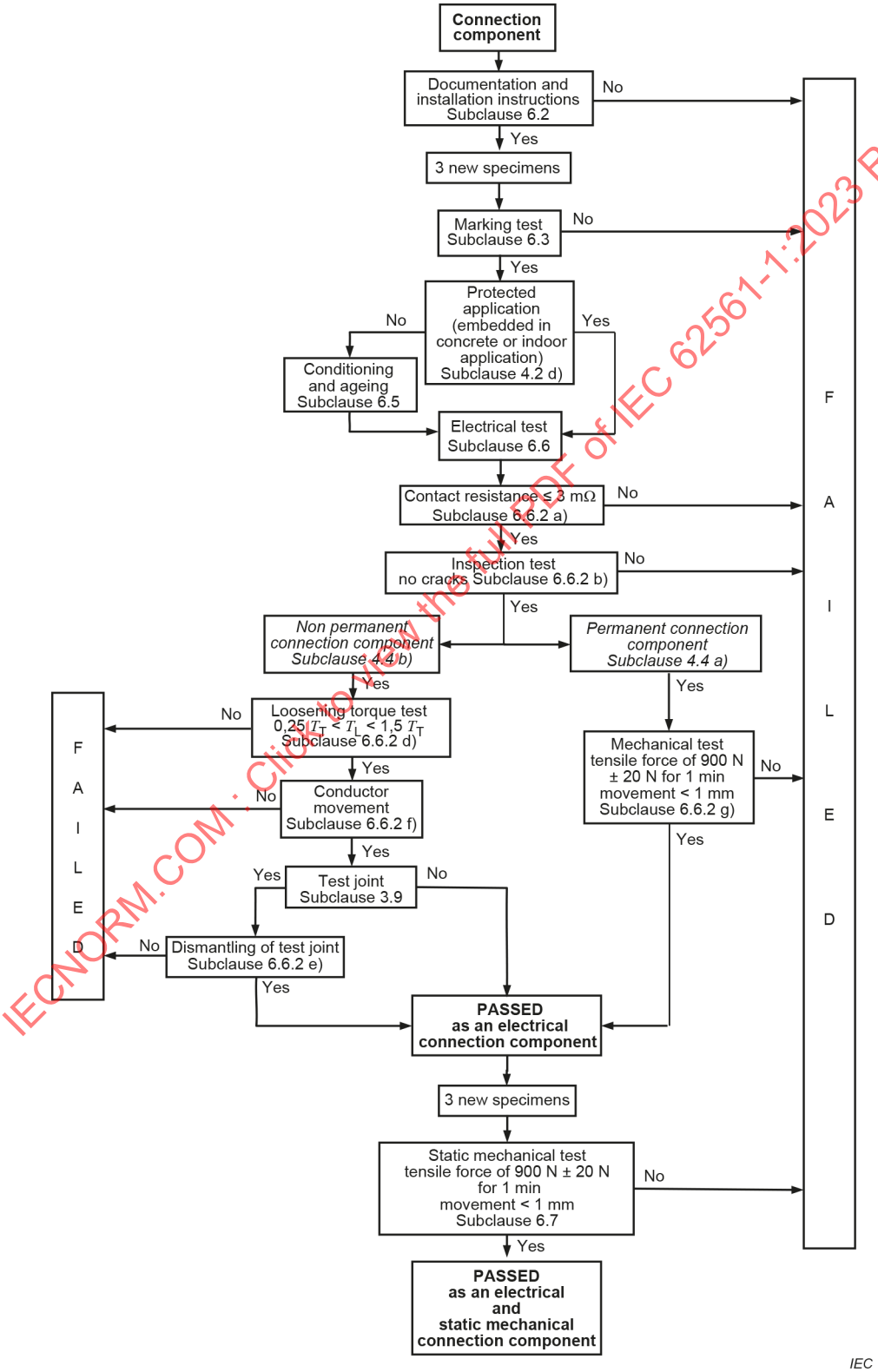

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Figure C.1 – Flowchart of tests for connection components

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.

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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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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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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.

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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)*

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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.]

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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.

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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]

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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.

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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.

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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.

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