SVENSK STANDARD

SS-EN IEC 61439-5, utg 3:2024

2024-04-24

REDLINE VERSION

Kopplingsutrustningar för högst 1000 V växelspänning eller 1500 V likspänning – Del 5: Särskilda fordringar på kabelskåp och lågspänningsfördelningar i nätstationer

Low-voltage switchgear and controlgear assemblies – Part 5: Assemblies for power distribution in public networks

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IEC 61439-5

Edition 3.0 2023-05
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Low-voltage switchgear and controlgear assemblies –
Part 5: Assemblies for power distribution in public networks

SEK Svensk Elstandard

SS-EN IEC 61439-5, utg 3:2024

IEC 61439-5:2023-05 RLV(en)

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Low-voltage switchgear and controlgear assemblies – Part 5: Assemblies for power distribution in public networks

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.130.20

ISBN 978-2-8322-6987-9

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 5: Assemblies for power distribution in public networks

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61439-5:2014. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 61439-5 has been prepared by subcommittee 121B: Low-voltage switchgear and controlgear assemblies, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage. It is an International Standard.

This third edition cancels and replaces the second edition published in 2014. This edition constitutes a technical revision.

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

a) omission of the requirement to conduct mechanical tests at -25 °C when enclosures are made of a metallic material;
b) addition of assumed loading factors generation supplies and electric vehicle charging applications;
c) additional dielectric tests when a PENDA is used in a distribution substation with separate HV and LV earths;
d) further clarification of representative samples for design verification.

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

Draft	Report on voting
121B/173/FDIS	121B/178/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.

This document is to be read in conjunction with IEC 61439-1. The provisions of the general rules dealt with in IEC 61439-1 are only applicable to this document insofar as they are specifically cited. When this document states "addition", "modification" or "replacement", the relevant text in IEC 61439-1:2020 is to be adapted accordingly. Subclauses that are numbered with a 101 (102, 103 etc.) suffix are additional to the same subclause in IEC 61439-1:2020.

Tables and figures in IEC 61439-5:2023 that are new are numbered starting with 101.

New annexes in IEC 61439-5:2023 are lettered AA, BB, etc.

The reader’s attention is drawn to the fact that Annex DD lists all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.

A list of all parts of the IEC 61439 series, under the general title *Low-voltage switchgear and controlgear assemblies* 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.

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

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 5: Assemblies for power distribution in public networks

1 Scope

This document defines the specific requirements for public electricity network distribution assemblies (PENDAs).

PENDAs have the following criteria:

– used for the distribution of electrical energy in three phase systems for which the rated voltage does not exceed 1 000 V AC (see Figure 101 for a typical distribution network) and DC systems not exceeding 1 500 V DC;

– stationary;

– open type assemblies are not covered by this document;

– suitable for installation in places where only skilled persons have access for their use, however, outdoor types ~~may~~ can be installed in situations that are accessible to ordinary persons

- intended for use in energy distribution in public power grids;
- indoor use: assemblies for installation inside of electric power substations;
- outdoor use: assemblies containing an enclosure suitable for open air installation.

The object of this document is to state the definitions and to specify the service conditions, construction requirements, technical characteristics and tests for PENDAs. ~~Network parameters may require~~ Tests at higher performance level can be applicable with some network parameters.

PENDAs ~~may~~ can also include control and or signalling devices associated with the distribution of electrical energy.

NOTE 1 Control and monitoring devices can be used in smart grid applications or the transmission of smart grid data.

This document applies to all PENDAs whether they are designed, manufactured on a one-off basis or fully standardised and manufactured in quantity.

The manufacture and/or assembly ~~may~~ can be carried out other than by the original manufacturer (see 3.10.1 of IEC 61439-1:~~2011~~2020).

This document does not apply to individual devices and self-contained components, such as motor starters, fuse switches, electronic equipment, etc. which comply with the relevant product standards.

If the substation is owned or operated by a public distribution system operator (DSO), PENDA's which are used as LV distribution panels in transformer substations are within the scope of this document,

This document does not apply to specific types of assemblies covered by other parts of IEC 61439 series.

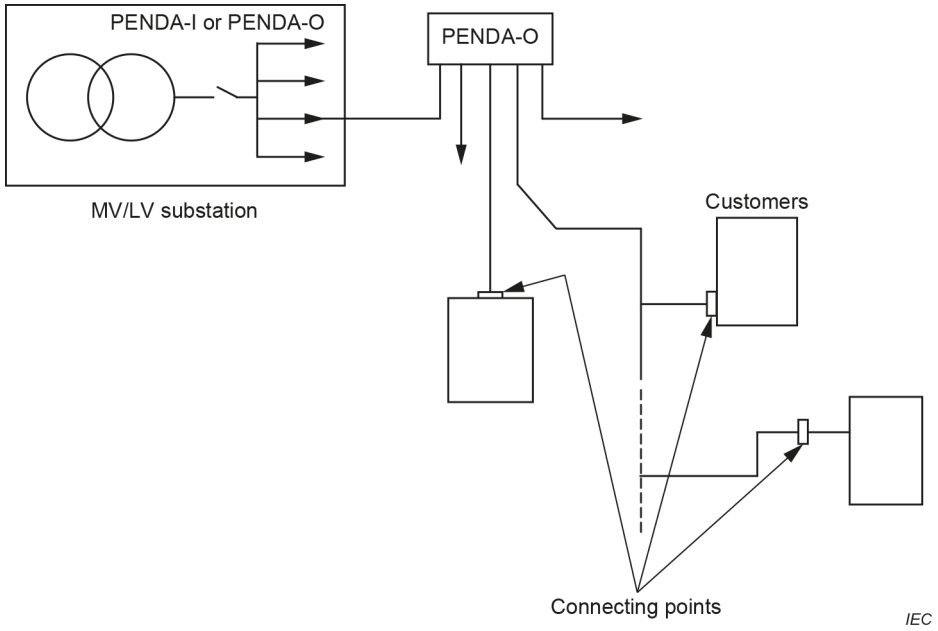


Figure 101 – Typical distribution network

NOTE 2 If a PENDA is equipped with additional equipment (for example meters), in such a way that the main function is changed considerably, then other standards can also apply as agreed between user and manufacturer (see 8.5 of IEC 61439-1:~~2011~~2020).

NOTE 3 Where local regulations and practices permit, a PENDA according to this document can be used in other than public networks.

NOTE 4 DSO's can define additional requirements for their PENDA's.

2 Normative references

This clause of IEC 61439-1:2020 applies except as follows.

Addition:

IEC 60695-11-10:2013, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 61439-1:~~2011~~2020, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

ISO 9223:2012, *Corrosion of metals and alloys – Corrosivity of atmospheres – Classification, determination and estimation*

ISO 6506-1:2014, *Metallic materials – Brinell hardness test – Part 1: Test method*

3 Terms and definitions

This clause of IEC 61439-1:2020 applies except as follows.

3.1 General terms

Additional terms:

3.1.101
public electricity network distribution assembly
PENDA
assembly, generally for installation in a public electricity network which in use, receives electrical energy from one or more supplies and distributes that energy through one or more cables to other equipment

Note 1 to entry: A PENDA is installed, operated and maintained solely by skilled persons.

Note 2 to entry: Some types of a PENDA were previously known as a cable distribution cabinet (CDC).

3.1.101.1
outdoor public electricity network distribution assembly
PENDA-O
cubicle type public electricity network distribution assembly that is suitable for outdoor installation in places that ~~may~~ can, or ~~may not~~ cannot, be accessible to the public

3.1.101.2
indoor public electricity network distribution assembly
PENDA-I
public electricity network distribution assembly suitable for installation indoors, generally without an enclosure, but including all structural parts necessary to support busbars, functional units and other ancillary devices, necessary to complete the assembly

3.1.102
design life
minimum duration for which specified performance characteristics of equipment are expected when the equipment is operated as intended and regularly maintained by instructed persons in accordance with the manufacturer's instructions

[SOURCE: IEC 60050-395:2014, 395-07-93, modified – Note to entry omitted and 'granted' replaced by 'expected when ..... instructions'.]

3.3 External design of assemblies

3.3.1
open-type assembly
This term of IEC 61439-1:2020 does not apply.

3.9 Verification

Modifications:

3.9.1
design verification
Delete the note.

3.9.1.2
verification comparison
This term of IEC 61439-1:2020 does not apply.

3.9.1.3
verification assessment
This term of IEC 61439-1:2020 does not apply.

4 Symbols and abbreviations

This clause of IEC 61439-1:2020 applies.

5 Interface characteristics

This clause of IEC 61439-1:2020 applies, except as follows.

5.4 Rated diversity factor (RDF)

Addition:

In the absence of an agreement between the assembly manufacturer and user concerning the actual load currents, the assumed loading of the outgoing circuits of the assembly or group of outgoing circuits ~~may~~ can be based on the values given in Table 101.

For distribution and final circuits, it is assumed that the load current is the rated current of the protective device, I_n, as required by the user, multiplied with the loading factor of Table 101.

Table 101 – Values of assumed loading

~~Number of main circuits~~	~~Assumed loading factor~~
~~2 and 3~~	~~0,9~~
~~4 and 5~~	~~0,8~~
~~6 to 9 inclusive~~	~~0,7~~
~~10 (and above)~~	~~0,6~~

Application	Assumed loading factor
Regular distribution grid connections 2 to 3 circuits	0,9
Regular distribution grid connections 4 to 5 circuits	0,8
Regular distribution grid connections 6 to 9 circuits	0,7
Regular distribution grid connections ≥ 10 circuits	0,6
Generation supply (e,g. PV, wind farm, biomass)	1,0
Charging infrastructure for EV	1,0

6 Information

This clause of IEC 61439-1:2020 applies except as follows.

6.1 Assembly designation marking

Addition to first paragraph:

Designation plates ~~may~~ can be placed inside an enclosure of an assembly provided their intended place ensures good legibility and visibility when the door(s) is(are) open or the cover is removed.

Replacement of item ~~d~~g):

~~d~~g) IEC 61439-5.

6.3 Device and/or component identification

Additional paragraph:

In the case of removable fuse-carriers which are specific to a fuseway, a label shall be placed on the fuse carrier as well as on the fuse base, to avoid incorrect interchangeability of the fuse-carrier.

Additional subclause:

6.101 Circuit identification

It shall be possible to identify each functional unit in a clearly visible manner.

7 Service conditions

This clause of IEC 61439-1:2020 applies except as follows.

7.1 Normal service conditions

7.1.1 Climatic conditions

Addition to the first paragraph:

Unless the user specifies that a PENDA shall be suitable for use in an arctic climate, the lower limit of ambient air temperature is –25 °C as specified in Table 15 of IEC 61439-1:2020. For an arctic climate the lower limit of ambient temperature is –50 °C.

~~**7.1.1.2 Ambient air temperature for outdoor installations**~~

~~*Replacement of last paragraph with:*~~

~~Unless the user specifies a PENDA shall be suitable for use in an arctic climate, the lower limit of ambient air temperature is –25 °C. For an arctic climate the lower limit of ambient temperature is –50 °C.~~

7.1.2 Pollution degree

Replace the first paragraph with the following:

The pollution degree referred to in Annex BB is the macro-environmental condition for which the assembly is intended.

7.2 Special service conditions

~~*Addition of the following note to item h):*~~

~~NOTE Exposure to vibration arising from traffic and/or occasional ground excavation is a normal service condition for PENDAs.~~

Additional paragraph:

Additional requirements for a PENDA-O, to be installed where heavy snowfalls occur and where they are adjacent to areas where there is snow clearance by ploughing, are subject to agreement between manufacturer and user.

8 Constructional requirements

This clause of IEC 61439-1:2020 applies except as follows.

8.1 Strength of materials and parts

8.1.1 General

Change the reference to Annex C to Annex BB in paragraph 5 of 8.1.1 of IEC 61439-1:2020.

Addition:

A PENDA-O shall be arranged for ground mounting, transformer mounting, pole mounting, surface wall mounting or mounting within a recess within a wall, as agreed between user and manufacturer.

A PENDA ~~may~~ can be directly coupled to a transformer by means of a flange coupling or it ~~may~~ can connect to its supply by means of cable or via busbars as agreed between user and manufacturer. Outgoing circuits shall be suitable for connection by means of cables.

A ~~reliable~~ locking device shall be provided on outdoor enclosures which prevents access by unauthorized persons. ~~Doors, lids and covers shall be so designed that, after they are locked, they do not open due to subsequent moderate ground settlement, nor due to exposure to vibration arising from traffic and/or ground excavation and reinstatement works.~~ The fixings of any covers etc. which are removable for installation or maintenance operations shall only be accessible while the door(s) is (are) open.

Any auxiliary equipment, e.g. meters, relays, instruments, circuit breaker trip units, communications equipment, that can be readily replaced, are excluded from the minimum design life of a PENDA.

NOTE When applicable, a design life can be agreed between user and manufacturer, assuming it is operated as intended and regularly maintained by instructed personnel in accordance with the manufacturer's instructions.

8.1.3.2 Resistance of insulating materials to heat and fire

Additional subclause:

8.1.3.2.101 Verification of category of flammability

The insulating materials used for enclosures, barriers and other insulating parts shall have ~~flame retardant~~ flammability properties in accordance with ~~10.2.3.102 of this standard~~ 10.2.3.101.

8.1.5 Mechanical strength

Additional subclause:

8.1.5.101 Verification of mechanical strength

The mechanical properties of a PENDA-O shall comply with 10.2.101.

Parts of the PENDA-O intended to be embedded in the ground shall withstand the stresses imposed on them during installation and normal service and comply with 10.2.101.9.

~~*Additional subclause:*~~

~~**8.1.101 Thermal stability**~~

~~The thermal stability of a PENDA shall be verified according to 10.2.3.101.~~

8.2 Degree of protection provided by an assembly enclosure

8.2.1 Protection against mechanical impact (IK code)

Subclause 8.2.1 of IEC 61439-1:2020 does not apply.

The mechanical impact tests required by this document are at least equal to IK10 in accordance with IEC 62262 (see 8.1.5.101).

8.2.2 Protection against contact with live parts, ingress of solid foreign bodies and water (IP code)

Addition:

Open type assemblies (IP00) are not covered by this document.

When a PENDA-O is intended to be installed in places accessible to the public, its enclosure shall, when fully-installed in accordance with the manufacturer's instructions, provide a degree of protection of at least IP34D according to IEC 60529. In other locations, the minimum level of protection shall be at least IP33.

PENDA-O's that are intended to be installed in places accessible to the public shall, unless otherwise stated by the user, be designed such that when any temporary cables are connected, the enclosure shall provide a degree of protection of at least IP23C according to IEC 60529. See 8.8.

~~**8.4 Protection against electric shock**~~

8.4.2.1 General

The third paragraph does not apply.

Additional subclause:

8.4.2.101 Earthing and short-circuiting means

When specified by the user, the outgoing units in an assembly shall be so constructed that they can be earthed and short-circuited in a secure manner by means of a device(s) recommended by the manufacturer, which ensures the ~~manufacturer's indicated~~ required degree of protection (IP code) is maintained for all parts of the assembly. ~~This requirement is not applicable if it could cause a safety hazard arising from the system conditions and/or operational practice.~~

8.4.3.1 Installation conditions

Additional paragraph:

~~For an assembly that is expected~~ When a user specifies the assembly is to feed overhead cable lines, outgoing units shall be designed in such a way that an attached cable(s) can be earthed at the termination(s).

8.8 Terminals for external ~~conductors~~ cables

Replacement of the first three paragraphs with the following:

In the absence of a special agreement between user and manufacturer, terminals shall be capable of accommodating cables having copper or aluminium conductors from the smallest to the largest cross-sectional area corresponding to the appropriate rated current (see Table AA.1).

The terminations for outgoing circuits shall be located so that adequate spacing is provided and to facilitate terminating the phase conductors of a cable irrespective of their lay.

When specified by the user the phase cable terminals of each outgoing circuit shall be separated from all other hazardous live parts. When the terminals of an outgoing circuit are exposed protection shall be provided against accidental contact with other hazardous live parts. Separation and protection shall be from the normal direction of access and in accordance with IPXXB of IEC 60529.

Where specified by the user, the incoming circuit shall be suitable for connection by means of either bare or insulated bars.

Additional subclauses:

8.101 Marking as an obstacle to snow clearance

When specified by the user, ~~Where~~ a PENDA-O that is intended for use in regions where heavy snowfalls occur in accordance with 7.2, ~~or alternatively, if required by the user, it~~ shall be ~~possible to mark it~~ marked as an obstacle to snow clearance. Holders shall be provided, attached to the PENDA-O, to accommodate marking rods and it shall be possible to install and make adjustments to the position of the marking rod from outside the PENDA-O. ~~The holders shall be constructed in a manner which ensures that the holder or marking rod will give way to a mechanical force before the transmitted force to the PENDA-O's enclosure reaches the value which would adversely affect the degree of protection (IP code).~~

8.102 Ease of operation and maintenance

All parts of the assembly shall, as far as practicable, be readily accessible and replaceable without excessive dismantling. ~~The conditions for interchangeability of parts of the ASSEMBLY may be subject to an agreement between the user and the manufacturer.~~

The design shall be such that the cables can be readily connected from the front.

When a PENDA does not have a means of measurement incorporated, it shall be possible, by the use of a portable instrument, to readily and safely measure voltages in all phases of incoming units and on both sides of all current breaking and/or switch devices of outgoing units, also the current in one phase of all outgoing units. During this operation all live parts of the PENDA shall be protected sufficiently to retain the required degree of protection in accordance with 8.2. Instructions concerning the procedure to be adopted shall be provided by the manufacturer.

If the assembly is intended to be connected to a live reserve power, for example a standby generator, the switchgear connecting device shall be designed so that connection can be made with the live parts having a degree of protection of ~~IP10~~ IPXXB according to IEC 60529.

~~Locking arrangements shall be provided on a PENDA to secure the door(s) and prevent unauthorised access. The fixings of any covers etc. which are removable for installation or maintenance operations shall only be accessible while the door(s) are open.~~

9 Performance requirements

This clause of IEC 61439-1:2020 applies.

10 Design verification

This clause of IEC 61439-1:2020 applies except as follows.

10.1 General

Replace ~~4th, 5th, and 6th~~ 6th, 7th, and 8th paragraph with:

Design verification shall only be achieved by the application of tests in accordance with Clause 10. The alternatives methods of verification by assessment or comparison with a reference design shall not be used (see Table CC.1).

It is not necessary to test every arrangement produced. Tests carried out on a representative sample of the most onerous PENDA are deemed to verify the performance of similar and less onerous assemblies of the same general construction and rating. ~~For example a temperature rise test carried out on an 800 A PENDA-O with 5 outgoing circuits is deemed to apply to a PENDA-O of the same construction (same general design of enclosure, same design of busbars and same incoming units) with 8 outgoing circuits of the same rating as those included in the PENDAO that was temperature rise tested. The same approach applies to short-circuit verification.~~ Examples of tests carried out on most onerous representative sample include:

1) A temperature rise test carried out on 800 A PENDA with 5 outgoing circuits is deemed to apply to an 800 A PENDA of the same construction (same general enclosure, same design of busbars and same incoming unit(s)) with 8 outgoing circuits of the same design.
2) Mechanical strength tests carried out on the smallest and largest enclosure in a series are deemed to apply to all other enclosures in the series, when they have the same number of doors and when they are of the same general construction.
3) Providing the busbar and connection support arrangements are the same, short-circuit tests carried out on a design of busbar and connections are deemed to apply to higher current ratings of busbars and connections.
4) A short circuit test carried out on 800 A PENDA with 8 outgoing circuits is deemed to apply to an 800 A PENDA of the same construction (same general enclosure, same design of busbars and same incoming unit(s)) with 5 outgoing circuits of the same design.
5) For a given short circuit rating, a short circuit tests carried out on an incoming or outgoing circuit is deemed to apply to higher current rating circuits of the same design and construction

Additional last paragraph:

Where necessary to suit their particular network parameters, users ~~may~~ can specify more onerous or additional test requirements.

10.2 Strength of materials and parts

10.2.2 Resistance to corrosion

10.2.2.1 ~~Test procedure~~ Verification by test

Replacement of last paragraph with the following:

When the corrosion resistance properties and projected life, as agreed between the manufacturer and the user, ~~can~~ shall be confirmed by reference to ISO 9223:2012, the tests detailed herein need not be performed.

In all other cases the corrosion resistance of each design of assembly shall be verified by severity test A or B, as applicable and as detailed 10.2.2.3 of IEC 61439-1:2020 and 10.2.2.2.

10.2.2.2 Severity test A

Replacement of the test specification (paragraph 2) with the following:

Damp heat cycling test of IEC 60068-2-30:2005: Severity – temperature 55 °C, 6 cycles and variant 1.

At the end of the test, the specimens are removed from the test chamber.

Compliance is checked by visual inspection. The parts tested shall not show rust, cracking or other deterioration. However, surface corrosion of the protective coating is allowed.

10.2.2.4 Results to be obtained

This subclause of IEC 61439-1:2020 is not applicable in respect of tests carried out in accordance with 10.2.2.2.

10.2.3 Properties of insulating materials

Additional subclause:

~~**10.2.3.101 Dry heat test**~~

~~The complete ASSEMBLY shall be placed in an oven, the internal temperature of which is raised to (100 ± 2) °C over a period of 2 h to 3 h and maintained at this temperature for 5 h.~~

~~Compliance is checked by inspection that there are no visible signs of deterioration. Deformation of protective covers manufactured from insulating materials is acceptable if they are more than 6 mm distant from parts which may have a temperature rise in excess of 40 K and do not support live components.~~

10.2.3.~~102~~101 Verification of category of flammability

Representative specimens of each of the materials of enclosures, barriers and other insulating parts shall be subjected to a flammability test in accordance with test method A – horizontal burning test of IEC 60695-11-10:2013.

Compliance is checked by inspection that each set of specimens can be classified to category HB40 criteria a) or b) in accordance with 8.4.3 of IEC 60695-11-10:2013.

10.2.6 Verification of protection against mechanical impact (IK code)

This subclause of IEC 61439-1:2020 is not applicable to assemblies complying with this document.

Additional subclauses:

10.2.101 Verification of mechanical strength

10.2.101.1 General

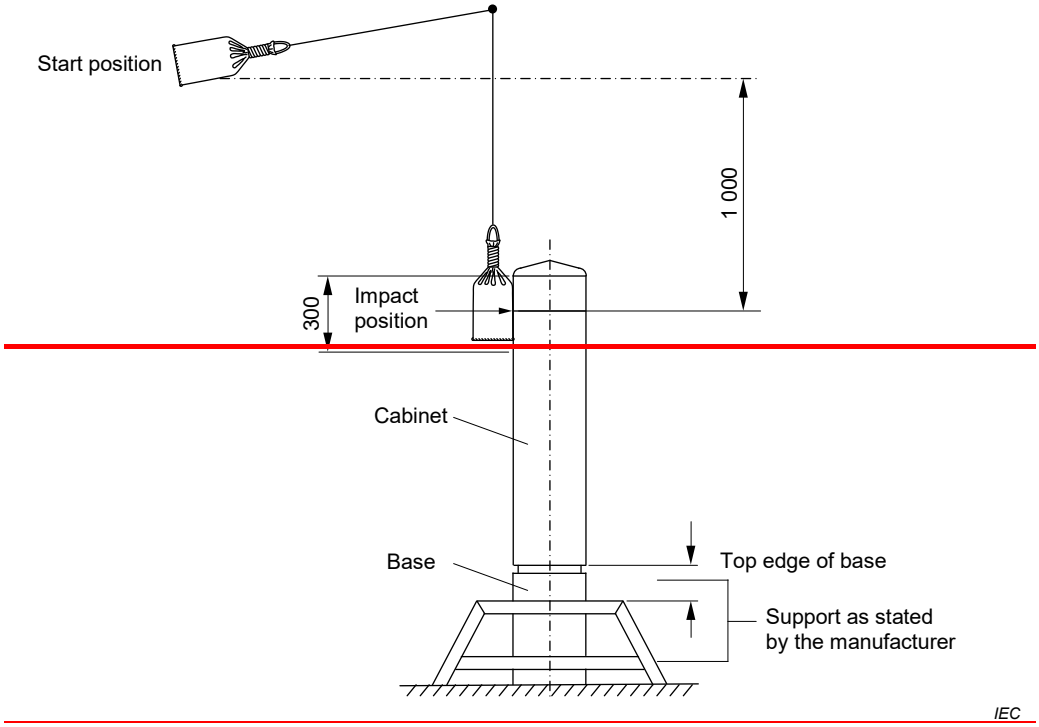
Where enclosures are manufactured in a series and are of the same design and construction, only the smallest and largest size of enclosure shall be tested.

The tests shall be carried out at an ambient temperature between 10 °C and 40 °C.

With the exception of the test of 10.2.101.7, a new sample assembly ~~may~~ can be used for each of the independent tests. If the same sample assembly is used for more than one test of 10.2.101, the compliance check for the second numeral of the degree of protection (IP code) need only be applied when the tests on that sample have been completed.

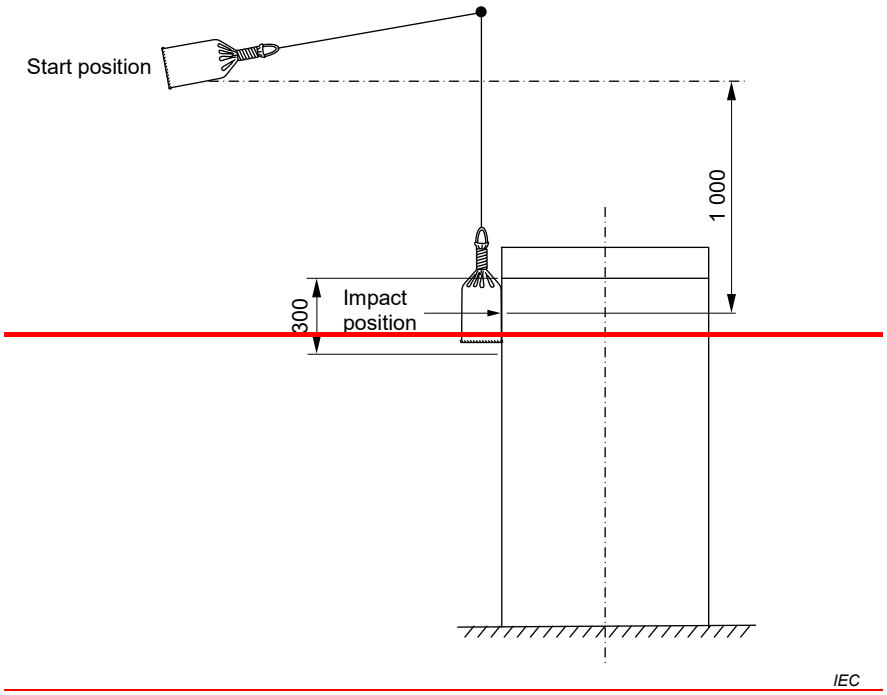
All tests shall be carried out with the assembly fixed at its normal service mounting and where appropriate, added support at normal ground level as indicated in Figure 102a, Figure 102b, Figure 103a, and Figure 103b.

~~*Dimensions in millimetres*~~



~~Figure 102a – Diagram of test to verify the resistance to shock load of a ground mounted PENDA-O with embedded base~~

~~*Dimensions in millimetres*~~



~~Figure 102b – Diagram of test to verify resistance to shock load of a ground mounted PENDA-O without embedded base~~

Dimensions in millimetres

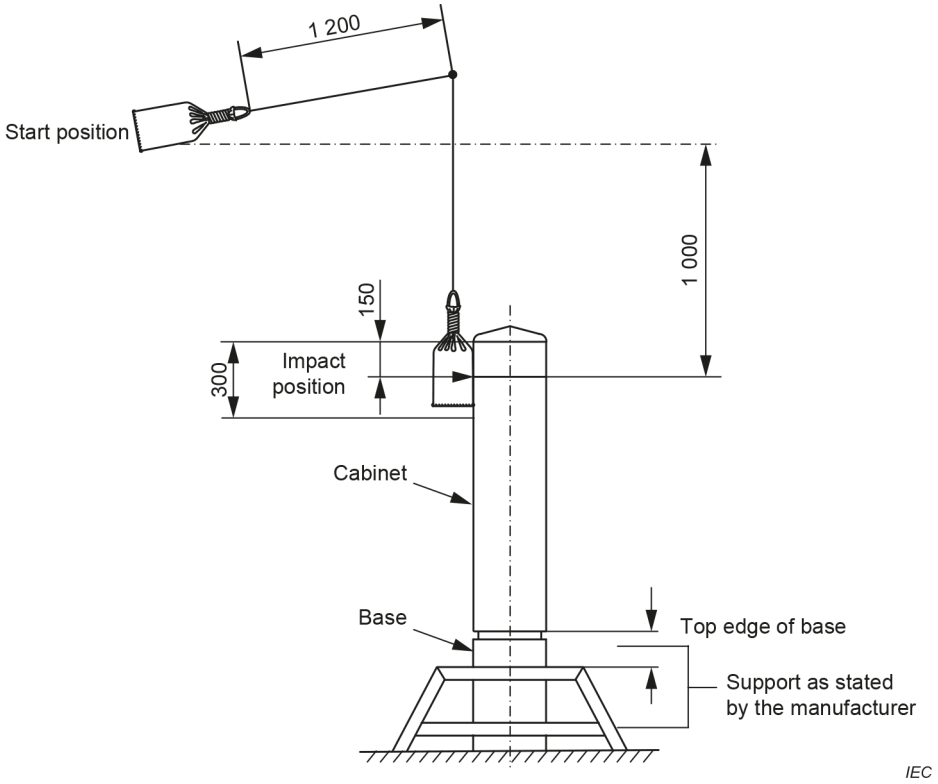


Figure 102a – Diagram of test to verify the resistance to shock load of a ground mounted PENDA-O with embedded base

Dimensions in millimetres

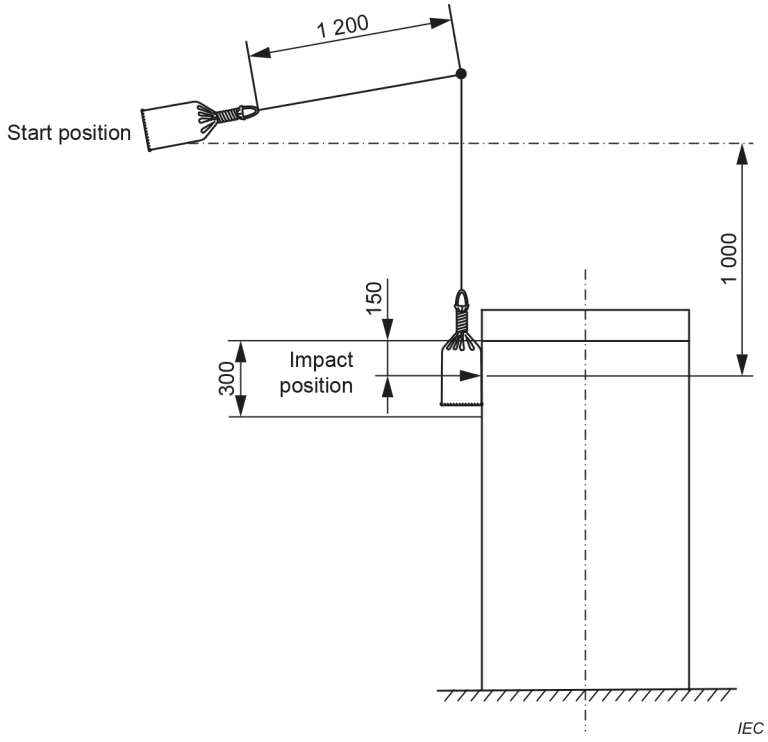


Figure 102b – Diagram of test to verify resistance to shock load of a ground mounted PENDA-O without embedded base

Figure 102 – Diagram of test to verify resistance to shock load of a PENDA-O

Dimensions in millimetres

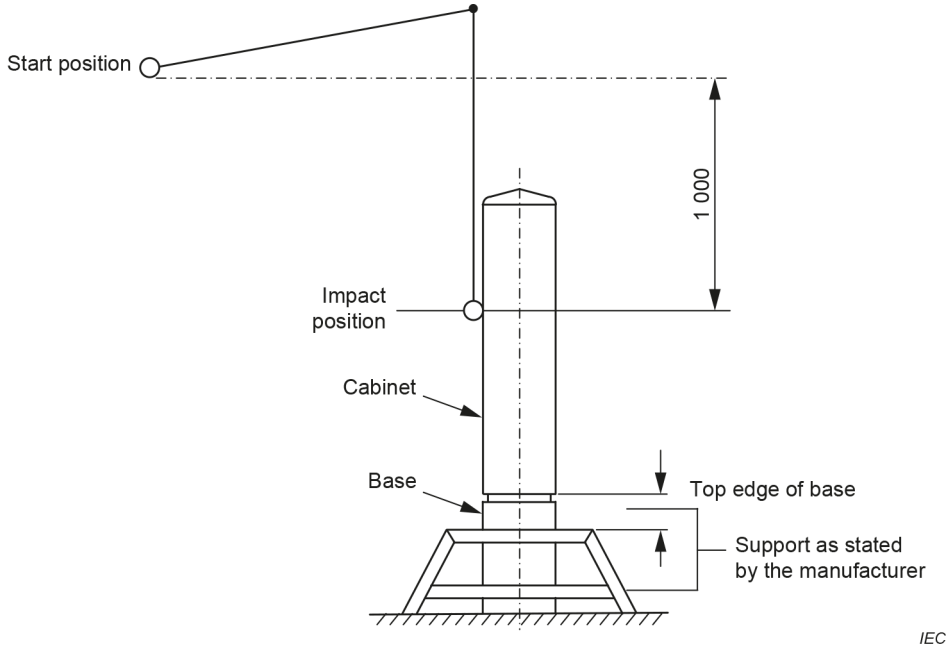


Figure 103a – Diagram of test to verify impact force withstand for a ground mounted PENDA-O with embedded base

Dimensions in millimetres

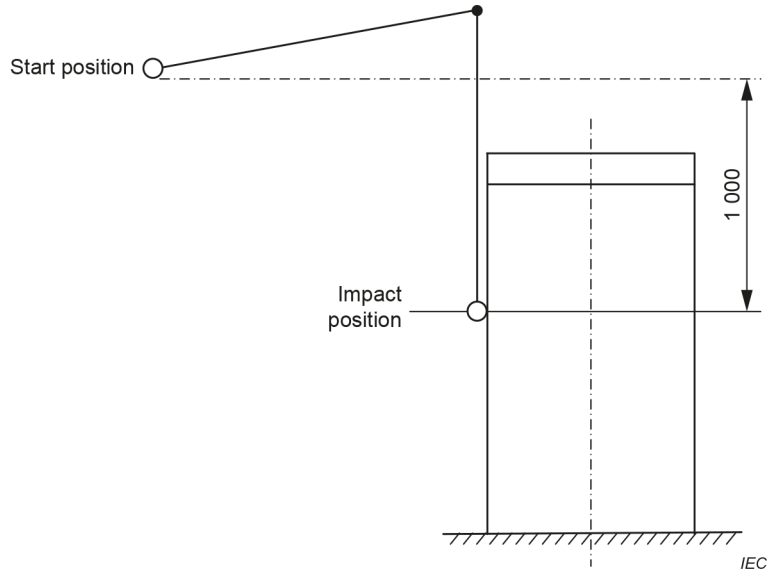


Figure 103b – Diagram of test to verify impact force withstand for a ground mounted PENDA-O without embedded base

Figure 103 – Diagram of test to verify impact force withstand of a PENDA-O

With the exception of the test of 10.2.101.8, the door(s) of the assembly, if applicable, shall be locked at the commencement of the test and remain locked for the duration of the test.

10.2.101.2 Verification of resistance to static load

The following tests shall be carried out on all types of PENDA-0:

Test 1 – An evenly distributed load of 8 500 N/m^2 shall be applied for 5 min to the roof of the enclosure (see Figure 104).

Test 2 – A force of 1 200 N shall be applied for 5 min in turn to the front and back upper edges of the roof of the enclosure (see Figure 104).

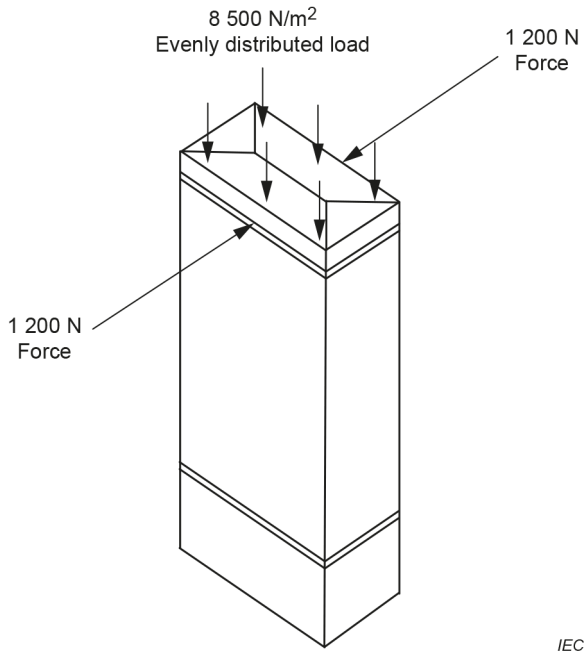


Figure 104 – Diagram of test to verify the resistance to static load

Compliance is checked by verification after the test that the minimum degree of protection is in accordance with 8.2.2, and the operation of the door(s) and locking points are not impaired; also by verification that the electrical clearances have remained satisfactory for the duration of the tests and in the case of an assembly having metallic enclosure, that no contact between live parts and the enclosure has occurred caused by permanent or temporary distortion.

10.2.101.3 Verification of resistance to shock load

The test shall apply to all types of PENDA-O.

A bag in accordance with Figure 105 containing dry sand and having a total mass of 15 kg shall be hung from an overhead support vertically above the surface under test and at ~~least~~ 1 m above the ~~highest~~ strike point of the assembly.

Dimensions in millimetres

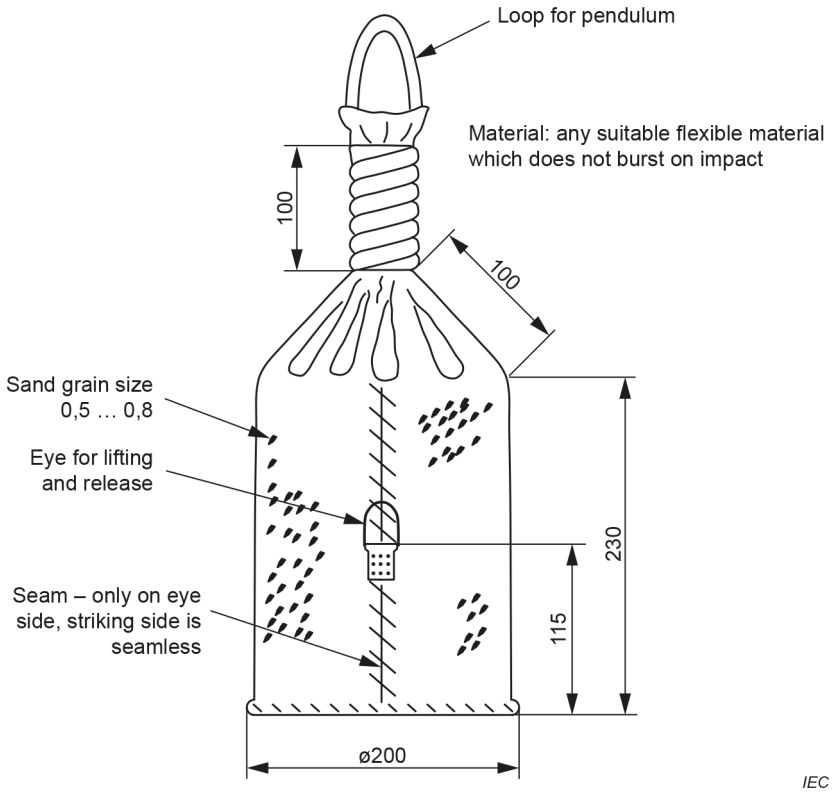


Figure 105 – Sandbag for test to verify the resistance to shock load

Each test shall consist of one blow aimed at the upper part of each of the vertical surfaces of the assembly which are visible when the assembly is installed in its normal service position. Separate enclosures ~~may~~ can be used for each of the test blows.

In the case of an enclosure of cylindrical form, the test shall consist of three blows which are positioned with an angular displacement of 120°.

A test shall consist of raising the lifting eye through a height of 1 m and allowing the sandbag to fall through a vertical arc to impact the approximate centre of the upper part of the surface of the assembly under test (see Figure 102a and Figure 102b).

Compliance is checked by verification after the test that the degree of protection remains in accordance with 8.2.2, and the operation of the door(s) and locking points are not impaired; also by verification that the electrical clearances have remained satisfactory for the duration of the tests and, in the case of an assembly having a metallic enclosure, that no contact between live parts and the enclosure has occurred caused by permanent or temporary distortion. In the case of an assembly having an insulating enclosure, if the appropriate conditions are satisfied, then damage such as small dents or small degrees of surface cracking or flaking are disregarded, provided that there are no associated cracks detrimental to the serviceability of the assembly.

10.2.101.4 Verification of resistance to torsional stress

The test only applies to all types of PENDA-O.

The test is carried out using a horizontally rotatable frame constructed from 60 mm × 60 mm × 5 mm angle iron, having vertical locations 100 mm long at the frame arm's extremities. The assembly under test is rigidly fixed at its base and the frame closely fitted over it, so that the end locations of the frame arm are in contact with the roof and walls of the assembly.

The assembly, with the door(s) closed shall have a torsional force ~~of 2 × 1 000 N~~ applied for 30 s as shown in Figure 106a and Figure 106b. This is comprised two separate tests, first with the two forces each of 1 000 N applied to twist the PENDA in a clockwise direction and the second with the two forces each of 1 000 N applied to rotate the PENDA in an anti-clockwise direction.

Dimensions in millimetres

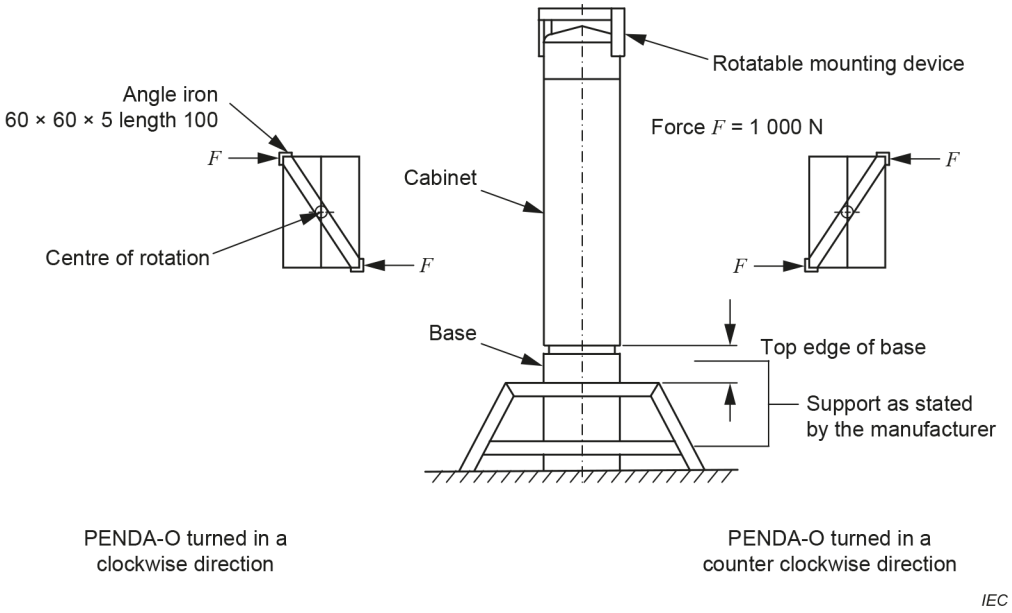


Figure 106a – Diagram of test to verify the resistance to torsional stress of a ground mounted PENDA-O with embedded base

Dimensions in millimetres

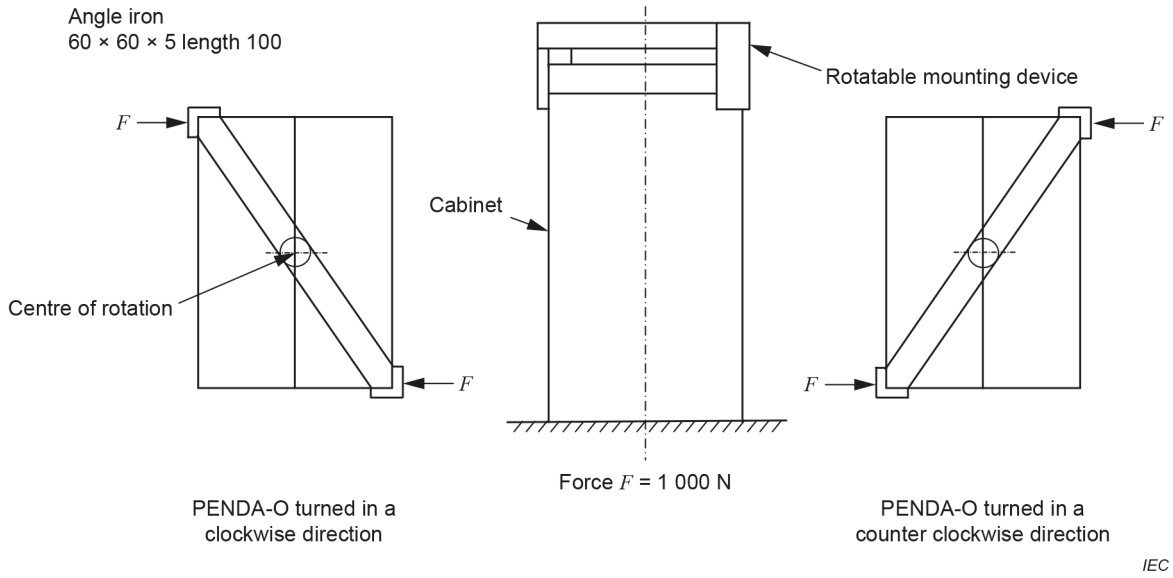


Figure 106b – Diagram of test to verify resistance to torsional stress of a ground mounted PENDA-O without embedded base

Figure 106 – Diagram of test to verify resistance to torsional stress of a PENDA-O

Compliance is checked by verifying that the doors(s) remain closed for the duration of the test and by verification after the test that the degree of protection remains in accordance with 8.2.2.

10.2.101.5 Verification of impact force withstand

10.2.101.5.1 Test applicable to ~~PENDAs~~ PENDA-Os designed for operation at ambient temperatures of between 40 °C and –25 °C

The test shall be carried out using impact apparatus in the form of a pendulum incorporating a 9 mm external diameter tube at least 1 m long. The pendulum shall be arranged to swing through a vertical arc.

Attached to one end is a solid steel ball of 2 kg mass, which shall be raised through a height of 1 m and allowed to drop and impact the surface of the assembly under test, thus providing an impact energy of 20 J (see Figure 103a and Figure 103b).

For each of the two tests detailed below, the test shall consist of one blow aimed at the centre of each of the vertical surfaces of the assembly which are visible when it is installed in its normal service position. Separate enclosures ~~may~~ can be used for each of the test blows.

In the case of an enclosure of cylindrical form, the test shall consist of three blows which are positioned with an angular displacement of 120°.

Test 1 shall be carried out at an ambient air temperature of between 10 °C and 40 °C after the assembly has been kept within these temperatures for not less than 12 h.

Test 2 shall be carried out at an ambient air temperature of between 10 °C and 40 °C immediately after the assembly has been kept at a temperature of $-25\ ^{0}_{-0,5}$ °C for a period of not less than 12 h. Test 2 is not required when a PENDA has an enclosure made of metallic material.

Compliance is checked by verification after the test that the degree of protection remains in accordance with 8.2.2, and the operation of the door(s) and locking points are not impaired; also by verification that the electrical clearances have remained satisfactory for the duration of the tests and in the case of an assembly having a metallic enclosure, that no contact between live parts and the enclosure has occurred caused by permanent or temporary distortion. In the case of an assembly having an insulating enclosure, if the appropriate conditions are satisfied, then damage such as small dents or small degrees of surface cracking or flaking are disregarded, provided that there are no associated cracks detrimental to the serviceability of the assembly.

10.2.101.5.2 Test applicable to ~~PENDAs~~ PENDA-Os designed for operation in arctic climate (see 7.1.1~~.2~~)

~~Following the ASSEMBLY being kept at a temperature of °C for a period of not less than 12 h, the impact test shall be carried out in an ambient air temperature between 10 °C and 40 °C and at a time when the external temperature of the enclosure has recovered to a temperature not higher than –40 °C. The test sequence shall be as follows:~~

~~Tests 1 and 2 involve applying a force of 1 500 N for 30 s to an earthed metal test body against the enclosure at the considered 10 weakest points. The test body shall be of spherical or hemispherical shape having a radius of 100 mm ± 3 mm and a surface hardness of HB 160 according to ISO 6506-1.~~

The specimen shall be kept at a temperature of -50 °C for a period of not less than 12 h. Tests shall be carried out in an ambient air temperature between 10 °C and 40 °C and at a time when the external temperature of the enclosure has recovered to a temperature not higher than -40 °C.

Test sequence:

For test 1 and test 2 a metal test body of spherical or hemispherical shape having a radius of 100 mm ± 3 mm and a surface hardness of HB 160 according to ISO 6506-1:2014 shall be used. Test 2 requires earthing of the test body.

Test 1 shall be carried out on an empty PENDA-O applying a force of 1 500 N for 30 s at the considerably 10 weakest points of the enclosure.

Compliance is checked by verification after the test that the degree of protection remains in accordance with 8.2.2 and the operation of the door(s) and locking points are not impaired.

Test 2 shall be carried out on an assembly containing equipment that provides the minimum clearances inside the enclosure. A metal enclosure shall be connected to earth, in case of an enclosure made of insulating materials all parts within the assembly that are intended to be connected to earth shall be connected to earth. ~~For the duration of the impact test, an a.c. voltage in accordance with 10.9.2.2 of Part 1 shall be applied between all live parts connected together and the earth.~~

A force of 1 500 N shall be applied for 30 s to earthed metal test body at the considerably 10 weakest points of the enclosure. For the duration of the test, an AC voltage in accordance with 10.9.2.2 of IEC 61439-1:2020, shall be applied between all live parts connected together and the earth.

Compliance is checked by verification that no puncture or flashovers occurs.

Test 3 shall be carried out on an empty enclosure using an impact apparatus as described in 10.2.101.5.1, but having a solid steel ball with an approximate mass of 15 kg. This striker element shall be raised through a height of approximately 1 m allowed to drop and impact the surface of the assembly under test, to provide an impact energy of 150 J (see Figure 103a and Figure 103b).

The test shall consist of one blow aimed at the centre of each of the vertical surfaces of the assembly which are visible when it is installed in its normal service position. Separate enclosures ~~may~~ can be used for each of the test blows.

In the case of an enclosure of cylindrical form, the test shall consist of three blows which are positioned with an angular displacement of 120°.

~~Compliance for Test 1 is checked by verification after the test that the degree of protection remains in accordance with 8.2.2, and the operation of the door(s) and locking points are not impaired.~~

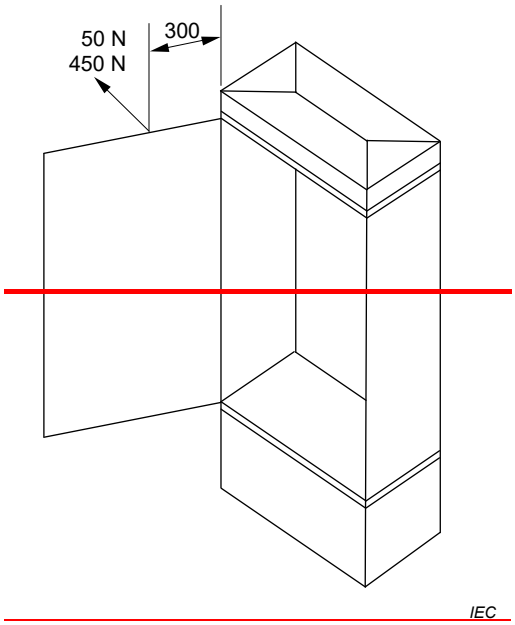
~~Compliance for Test 2 is checked by verification that no puncture or flashover occurs.~~

Compliance for Test 3 is checked by verification after the test that the degree of the protection is at least IP3X.

10.2.101.6 Verification of mechanical strength of doors

The test applies to all types of PENDA-O having a door(s) hinged on a vertical edge of the enclosure.

The tests shall be carried out with the door(s) fully open and in contact with the designed restraint. A load of ~~50~~ 450 N shall be applied at the top edge of the door perpendicular to the plane of the door(s) and at a distance 300 mm from the hinged edge and maintained for 3 s (see Figure 107). ~~Unless the door(s) are designed to be unhinged without the use of a tool for maintenance or operational use, the test shall then be repeated with the load increased to 450 N (see Figure 107).~~



Dimensions in millimetres

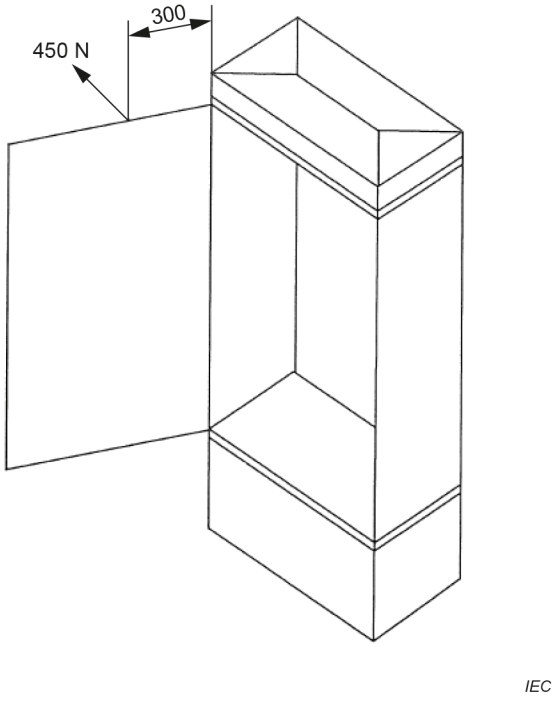


Figure 107 – Diagram of test to verify the mechanical strength of doors

Compliance is checked by verification that ~~the door(s) have not become unhinged and the operation of the door(s), hinges and locking points are not impaired by the application of a load of 50 N. In addition, by verification that~~ the degree of protection remains in accordance with 8.2.2 after the door(s) has (have) been closed following tests. If the door(s) become unhinged during the ~~450 N~~ test, this is not regarded as a failure if it is possible to reinstall the same door(s) without the use of a tool and the operation of hinges and locking points are not impaired.

10.2.101.7 Verification of resistance to axial load of metal inserts in synthetic material

The test only applies to all types of assembly when threaded metal inserts are provided to retain the mounting plate or switchgear and controlgear supports in place.

The test shall be carried out on a representative specimen of each type and size of metal insert. Also, if there is a difference in the thickness of the profile of the material surrounding a particular insert, the test shall be repeated for this condition.

During the test the assembly shall be fully supported on a platform.

A screw-eye shall be fitted to each insert under test and an axial force in accordance with Table 102 shall be applied for 10 s in an attempt to extract the insert from its anchorage.

Table 102 – Axial load to be applied to the inserts

Size of insert	Axial load N
M4	350
M5	350
M6	500
M8	500
M10	800
M12	800

Compliance is checked by inspection that the inserts remain undamaged and in their original position; and also, that there is no cracking of the surrounding material forming the anchorage for the insert.

NOTE Small cracks, created by air bubbles that were visible before the test, but not affected by the application of the axial load, are ignored.

10.2.101.8 Verification of resistance to mechanical shock impacts induced by sharp-edged objects

The test applies to all types of PENDA-O.

The test shall be carried out using an impact apparatus as described in 10.2.101.5.1 but having a steel striker element with a mass of 5 kg and having the end profiled as shown in Figure 108.

Dimensions in millimetres

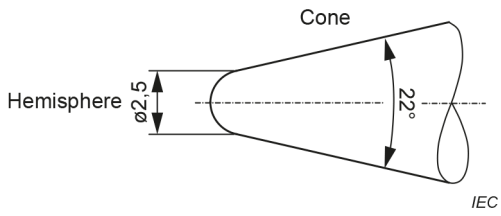


Figure 108 – Striker element for test of resistance to mechanical shock impacts induced by sharp-edged objects

The striker element shall be raised through a height of 0,4 m and allowed to drop and impact the surface of the assembly under test, thus providing an impact energy of 20 J (see Figure 103a and Figure 103b).

Each test shall consist of one blow aimed at the centre of each of the vertical surfaces of the assembly which are visible when the assembly is installed in its normal service position. Separate enclosures ~~may~~ can be used for each of the test blows.

In the case of an enclosure of cylindrical form, the test shall consist of three blows which are positioned with an angular displacement of 120°.

Test 1 shall be carried out at an ambient air temperature between 10 °C and 40 °C after the assembly has been kept within these temperatures for not less than 12 h.

Test 2 shall be carried out at an ambient air temperature between 10 °C and 40 °C immediately after the assembly has been kept at a temperature of $-25\,^{0}_{-5}$ °C for a period of not less than 12 h. Test 2 is not required when a PENDA has an enclosure made of metallic material.

Compliance is checked by inspection that cracks resulting from the blows are contained within a circle of diameter not exceeding 15 mm. If the tip of the striker element has penetrated the enclosure of the assembly, it shall not be possible to insert a gauge of 4 mm diameter having a hemispherical tip, applied to the hole with a force of 5 N.

10.2.101.9 Test of mechanical strength of a base intended to be embedded in the ground

This test is applicable to a PENDA-O only.

The test shall be carried out with the PENDA-O fixed to the base, in accordance with Figure 109 and the manufacturer's installation instructions. A mechanical force is transferred via a thick-walled steel tube and shall be applied to the lowest part of the longest section of the PENDA base that is beneath the ground surface when it is installed.

Dimensions in millimetres

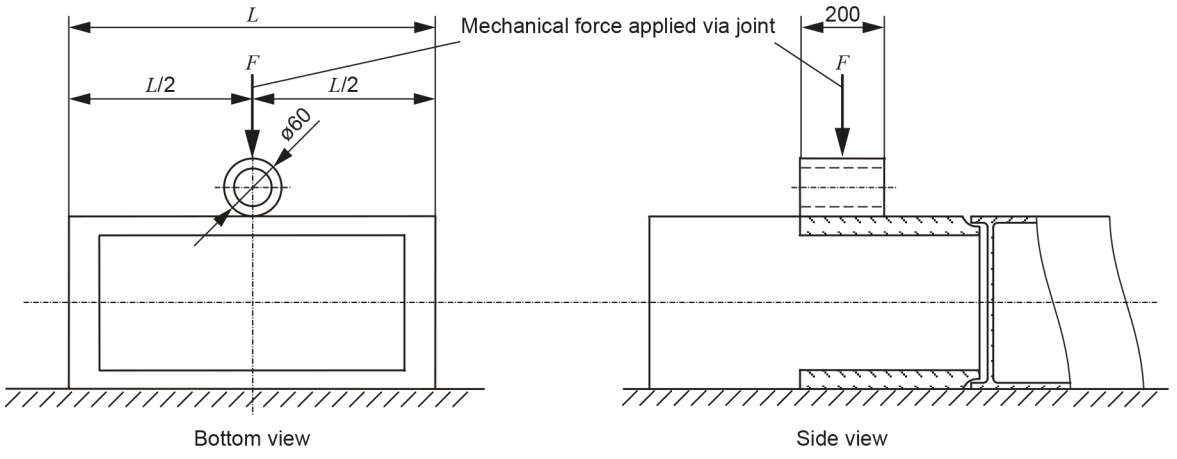


Figure 109 – Typical test arrangement for mechanical strength of base

If the design of the base includes one or more permanent supports (back to front), the force shall be applied by means of a number of steel tubes. One tube shall be placed in the centre of each unsupported length. The individual forces shall simultaneously be applied to each tube and shall be calculated according to the following formula:

$$F = 3{,}5\ \text{N/mm} \times L$$

where L is the unsupported length in millimetres.

The force(s) shall be applied for 1 min. After this period and whilst the force is still maintained, the degree of protection shall be verified.

If there is another section of the PENDA-O base that is of similar length but has a different profile, the test shall be repeated on this section.

Compliance is checked by inspection that the base has not broken and by verification that the degree of protection of that part of the PENDA-O and base which is normally above ground remains in accordance with 8.2.2.

10.3 Degree of protection of assemblies (IP Code)

Add the following first paragraph:

The declared IP for a PENDA-O does not apply to a base intended to be embedded in the ground. However, the declared IP does apply to the bottom of the assembly.

If a PENDA-O consists of an enclosure and a base (to be embedded in the ground or to be surface mounted) without sealed cable entry, ingress of solid objects through the ground area inside of the base is excluded when determining the degree of protection. When the PENDA is mounted on a base with an open ground area the PENDA and any exposed area of the base shall provide the PENDA with the minimum level of IP protection specified in this document.

NOTE In some instances, additional measure are taken to prohibit the entry of animals/vermin

10.5 Protection against electric shock and integrity of protective circuits

10.5.3.1 General

Replacement of the two paragraphs with the following:

Verification shall be achieved by the application of tests in accordance with 10.5.3.5 of IEC 61439-1:2020.

10.9 Dielectric properties

Additional subclause:

10.9.2.101 Power frequency dielectric test for PENDA's installed in substation with separate HV and LV neutral earths.

When a PENDA is to form part of a distribution substation in which the HV and LV earths are separated an additional dielectric test shall be carried out. A test voltage equal to the HV line to earth voltage shall be applied between the phase plus neutral conductor and the extraneous conductive part of the PENDA for a period of 10 s. Acceptance criteria shall be as given in 10.9.2.4 of IEC 61439-1:2020.

10.9.3 Impulse withstand voltage

10.9.3.1 General

Replacement of the first paragraph with:

Verification shall be achieved by the application of tests in accordance with one of the alternative test methods detailed in 10.9.3.2 to 10.9.3.4, inclusive, of IEC 61439-1:2020.

10.10 ~~Verification of~~ Temperature rise

10.10.1 General

Replacement with:

It shall be verified that the temperature-rise limits specified in 9.2 of IEC 61439-1:2020 for the different parts of the assembly will not be exceeded. Verification shall be by test as specified in 10.10.2 of IEC 61439-1:2020.

Temperature rise verification shall be undertaken on a representative sample(s). It is not necessary to test every arrangement produced, but the sample(s) tested shall, with reasonable accuracy, be thermally the most onerous for the range being considered. Assessing the most onerous arrangement(s) shall take into consideration total power loss, rating of devices (incoming and outgoing), sections of conductors, size of the enclosure and the rated current of the assembly.

10.10.2 Verification by testing

10.10.2.2 Selection of the representative arrangement

10.10.2.2.1 General

Addition of the following paragraph:

When the design of a PENDA is suitable for installation in a recess in wall the temperature rise test shall be carried out with ~~adequate~~ insulation to simulate the presence of the wall.

10.11 Short-circuit withstand strength

10.11.1 General

Replacement with:

With the exception of the circuits of assemblies that are exempt verification in accordance with 10.11.2 of IEC 61439-1:2020, the short-circuit withstand strength specified by the manufacturer shall be verified. Verification shall be by means of test as specified in 10.11.5 of IEC 61439-1:2020.

11 Routine verification

This clause of IEC 61439-1:2020 applies.

Annexes

The annexes of IEC 61439-1:2020 are applicable except as follows:

Annexes A, C, D, H, ~~N~~ K and ~~P~~ M are not applicable.

Modification of Annex ~~O~~ L.

Addition of Annexes AA, BB, CC and DD.

Annex ~~O~~ L
(informative)

Guidance on verification of temperature rise ~~verification~~

Modifications:

~~O.4 Calculation~~

~~This clause of Part 1 is not applicable.~~

~~O.5 Design rules~~

~~This clause of Part 1 is not applicable.~~

L.4 Verification assessment

This clause of IEC 61439-1:2020 is not applicable.

L.5 Verification by comparison with a reference design

This clause of IEC 61439-1:2020 is not applicable.

Annex AA
(normative)

Cross-section of conductors

Table AA.1 applies for the connection of one cable per terminal.

Table AA.1 – Minimum and maximum cross-section of copper and aluminium conductors, suitable for connection (see 8.8)

Rated current A	Solid or stranded conductors (aluminium or copper) Cross-sections mm^2		Flexible copper conductors Cross sections mm^2	
	Minimum	Maximum	Minimum	Maximum
6	0,75	1,5	0,5	1,5
8	1	2,5	0,75	2,5
10	1	2,5	0,75	2,5
12	1	2,5	0,75	2,5
16	1,5	4	1	4
20	1,5	6	1	4
25	2,5	6	1,5	4
32	2,5	10	1,5	6
40	4	16	2,5	10
63	6	25	6	16
80	10	35	10	25
100	16	50	16	35
125	25	70	25	50
160	35	95	35	70
200	50	150	50	95
250	70	150	70	120
315	70	240	95	185
400	70	240	95	185
500	70	300	95	240
630	70	300	95	240

This table applies for the connection of one conductor per terminal.

If the external conductors are connected directly to built-in apparatus, the cross-sections indicated in the relevant specification are valid.

In cases where it is necessary to provide for conductors other than those specified in the table, agreement shall be reached between the manufacturer and the user.

The approximate relationship between mm^2 and AWG/kcmil sizes as shown in Table AA.2 is to be used where metric sized round copper conductors are not available.

Table AA.2 – Standard cross-sections of round copper conductors and approximate relationship between mm² and AWG/kcmil sizes (see 8.8 of IEC 61439-1:2020)

Rated cross-section mm²	AWG/kcmil size	Equivalent metric area mm²
0,2	24	0,205
0,34	22	0,324
0,5	20	0,519
0,75	18	0,82
1	–	–
1,5	16	1,3
2,5	14	2,1
4	12	3,3
6	10	5,3
10	8	8,4
16	6	13,3
25	4	21,2
35	2	33,6
–	1	42,4
50	0	53,5
70	00	67,4
95	000	85,0
–	0000	107,2
120	250 kcmil	127
150	300 kcmil	152
185	350 kcmil	177
–	400 kcmil	203
240	500 kcmil	253
300	600 kcmil	304

NOTE The dash, when it appears, counts as a size when considering connecting capacity (see 8.8).

Annex BB
(informative)

Items subject to agreement between the assembly manufacturer and the user

The information given in Table BB.1 below is subject to an agreement between the assembly manufacturer and the user. In some cases, information declared by the assembly manufacturer ~~may~~ can take the place of an agreement.

Table BB.1 – Items subject to agreement between the ASSEMBLY manufacturer and the user

Characteristics	Reference clause or subclause [c]	Default arrangement [b]	Options listed in document	User requirement [a]
Electrical system				
Earthing system	5.6, 8.4.3.1, 8.4.3.2.3, 8.6.2, 10.5, 11.4	Manufacturer's standard, selected to suit local requirements	TT / TN-C / TN-C-S / IT, TN-S	
Nominal voltage (V)	3.8.9.1, 5.2.1, 8.5.3	Local, according to installation conditions	max 1 000 V AC	
Transient overvoltages	5.2.4, 8.5.3, 9.1, Annex G	Overvoltage category IV	None	
Temporary overvoltages	9.1	Nominal system voltage + 1 200 V	None	
Rated frequency f_n (Hz)	3.8.12, 5.5, 8.5.3, 10.10.~~2~~3.1, 10.11.5.4	According to local installation conditions	50 Hz/60 Hz	
Additional on-site testing requirements: wiring, operational performance and function	11.10	Manufacturer's standard, according to application	None	
Short-circuit withstand capability				
Prospective short-circuit current at supply terminals I_{cp} (kA)	3.8.7	Determined by the electrical system	None	
Prospective short-circuit current in the neutral	10.11.5.3.5	Max. 60 % of phase values	None	
Prospective short-circuit current in the protective circuit	10.11.5.6	Max. 60 % of phase values	None	
SCPD in the incoming functional unit requirement	9.3.2	According to local installation conditions	Yes / No	
Co-ordination of short-circuit protective devices including external short-circuit protective device details	9.3.4	According to local installation conditions	None	
Data associated with loads likely to contribute to the short-circuit current	9.3.2	No loads likely to make a significant contribution allowed for	None	

Characteristics	Reference clause or subclause [c]	Default arrangement [b]	Options listed in document	User requirement [a]
Protection of persons against electric shock in accordance with IEC 60364-4-41				
Type of protection against electric shock – Basic protection (protection against direct contact)	8.4.2	Basic protection	According to local installation regulations	
Type of protection against electric shock – Fault protection (protection against indirect contact)	8.4.3	According to local installation conditions	Automatic disconnection of supply / Electrical separation / Total insulation	
Installation environment				
Location type	3.5, 8.1.4, 8.2	Manufacturer's standard, according to application	Indoor / outdoor	
Protection against ingress of solid foreign bodies and ingress of water	8.2.2, 8.2.3	Indoor (enclosed): minimum IP2X Outdoor - minimum: IP34D when installed in places accessible to the public. In other locations IP33.		
External mechanical impact NOTE IEC 61439-5 does not nominate specific IK codes.	10.2.101	As Standard (IEC 61439-5)	None	
Resistance to UV radiation (applies for outdoor assemblies only unless specified otherwise)	10.2.4	Indoor: Not applicable. Outdoor: Temperate climate	None	
Resistance to corrosion	10.2.2	Normal Indoor/Outdoor arrangements	None	
Ambient air temperature – Lower limit	7.1.1	Indoor: –5 °C Outdoor: Normal climate –25 °C Arctic climate –50 °C	None	
Ambient air temperature – Upper limit	7.1.1	40 °C	None	
Ambient air temperature – Daily average maximum	7.1.1, 9.2	35 °C	None	
Maximum relative humidity	7.1.~~2~~1	Indoor: ~~50~~ 95 % at −5 °C to +30 °C 70 % at +35 °C 57 % at +40 °C Outdoor: 100 % at −25 °C to +27 °C 60 % at 35 °C 46 % at 40 °C	None	

Characteristics	Reference clause or subclause [c]	Default arrangement [b]	Options listed in document	User requirement [a]
Pollution degree (of the installation environment)	7.1.~~3~~2	~~**Industrial**~~ PENDA-O: 4 PENDA-I: 3	2, 3, 4	
Altitude	7.1.~~4~~1	≤ 2 000 m	None	
EMC environment (A or B)	9.4, 10.12, Annex J	A/B	A/B	
Special service conditions (e.g. vibration, exceptional condensation, heavy pollution, corrosive environment, strong electric or magnetic fields, fungus, small creatures, explosion hazards, heavy vibration and shocks, earthquakes)	7.2, 8.5.4, 9.3.3 Table 7	No special service conditions	Arctic climate	
Installation method				
Type	3.3, 5.6	Manufacturer's standard	Various e.g. ground mounting, transformer mounting, pole mounting, surface wall mounting or mounting within a recess within a wall	
Stationary/Movable	3.5	Stationary	None	
Maximum overall dimensions and weight	5.6, 6.2.1	Manufacturer's standard, according to application	None	
External conductor type(s)	8.8	Cable	Bare or insulated bars.	
Direction(s) of external conductors	8.8	From below	From above	
External conductor material	8.8	Copper/ aluminium	None	
External phase conductor, cross sections, and terminations	8.8	As defined within the document	None	
External PE, N, PEN conductors cross sections, and terminations	8.8	As defined within the document	None	
Special terminal identification requirements	8.8	Manufacturer's standard	None	
Storage and handling				
Maximum dimensions and weight of transport units	6.2.2, 10.2.5	Manufacturer's standard	None	
Methods of transport (e.g. forklift, crane)	6.2.2, 8.1.6	Manufacturer's standard	None	
Environmental conditions different from the service conditions	7.3	As service conditions	None	
Packing details	6.2.2	Manufacturer's standard	None	
Operating arrangements				
Access to manually operated devices	8.4	Authorised persons	None	

Characteristics	Reference clause or subclause [c]	Default arrangement [b]	Options listed in document	User requirement [a]
Location of manually operated devices	8.5.5	Easily accessible	None	
Isolation of load installation equipment items	8.4.2, 8.4.3.3, 8.4.6.2	Manufacturer's standard	Individual / groups / all	
Maintenance and upgrade capabilities				
Requirements related to accessibility for inspection and similar operations	8.4.6.2.2	No requirements for accessibility	None	
Requirements related to accessibility for maintenance in service by authorized persons	8.4.6.2.3	No requirements for accessibility	None	
Requirements related to accessibility for extension in service by authorized persons	8.4.6.2.4	No requirements for accessibility	None	
Method of functional units connection	8.5.1, 8.5.2	Manufacturer's standard	None	
Protection against direct contact with hazardous live internal parts during maintenance or upgrade (e.g. functional units, main busbars, distribution busbars)	8.4	No requirements for protection during maintenance or upgrade	None	
Current carrying capability				
Maximum total load current to be supplied by the assembly (from which the rated current of the assembly I_{nA} (A) will be determined)	3.8.~~9~~10.1, 5.3, 8.4.3.2.3, 8.5.3, 8.8, 10.10.2, 10.10.3, 10.11.5, Annex E	Manufacturer's standard, according to application	None	
~~Rated current of circuits I_{nc} (A)~~	~~5.3.2~~	~~Manufacturer's standard, according to application~~	~~None~~	
~~Rated diversity factor~~	~~5.4, 10.10.2.3, Annex E~~	~~**As defined within the standard**~~	~~RDF for groups of circuits / RDF for whole ASSEMBLY~~	
Design current I_B and nature of load for each circuit; alternatively, I_n of the devices and nature of the load (in such cases, the assumed loading factors can be used based on the relevant part of IEC 61439)	3.8.10.8	None	None	
Ratio of cross section of the neutral conductor to phase conductors: phase conductors up to and including 16 mm^2	8.6.1	100 %	None	
Ratio of cross section of the neutral conductor to phase conductors: phase conductors above 16 mm^2	8.6.1	50 % (min. 16 mm^2)	None	

[a] For exceptionally onerous applications, the user ~~may need to~~ can specify more stringent requirements to those in the standard.

[b] In some cases information declared by the assembly manufacturer ~~may~~ can take the place of an agreement.

[c] When a reference does not exist in this document, IEC 61439-1:2020 applies.

Annex CC
(informative)

Design verification

Table CC.1 – List of design verifications to be performed

No.	Characteristic to be verified	Clauses or subclauses
1	Strength of material and parts:	10.2
	Resistance to corrosion	10.2.2
	Properties of insulating materials:	10.2.3
	Thermal stability	10.2.3.1
	Resistance to abnormal heat and fire due to internal electric effects	10.2.3.2
	Dry heat	10.2.3.101
	Category of flammability	10.2.3.102
	Resistance to ultra-violet (UV) radiation	10.2.4
	Lifting	10.2.5
	Mechanical impact	10.2.101
	Resistance to static load	10.2.101.2
	Resistance to shock load	10.2.101.3
	Resistance to torsional stress	10.2.101.4
	Impact force withstand	10.2.101.5
	Mechanical strength of doors	10.2.101.6
	Resistance to axial load of metal inserts in synthetic material	10.2.101.7
	Resistance to mechanical shock induced by sharp objects	10.2.101.8
	Mechanical strength of a base intended to be embedded in the ground	10.2.101.9
	Marking	10.2.7
2	Degree of protection of enclosures	10.3
3	Clearances	10.4
4	Creepage distances	10.4
5	Protection against electric shock and integrity of protective circuits:	10.5
	Effective continuity between the exposed conductive parts of the ASSEMBLY and the protective circuit	10.5.2
	Short-circuit withstand strength of the protective circuit	10.5.3
6	Incorporation of switching devices and components	10.6
7	Internal electrical circuits and connections	10.7
8	Terminals for external conductors	10.8
9	Dielectric properties:	10.9
	Power-frequency withstand voltage	10.9.2
	Impulse withstand voltage	10.9.3
10	Temperature-rise limits	10.10
11	Short-circuit withstand strength	10.11
12	Electromagnetic compatibility (EMC)	10.12
13	Mechanical operation	10.13

No.	Characteristic to be verified	Clauses or subclauses [a]
1	Strength of material and parts:	10.2
	Resistance to corrosion	10.2.2
	Properties of insulating materials:	10.2.3
	Thermal stability	10.2.3.1
	Resistance to abnormal heat and fire due to internal electric effects	10.2.3.2
	Category of flammability	10.2.3.101
	Resistance to ultra-violet (UV) radiation	10.2.4
	Lifting	10.2.5
	Mechanical impact	10.2.101
	Resistance to static load	10.2.101.2
	Resistance to shock load	10.2.101.3
	Resistance to torsional stress	10.2.101.4
	Impact force withstand	10.2.101.5
	Mechanical strength of doors	10.2.101.6
	Resistance to axial load of metal inserts in synthetic material	10.2.101.7
	Resistance to mechanical shock induced by sharp objects	10.2.101.8
	Mechanical strength of a base intended to be embedded in the ground	10.2.101.9
	Marking	10.2.7
	Mechanical operation	10.2.8
2	Degree of protection of enclosures	10.3
3	Clearances	10.4
4	Creepage distances	10.4
5	Protection against electric shock and integrity of protective circuits:	10.5
	Effective continuity between the exposed conductive parts of the assembly and the protective circuit	10.5.2
	Short-circuit withstand strength of the protective circuit	10.5.3
6	Incorporation of switching devices and components	10.6
7	Internal electrical circuits and connections	10.7
8	Terminals for external conductors	10.8
9	Dielectric properties:	10.9
	Power-frequency withstand voltage	10.9.2
	Impulse withstand voltage	10.9.3
10	Temperature-rise limits	10.10
11	Short-circuit withstand strength	10.11
12	Electromagnetic compatibility (EMC)	10.12

[a] When a reference does not exist in this document, IEC 61439-1:2020 applies.

Annex DD
(informative)

List of notes concerning certain countries

Subclause	Text
8.8	Add the following note after the last paragraph: NOTE In the United States of America (USA) the conductor size requirement is dependent on the current rating, conductor insulation temperature rating, ambient temperature and configuration, along with conductor insulation type. The specific requirements are contained in the US National Electrical Code (NEC) NFPA 70 Chapter 3.

Bibliography

The bibliography of IEC 61439-1:2020 is applicable except as follows:

Addition:

~~ISO 9223, *Corrosion of metals and alloys – Corrosivity of atmospheres – Classification, determination and estimation*~~

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)*, available at www.electropedia.org

SVENSK STANDARD

SS-EN IEC 61439-5, utg 3:2024

Fastställd	Sida	Ansvarig kommitté
2024-04-24	1 (41)	SEK TK 121B

Kopplingsutrustningar för högst 1000 V växelspänning eller 1500 V likspänning – Del 5: Särskilda fordringar på kabelskåp och lågspänningsfördelningar i nätstationer

Low-voltage switchgear and controlgear assemblies – Part 5: Assemblies for power distribution in public networks

Som svensk standard gäller europastandarden EN IEC 61439-5:2023 Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 61439-5:2023.

Nationellt förord

Europastandarden EN IEC 61439-5:2023

består av:

– **europastandardens ikraftsättningsdokument,** utarbetat inom CENELEC
– **IEC 61439-5, Third edition, 2023 - Low-voltage switchgear and controlgear assemblies – Part 5: Assemblies for power distribution in public networks**

utarbetad inom International Electrotechnical Commission, IEC.

Standarden ska användas tillsammans med SS-EN IEC 61439-1, utg 3:2021.

Tidigare fastställd svensk standard SS-EN 61439-5, utg 2:2015 med eventuella tillägg, ändringar och rättelser gäller ej fr o m 2026-09-06.

ICS 29.130.20

Denna standard är fastställd av SEK Svensk Elstandard,
som också kan lämna upplysningar om **sakinnehållet** i standarden.
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Telefon: 08 - 444 14 00.
E-post: sek@elstandard.se. Internet: www.elstandard.se

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

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Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 61439-5

September 2023

ICS 29.130.20

Supersedes EN 61439-5:2015;
EN 61439-5:2015/AC:2015

English Version

Low-voltage switchgear and controlgear assemblies - Part 5: Assemblies for power distribution in public networks (IEC 61439-5:2023)

Ensembles d'appareillage à basse tension - Partie 5: Ensembles pour réseaux de distribution publique (IEC 61439-5:2023)

Niederspannungs-Schaltgerätekombinationen - Teil 5: Schaltgerätekombinationen in öffentlichen Energieverteilungsnetzen (IEC 61439-5:2023)

This European Standard was approved by CENELEC on 2023-09-06. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN IEC 61439-5:2023 E

SEK Svensk Elstandard SS-EN IEC 61439-5, utg 3:2024

European foreword

The text of document 121B/173/FDIS, future edition 3 of IEC 61439-5, prepared by SC 121B "Low-voltage switchgear and controlgear assemblies" of IEC/TC 121 "Switchgear and controlgear and their assemblies for low voltage" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61439-5:2023.

The following dates are fixed:

•	latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop) 2024-06-06
•	latest date by which the national standards conflicting with the document have to be withdrawn	(dow) 2026-09-06

This document supersedes EN 61439-5:2015 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a Standardization Request addressed to CENELEC by the European Commission.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 61439-5:2023 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cencenelec.eu.

The Annex ZA of EN IEC 61439-1:2021 applies with the following changes:

Publication	Year	Title	EN/HD	Year
Add the following references:				
IEC 60695-11-10	2013	Fire hazard testing - Part 11-10: Test flames - 50 W horizontal and vertical flame test methods	EN 60695-11-10	2013
IEC 61439-1	2020	Low-voltage switchgear and controlgear assemblies - Part 1: General rules	EN IEC 61439-1	2021
IEC 62262	-	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)	EN 62262	-
ISO 6506-1	2014	Metallic materials - Brinell hardness test - Part 1: Test method	EN ISO 6506-1	2014
ISO 9223	2012	Corrosion of metals and alloys - Corrosivity of atmospheres - Classification, determination and estimation	EN ISO 9223	2012

IEC 61439-5

Edition 3.0 2023-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Low-voltage switchgear and controlgear assemblies – Part 5: Assemblies for power distribution in public networks

Ensembles d'appareillage à basse tension – Partie 5: Ensembles pour réseaux de distribution publique

SEK Svensk Elstandard

SS-EN IEC 61439-5, utg 3:2024

IEC 61439-5:2023-05(en-fr)

IEC 61439-5

Edition 3.0 2023-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Low-voltage switchgear and controlgear assemblies – Part 5: Assemblies for power distribution in public networks

Ensembles d'appareillage à basse tension – Partie 5: Ensembles pour réseaux de distribution publique

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.130.20

ISBN 978-2-8322-6939-8

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 5: Assemblies for power distribution in public networks

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 61439-5 has been prepared by subcommittee 121B: Low-voltage switchgear and controlgear assemblies, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage. It is an International Standard.

This third edition cancels and replaces the second edition published in 2014. This edition constitutes a technical revision.

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

a) omission of the requirement to conduct mechanical tests at -25 °C when enclosures are made of a metallic material;
b) addition of assumed loading factors generation supplies and electric vehicle charging applications;
c) additional dielectric tests when a PENDA is used in a distribution substation with separate HV and LV earths;
d) further clarification of representative samples for design verification.

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

Draft	Report on voting
121B/173/FDIS	121B/178/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.

This document is to be read in conjunction with IEC 61439-1. The provisions of the general rules dealt with in IEC 61439-1 are only applicable to this document insofar as they are specifically cited. When this document states "addition", "modification" or "replacement", the relevant text in IEC 61439-1:2020 is to be adapted accordingly. Subclauses that are numbered with a 101 (102, 103 etc.) suffix are additional to the same subclause in IEC 61439-1:2020.

Tables and figures in IEC 61439-5:2023 that are new are numbered starting with 101.

New annexes in IEC 61439-5:2023 are lettered AA, BB, etc.

The reader’s attention is drawn to the fact that Annex DD lists all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.

A list of all parts of the IEC 61439 series, under the general title *Low-voltage switchgear and controlgear assemblies* 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.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 5: Assemblies for power distribution in public networks

1 Scope

This document defines the specific requirements for public electricity network distribution assemblies (PENDAs).

PENDAs have the following criteria:

– used for the distribution of electrical energy in three phase systems for which the rated voltage does not exceed 1 000 V AC (see Figure 101 for a typical distribution network) and DC systems not exceeding 1 500 V DC;
– stationary;
– open type assemblies are not covered by this document;
– suitable for installation in places where only skilled persons have access for their use, however, outdoor types can be installed in situations that are accessible to ordinary persons
  - intended for use in energy distribution in public power grids;
  - indoor use: assemblies for installation inside of electric power substations;
  - outdoor use: assemblies containing an enclosure suitable for open air installation.

The object of this document is to state the definitions and to specify the service conditions, construction requirements, technical characteristics and tests for PENDAs. Tests at higher performance level can be applicable with some network parameters.

PENDAs can also include control and or signalling devices associated with the distribution of electrical energy.

NOTE 1 Control and monitoring devices can be used in smart grid applications or the transmission of smart grid data.

This document applies to all PENDAs whether they are designed, manufactured on a one-off basis or fully standardised and manufactured in quantity.

The manufacture and/or assembly can be carried out other than by the original manufacturer (see 3.10.1 of IEC 61439-1:2020).

This document does not apply to individual devices and self-contained components, such as motor starters, fuse switches, electronic equipment, etc. which comply with the relevant product standards.

If the substation is owned or operated by a public distribution system operator (DSO), PENDA’s which are used as LV distribution panels in transformer substations are within the scope of this document,

This document does not apply to specific types of assemblies covered by other parts of IEC 61439 series.

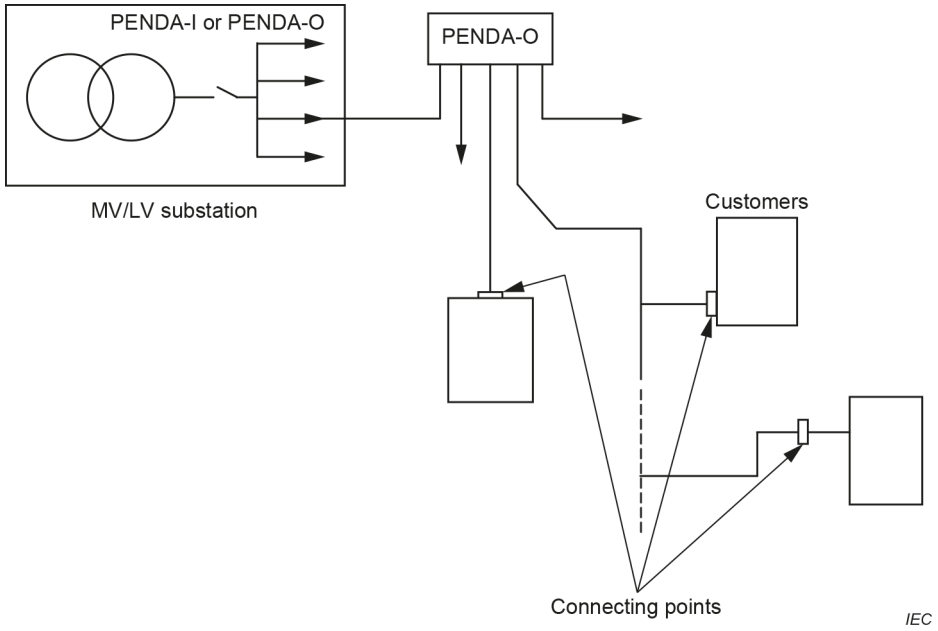

Figure 101 – Typical distribution network

NOTE 2 If a PENDA is equipped with additional equipment (for example meters), in such a way that the main function is changed considerably, then other standards can also apply as agreed between user and manufacturer (see 8.5 of IEC 61439-1:2020).

NOTE 3 Where local regulations and practices permit, a PENDA according to this document can be used in other than public networks.

NOTE 4 DSO's can define additional requirements for their PENDA's.

2 Normative references

This clause of IEC 61439-1:2020 applies except as follows.

Addition:

IEC 60695-11-10:2013, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 61439-1:2020, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

ISO 9223:2012, *Corrosion of metals and alloys – Corrosivity of atmospheres – Classification, determination and estimation*

ISO 6506-1:2014, *Metallic materials – Brinell hardness test – Part 1: Test method*

3 Terms and definitions

This clause of IEC 61439-1:2020 applies except as follows.

3.1 General terms

Additional terms:

3.1.101
public electricity network distribution assembly
PENDA
assembly, generally for installation in a public electricity network which in use, receives electrical energy from one or more supplies and distributes that energy through one or more cables to other equipment

Note 1 to entry: A PENDA is installed, operated and maintained solely by skilled persons.

Note 2 to entry: Some types of a PENDA were previously known as a cable distribution cabinet (CDC).

3.1.101.1
outdoor public electricity network distribution assembly
PENDA-O
cubicle type public electricity network distribution assembly that is suitable for outdoor installation in places that can, or cannot, be accessible to the public

3.1.101.2
indoor public electricity network distribution assembly
PENDA-I
public electricity network distribution assembly suitable for installation indoors, generally without an enclosure, but including all structural parts necessary to support busbars, functional units and other ancillary devices, necessary to complete the assembly

3.1.102
design life
minimum duration for which specified performance characteristics of equipment are expected when the equipment is operated as intended and regularly maintained by instructed persons in accordance with the manufacturer’s instructions

[SOURCE: IEC 60050-395:2014, 395-07-93, modified – Note to entry omitted and 'granted' replaced by 'expected when ..... instructions'.]

3.3 External design of assemblies

3.3.1
open-type assembly
This term of IEC 61439-1:2020 does not apply.

3.9 Verification

Modifications:

3.9.1
design verification
Delete the note.

3.9.1.2
verification comparison
This term of IEC 61439-1:2020 does not apply.

3.9.1.3
verification assessment
This term of IEC 61439-1:2020 does not apply.

4 Symbols and abbreviations

This clause of IEC 61439-1:2020 applies.

5 Interface characteristics

This clause of IEC 61439-1:2020 applies, except as follows.

5.4 Rated diversity factor (RDF)

Addition:

In the absence of an agreement between the assembly manufacturer and user concerning the actual load currents, the assumed loading of the outgoing circuits of the assembly or group of outgoing circuits can be based on the values given in Table 101.

For distribution and final circuits, it is assumed that the load current is the rated current of the protective device, I_n, as required by the user, multiplied with the loading factor of Table 101.

Table 101 – Values of assumed loading

Application	Assumed loading factor
Regular distribution grid connections 2 to 3 circuits	0,9
Regular distribution grid connections 4 to 5 circuits	0,8
Regular distribution grid connections 6 to 9 circuits	0,7
Regular distribution grid connections ≥ 10 circuits	0,6
Generation supply (e,g. PV, wind farm, biomass)	1,0
Charging infrastructure for EV	1,0

6 Information

This clause of IEC 61439-1:2020 applies except as follows.

6.1 Assembly designation marking

Addition to first paragraph:

Designation plates can be placed inside an enclosure of an assembly provided their intended place ensures good legibility and visibility when the door(s) is(are) open or the cover is removed.

Replacement of item g):

g) IEC 61439-5.

6.3 Device and/or component identification

Additional paragraph:

In the case of removable fuse-carriers which are specific to a fuseway, a label shall be placed on the fuse carrier as well as on the fuse base, to avoid incorrect interchangeability of the fuse-carrier.

Additional subclause:

6.101 Circuit identification

It shall be possible to identify each functional unit in a clearly visible manner.

7 Service conditions

This clause of IEC 61439-1:2020 applies except as follows.

7.1 Normal service conditions

7.1.1 Climatic conditions

Addition to the first paragraph:

Unless the user specifies that a PENDA shall be suitable for use in an arctic climate, the lower limit of ambient air temperature is –25 °C as specified in Table 15 of IEC 61439-1:2020. For an arctic climate the lower limit of ambient temperature is –50 °C.

7.1.2 Pollution degree

Replace the first paragraph with the following:

The pollution degree referred to in Annex BB is the macro-environmental condition for which the assembly is intended.

7.2 Special service conditions

Additional paragraph:

Additional requirements for a PENDA-O, to be installed where heavy snowfalls occur and where they are adjacent to areas where there is snow clearance by ploughing, are subject to agreement between manufacturer and user.

8 Constructional requirements

This clause of IEC 61439-1:2020 applies except as follows.

8.1 Strength of materials and parts

8.1.1 General

Change the reference to Annex C to Annex BB in paragraph 5 of 8.1.1 of IEC 61439-1:2020.

Addition:

A PENDA-O shall be arranged for ground mounting, transformer mounting, pole mounting, surface wall mounting or mounting within a recess within a wall, as agreed between user and manufacturer.

A PENDA can be directly coupled to a transformer by means of a flange coupling or it can connect to its supply by means of cable or via busbars as agreed between user and manufacturer. Outgoing circuits shall be suitable for connection by means of cables.

A locking device shall be provided on outdoor enclosures which prevents access by unauthorized persons. The fixings of any covers etc. which are removable for installation or maintenance operations shall only be accessible while the door(s) is (are) open.

Any auxiliary equipment, e.g. meters, relays, instruments, circuit breaker trip units, communications equipment, that can be readily replaced, are excluded from the minimum design life of a PENDA.

NOTE When applicable, a design life can be agreed between user and manufacturer, assuming it is operated as intended and regularly maintained by instructed personnel in accordance with the manufacturer's instructions.

8.1.3.2 Resistance of insulating materials to heat and fire

Additional subclause:

8.1.3.2.101 Verification of category of flammability

The insulating materials used for enclosures, barriers and other insulating parts shall have flammability properties in accordance with 10.2.3.101.

8.1.5 Mechanical strength

Additional subclause:

8.1.5.101 Verification of mechanical strength

The mechanical properties of a PENDA-O shall comply with 10.2.101.

Parts of the PENDA-O intended to be embedded in the ground shall withstand the stresses imposed on them during installation and normal service and comply with 10.2.101.9.

8.2 Degree of protection provided by an assembly enclosure

8.2.1 Protection against mechanical impact (IK code)

Subclause 8.2.1 of IEC 61439-1:2020 does not apply.

The mechanical impact tests required by this document are at least equal to IK10 in accordance with IEC 62262 (see 8.1.5.101).

8.2.2 Protection against contact with live parts, ingress of solid foreign bodies and water (IP code)

Addition:

Open type assemblies (IP00) are not covered by this document.

When a PENDA-O is intended to be installed in places accessible to the public, its enclosure shall, when fully-installed in accordance with the manufacturer's instructions, provide a degree of protection of at least IP34D according to IEC 60529. In other locations, the minimum level of protection shall be at least IP33.

PENDA-O's that are intended to be installed in places accessible to the public shall, unless otherwise stated by the user, be designed such that when any temporary cables are connected, the enclosure shall provide a degree of protection of at least IP23C according to IEC 60529. See 8.8.

8.4.2.1 General

The third paragraph does not apply.

Additional subclause:

8.4.2.101 Earthing and short-circuiting means

When specified by the user, the outgoing units in an assembly shall be so constructed that they can be earthed and short-circuited in a secure manner by means of a device(s) recommended by the manufacturer, which ensures the required degree of protection (IP code) is maintained for all parts of the assembly.

8.4.3.1 Installation conditions

Additional paragraph:

When a user specifies the assembly is to feed overhead cable lines, outgoing units shall be designed in such a way that an attached cable(s) can be earthed at the termination(s).

8.8 Terminals for external cables

Replacement of the first three paragraphs with the following:

In the absence of a special agreement between user and manufacturer, terminals shall be capable of accommodating cables having copper or aluminium conductors from the smallest to the largest cross-sectional area corresponding to the appropriate rated current (see Table AA.1).

The terminations for outgoing circuits shall be located so that adequate spacing is provided and to facilitate terminating the phase conductors of a cable irrespective of their lay.

When specified by the user the phase cable terminals of each outgoing circuit shall be separated from all other hazardous live parts. When the terminals of an outgoing circuit are exposed protection shall be provided against accidental contact with other hazardous live parts. Separation and protection shall be from the normal direction of access and in accordance with IPXXB of IEC 60529.

Where specified by the user, the incoming circuit shall be suitable for connection by means of either bare or insulated bars.

Additional subclauses:

8.101 Marking as an obstacle to snow clearance

When specified by the user, a PENDA-O that is intended for use in regions where heavy snowfalls occur in accordance with 7.2, shall be marked as an obstacle to snow clearance. Holders shall be provided, attached to the PENDA-O, to accommodate marking rods and it shall be possible to install and make adjustments to the position of the marking rod from outside the PENDA-O.

8.102 Ease of operation and maintenance

All parts of the assembly shall, as far as practicable, be readily accessible and replaceable without excessive dismantling.

The design shall be such that the cables can be readily connected from the front.

When a PENDA does not have a means of measurement incorporated, it shall be possible, by the use of a portable instrument, to readily and safely measure voltages in all phases of incoming units and on both sides of all current breaking and/or switch devices of outgoing units, also the current in one phase of all outgoing units. During this operation all live parts of the PENDA shall be protected sufficiently to retain the required degree of protection in accordance with 8.2. Instructions concerning the procedure to be adopted shall be provided by the manufacturer.

If the assembly is intended to be connected to a live reserve power, for example a standby generator, the switchgear connecting device shall be designed so that connection can be made with the live parts having a degree of protection of IPXXB according to IEC 60529.

9 Performance requirements

This clause of IEC 61439-1:2020 applies.

10 Design verification

This clause of IEC 61439-1:2020 applies except as follows.

10.1 General

Replace 6th, 7th, and 8th paragraph with:

Design verification shall only be achieved by the application of tests in accordance with Clause 10. The alternatives methods of verification by assessment or comparison with a reference design shall not be used (see Table CC.1).

It is not necessary to test every arrangement produced. Tests carried out on a representative sample of the most onerous PENDA are deemed to verify the performance of similar and less onerous assemblies of the same general construction and rating. Examples of tests carried out on most onerous representative sample include:

1) A temperature rise test carried out on 800 A PENDA with 5 outgoing circuits is deemed to apply to an 800 A PENDA of the same construction (same general enclosure, same design of busbars and same incoming unit(s)) with 8 outgoing circuits of the same design.
2) Mechanical strength tests carried out on the smallest and largest enclosure in a series are deemed to apply to all other enclosures in the series, when they have the same number of doors and when they are of the same general construction.

3) Providing the busbar and connection support arrangements are the same, short-circuit tests carried out on a design of busbar and connections are deemed to apply to higher current ratings of busbars and connections.
4) A short circuit test carried out on 800 A PENDA with 8 outgoing circuits is deemed to apply to an 800 A PENDA of the same construction (same general enclosure, same design of busbars and same incoming unit(s)) with 5 outgoing circuits of the same design.
5) For a given short circuit rating, a short circuit tests carried out on an incoming or outgoing circuit is deemed to apply to higher current rating circuits of the same design and construction

Additional last paragraph:

Where necessary to suit their particular network parameters, users can specify more onerous or additional test requirements.

10.2 Strength of materials and parts

10.2.2 Resistance to corrosion

10.2.2.1 Verification by test

Replacement of last paragraph with the following:

When the corrosion resistance properties and projected life, as agreed between the manufacturer and the user, shall be confirmed by reference to ISO 9223:2012, the tests detailed herein need not be performed.

In all other cases the corrosion resistance of each design of assembly shall be verified by severity test A or B, as applicable and as detailed 10.2.2.3 of IEC 61439-1:2020 and 10.2.2.2.

10.2.2.2 Severity test A

Replacement of the test specification (paragraph 2) with the following:

Damp heat cycling test of IEC 60068-2-30:2005: Severity – temperature 55 °C, 6 cycles and variant 1.

At the end of the test, the specimens are removed from the test chamber.

Compliance is checked by visual inspection. The parts tested shall not show rust, cracking or other deterioration. However, surface corrosion of the protective coating is allowed.

10.2.2.4 Results to be obtained

This subclause of IEC 61439-1:2020 is not applicable in respect of tests carried out in accordance with 10.2.2.2.

10.2.3 Properties of insulating materials

Additional subclause:

10.2.3.101 Verification of category of flammability

Representative specimens of each of the materials of enclosures, barriers and other insulating parts shall be subjected to a flammability test in accordance with test method A – horizontal burning test of IEC 60695-11-10:2013.

Compliance is checked by inspection that each set of specimens can be classified to category HB40 criteria a) or b) in accordance with 8.4.3 of IEC 60695-11-10:2013.

10.2.6 Verification of protection against mechanical impact (IK code)

This subclause of IEC 61439-1:2020 is not applicable to assemblies complying with this document.

Additional subclauses:

10.2.101 Verification of mechanical strength

10.2.101.1 General

Where enclosures are manufactured in a series and are of the same design and construction, only the smallest and largest size of enclosure shall be tested.

The tests shall be carried out at an ambient temperature between 10 °C and 40 °C.

With the exception of the test of 10.2.101.7, a new sample assembly can be used for each of the independent tests. If the same sample assembly is used for more than one test of 10.2.101, the compliance check for the second numeral of the degree of protection (IP code) need only be applied when the tests on that sample have been completed.

All tests shall be carried out with the assembly fixed at its normal service mounting and where appropriate, added support at normal ground level as indicated in Figure 102a, Figure 102b, Figure 103a, and Figure 103b.

Dimensions in millimetres

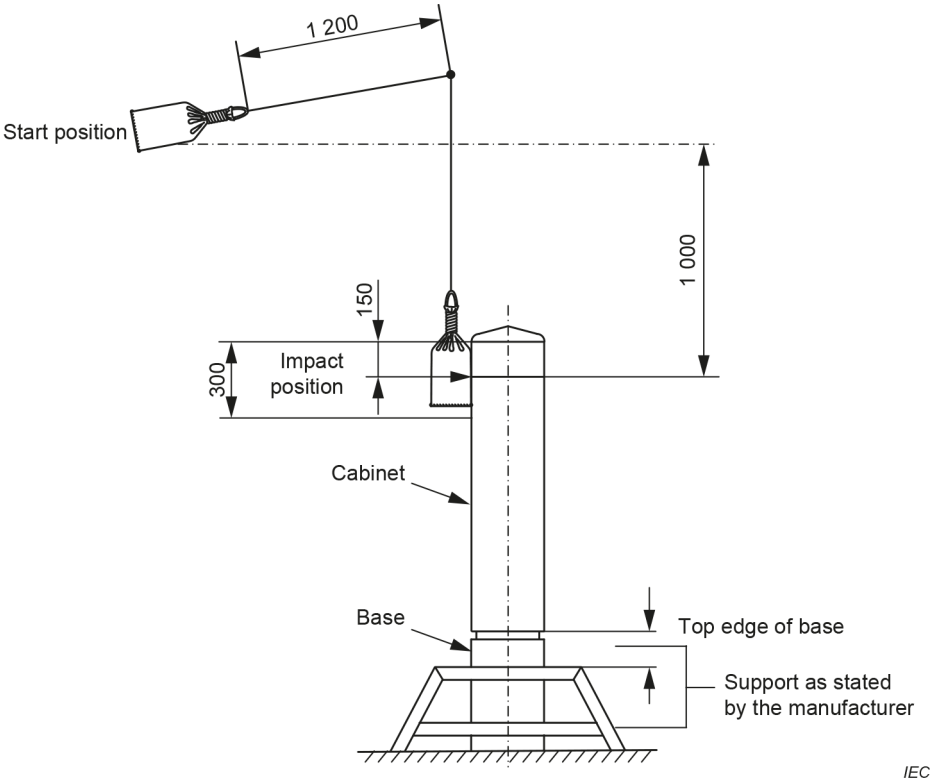

Figure 102a – Diagram of test to verify the resistance to shock load of a ground mounted PENDA-O with embedded base

Dimensions in millimetres

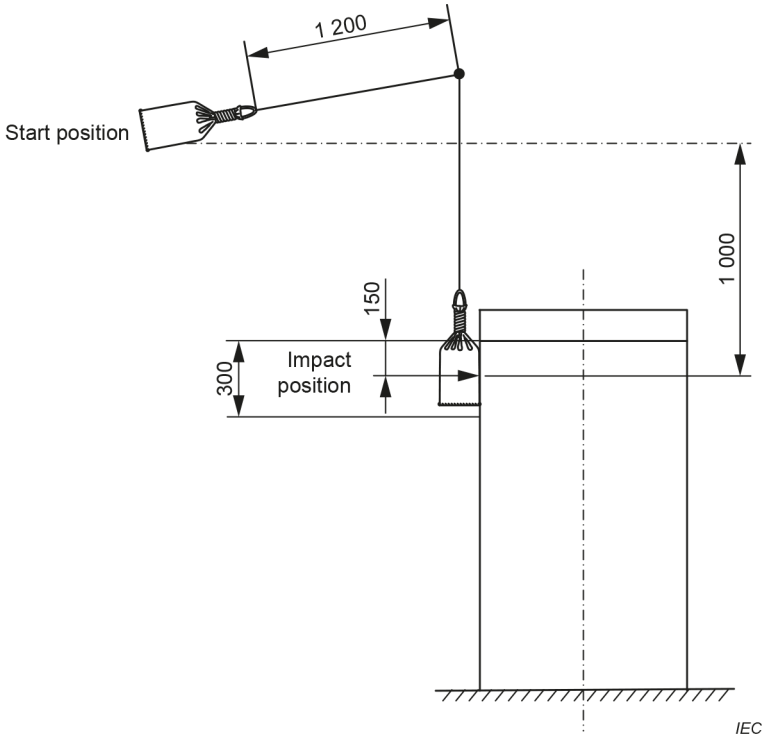

Figure 102b – Diagram of test to verify resistance to shock load of a ground mounted PENDA-O without embedded base

Figure 102 – Diagram of test to verify resistance to shock load of a PENDA-O

Dimensions in millimetres

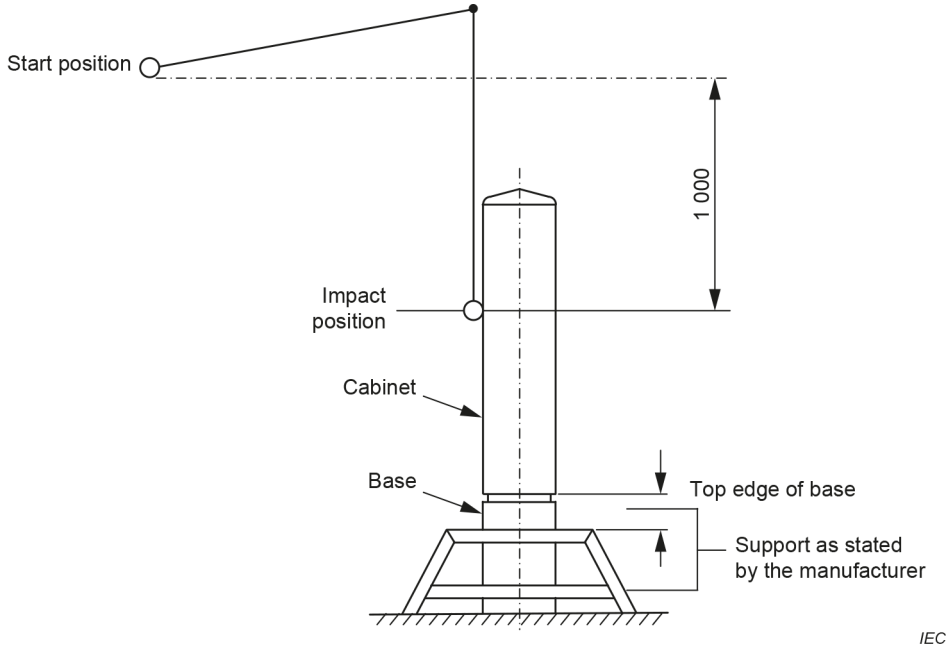

Figure 103a – Diagram of test to verify impact force withstand for a ground mounted PENDA-O with embedded base

Dimensions in millimetres

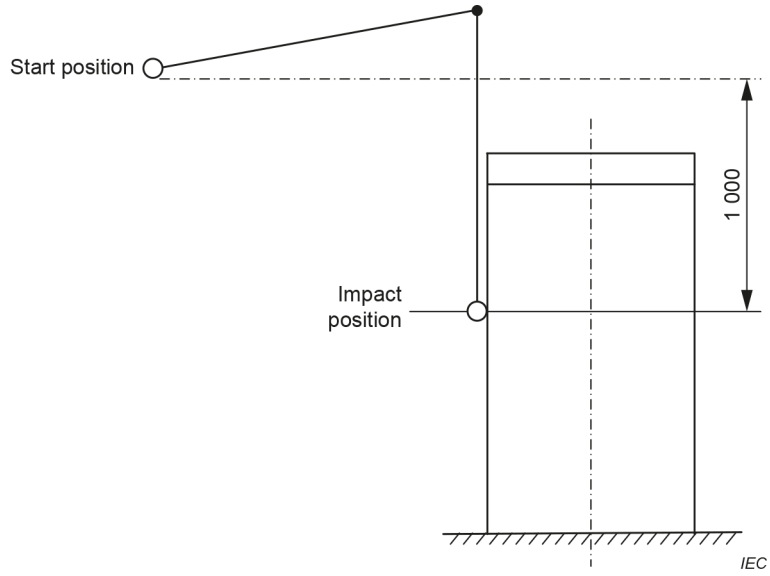

Figure 103b – Diagram of test to verify impact force withstand for a ground mounted PENDA-O without embedded base

Figure 103 – Diagram of test to verify impact force withstand of a PENDA-O

With the exception of the test of 10.2.101.8, the door(s) of the assembly, if applicable, shall be locked at the commencement of the test and remain locked for the duration of the test.

10.2.101.2 Verification of resistance to static load

The following tests shall be carried out on all types of PENDA-0:

Test 1 – An evenly distributed load of 8 500 N/m^2 shall be applied for 5 min to the roof of the enclosure (see Figure 104).

Test 2 – A force of 1 200 N shall be applied for 5 min in turn to the front and back upper edges of the roof of the enclosure (see Figure 104).

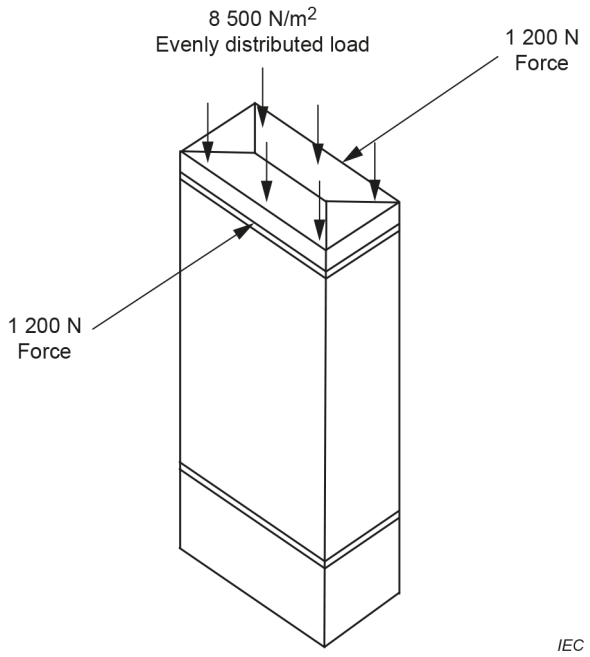

Figure 104 – Diagram of test to verify the resistance to static load

Compliance is checked by verification after the test that the minimum degree of protection is in accordance with 8.2.2, and the operation of the door(s) and locking points are not impaired; also by verification that the electrical clearances have remained satisfactory for the duration of the tests and in the case of an assembly having metallic enclosure, that no contact between live parts and the enclosure has occurred caused by permanent or temporary distortion.

10.2.101.3 Verification of resistance to shock load

The test shall apply to all types of PENDA-O.

A bag in accordance with Figure 105 containing dry sand and having a total mass of 15 kg shall be hung from an overhead support vertically above the surface under test and at 1 m above the strike point of the assembly.

Dimensions in millimetres

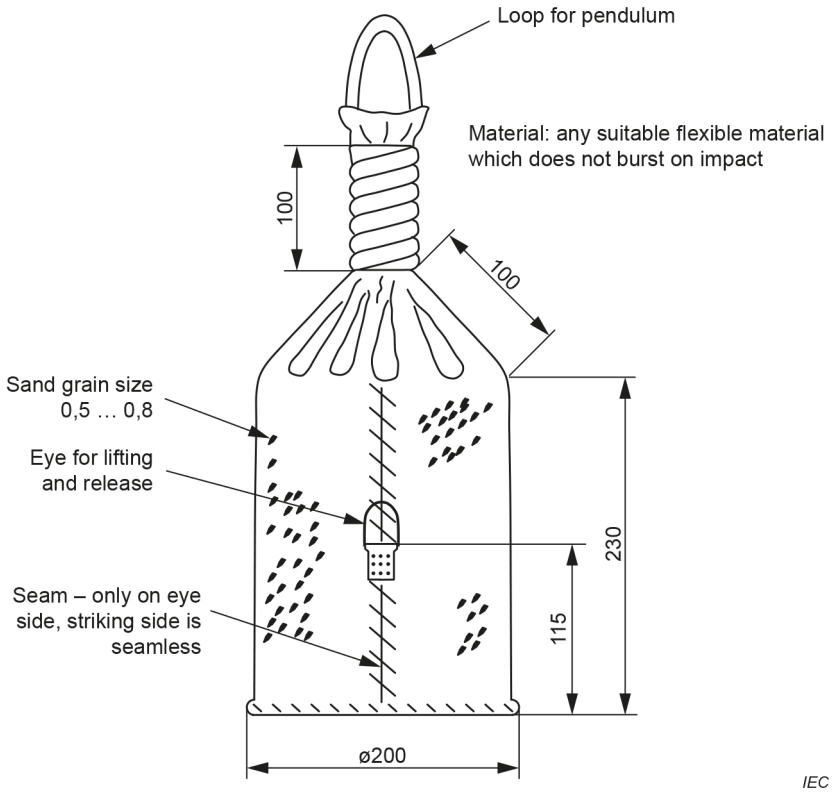

Figure 105 – Sandbag for test to verify the resistance to shock load

Each test shall consist of one blow aimed at the upper part of each of the vertical surfaces of the assembly which are visible when the assembly is installed in its normal service position. Separate enclosures can be used for each of the test blows.

In the case of an enclosure of cylindrical form, the test shall consist of three blows which are positioned with an angular displacement of 120°.

A test shall consist of raising the lifting eye through a height of 1 m and allowing the sandbag to fall through a vertical arc to impact the approximate centre of the upper part of the surface of the assembly under test (see Figure 102a and Figure 102b).

Compliance is checked by verification after the test that the degree of protection remains in accordance with 8.2.2, and the operation of the door(s) and locking points are not impaired; also by verification that the electrical clearances have remained satisfactory for the duration of the tests and, in the case of an assembly having a metallic enclosure, that no contact between live parts and the enclosure has occurred caused by permanent or temporary distortion. In the case of an assembly having an insulating enclosure, if the appropriate conditions are satisfied, then damage such as small dents or small degrees of surface cracking or flaking are disregarded, provided that there are no associated cracks detrimental to the serviceability of the assembly.

10.2.101.4 Verification of resistance to torsional stress

The test only applies to all types of PENDA-O.

The test is carried out using a horizontally rotatable frame constructed from 60 mm × 60 mm × 5 mm angle iron, having vertical locations 100 mm long at the frame arm's extremities. The assembly under test is rigidly fixed at its base and the frame closely fitted over it, so that the end locations of the frame arm are in contact with the roof and walls of the assembly.

The assembly, with the door(s) closed shall have a torsional force applied for 30 s as shown in Figure 106a and Figure 106b. This is comprised two separate tests, first with the two forces each of 1 000 N applied to twist the PENDA in a clockwise direction and the second with the two forces each of 1 000 N applied to rotate the PENDA in an anti-clockwise direction.

Dimensions in millimetres

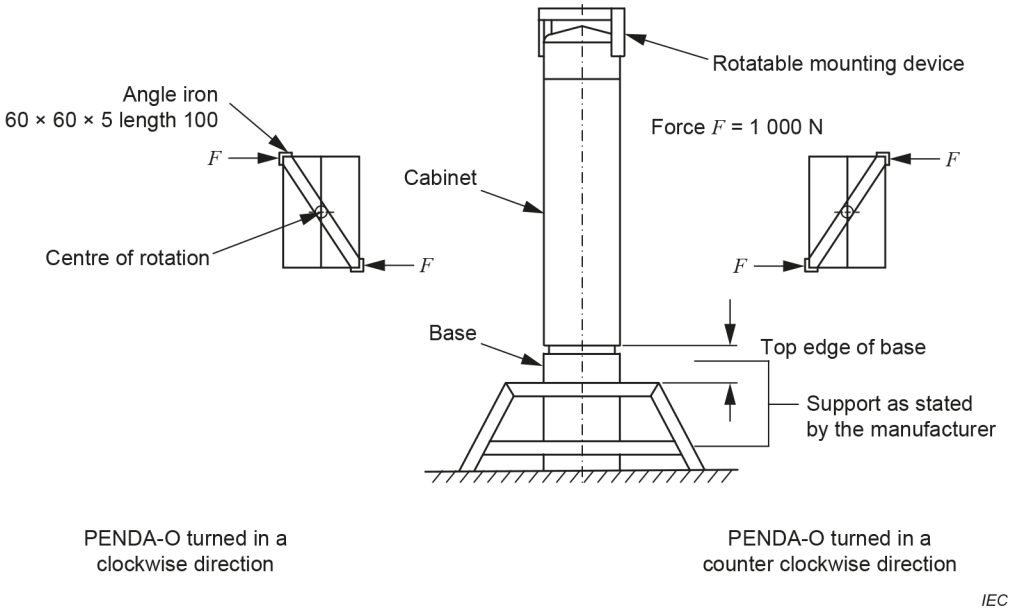

Figure 106a – Diagram of test to verify the resistance to torsional stress of a ground mounted PENDA-O with embedded base

Dimensions in millimetres

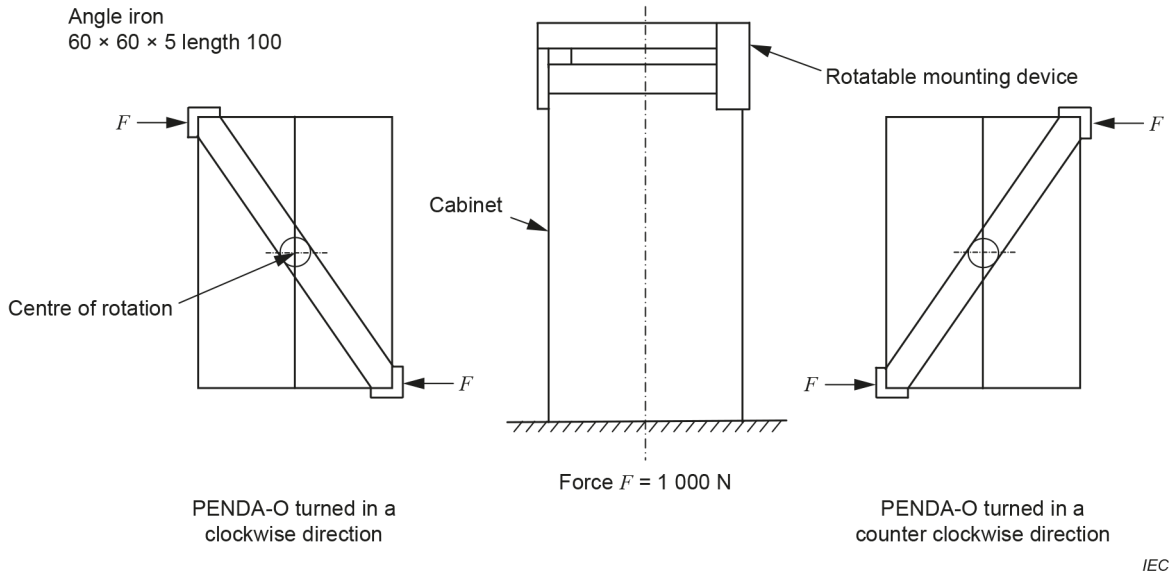

Figure 106b – Diagram of test to verify resistance to torsional stress of a ground mounted PENDA-O without embedded base

Figure 106 – Diagram of test to verify resistance to torsional stress of a PENDA-O

Compliance is checked by verifying that the doors(s) remain closed for the duration of the test and by verification after the test that the degree of protection remains in accordance with 8.2.2.

10.2.101.5 Verification of impact force withstand

10.2.101.5.1 Test applicable to PENDA-Os designed for operation at ambient temperatures of between 40 °C and –25 °C

The test shall be carried out using impact apparatus in the form of a pendulum incorporating a 9 mm external diameter tube at least 1 m long. The pendulum shall be arranged to swing through a vertical arc.

Attached to one end is a solid steel ball of 2 kg mass, which shall be raised through a height of 1 m and allowed to drop and impact the surface of the assembly under test, thus providing an impact energy of 20 J (see Figure 103a and Figure 103b).

For each of the two tests detailed below, the test shall consist of one blow aimed at the centre of each of the vertical surfaces of the assembly which are visible when it is installed in its normal service position. Separate enclosures can be used for each of the test blows.

In the case of an enclosure of cylindrical form, the test shall consist of three blows which are positioned with an angular displacement of 120°.

Test 1 shall be carried out at an ambient air temperature of between 10 °C and 40 °C after the assembly has been kept within these temperatures for not less than 12 h.

Test 2 shall be carried out at an ambient air temperature of between 10 °C and 40 °C immediately after the assembly has been kept at a temperature of $-25\,^{0}_{-0,5}$ °C for a period of not less than 12 h. Test 2 is not required when a PENDA has an enclosure made of metallic material.

Compliance is checked by verification after the test that the degree of protection remains in accordance with 8.2.2, and the operation of the door(s) and locking points are not impaired; also by verification that the electrical clearances have remained satisfactory for the duration of the tests and in the case of an assembly having a metallic enclosure, that no contact between live parts and the enclosure has occurred caused by permanent or temporary distortion. In the case of an assembly having an insulating enclosure, if the appropriate conditions are satisfied, then damage such as small dents or small degrees of surface cracking or flaking are disregarded, provided that there are no associated cracks detrimental to the serviceability of the assembly.

10.2.101.5.2 Test applicable to PENDA-Os designed for operation in arctic climate (see 7.1.1)

The specimen shall be kept at a temperature of -50 °C for a period of not less than 12 h. Tests shall be carried out in an ambient air temperature between 10 °C and 40 °C and at a time when the external temperature of the enclosure has recovered to a temperature not higher than -40 °C.

Test sequence:

For test 1 and test 2 a metal test body of spherical or hemispherical shape having a radius of 100 mm ± 3 mm and a surface hardness of HB 160 according to ISO 6506-1:2014 shall be used. Test 2 requires earthing of the test body.

Test 1 shall be carried out on an empty PENDA-O applying a force of 1 500 N for 30 s at the considerably 10 weakest points of the enclosure.

Compliance is checked by verification after the test that the degree of protection remains in accordance with 8.2.2 and the operation of the door(s) and locking points are not impaired.

Test 2 shall be carried out on an assembly containing equipment that provides the minimum clearances inside the enclosure. A metal enclosure shall be connected to earth, in case of an enclosure made of insulating materials all parts within the assembly that are intended to be connected to earth shall be connected to earth.

A force of 1 500 N shall be applied for 30 s to earthed metal test body at the considerably 10 weakest points of the enclosure. For the duration of the test, an AC voltage in accordance with 10.9.2.2 of IEC 61439-1:2020, shall be applied between all live parts connected together and the earth.

Compliance is checked by verification that no puncture or flashovers occurs.

Test 3 shall be carried out on an empty enclosure using an impact apparatus as described in 10.2.101.5.1, but having a solid steel ball with an approximate mass of 15 kg. This striker element shall be raised through a height of approximately 1 m allowed to drop and impact the surface of the assembly under test, to provide an impact energy of 150 J (see Figure 103a and Figure 103b).

The test shall consist of one blow aimed at the centre of each of the vertical surfaces of the assembly which are visible when it is installed in its normal service position. Separate enclosures can be used for each of the test blows.

In the case of an enclosure of cylindrical form, the test shall consist of three blows which are positioned with an angular displacement of 120°.

Compliance for Test 3 is checked by verification after the test that the degree of the protection is at least IP3X.

10.2.101.6 Verification of mechanical strength of doors

The test applies to all types of PENDA-O having a door(s) hinged on a vertical edge of the enclosure.

The tests shall be carried out with the door(s) fully open and in contact with the designed restraint. A load of 450 N shall be applied at the top edge of the door perpendicular to the plane of the door(s) and at a distance 300 mm from the hinged edge and maintained for 3 s (see Figure 107).

Dimensions in millimetres

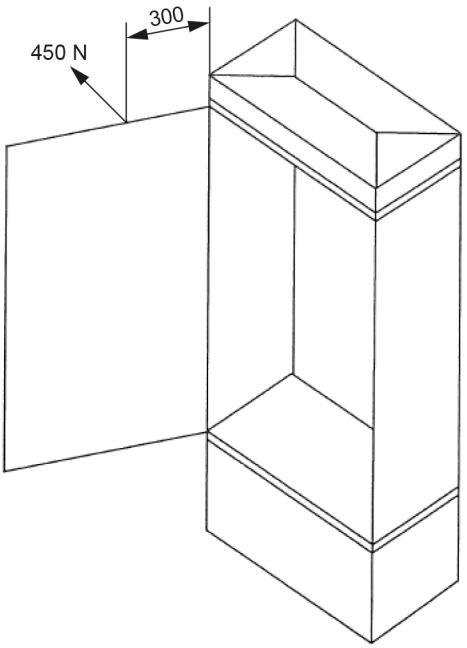

Figure 107 – Diagram of test to verify the mechanical strength of doors

Compliance is checked by verification that the degree of protection remains in accordance with 8.2.2 after the door(s) has (have) been closed following tests. If the door(s) become unhinged during the test, this is not regarded as a failure if it is possible to reinstall the same door(s) without the use of a tool and the operation of hinges and locking points are not impaired.

10.2.101.7 Verification of resistance to axial load of metal inserts in synthetic material

The test only applies to all types of assembly when threaded metal inserts are provided to retain the mounting plate or switchgear and controlgear supports in place.

The test shall be carried out on a representative specimen of each type and size of metal insert. Also, if there is a difference in the thickness of the profile of the material surrounding a particular insert, the test shall be repeated for this condition.

During the test the assembly shall be fully supported on a platform.

A screw-eye shall be fitted to each insert under test and an axial force in accordance with Table 102 shall be applied for 10 s in an attempt to extract the insert from its anchorage.

Table 102 – Axial load to be applied to the inserts

Size of insert	Axial load N
M4	350
M5	350
M6	500
M8	500
M10	800
M12	800

Compliance is checked by inspection that the inserts remain undamaged and in their original position; and also, that there is no cracking of the surrounding material forming the anchorage for the insert.

NOTE Small cracks, created by air bubbles that were visible before the test, but not affected by the application of the axial load, are ignored.

10.2.101.8 Verification of resistance to mechanical shock impacts induced by sharp-edged objects

The test applies to all types of PENDA-O.

The test shall be carried out using an impact apparatus as described in 10.2.101.5.1 but having a steel striker element with a mass of 5 kg and having the end profiled as shown in Figure 108.

Dimensions in millimetres

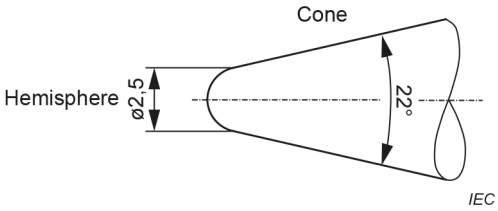

Figure 108 – Striker element for test of resistance to mechanical shock impacts induced by sharp-edged objects

The striker element shall be raised through a height of 0,4 m and allowed to drop and impact the surface of the assembly under test, thus providing an impact energy of 20 J (see Figure 103a and Figure 103b).

Each test shall consist of one blow aimed at the centre of each of the vertical surfaces of the assembly which are visible when the assembly is installed in its normal service position. Separate enclosures can be used for each of the test blows.

In the case of an enclosure of cylindrical form, the test shall consist of three blows which are positioned with an angular displacement of 120°.

Test 1 shall be carried out at an ambient air temperature between 10 °C and 40 °C after the assembly has been kept within these temperatures for not less than 12 h.

Test 2 shall be carried out at an ambient air temperature between 10 °C and 40 °C immediately after the assembly has been kept at a temperature of $-25\,^{0}_{-5}$ °C for a period of not less than 12 h. Test 2 is not required when a PENDA has an enclosure made of metallic material.

Compliance is checked by inspection that cracks resulting from the blows are contained within a circle of diameter not exceeding 15 mm. If the tip of the striker element has penetrated the enclosure of the assembly, it shall not be possible to insert a gauge of 4 mm diameter having a hemispherical tip, applied to the hole with a force of 5 N.

10.2.101.9 Test of mechanical strength of a base intended to be embedded in the ground

This test is applicable to a PENDA-O only.

The test shall be carried out with the PENDA-O fixed to the base, in accordance with Figure 109 and the manufacturer's installation instructions. A mechanical force is transferred via a thick-walled steel tube and shall be applied to the lowest part of the longest section of the PENDA base that is beneath the ground surface when it is installed.

Dimensions in millimetres

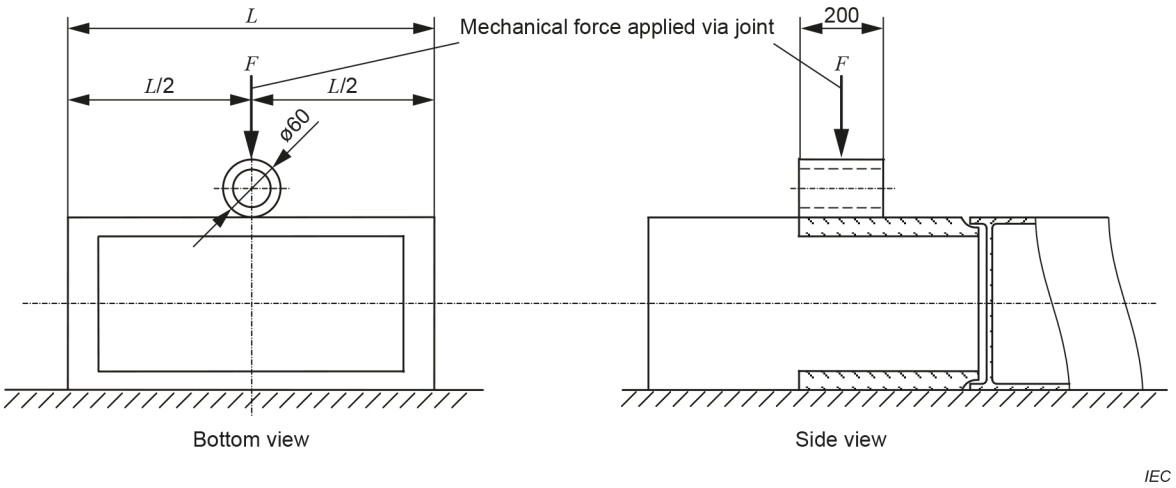

Figure 109 – Typical test arrangement for mechanical strength of base

If the design of the base includes one or more permanent supports (back to front), the force shall be applied by means of a number of steel tubes. One tube shall be placed in the centre of each unsupported length. The individual forces shall simultaneously be applied to each tube and shall be calculated according to the following formula:

$$F = 3{,}5 \text{ N/mm} \times L$$

where L is the unsupported length in millimetres.

The force(s) shall be applied for 1 min. After this period and whilst the force is still maintained, the degree of protection shall be verified.

If there is another section of the PENDA-O base that is of similar length but has a different profile, the test shall be repeated on this section.

Compliance is checked by inspection that the base has not broken and by verification that the degree of protection of that part of the PENDA-O and base which is normally above ground remains in accordance with 8.2.2.

10.3 Degree of protection of assemblies (IP Code)

Add the following first paragraph:

The declared IP for a PENDA-O does not apply to a base intended to be embedded in the ground. However, the declared IP does apply to the bottom of the assembly.

If a PENDA-O consists of an enclosure and a base (to be embedded in the ground or to be surface mounted) without sealed cable entry, ingress of solid objects through the ground area inside of the base is excluded when determining the degree of protection. When the PENDA is mounted on a base with an open ground area the PENDA and any exposed area of the base shall provide the PENDA with the minimum level of IP protection specified in this document.

NOTE In some instances, additional measure are taken to prohibit the entry of animals/vermin

10.5 Protection against electric shock and integrity of protective circuits

10.5.3.1 General

Replacement of the two paragraphs with the following:

Verification shall be achieved by the application of tests in accordance with 10.5.3.5 of IEC 61439-1:2020.

10.9 Dielectric properties

Additional subclause:

10.9.2.101 Power frequency dielectric test for PENDA's installed in substation with separate HV and LV neutral earths.

When a PENDA is to form part of a distribution substation in which the HV and LV earths are separated an additional dielectric test shall be carried out. A test voltage equal to the HV line to earth voltage shall be applied between the phase plus neutral conductor and the extraneous conductive part of the PENDA for a period of 10 s. Acceptance criteria shall be as given in 10.9.2.4 of IEC 61439-1:2020.

10.9.3 Impulse withstand voltage

10.9.3.1 General

Replacement of the first paragraph with:

Verification shall be achieved by the application of tests in accordance with one of the alternative test methods detailed in 10.9.3.2 to 10.9.3.4, inclusive, of IEC 61439-1:2020.

10.10 Temperature rise

10.10.1 General

Replacement with:

It shall be verified that the temperature-rise limits specified in 9.2 of IEC 61439-1:2020 for the different parts of the assembly will not be exceeded. Verification shall be by test as specified in 10.10.2 of IEC 61439-1:2020.

Temperature rise verification shall be undertaken on a representative sample(s). It is not necessary to test every arrangement produced, but the sample(s) tested shall, with reasonable accuracy, be thermally the most onerous for the range being considered. Assessing the most onerous arrangement(s) shall take into consideration total power loss, rating of devices (incoming and outgoing), sections of conductors, size of the enclosure and the rated current of the assembly.

10.10.2 Verification by testing

10.10.2.2 Selection of the representative arrangement

10.10.2.2.1 General

Addition of the following paragraph:

When the design of a PENDA is suitable for installation in a recess in wall the temperature rise test shall be carried out with insulation to simulate the presence of the wall.

10.11 Short-circuit withstand strength

10.11.1 General

Replacement with:

With the exception of the circuits of assemblies that are exempt verification in accordance with 10.11.2 of IEC 61439-1:2020, the short-circuit withstand strength specified by the manufacturer shall be verified. Verification shall be by means of test as specified in 10.11.5 of IEC 61439-1:2020.

11 Routine verification

This clause of IEC 61439-1:2020 applies.

Annexes

The annexes of IEC 61439-1:2020 are applicable except as follows:

Annexes A, C, D, H, K and M are not applicable.

Modification of Annex L.

Addition of Annexes AA, BB, CC and DD.

Annex L
(informative)

Guidance on verification of temperature rise

Modifications:

L.4 Verification assessment

This clause of IEC 61439-1:2020 is not applicable.

L.5 Verification by comparison with a reference design

This clause of IEC 61439-1:2020 is not applicable.

Annex AA
(normative)

Cross-section of conductors

Table AA.1 applies for the connection of one cable per terminal.

Table AA.1 – Minimum and maximum cross-section of copper and aluminium conductors, suitable for connection (see 8.8)

Rated current A	Solid or stranded conductors (aluminium or copper) Cross-sections mm^2		Flexible copper conductors Cross sections mm^2	
	Minimum	Maximum	Minimum	Maximum
6	0,75	1,5	0,5	1,5
8	1	2,5	0,75	2,5
10	1	2,5	0,75	2,5
12	1	2,5	0,75	2,5
16	1,5	4	1	4
20	1,5	6	1	4
25	2,5	6	1,5	4
32	2,5	10	1,5	6
40	4	16	2,5	10
63	6	25	6	16
80	10	35	10	25
100	16	50	16	35
125	25	70	25	50
160	35	95	35	70
200	50	150	50	95
250	70	150	70	120
315	70	240	95	185
400	70	240	95	185
500	70	300	95	240
630	70	300	95	240

This table applies for the connection of one conductor per terminal.

If the external conductors are connected directly to built-in apparatus, the cross-sections indicated in the relevant specification are valid.

In cases where it is necessary to provide for conductors other than those specified in the table, agreement shall be reached between the manufacturer and the user.

The approximate relationship between mm^2 and AWG/kcmil sizes as shown in Table AA.2 is to be used where metric sized round copper conductors are not available.

Table AA.2 – Standard cross-sections of round copper conductors and approximate relationship between mm² and AWG/kcmil sizes (see 8.8 of IEC 61439-1:2020)

Rated cross-section mm²	AWG/kcmil size	Equivalent metric area mm²
0,2	24	0,205
0,34	22	0,324
0,5	20	0,519
0,75	18	0,82
1	–	–
1,5	16	1,3
2,5	14	2,1
4	12	3,3
6	10	5,3
10	8	8,4
16	6	13,3
25	4	21,2
35	2	33,6
–	1	42,4
50	0	53,5
70	00	67,4
95	000	85,0
–	0000	107,2
120	250 kcmil	127
150	300 kcmil	152
185	350 kcmil	177
–	400 kcmil	203
240	500 kcmil	253
300	600 kcmil	304

NOTE The dash, when it appears, counts as a size when considering connecting capacity (see 8.8).

Annex BB
(informative)

Items subject to agreement between the assembly manufacturer and the user

The information given in Table BB.1 below is subject to an agreement between the assembly manufacturer and the user. In some cases, information declared by the assembly manufacturer can take the place of an agreement.

Table BB.1 – Items subject to agreement between the ASSEMBLY manufacturer and the user

Characteristics	Reference clause or subclause [c]	Default arrangement [b]	Options listed in document	User requirement [a]
Electrical system				
Earthing system	5.6, 8.4.3.1, 8.4.3.2.3, 8.6.2, 10.5, 11.4	Manufacturer's standard, selected to suit local requirements	TT / TN-C / TN-C-S / IT, TN-S	
Nominal voltage (V)	3.8.9.1, 5.2.1, 8.5.3	Local, according to installation conditions	max 1 000 V AC	
Transient overvoltages	5.2.4, 8.5.3, 9.1, Annex G	Overvoltage category IV	None	
Temporary overvoltages	9.1	Nominal system voltage + 1 200 V	None	
Rated frequency f_n (Hz)	3.8.12, 5.5, 8.5.3, 10.10.3.1, 10.11.5.4	According to local installation conditions	50 Hz/60 Hz	
Additional on-site testing requirements: wiring, operational performance and function	11.10	Manufacturer's standard, according to application	None	
Short-circuit withstand capability				
Prospective short-circuit current at supply terminals I_{cp} (kA)	3.8.7	Determined by the electrical system	None	
Prospective short-circuit current in the neutral	10.11.5.3.5	Max. 60 % of phase values	None	
Prospective short-circuit current in the protective circuit	10.11.5.6	Max. 60 % of phase values	None	
SCPD in the incoming functional unit requirement	9.3.2	According to local installation conditions	Yes / No	
Co-ordination of short-circuit protective devices including external short-circuit protective device details	9.3.4	According to local installation conditions	None	
Data associated with loads likely to contribute to the short-circuit current	9.3.2	No loads likely to make a significant contribution allowed for	None	

Characteristics	Reference clause or subclause [c]	Default arrangement [b]	Options listed in document	User requirement [a]
Protection of persons against electric shock in accordance with IEC 60364-4-41				
Type of protection against electric shock – Basic protection (protection against direct contact)	8.4.2	Basic protection	According to local installation regulations	
Type of protection against electric shock – Fault protection (protection against indirect contact)	8.4.3	According to local installation conditions	Automatic disconnection of supply / Electrical separation / Total insulation	
Installation environment				
Location type	3.5, 8.1.4, 8.2	Manufacturer's standard, according to application	Indoor / outdoor	
Protection against ingress of solid foreign bodies and ingress of water	8.2.2, 8.2.3	Indoor (enclosed): minimum IP2X Outdoor - minimum: IP34D when installed in places accessible to the public. In other locations IP33.		
External mechanical impact NOTE IEC 61439-5 does not nominate specific IK codes.	10.2.101	As Standard (IEC 61439-5)	None	
Resistance to UV radiation (applies for outdoor assemblies only unless specified otherwise)	10.2.4	Indoor: Not applicable. Outdoor: Temperate climate	None	
Resistance to corrosion	10.2.2	Normal Indoor/Outdoor arrangements	None	
Ambient air temperature – Lower limit	7.1.1	Indoor: –5 °C Outdoor: Normal climate –25 °C Arctic climate –50 °C	None	
Ambient air temperature – Upper limit	7.1.1	40 °C	None	
Ambient air temperature – Daily average maximum	7.1.1, 9.2	35 °C	None	
Maximum relative humidity	7.1.1	Indoor: 95 % at −5 °C to +30 °C 70 % at +35 °C 57 % at +40 °C Outdoor: 100 % at −25 °C to +27 °C 60 % at 35 °C 46 % at 40 °C	None	
Pollution degree (of the installation environment)	7.1.2	PENDA-O: 4 PENDA-I: 3	2, 3, 4	

Characteristics	Reference clause or subclause [c]	Default arrangement [b]	Options listed in document	User requirement [a]
Altitude	7.1.1	≤ 2 000 m	None	
EMC environment (A or B)	9.4, 10.12, Annex J	A/B	A/B	
Special service conditions (e.g. vibration, exceptional condensation, heavy pollution, corrosive environment, strong electric or magnetic fields, fungus, small creatures, explosion hazards, heavy vibration and shocks, earthquakes)	7.2, 8.5.4, 9.3.3 Table 7	No special service conditions	Arctic climate	
Installation method				
Type	3.3, 5.6	Manufacturer's standard	Various e.g. ground mounting, transformer mounting, pole mounting, surface wall mounting or mounting within a recess within a wall	
Stationary/Movable	3.5	Stationary	None	
Maximum overall dimensions and weight	5.6, 6.2.1	Manufacturer's standard, according to application	None	
External conductor type(s)	8.8	Cable	Bare or insulated bars.	
Direction(s) of external conductors	8.8	From below	From above	
External conductor material	8.8	Copper/ aluminium	None	
External phase conductor, cross sections, and terminations	8.8	As defined within the document	None	
External PE, N, PEN conductors cross sections, and terminations	8.8	As defined within the document	None	
Special terminal identification requirements	8.8	Manufacturer's standard	None	
Storage and handling				
Maximum dimensions and weight of transport units	6.2.2, 10.2.5	Manufacturer's standard	None	
Methods of transport (e.g. forklift, crane)	6.2.2, 8.1.6	Manufacturer's standard	None	
Environmental conditions different from the service conditions	7.3	As service conditions	None	
Packing details	6.2.2	Manufacturer's standard	None	
Operating arrangements				
Access to manually operated devices	8.4	Authorised persons	None	
Location of manually operated devices	8.5.5	Easily accessible	None	
Isolation of load installation equipment items	8.4.2, 8.4.3.3, 8.4.6.2	Manufacturer's standard	Individual / groups / all	

Characteristics	Reference clause or subclause [c]	Default arrangement [b]	Options listed in document	User requirement [a]
Maintenance and upgrade capabilities				
Requirements related to accessibility for inspection and similar operations	8.4.6.2.2	No requirements for accessibility	None	
Requirements related to accessibility for maintenance in service by authorized persons	8.4.6.2.3	No requirements for accessibility	None	
Requirements related to accessibility for extension in service by authorized persons	8.4.6.2.4	No requirements for accessibility	None	
Method of functional units connection	8.5.1, 8.5.2	Manufacturer's standard	None	
Protection against direct contact with hazardous live internal parts during maintenance or upgrade (e.g. functional units, main busbars, distribution busbars)	8.4	No requirements for protection during maintenance or upgrade	None	
Current carrying capability				
Maximum total load current to be supplied by the assembly (from which the rated current of the assembly I_{nA} (A) will be determined)	3.8.10.1, 5.3, 8.4.3.2.3, 8.5.3, 8.8, 10.10.2, 10.10.3, 10.11.5, Annex E	Manufacturer's standard, according to application	None	
Design current I_B and nature of load for each circuit; alternatively, I_n of the devices and nature of the load (in such cases, the assumed loading factors can be used based on the relevant part of IEC 61439)	3.8.10.8	None	None	
Ratio of cross section of the neutral conductor to phase conductors: phase conductors up to and including 16 mm^2	8.6.1	100 %	None	
Ratio of cross section of the neutral conductor to phase conductors: phase conductors above 16 mm^2	8.6.1	50 % (min. 16 mm^2)	None	

[a] For exceptionally onerous applications, the user can specify more stringent requirements to those in the standard.

[b] In some cases information declared by the assembly manufacturer can take the place of an agreement.

[c] When a reference does not exist in this document, IEC 61439-1:2020 applies.

Annex CC
(informative)

Design verification

Table CC.1 – List of design verifications to be performed

No.	Characteristic to be verified	Clauses or subclauses [a]
1	Strength of material and parts:	10.2
	Resistance to corrosion	10.2.2
	Properties of insulating materials:	10.2.3
	Thermal stability	10.2.3.1
	Resistance to abnormal heat and fire due to internal electric effects	10.2.3.2
	Category of flammability	10.2.3.101
	Resistance to ultra-violet (UV) radiation	10.2.4
	Lifting	10.2.5
	Mechanical impact	10.2.101
	Resistance to static load	10.2.101.2
	Resistance to shock load	10.2.101.3
	Resistance to torsional stress	10.2.101.4
	Impact force withstand	10.2.101.5
	Mechanical strength of doors	10.2.101.6
	Resistance to axial load of metal inserts in synthetic material	10.2.101.7
	Resistance to mechanical shock induced by sharp objects	10.2.101.8
	Mechanical strength of a base intended to be embedded in the ground	10.2.101.9
	Marking	10.2.7
	Mechanical operation	10.2.8
2	Degree of protection of enclosures	10.3
3	Clearances	10.4
4	Creepage distances	10.4
5	Protection against electric shock and integrity of protective circuits:	10.5
	Effective continuity between the exposed conductive parts of the assembly and the protective circuit	10.5.2
	Short-circuit withstand strength of the protective circuit	10.5.3
6	Incorporation of switching devices and components	10.6
7	Internal electrical circuits and connections	10.7
8	Terminals for external conductors	10.8
9	Dielectric properties:	10.9
	Power-frequency withstand voltage	10.9.2
	Impulse withstand voltage	10.9.3
10	Temperature-rise limits	10.10
11	Short-circuit withstand strength	10.11
12	Electromagnetic compatibility (EMC)	10.12

[a] When a reference does not exist in this document, IEC 61439-1:2020 applies.

Annex DD
(informative)

List of notes concerning certain countries

Subclause	Text
8.8	Add the following note after the last paragraph: NOTE In the United States of America (USA) the conductor size requirement is dependent on the current rating, conductor insulation temperature rating, ambient temperature and configuration, along with conductor insulation type. The specific requirements are contained in the US National Electrical Code (NEC) NFPA 70 Chapter 3.

Bibliography

The bibliography of IEC 61439-1:2020 is applicable except as follows:

Addition:

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)*, available at www.electropedia.org