

BS EN 61439-5:2015



BSI Standards Publication

Low-voltage switchgear and controlgear assemblies

Part 5: Assemblies for power distribution
in public networks

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National foreword

This British Standard is the UK implementation of EN 61439-5:2015. It is identical to IEC 61439-5:2014. It supersedes BS EN 61439-5:2011 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee PEL/121, Switchgear and Controlgear and their assemblies for low voltage, to Subcommittee PEL/121/2, Low voltage switchgear and controlgear assemblies.

A list of organizations represented on this committee can be obtained on request to its secretary.

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EUROPEAN STANDARD

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January 2015

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English Version

**Low-voltage switchgear and controlgear assemblies -
Part 5: Assemblies for power distribution in public networks
(IEC 61439-5:2014)**

Ensembles d'appareillage à basse tension -
Partie 5: Ensembles pour réseaux de distribution publique
(IEC 61439-5:2014)

Niederspannungs-Schaltgerätekombinationen -
Teil 5: Schaltgerätekombinationen in öffentlichen
Energieverteilungsnetzen
(IEC 61439-5:2014)

This European Standard was approved by CENELEC on 2014-09-29. 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.

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Foreword

The text of document 17D/492/CDV, future edition 2 of IEC 61439-5, prepared by SC 17D "Low-voltage switchgear and controlgear assemblies" of IEC/TC 17 "Switchgear and controlgear" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61439-5:2015.

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) 2015-07-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2017-09-29

This document supersedes EN 60439-5:2011.

This standard is to be read in conjunction with EN 61439-1.

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

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive.

For the relationship with EU Directive see informative Annex ZZ, which is an integral part of this document.

Endorsement notice

The text of the International Standard IEC 61439-5:2014 was approved by CENELEC as a European Standard without any modification.

In the Bibliography of EN 61439-1:2011, the following note has to be **added** for the standard indicated:

ISO 9223

NOTE

Harmonised as EN ISO 9223.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When 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.cenelec.eu.

Annex ZA of EN 61439-1:2011 applies, except as follows:

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
<i>Addition:</i>				
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	2011	Low-voltage switchgear and controlgear assemblies -- Part 1: General rules	EN 61439-1	2011
ISO 6506-1	-	Corrosion of metals and alloys - Corrosivity of atmospheres - Classification, determination and estimation	EN ISO 6506-1	-

Annex ZZ
(informative)

Coverage of Essential Requirements of EU Directive 2004/108/EC

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers all relevant essential requirements as given in Article 1 of Annex I of the EU Directive 2004/108/EC.

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive concerned.

WARNING: Other requirements and other EU Directives may be applicable to the products falling within the scope of this standard.

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 5: Assemblies for power distribution in public networks

1 Scope

This part of IEC 61439 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 a.c. (see Figure 101 for a typical distribution network);
- stationary;
- open ASSEMBLIES are not covered by this standard;
- suitable for installation in places where only skilled persons have access for their use, however, outdoor types may be installed in situations that are accessible to ordinary persons;
- for indoor or outdoor use.

The object of this standard 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 levels.

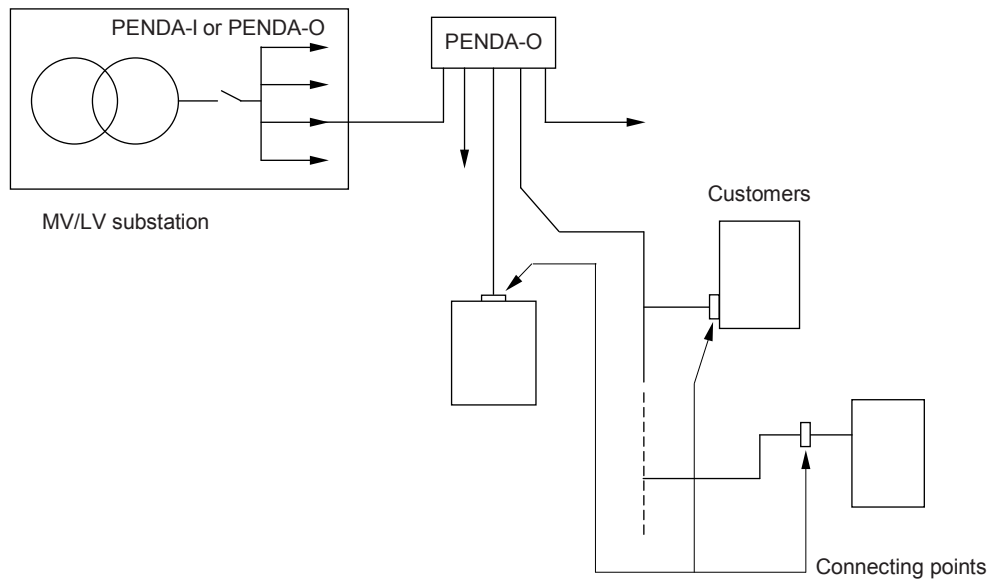
PENDAs may also include control and or signalling devices associated with the distribution of electrical energy.

This standard 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 be carried out other than by the original manufacturer (see 3.10.1 of IEC 61439-1:2011).

This standard 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.

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



IEC

Figure 101 – Typical distribution network

NOTE 1 If a PANDA 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).

NOTE 2 Where local regulations and practices permit, a PANDA according to this standard can be used in other than public networks.

2 Normative references

This clause of Part 1 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, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

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

3 Terms and definitions

This clause of Part 1 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**

cabicle type public electricity network distribution ASSEMBLY that is suitable for outdoor installation in places that may, or may not, 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

3.3 External design of ASSEMBLIES**3.3.1****open-type ASSEMBLY**

This term of Part 1 does not apply.

3.9 Verification

Modifications:

3.9.1**design verification**

Delete the note.

3.9.1.2**verification comparison**

This term of Part 1 does not apply.

3.9.1.3**verification assessment**

This term of Part 1 does not apply.

4 Symbols and abbreviations

This clause of Part 1 applies.

5 Interface characteristics

This clause of Part 1 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 be based on the values given in 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

6 Information

This clause of Part 1 applies except as follows.

6.1 Assembly designation marking

Addition to first paragraph:

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

Replacement of item d):

d) 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 Part 1 applies except as follows.

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 .

7.2 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 PENDINGAs.

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 Part 1 applies except as follows.

8.1 Strength of materials and parts

8.1.1 General

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 be direct coupled to a transformer by means of a flange coupling or it may 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.

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 properties in accordance with 10.2.3.102 of this standard.

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 of this standard.

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

Subclause 8.2.1 of Part 1 does not apply.

8.2.2 Protection against contact with live parts, ingress of solid foreign bodies and water

Addition:

Open type ASSEMBLIES (IP00) are not covered by this standard.

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 of this standard.

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

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 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 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

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.

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

Where a PENDA-O 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 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 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 Part 1 applies.

10 Design verification

This clause of Part 1 applies except as follows.

10.1 General

Replace 4th, 5th, and 6th paragraph with:

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

Tests carried out on 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.

Additional last paragraph:

Where necessary to suit their particular network parameters, users may 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

Replacement of last paragraph with the following:

When the corrosion resistance properties and projected life, as agreed between manufacturer and user, can be confirmed by reference to ISO 9223, 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 in 10.2.2.2 and 10.2.2.3 of Part 1.

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: 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 Part 1 is not applicable in respect of tests carried out in accordance with 10.2.2.2.

10.2.3 Properties of insulating materials

Additional subclauses:

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 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 Mechanical impact

This subclause of Part 1 is not applicable to ASSEMBLIES complying with this standard.

Additional subclauses:

10.2.101 Verification of mechanical strength

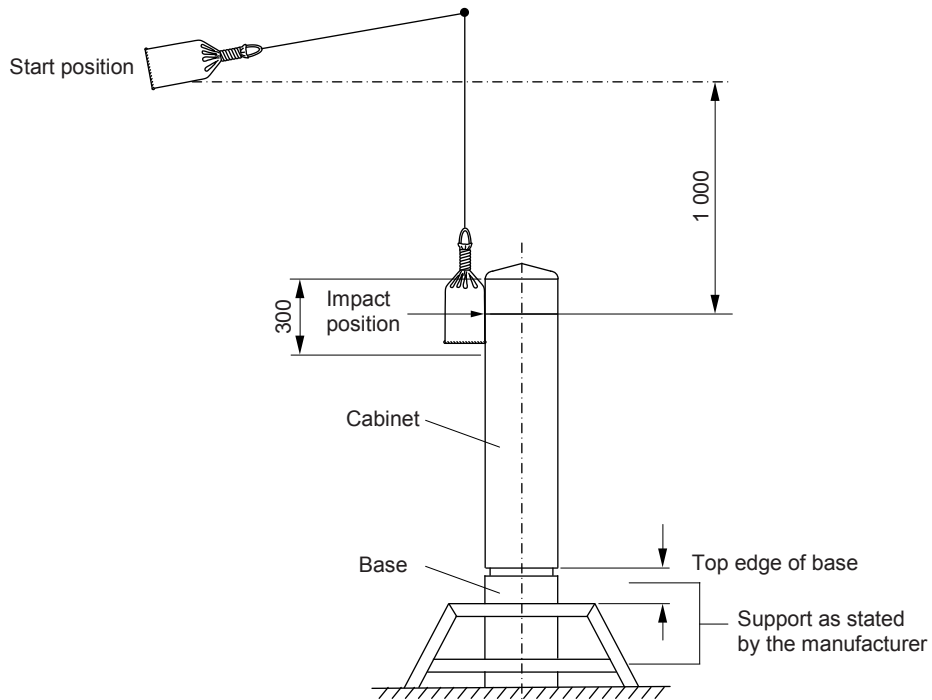
10.2.101.1 General

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

With the exception of the test of 10.2.101.7, a new sample ASSEMBLY may 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 Figures 102a, 102b, 103a, and 103b.

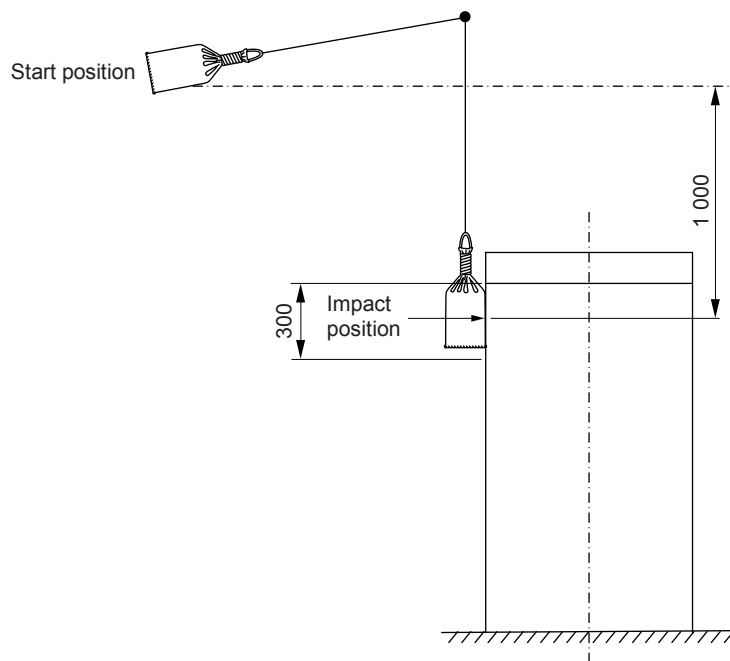
Dimensions in millimetres



IEC

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

Dimensions in millimetres

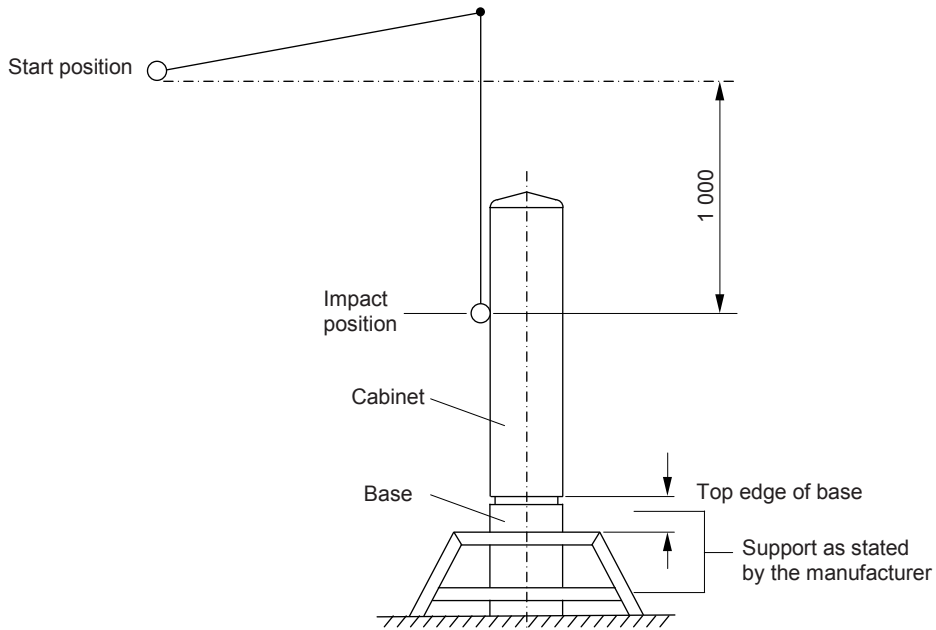


IEC

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

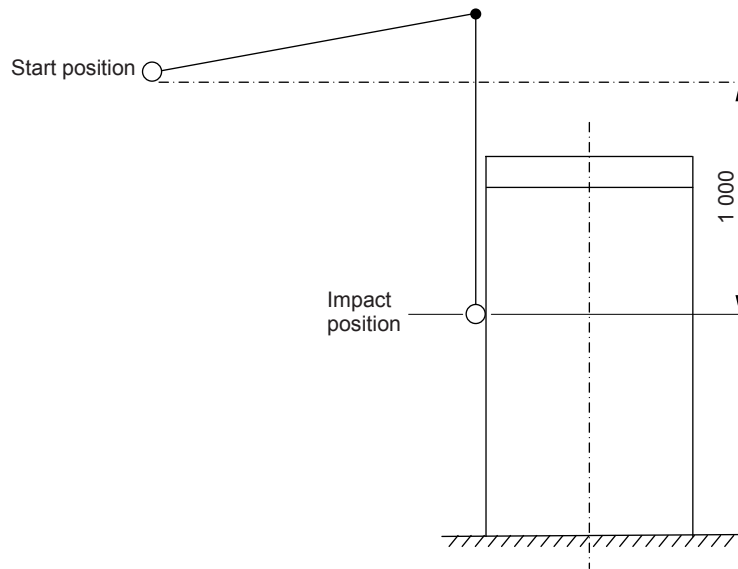
Dimensions in millimetres



IEC

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

Dimensions in millimetres



IEC

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 of this standard, 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 $8\,500\text{ N/m}^2$ shall be applied for 5 min to the roof of the enclosure (see Figure 104).

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

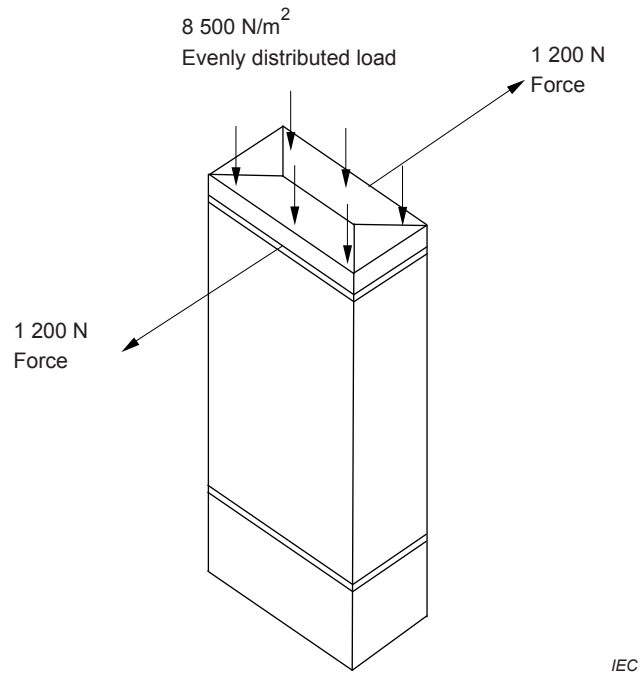


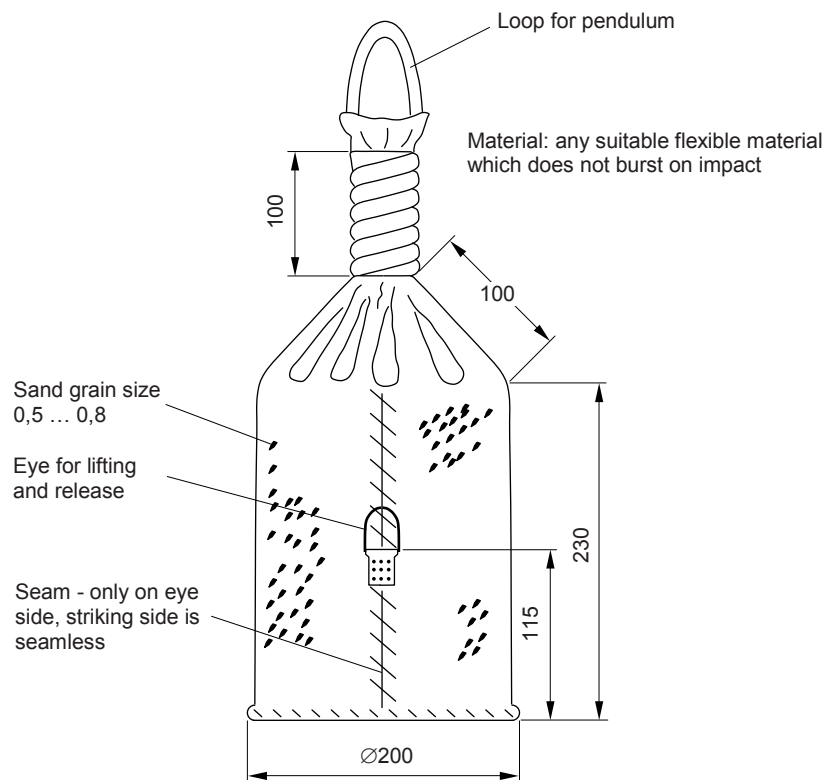
Figure 104 – Diagram of test to verify the resistance to static load

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 point of the ASSEMBLY.



IEC

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 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 Figures 102a and 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 $2 \times 1\,000\text{ N}$ applied for 30 s as shown in Figures 106a and 106b.

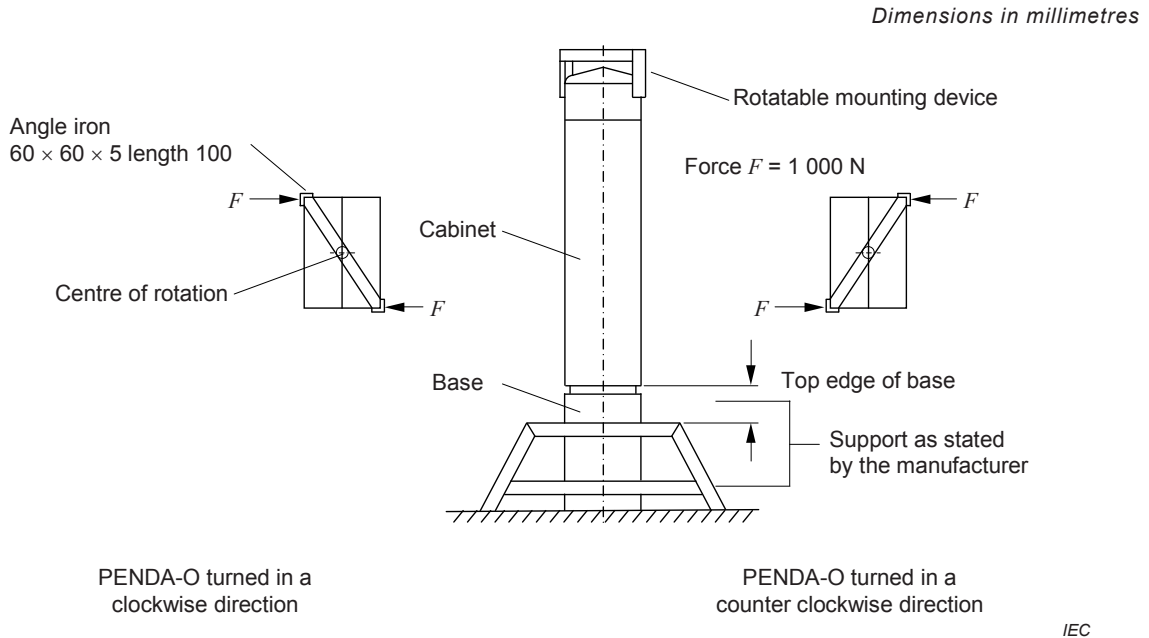


Figure 106a – Diagram of test to verify the resistance to torsional stress of a ground mounted PENDA-O with embedded base

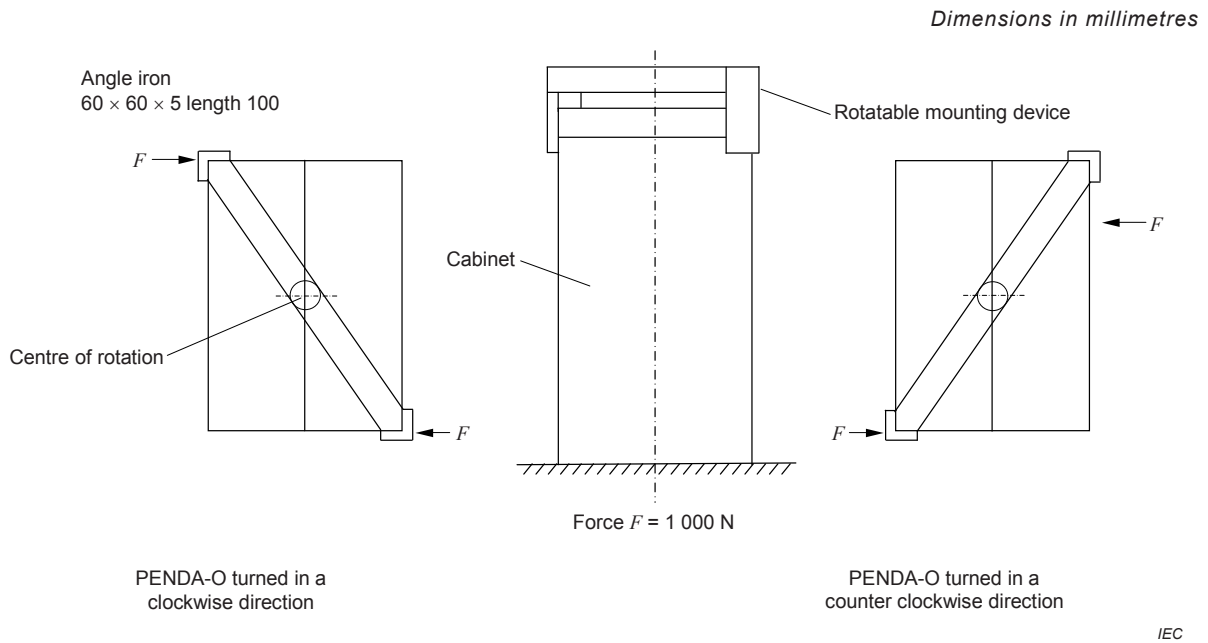


Figure 106b – Diagram of test to verify resistance to torsional stress of a ground mounted PENDA-O without embedded base

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

Compliance is checked by verifying that the door(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 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 Figures 103a and 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 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 $-25_{-0,5}^0$ °C for a period of not less than 12 h.

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 designed for operation in an arctic climate (see 7.1.1.2)

Following the ASSEMBLY being kept at a temperature of -50_{-5}^0 °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.

Test 1 shall be carried out on an empty PENDA-O.

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. 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.

Test 3 shall be carried out on an empty enclosure using an impact apparatus as described in 10.2.101.5.1 of this standard 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 Figures 103a and 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 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 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. 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).

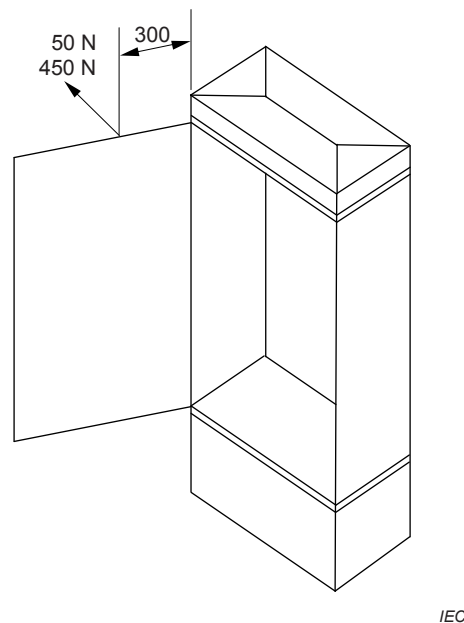


Figure 107 – Diagram of test to verify the mechanical strength of doors

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) 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.

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 of this standard 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 of this standard 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

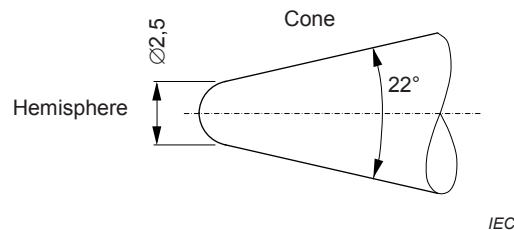


Figure 108 – Striker element for test of resistance to mechanical shock impacts induced by sharp-edged objects

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 Figures 103a and 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 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.

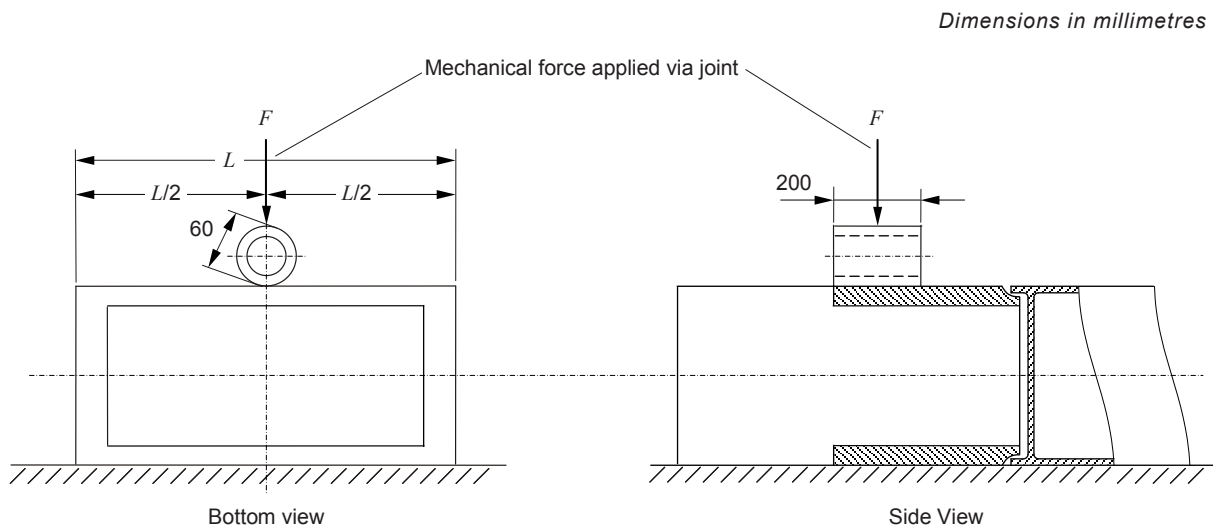
Test 2 shall be carried out at an ambient air temperature between 10 °C and 40 °C immediately after the ASSEMBLY has been kept at a temperature of $-25 \frac{0}{5}$ °C for a period of not less than 12 h.

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.



IEC

Figure 109 – Typical test arrangement for mechanical strength of base

If the design of the base includes one or more permanent supports, 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.

10.5 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 Part 1.

10.9 Dielectric properties

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 Part 1.

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 Part 1 for the different parts of the ASSEMBLY will not be exceeded. Verification shall be by test as specified in 10.10.2 of Part 1.

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 Part 1, 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 Part 1.

11 Routine verification

This clause of Part 1 applies.

Annexes

The annexes of Part 1 are applicable except as follows:

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

Modification of Annex O.

Addition of Annexes AA, BB, CC and DD.

Annex O (informative)

Guidance on 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.

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 mm² 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 Part 1)

Rated cross-section mm ²	AWG/kcmil size	Equivalent metric area mm ²
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 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	Default arrangement ^b	Options listed in standard	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 a.c.	
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, 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	Default arrangement ^b	Options listed in standard	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	Indoor: 50 % at 40 °C Outdoor: 100 % at 25 °C	None	
Pollution degree (of the installation environment)	7.1.3	Industrial: 3	2, 3, 4	
Altitude	7.1.4	≤ 2 000 m	None	
EMC environment (A or B)	9.4, 10.12, Annex J	A/B	A/B	

Characteristics	Reference clause or subclause	Default arrangement ^b	Options listed in standard	User requirement ^a
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 standard	None	
External PE, N, PEN conductors cross sections, and terminations	8.8	As defined within the standard	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	Default arrangement ^b	Options listed in standard	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				
Rated current of the ASSEMBLY I_{nA} (A)	3.8.9.1, 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	
Ratio of cross section of the neutral conductor to phase conductors: phase conductors up to and including 16 mm	8.6.1	100 %	None	
Ratio of cross section of the neutral conductor to phase conductors: phase conductors above 16 mm	8.6.1	50 % (min. 16 mm ²)	None	
^a For exceptionally onerous applications, the user may need to specify more stringent requirements to those in the standard. ^b In some cases information declared by the ASSEMBLY manufacturer may take the place of an agreement.				

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: Resistance to corrosion Properties of insulating materials: Thermal stability Resistance to abnormal heat and fire due to internal electric effects Dry heat Category of flammability Resistance to ultra-violet (UV) radiation Lifting Mechanical impact Resistance to static load Resistance to shock load Resistance to torsional stress Impact force withstand Mechanical strength of doors Resistance to axial load of metal inserts in synthetic material Resistance to mechanical shock induced by sharp objects Mechanical strength of a base intended to be embedded in the ground Marking	10.2 10.2.2 10.2.3 10.2.3.1 10.2.3.2 10.2.3.101 10.2.3.102 10.2.4 10.2.5 10.2.101 10.2.101.2 10.2.101.3 10.2.101.4 10.2.101.5 10.2.101.6 10.2.101.7 10.2.101.8 10.2.101.9 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: Effective continuity between the exposed conductive parts of the ASSEMBLY and the protective circuit Short-circuit withstand strength of the protective circuit	10.5 10.5.2 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: Power-frequency withstand voltage Impulse withstand voltage	10.9 10.9.2 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

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 Part 1 is applicable except as follows:

Addition:

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

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