SLOVENSKI STANDARD
oSIST prEN 50187:2021

01-oktober-2021

Visokonapetostne stikalne in krmilne naprave - Plinske pregrade za stikalne in krmilne naprave z izmeničnim tokom z naznačeno napetostjo nad 1 kV do vključno 52 kV

High-voltage switchgear and controlgear - Gas-filled compartments of AC switchgear and controlgear with rated voltages above 1 kV up to and including 52 kV

Gasgefullte Schottraume für Wechselstrom-Schaltgerate und -Schaltanlagen mit Nennspannungen über 1 kV bis einschliel3lich 52 kV

Appareillage à haute tension - Compartiments sous pression de gaz pour appareillage à courant alternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 52 kV

Ta slovenski standard je istoveten z: **prEN 50187:2021**

ICS:

29.130.99	Druge stikalne in krmilne naprave	Other switchgear and controlgear

oSIST prEN 50187:2021 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 50187

August 2021

ICS 29.130.99

Will supersede EN 50187:1996 and all of its amendments and corrigenda (if any)

English Version

High-voltage switchgear and controlgear - Gas-filled compartments of AC switchgear and controlgear with rated voltages above 1 kV up to and including 52 kV

Appareillage à haute tension - Compartiments sous pression de gaz pour appareillage à courant alternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 52 kV

Gasgefullte Schottraume für Wechselstrom-Schaltgerate und -Schaltanlagen mit Nennspannungen über 1 kV bis einschliel3lich 52 kV

This draft European Standard is submitted to CENELEC members for enquiry.
Deadline for CENELEC: 2021-10-29.

It has been drawn up by CLC/TC 17AC.

If this draft becomes a European Standard, 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.

This draft European Standard was established by CENELEC 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.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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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

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European foreword

This document [prEN 50187:2021] has been prepared by CLC/TC17AC "High-voltage switchgear and controlgear".

This document is currently submitted to the Enquiry.

The following dates are proposed:

• latest date by which the existence of this document has to be announced at national level	(doa)	dor + 6 months
• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	dor + 12 months
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	dor + 36 months (to be confirmed or modified when voting)

This document will supersede EN 50187:1996 and all its amendments and corrigenda (if any).

This edition includes the following significant technical changes with respect to EN 50187:1996:

- Consistency with EN 62271-200;
- Added references to quality standards for welding;
- Added Clause 11 on transport;

- Removal of the limitation on maximum product pressure x volume of 2 000 bar litres in the scope;
- Removal of the 300 kPa design pressure limitation;
- Compressed air, natural origin gases, alternative fluorinated compounds used alone or in gas mixtures with natural-origin gases[1] are added in the scope.

The present document has been established as an international specification for the design, construction, testing and certification of pressurized compartments used in high-voltage switchgear and controlgear, regarding safety aspects.

In this respect, this document constitutes the exclusion of HV switchgear from the scope of the Directive 2014/68/EU (superseding 97/23/EC) concerning pressure equipment. Article 1, 2. (l) excludes “compartments for high-voltage electrical equipment such as switchgear, controlgear, transformers, and rotating machines” from the scope of the Directive.

This document supplements the general specifications given in EN 62271-200 in that it provides specific requirements for pressurized gas-filled compartments of high-voltage switchgear and controlgear.

Due to the compartment geometries dictated by electrical and installation conditions they require the verification of the design by proof tests instead of calculations.

National deviations from this European Standard are listed in Annex A (informative).

[1] Compressed air, natural-origin gases and alternative fluorinated compounds used alone or in gas mixtures with natural origin gases are described in future edition 2 of IEC 62271-4.

Introduction

This document covers the requirements for the design, construction, testing, transportation, inspection and certification of gas-filled compartments with maximum allowable pressure above 50 kPa (relative), for use in AC switchgear and controlgear or for associated gas-filled equipment. Special consideration is given to these compartments for the following reasons:

a) The compartments usually form the containment of electrical equipment; thus, their shape is determined by electrical rather than mechanical requirements.

b) The compartments are installed in restricted areas and the equipment is operated by instructed, authorized persons only.

c) Compartments are normally filled with a thoroughly dried gas or gas mixture that is stable and non-corrosive in the conditions that prevail inside the compartment. For this reason, no internal corrosion allowance is required on the wall thickness of these compartments.

d) The compartments are subjected to only small fluctuations of pressure as the gas-filling density will be maintained within close product related limitations to ensure satisfactory insulating and arc-quenching properties. Therefore, the compartments are not liable to fatigue due to pressure cycling.

e) The operating pressure is relatively low.

Due to the foregoing reasons and to ensure the maximum service continuity as well as to reduce the risk of moisture and dust entering the compartments which could endanger safe electrical operation of the switchgear, no pressure tests should be carried out after installation and before placing in service and no periodic inspection of the compartment interiors or pressure tests should be carried out after the equipment is placed in service.

Current known gases and gas mixtures which have been applied or proposed to be applied in high-voltage gas-filled switchgear and controlgear are:

- Sulphur Hexafluoride (SF6)
- SF6 mixtures with N2 and with CF4
- Compressed air
- Natural-origin gases and their mixtures (N2, O2, CO2)
- C5 F10 O (C5-FK) in mixtures with natural-origin gases (C5-FK mixtures)
- C4F7N (C4-FN) in mixtures with natural-origin gases (C4-FN mixtures)
- C3H2F4 (HFO1234zeE)

Other gases and gas mixtures based or not on those mentioned above which comply with the condition c) above are possible to apply this document.

1 Scope

This document applies to pressurized compartments (gas-filled compartments with maximum allowable pressure above 50 kPa relative) of AC switchgear and controlgear with rated voltages above 1 kV up to and including 52 kV for indoor or outdoor installations. All gases stable and non-corrosive in the conditions that prevail inside the compartment are covered e.g. gases such as SF6, compressed air, natural-origin gases, alternative fluorinated compounds used alone or in gas mixtures with natural origin gases. The gas or gas mixture being used principally for its dielectric and/or arc-quenching properties.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 62271-1:2017, *High-voltage switchgear and controlgear - Part 1: Common specifications for alternating current switchgear and controlgear*

EN 62271-200, *High-voltage switchgear and controlgear - Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

EN ISO 3834 (all parts), *Quality requirements for fusion welding of metallic materials (ISO 3834)*

EN ISO 5817, *Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections (ISO 5817)*

EN ISO 9606 (all parts), *Qualification testing of welders - Fusion welding*

EN ISO 14732, *Welding personnel - Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732)*

3 Terms and definitions

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

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

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

3.1
compartment
part of gas-insulated metal-enclosed switchgear retaining the insulating gas under the prescribed conditions necessary to safely maintain the rated insulation level, protecting the equipment against external influences and providing a high degree of protection to personnel

3.2
manufacturer
individual or body finally responsible for designing and producing the compartment

Note 1 to entry: In this document, this is the switchgear manufacturer, even when the compartment is produced by a sub-manufacturer.

3.3
design pressure (of a compartment)
upper limit of the relative pressure between the pressure inside a compartment at the design temperature, under defined installation conditions, and the pressure outside that compartment, that is used to determine the design of the compartment

Note 1 to entry: The transient pressure occurring during and after a breaking operation (e.g. circuit-breaker) is not considered in the determination of the design pressure.

3.4
design temperature (of a compartment)
highest average temperature over the compartment, which can be reached by the gas under service conditions

Note 1 to entry: Solar radiation should be considered when it has a significant effect on the temperature of the gas and on the mechanical properties of materials. Similarly, the effects of low temperatures on the properties of some materials should be considered.

3.5
filling pressure (of a compartment)
pressure in kPa (relative) assigned by the manufacturer referred to atmospheric air conditions of 20 °C and 1 013 hPa at which the gas-filled compartment is filled before being put into service

Note 1 to entry: Complete gas filling may be made during manufacturing or at installation site depending on transportation limitations.

3.6
bursting disc
non-reclosing pressure relief device operated by differential pressure; also known as pressure safety disc, rupture disk, or burst diaphragm

3.7
spring loaded safety valve
self-closing safety valve which is closed by a spring

Note 1 to entry: These safety valves are part of the gas handling equipment and not of the switchgear itself.

3.8
integrated pressure relief device
protective device which intentionally weakened integral parts or areas of the compartment with the functionality of a bursting disc

4 Normal and special service conditions

Unless otherwise specified in this document, the pressurized compartments of metal-enclosed switchgear and controlgear are designed to be used under normal service conditions according to 4.1 of EN 62271-1:2017.

For pressurized compartments of metal-enclosed switchgear and controlgear intended to be used in special service conditions, 4.2 of EN 62271-1:2017 is applicable.

5 Design and construction

5.1 General

Design of compartments for gas insulated switchgear and controlgear prescribed in this clause considers that the compartments are subjected to particular operating conditions (see introduction) which distinguish them from parts for compressed air receivers and similar storage vessels.

5.2 Materials

Any suitable materials or combination of materials may be used for the manufacturing of compartments. Typical examples are:

- Wrought mild steel
- Wrought austenitic stainless steel
- Wrought aluminium
- Cast aluminium
- Cast resin

The properties of the materials should be taken from the applicable standards.

The material properties shall be verified either by a certificate from the supplier or tests carried out by the switchgear manufacturer.

5.3 Corrosion allowance

Compartments are normally filled with a thoroughly dried gas or gas mixture that is stable and non-corrosive in the conditions that prevail inside the compartment. For this reason, no internal corrosion allowance is required on the wall thickness of these compartments.

5.4 Manholes and inspection openings

No manholes or inspection openings are necessary for inspection of the condition of the compartment.

5.5 Design pressure

The design is based on the design pressure as defined in 3.3.

5.6 Design temperature

The selection of material and the determination of the design stress depend upon the highest wall temperature which can be expected during service. Thus, the design of a compartment is based on the design temperature as defined in 3.4.

5.7 Design

5.7.1 General

The geometry of a compartment can be determined by electrical rather than mechanical considerations. This constraint can result in a compartment geometry which requires an unacceptable degree of calculation or which cannot be calculated at all. In such a case, a test in accordance with subclause 8.3 is sufficient to verify the design of the pressurized enclosure against pressure increase with a safety margin.

When designing a compartment, account shall be taken of the following, if applicable:

a) The possible evacuation of the compartments as part of the filling process.

For enclosures of this type it can be necessary to evacuate the air before introducing gas pressure, this ensures purity of the gas. However, the evacuated condition is not an operational condition, and, in most cases, enclosures are evacuated inside an evacuation chamber with compensated pressure to reduce the stress and possible damages to the enclosure.

b) The resulting pressure in the event of an accidental leak between compartments having different pressures.

c) The full differential pressure possible across the compartment wall.

d) Superimposed loads and vibrations by external effects.

e) Stresses caused by temperature differences including transient conditions and by differences in coefficients of thermal expansion.

f) Effects of solar radiation, when applicable.

g) Dynamic stress due to short circuit current.

5.7.2 Calculation methods

Because of the various shapes, sizes, and materials used it is not possible to design such compartments using equations from conventional pressure vessel codes, therefore established methods should be used, using the design pressure and the design temperature as defined in 3.3 and 3.4.

The nominal design strength should be selected from the material standards. For castings the nominal design strength of the material without heat treatment should be used in the heat affected areas of welds. For wrought aluminium parts the nominal design strength in the annealed condition should be used in the design of welded structures.

Design stresses can be established either by calculation and/or pressure tests, where tensile stresses are measured at several locations of the enclosure in order to verify the calculation and/or the design.

The permissible design stress (f_a) at the design pressure and at the design temperature including the safety factor of the appropriate equations is given by:

$$f_a = R_m / 3{,}0$$

where

R_m is minimum tensile strength of the material at the design temperature taken from the material standard.

3,0 is the safety factor.

The calculation may be made on different values of tensile strength if the values are guaranteed by a material certification (metal sheet) or by quality control and testing for moulded pieces, e.g. cast resin composite.

6 Manufacturing and workmanship

Manufacturing shall be carried out in accordance with proven engineering practice and meet welding quality requirements per the EN ISO 3834 series and EN ISO 5817.

Any welding shall be carried out by welders who have successfully carried out welder procedure tests in accordance with the EN ISO 9606 series for manual or partly mechanized welding processes and with EN ISO 14732 for mechanized and automatic welding.

Where mechanized and automatic welding are employed, the initial setting of the machine shall be verified for each weld configuration by a test specimen before production commences.

Periodically the performance of the equipment shall be verified by an identical test specimen.

For cast resin compartments, refer to subclause 8 of prEN 50089:2021.

7 Quality assurance

The switchgear manufacturer shall be responsible for achieving and maintaining a consistent and adequate quality of product. In this respect, reference to EN ISO 9000 series of standards is appropriate.

Enough examinations shall be made by the compartment manufacturer to ensure that the materials, production and testing comply in all respects with the requirements of this document. Inspection by user's inspectors shall not absolve the switchgear manufacturer from this responsibility to exercise such quality assurance procedures as to ensure that the requirements and intent of this document are satisfied.