



BSI Standards Publication

High-voltage switchgear and controlgear

Part 203: AC gas-insulated metal-enclosed switchgear
for rated voltages above 52 kV

National foreword

This British Standard is the UK implementation of EN IEC 62271-203:2022. It is identical to IEC 62271-203:2022. It supersedes BS EN 62271-203:2012, which will be withdrawn on 20 December 2022.

The UK participation in its preparation was entrusted to Technical Committee PEL/17, High voltage switchgear, controlgear and assemblies.

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

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English Version

High-voltage switchgear and controlgear - Part 203: AC gas-insulated metal-enclosed switchgear for rated voltages above
52 kV
(IEC 62271-203:2022)

Appareillage à haute tension - Partie 203: Appareillage sous enveloppe métallique à isolation gazeuse et à courant alternatif de tensions assignées supérieures à 52 kV
(IEC 62271-203:2022)

Hochspannungs-Schaltgeräte und -Schaltanlagen - Teil 203: Gasisolierte metallgekapselte Schaltanlagen für Bemessungsspannungen über 52 kV
(IEC 62271-203:2022)

This European Standard was approved by CENELEC on 2022-07-04. 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.

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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

European foreword

The text of document 17C/835/FDIS, future edition 3 of IEC 62271-203, prepared by SC 17C "Assemblies" of IEC/TC 17 "High-voltage switchgear and controlgear" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62271-203:2022.

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) 2023-04-04
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2025-07-04

This document supersedes EN 62271-203:2012 and all of its amendments and corrigenda (if any).

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Endorsement notice

The text of the International Standard IEC 62271-203:2022 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60060-1 NOTE Harmonized as EN 60060-1

IEC 60071-1:2019 NOTE Harmonized as EN IEC 60071-1:2019 (not modified)

IEC 61462 NOTE Harmonized as EN 61462

IEC 61672-1 NOTE Harmonized as EN 61672-1

IEC 61672-2 NOTE Harmonized as EN 61672-2

IEC 62155 NOTE Harmonized as EN 62155

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.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60068-2-11	-	Environmental testing - Part 2-11: Tests - Test Ka: Salt mist	EN IEC 60068-2-11	-
IEC 60068-2-17	-	Basic environmental testing procedures - Part 2-17: Tests - Test Q: Sealing	EN 60068-2-17	-
IEC 60085	2007	Electrical insulation - Thermal evaluation and designation	EN 60085	2008
IEC 60099-4	2014	Surge arresters - Part 4: Metal-oxide surge arresters without gaps for a.c. systems	EN 60099-4	2014
IEC 60137	2017	Insulated bushings for alternating voltages above 1000 V	EN 60137	2017
IEC 60141-1	-	Tests on oil-filled and gas-pressure cables - and their accessories - Part 1: Oil-filled, paper or polypropylene paper laminate insulated, metal-sheathed cables and accessories for alternating voltages up to and including 500 kV		-
IEC 60270	-	High-voltage test techniques - Partial discharge measurements	EN 60270	-
IEC 60376	-	Specifications of technical grade sulphur hexafluoride (SF ₆) and complementary gases to be used in its mixtures for use in electrical equipment	EN IEC 60376	-
IEC 60480	-	Specifications for the re-use of sulphur hexafluoride (SF ₆) and its mixtures in electrical equipment	EN IEC 60480	-
IEC 60840	-	Power cables with extruded insulation and their accessories for rated voltages above 30 kV (U _m = 36 kV) up to 150 kV (U _m = 170 kV) - Test methods and requirements		-
IEC 61869-1	-	Instrument transformers - Part 1: General requirements	EN 61869-1	-

EN IEC 62271-203:2022 (E)

IEC 61869-2	-	Instrument transformers - Part 2: Additional requirements for current transformers	EN 61869-2	-
IEC 61869-3	-	Instrument transformers - Part 3: Additional requirements for inductive voltage transformers	EN 61869-3	-
IEC 62067	-	Power cables with extruded insulation and their accessories for rated voltages above 150 kV ($U_m = 170$ kV) up to 500 kV ($U_m = 550$ kV) - Test methods and requirements	-	-
IEC 62271-1	2017	High-voltage switchgear and controlgear - Part 1: Common specifications for alternating current switchgear and controlgear	EN 62271-1	2017
IEC 62271-4	-	High-voltage switchgear and controlgear - Part 4: Handling procedures for sulphur hexafluoride (SF ₆) and its mixtures	EN 62271-4	-
IEC 62271-100	2021	High-voltage switchgear and controlgear - Part 100: Alternating-current circuit-breakers	EN IEC 62271-100	2021
IEC 62271-102	2018	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches	EN IEC 62271-102	2018
IEC 62271-209	2019	High-voltage switchgear and controlgear - Part 209: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV - Fluid-filled and extruded insulation cables - Fluid-filled and dry-type cable-terminations	EN IEC 62271-209	2019
IEC 62271-211	2014	High-voltage switchgear and controlgear - Part 211: Direct connection between power transformers and gas-insulated metal-enclosed switchgear for rated voltages above 52 kV	EN 62271-211	2014
ISO 22479	-	Corrosion of metals and alloys – Sulfur dioxide test in a humid atmosphere (fixed gas method)	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

**Part 203: AC gas-insulated metal-enclosed switchgear
for rated voltages above 52 kV**

FOREWORD

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IEC 62271-203 has been prepared by subcommittee 17C: Assemblies, of IEC technical committee 17: High-voltage switchgear and controlgear. It is an International Standard.

This third edition cancels and replaces the second edition published in 2011. This edition constitutes a technical revision.

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

- a) the document has been aligned with IEC 62271-1:2017;
- b) beside SF₆ also alternative gases have been implemented where needed;
- c) the terms and definitions have been updated and terms not used have been removed;
- d) Subclause 6.16 “Gas and vacuum tightness” has been updated;

- e) Subclause 6.16.3 “Closed pressure systems”: Two classes of gas has been introduced:
- 1) $GWP \leq 1\,000$
 - 2) $GWP > 1\,000$
- and the tightness requirements for type tests for gasses with $GWP > 1\,000$ has been reduced from 0,5 % to 0,1 % per year per gas compartment;
- f) Subclause 6.108 “Interfaces”: Typical maximum pressures in service for interfaces connected to GIS have been defined;
- g) Subclauses 7.2 through 7.8 have been restructured;
- h) Subclause 7.107 “Corrosion test on earthing connections” has been updated;
- i) Subclause 7.108 “Corrosion tests on sealing systems of enclosures and auxiliary equipment” has been updated;
- j) Annex F ‘Service Continuity’ has been modified and aligned with the recommendations of CIGRE WG B3.51.

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

Draft	Report on voting
17C/835/FDIS	17C/844/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/standardsdev/publications.

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.

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 203: AC gas-insulated metal-enclosed switchgear for rated voltages above 52 kV

1 Scope

This part of IEC 62271 specifies requirements for gas-insulated metal-enclosed switchgear in which the insulation is obtained, at least partly, by an insulating gas or gas mixture other than air at atmospheric pressure, for alternating current of rated voltages above 52 kV, for indoor and outdoor installation, and for service frequencies up to and including 60 Hz.

For the purpose of this document, the terms “GIS” and “switchgear” are used for “gas-insulated metal-enclosed switchgear”.

The gas-insulated metal-enclosed switchgear covered by this document consists of individual components intended to be directly connected together and able to operate only in this manner.

This document completes and amends, if applicable, the various relevant standards applying to the individual components constituting GIS.

2 Normative references

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

IEC 60068-2-11, *Environmental testing – Part 2-11: Tests – Test Ka: Salt mist*

IEC 60068-2-17, *Basic environmental testing procedures – Part 2-17: Tests – Test Q: Sealing*

IEC 60085:2007, *Electrical insulation – Thermal evaluation and designation*

IEC 60099-4:2014, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*

IEC 60137:2017, *Insulated bushings for alternating voltages above 1 000 V*

IEC 60141-1, *Tests on oil-filled and gas-pressure cables and their accessories – Part 1: Oil-filled, paper or polypropylene paper laminate insulated, metal-sheathed cables and accessories for alternating voltages up to and including 500 kV*

IEC 60270, *High-voltage test techniques – Partial discharge measurements*

IEC 60376, *Specification of technical grade sulphur hexafluoride (SF₆) and complementary gases to be used in its mixtures for use in electrical equipment*

IEC 60480, *Specifications for the re-use of sulphur hexafluoride (SF₆) and its mixtures in electrical equipment*

IEC 60840, *Power cables with extruded insulation and their accessories for rated voltages above 30 kV ($U_m = 36$ kV) up to 150 kV ($U_m = 170$ kV) – Test methods and requirements*

IEC 61869-1, *Instrument transformers – Part 1: General requirements*

IEC 61869-2, *Instrument transformers – Part 2: Additional requirements for current transformers*

IEC 61869-3, *Instrument transformers – Part 3: Additional requirements for inductive voltage transformers*

IEC 62067, *Power cables with extruded insulation and their accessories for rated voltages above 150 kV ($U_m = 170$ kV) up to 500 kV ($U_m = 550$ kV) – Test methods and requirements*

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

IEC 62271-4, *High-voltage switchgear and controlgear – Part 4: Handling procedures for sulphur hexafluoride (SF_6) and its mixtures*

IEC 62271-100:2021, *High-voltage switchgear and controlgear – Part 100: Alternating current circuit-breakers*

IEC 62271-102:2018, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

IEC 62271-209:2019, *High-voltage switchgear and controlgear – Part 209: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV – Fluid-filled and extruded insulation cables – Fluid-filled and dry-type cable-terminations*

IEC 62271-211:2014, *High-voltage switchgear and controlgear – Part 211: Direct connection between power transformers and gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62271-1:2017 and the following, 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 <http://www.electropedia.org/>

3.101

metal-enclosed switchgear and controlgear

switchgear and controlgear assemblies with an external metal enclosure intended to be earthed, and complete except for external connections

[SOURCE: IEC 60050-441:1984, 441-12-04, modified – The note was deleted.]

3.102

gas-insulated metal-enclosed switchgear

metal-enclosed switchgear in which the insulation is obtained, at least partly, by an insulating gas or gas mixture other than air at atmospheric pressure

Note 1 to entry: This term generally applies to high-voltage switchgear and controlgear.

Note 2 to entry: Three-phase enclosed gas-insulated switchgear applies to switchgear with the three phases enclosed in a common enclosure.

Note 3 to entry: Single-phase enclosed gas-insulated switchgear applies to switchgear with each phase enclosed in a single independent enclosure.

[SOURCE: IEC 60050-441:1984, 441-12-05, modified – "or gas mixture" has been added in the definition, and Note 2 and 3 to entry have been added.]

3.103

gas-insulated switchgear enclosure

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

Note 1 to entry: The enclosure can be single-phase or three-phase.

3.104

isolating link

part of the conductor which can easily be opened or removed in order to isolate two parts of the GIS from each other

Note 1 to entry: The open gap is designed to withstand the test voltages across isolating distance according to Table 2 and Table 3.

Note 2 to entry: The purpose of an isolating link is to ensure electrical isolation between sections of a GIS e.g. during maintenance and repair work.

3.105

removable link

part of the conductor which can easily be opened or removed in order to separate two parts of the GIS from each other

Note 1 to entry: The open gap is designed to withstand the phase-to-earth test voltages according to Table 2 and Table 3.

Note 2 to entry: The purpose of a removable link is to ensure electrical separation between sections of a GIS, where the equipment is separated from the rest of the GIS, e.g. in front of voltage transformers, surge arresters, cable connections and transformer connections during high voltage testing of GIS or testing of the components.

3.106

compartment

part of gas-insulated metal-enclosed switchgear, which is gastight and enclosed

Note 1 to entry: A compartment can be designated by the main component contained therein, e.g. circuit-breaker compartment, busbar compartment.

3.107

component

essential part of the main or earthing circuits of gas-insulated metal-enclosed switchgear which serves a specific function (for example circuit-breaker, disconnecter, switch, fuse, instrument transformer, bushing, busbar, etc.)

3.108

support insulator

internal insulator supporting one or more conductors

3.109**partition**

gas tight support insulator of gas-insulated metal-enclosed switchgear separating two adjacent compartments

3.110**bushing**

a device that enables one or several conductors to pass through an enclosure and insulate the conductors from it

[SOURCE: IEC 60050-471:2007, 471-02-01, modified – “an enclosure” inserted after “pass through” and “a partition such as a wall or a tank” deleted. Notes 1 and 2 were deleted.]

3.111**main circuit**

all the conductive parts of gas-insulated metal-enclosed switchgear included in a circuit which is intended to transmit electrical energy

[SOURCE: IEC 60050-441:1984, 441-13-02, modified – “gas-insulated metal-enclosed switchgear” inserted after “parts of” and “an assembly” deleted]

3.112**auxiliary circuit**

all the conductive parts of gas-insulated metal-enclosed switchgear included in a circuit intended to control, measure, signal and regulate

Note 1 to entry: The auxiliary circuits of gas-insulated metal-enclosed switchgear include the control and auxiliary circuits of the switching devices.

3.113**enclosure design temperature**

maximum temperature that the enclosures can reach under specified maximum service conditions

3.114**enclosure design pressure**

relative pressure used to determine the design of the enclosure

Note 1 to entry: It is at least equal to the maximum pressure in the enclosure at the highest temperature that the gas used for insulation can reach under specified maximum service conditions.

Note 2 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.

3.115**partition design pressure**

relative pressure across the partition used to determine the design of the partition

Note 1 to entry: It is at least equal to the maximum differential pressure across the partition during maintenance activities.

Note 2 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.

3.116**operating pressure**

<pressure relief device> relative pressure chosen for the opening operation of pressure relief devices

3.117

routine test pressure

<enclosures and partitions> relative pressure to which all enclosures and partitions are subjected after manufacturing

3.118

type test pressure

<enclosures and partitions> relative pressure to which enclosures and partitions are subjected for type test

3.119

fragmentation

damage to enclosure due to pressure rise with projection of solid material

3.120

disruptive discharge

phenomena associated with the failure of insulation under electric stress, in which the discharge completely bridges the insulation under test, reducing the voltage between the electrodes to zero or almost zero

3.121

transport unit

part of gas-insulated metal-enclosed switchgear suitable for shipment without being dismantled

3.122

functional unit

part of metal-enclosed switchgear and controlgear comprising all the components of the main circuits and auxiliary circuits that contribute to the fulfilment of a single function

Note 1 to entry: Functional units can be distinguished according to the function for which they are intended, for example complete single-phase or three-phase bay or functional parts of a bay like complete circuit-breaker, disconnector, earthing switch, voltage transformer, current transformer, operating mechanism, enclosure, etc.

[SOURCE: IEC 60050-441:1984, 441-13-04, modified – In the definition, “metal-enclosed” inserted after “part of” and “an assembly of” deleted. In the note the examples have been exchanged with examples relevant for GIS.]

4 Normal and special service conditions

4.1 Normal service conditions

Subclause 4.1 of IEC 62271-1:2017 is applicable, taking into account the recommended values presented in Table 1 of this document.

4.2 Special service conditions

Subclause 4.2 of IEC 62271-1:2017 is applicable, taking into account the recommended values presented in Table 1 of this document.

In the cases where higher than (>) is used in Table 1, the values shall be specified by the user as described in IEC 62271-1:2017.

4.101 General

Table 1 – Reference table of service conditions relevant to GIS

Item	Normal		Special	
	Indoor	Outdoor	Indoor	Outdoor
Ambient air temperature:				
Minimum (°C)	–5	–25	–25	–50
Maximum (°C)	+40	+40	+50	+50
Solar radiation (W/m ²)	Not applicable	1 000	Not applicable	>1 000
Altitude (m)	1 000	1 000	>1 000	>1 000
Site pollution severity ^a	Not applicable	c	c, d or e	d or e
Ice coating (mm)	Not applicable	20	Not applicable	>20
Wind (m/s)	Not applicable	34	Not applicable	>34
Average humidity over 24 h (%)	95	100	98	100
Condensation or precipitation	Occasional	Yes	Yes	Yes
Abnormal vibrations, shock or tilting	Not applicable	Not applicable	Applicable	Applicable
NOTE The user's specification can use any combination of normal or special service conditions above.				
^a Site pollution severity c, d or e according to IEC TS 60815-1:2008, 8.3 [5] ¹				

At any altitude the dielectric characteristics of the internal insulation are identical with those measured at sea-level. For this internal insulation no specific requirements concerning the altitude are applicable.

Some items of a GIS such as pressure relief devices and pressure and density monitoring devices can be affected by altitude. The manufacturer shall take appropriate measures if necessary.

5 Ratings

5.1 General

Subclause 5.1 of IEC 62271-1:2017 is applicable with the following modifications:

- e) rated short-time withstand current (I_k) (for main and earthing circuits);
- f) rated peak withstand current (I_p) (for main and earthing circuits);

and with the following addition:

- k) rated values of the components forming part of gas-insulated metal-enclosed switchgear, including their operating devices and auxiliary equipment.

5.2 Rated voltage (U_r)

Subclause 5.2 of IEC 62271-1:2017 is applicable with the following addition:

Components forming part of the GIS can have individual values of rated for equipment in accordance with the relevant standards.

¹ Numbers in square brackets refer to the Bibliography.

5.3 Rated insulation level (U_d , U_p , U_s)

Subclause 5.3 of IEC 62271-1:2017 is applicable with the following addition:

Tables 1, 2, 3 and 4 in Subclause 5.3 of IEC 62271-1:2017 are replaced with Table 2 and Table 3 below.

NOTE 1 The higher values for GIS in IEC 62271-203 compared to the values in IEC 62271-1 were introduced with revision 1 in 2003. They have now been established as standard values.

The GIS comprises components having a definite insulation level. Although internal faults can largely be avoided by the choice of a suitable insulation level, measures to limit external overvoltages (e.g. surge arresters,) should be considered.

NOTE 2 Regarding the external parts of bushings (if any), see to IEC 60137:2017.

NOTE 3 The waveforms are standardized lightning impulse and switching impulse shapes, pending the results of studies on the ability of this equipment to withstand other types of impulses.

NOTE 4 The choice between alternative insulation levels for a particular rated voltage for equipment can be based on insulation coordination studies, taking into account also the self-generated transient overvoltages due to switching.

**Table 2 – Rated insulation levels for rated voltages
for equipment of range I (245 kV and below)**

Rated voltage for equipment U_r kV (RMS value)	Rated short-duration power-frequency withstand voltage U_d kV (RMS value)		Rated lightning impulse withstand voltage U_p kV (peak value)	
	Phase-to-earth, across open switching device and between phases	Across the isolating distance	Phase-to-earth, across open switching device and between phases	Across the isolating distance
(1)	(2)	(3)	(4)	(5)
72,5	140	160	325	375
100	185	210	450	520
123	230	265	550	630
145	275	315	650	750
170	325	375	750	860
245	460	530	1 050	1 200
NOTE Values in column (2) are applicable: a) for type tests, phase-to-earth and between phases; b) for routine tests, phase-to-earth, phase-to-phase, and across the open switching device. Values in columns (3), (4) and (5) are applicable for type tests only.				

Table 3 – Rated insulation levels for rated voltages for equipment of range II (above 245 kV)

Rated voltage for equipment U_r kV (RMS value)	Rated short-duration power-frequency withstand voltage U_d kV (RMS value)		Rated switching impulse withstand voltage U_s kV (peak value)			Rated lightning impulse withstand voltage U_p kV (peak value)	
	Phase-to-earth and between phases (Notes 3 and 5)	Across open switching device and/or isolating distance (Note 3)	Phase-to-earth and across open switching device (Note 5)	Between phases (Notes 3 and 4)	Across isolating distance (Notes 1, 2 and 3)	Phase-to-earth and between phases (Note 5)	Across open switching device and/or isolating distance (Notes 2 and 3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
300	460	595	850	1 275	700 (+245)	1 050	1 050 (+170)
362	520	675	950	1 425	800 (+295)	1 175	1 175 (+205)
420	650	815	1 050	1 575	900 (+345)	1 425	1 425 (+240)
550	710	925	1 175	1 760	900 (+450)	1 550	1 550 (+315)
800	960	1 270	1 425	2 420	1 100 (+650)	2 100	2 100 (+455)
1 100	1 100	1 100	1 550	2 635	1 550 +(900)	2 250	2 250 + (630)
		1 100 +(635)	1 800	2 880	1 675 +(900)	2 400	2 400 + (630)
1 200	1 200	1 200	1 800	2 970	1 675 +(980)	2 400	2 400 + (685)
		1 200 +(695)	1 950	3 120		2 550	2 550 + (685)

NOTE 1 Column (6) is also applicable to some circuit-breakers, see IEC 62271-100:2021.

NOTE 2 In column (6), values in brackets are the peak values of the power-frequency voltage $U_r \sqrt{2} / \sqrt{3}$ applied to the opposite terminal (combined voltage).

In column (8), values in brackets are the peak values of the power-frequency voltage $0,7 U_r \sqrt{2} / \sqrt{3}$ applied to the opposite terminal (combined voltage).

NOTE 3 Values in column (2) are applicable:

- a) for type tests, phase-to-earth and between phases;
- b) for routine tests, phase-to-earth, phase-to-phase, and across the open switching device.

Values in columns (3), (4), (5), (6), (7) and (8) are applicable for type tests only.

NOTE 4 These values are derived using the multiplying factors stated in Table 3 of IEC 60071-1:2019 [4].

NOTE 5 For earthing switches only phase-to-earth tests according column (2), (4) and (7) are applicable.

5.4 Rated frequency (f_r)

Subclause 5.4 of IEC 62271-1:2017 is applicable.

5.5 Rated continuous current (I_r)

Subclause 5.5 of IEC 62271-1:2017 is applicable with the following addition:

Some main circuits of GIS (e.g. busbars, feeder circuits, etc.) can have different values of rated continuous current. However, these values should also be selected from R10 series.

5.6 Rated short-time withstand current (I_k)

Subclause 5.6 of IEC 62271-1:2017 is applicable.

5.7 Rated peak withstand current (I_p)

Subclause 5.7 of IEC 62271-1:2017 is applicable.

5.8 Rated duration of short-circuit (t_k)

Subclause 5.8 of IEC 62271-1:2017 is applicable.

5.9 Rated supply voltage of auxiliary and control circuits (U_a)

Subclause 5.9 of IEC 62271-1:2017 is applicable.

5.10 Rated supply frequency of auxiliary and control circuits

Subclause 5.10 of IEC 62271-1:2017 is applicable.

5.11 Rated pressure of compressed gas supply for controlled pressure systems

Subclause 5.11 of IEC 62271-1:2017 is applicable.

6 Design and construction

6.1 Requirements for liquids in switchgear and controlgear

Subclause 6.1 of IEC 62271-1:2017 is applicable.

6.2 Requirements for gases in switchgear and controlgear

Subclause 6.2 of IEC 62271-1:2017 is applicable.

6.3 Earthing of switchgear and controlgear

Subclause 6.3 of IEC 62271-1:2017 is applicable.

6.3.101 Earthing of the main circuit

To ensure safety during maintenance work, all parts of the main circuit to which access is required or provided shall be capable of being earthed.

Earthing can be made by:

- a) earthing switches with a making capacity equal to the rated peak withstand current, if there is still a possibility that the circuit connected is energised;
- b) earthing switches without a making capacity or with a making capacity lower than the rated peak withstand current, if there is certainty that the circuit connected is not energised.

Furthermore, it shall be possible, after opening the enclosure, to connect removable earthing devices for the duration of the work on a circuit element previously earthed via an earthing switch. The removable earthing device shall have the relevant short-circuit withstand capability and/or induced current withstand capability.

The earthing circuit can be degraded after being subjected to the short-circuit current. After such event, earthing circuit can need to be replaced.

6.3.102 Earthing of the enclosure

The enclosures shall be connected to earth. All metal parts which do not belong to a main or an auxiliary circuit shall be earthed. For the interconnection of enclosures, frames, etc., fastening (e.g. bolting or welding) is acceptable for providing electrical continuity.

The continuity of the earthing circuits shall be ensured taking into account the thermal and electrical stresses caused by the current they can have to carry.

If using single-phase enclosed switchgear, a looping circuit, i.e. an interconnection between the enclosures of the three phases, should be installed for the induced current. Each of these looping circuits should be linked as directly as possible to the general earthing grid by a conductor capable to carry the short-circuit current.

NOTE The looping circuits are intended to avoid induced currents in the enclosures from flowing in the earthing circuits and earthing grid. They are usually dimensioned for the rated continuous current and located at the appropriate location according to the layout of the GIS installation.

6.4 Auxiliary and control equipment and circuits

Subclause 6.4 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is applicable.

6.5 Dependent power operation

Subclause 6.5 of IEC 62271-1:2017 is applicable.

6.6 Stored energy operation

Subclause 6.6 of IEC 62271-1:2017 is applicable.

6.7 Independent unlatched operation (independent manual or power operation)

Subclause 6.7 of IEC 62271-1:2017 is applicable.

6.8 Manually operated actuators

Subclause 6.8 of IEC 62271-1:2017 is applicable.

6.9 Operation of releases

Subclause 6.9 of IEC 62271-1:2017 is applicable.

6.10 Pressure/level indication

Subclause 6.10 of IEC 62271-1:2017 is applicable with the following addition:

The performance of the GIS is depending on the gas density of the pure gas or the gas mixtures.

For GIS it is not sufficient to monitor the gas pressure without temperature compensation.

The gas density or temperature compensated gas pressure in each compartment shall be continuously monitored. The monitoring device shall provide at least two alarm levels for pressure or density (alarm and minimum functional pressure or density). The correct functioning of gas monitoring devices shall be able to be checked with the high-voltage equipment in service.

NOTE 1 When the filling density differs between adjacent compartments, an additional alarm indicating over pressure or density can be used, if it is applicable for the GIS design.

NOTE 2 Tolerances of the monitoring device, as well as possible differences in temperature (e.g. inside/outside of a building) between the monitoring device and the volume of gas being monitored, can be considered.

NOTE 3 Checking of gas monitoring can initiate wrong alarms which can initiate or inhibit switching operations.

NOTE 4 It is preferable for gas monitoring devices to be placed as close as possible to the gas compartment which is being monitored to ensure measuring accuracy and minimum leakage, however consideration can be given to safety and accessibility when choosing the location.

NOTE 5 The preferred solution for checking the gas monitoring device is to isolate the density monitor from the gas compartment without mechanically removing it from the GIS, in order to minimize gas losses.

6.11 Nameplates

Subclause 6.11 of IEC 62271-1:2017 is applicable with the following addition:

A common nameplate shall be provided to identify the GIS. It shall, as a minimum, detail the ratings listed in Clause 5 of this document. The common nameplate shall be clearly readable from the position of local operation side.

For each individual device a nameplate according to its relevant standard is required where ratings are not detailed on the common nameplate.

The nameplates shall be durable and clearly legible for the lifetime of the GIS.

The manufacturer shall give information of the type, volume and mass of the gas contained in each gas compartment as well as the total mass for the entire GIS installation either on the nameplate or on a label placed in a visible location. If required, more information shall be provided in the instruction manual.

6.12 Locking devices

Subclause 6.12 of IEC 62271-1:2017 is applicable with the following addition:

The following provisions are mandatory for apparatus installed in main circuits which are used as isolating distance and earthing:

- apparatus installed in main circuits, which are used for ensuring isolating distances during maintenance work, shall be provided with visible locking devices to prevent closing (e.g. padlock);
- earthing switches shall be provided with locking devices to avoid opening during maintenance work.

6.13 Position indication

Subclause 6.13 of IEC 62271-1:2017 is applicable with the following addition:

In case of disconnector switch and earthing switch 6.104.3.2 of IEC 62271-102:2018 is applicable.

6.14 Degrees of protection provided by enclosures

Subclause 6.14 of IEC 62271-1:2017 is applicable.

6.15 Creepage distances for outdoor insulators

Subclause 6.15 of IEC 62271-1:2017 is applicable with the following addition:

This applies to bushings only.

6.16 Gas and vacuum tightness

6.16.1 General

Subclause 6.16.1 of IEC 62271-1:2017 is applicable with the following addition:

This applies only to insulating and switching medium, not to operating medium of switchgear and controlgear.

GIS shall be a closed pressure system or a sealed pressure system.

Leakage losses and handling releases shall be considered separately. The objective is to minimize the release of gas in the atmosphere due to leakage and handling (see IEC 62271-4).

The cause of any leakage shall be investigated carefully, and corrective actions shall be considered, especially if it is above the limits specified in this document.

6.16.2 Controlled pressure systems for gas

Subclause 6.16.2 of IEC 62271-1:2017 is applicable.

6.16.3 Closed pressure systems for gas

Subclause 6.16.3 of IEC 62271-1:2017 is applicable with the following addition:

The relative leakage rate from any single compartment of GIS to atmosphere and between compartments shall not exceed 0,5 % per year for the expected operation duration of the equipment.

NOTE 1 Expected operation duration is typically 40 years under normal service condition as specified in Annex E.

The maximum relative leakage rate F_{rel} for type tests is specified as:

- $\leq 0,1$ % per year for SF₆, SF₆ mixtures and for other gas mixtures with GWP > 1 000;
- $\leq 0,5$ % per year for other gas mixtures with GWP ≤ 1 000.

NOTE 2 The global warming potential (GWP) of gases in GIS is the major reason for requiring low permissible leakage rates. Solutions with alternative gases with GWP lower than 1 000 exist. GWP (100 years) of SF₆ is 23 500 according the IPCC – AR5 Climate Change 2013 [31].

For small gas compartments containing less than 1 kg gas the permissible relative leakage rate F_{rel} for type tests is specified as:

- $\leq 0,2$ % per year for SF₆, SF₆ mixtures and for other gas mixtures with GWP > 1 000.

6.16.4 Sealed pressure systems

Subclause 6.16.4 of IEC 62271-1:2017 is applicable.

6.16.101 Leakage

In accordance with standardized procedure defined in Clause 10 of IEC TR 62271-306:2012 and IEC TR 62271-306:2012/AMD1:2018 [12], the manufacturer shall demonstrate that the relative leakage rate from any compartment of GIS or between compartments complies with 6.16.3 or 6.16.4.

6.16.102 Gas handling

The GIS shall be designed to minimize life cycle gas-handling losses (including end of life activities). The manufacturer shall specify test and maintenance procedures for minimizing gas-handling releases and shall identify the gas releases associated with each procedure.

The manufacturer shall recommend procedures for gas handling according to IEC 62271-4.

6.17 Tightness for liquid systems

Subclause 6.17 of IEC 62271-1:2017 is applicable.

6.18 Fire hazard (flammability)

Subclause 6.18 of IEC 62271-1:2017 is applicable.

6.19 Electromagnetic compatibility (EMC)

Subclause 6.19 of IEC 62271-1:2017 is applicable.

6.20 X-Ray emission

Subclause 6.20 of IEC 62271-1:2017 is applicable with the following addition:

This applies only to GIS components which use vacuum interrupters.

6.21 Corrosion

Subclause 6.21 of IEC 62271-1:2017 is applicable with the following addition:

The corrosion of bolted and screwed assemblies shall be taken into account when ensuring the continuity of the earthing circuits

6.22 Filling levels for insulation, switching and/or operation

Subclause 6.22 of IEC 62271-1:2017 is applicable.

6.101 General requirements for GIS

GIS shall be designed so that normal service, inspection and maintenance operations, earthing of connected cables, locating of cable faults, voltage tests on connected cables or other apparatus and the elimination of dangerous electrostatic charges, can be carried out safely, including the checking of phase sequence after installation and extension.

The design of the equipment shall be such that the agreed permitted movement of foundations and mechanical or thermal effects do not impair the assigned performance of the equipment.

All components of the same type (rating, design and construction, etc.) which can be replaced shall be interchangeable.

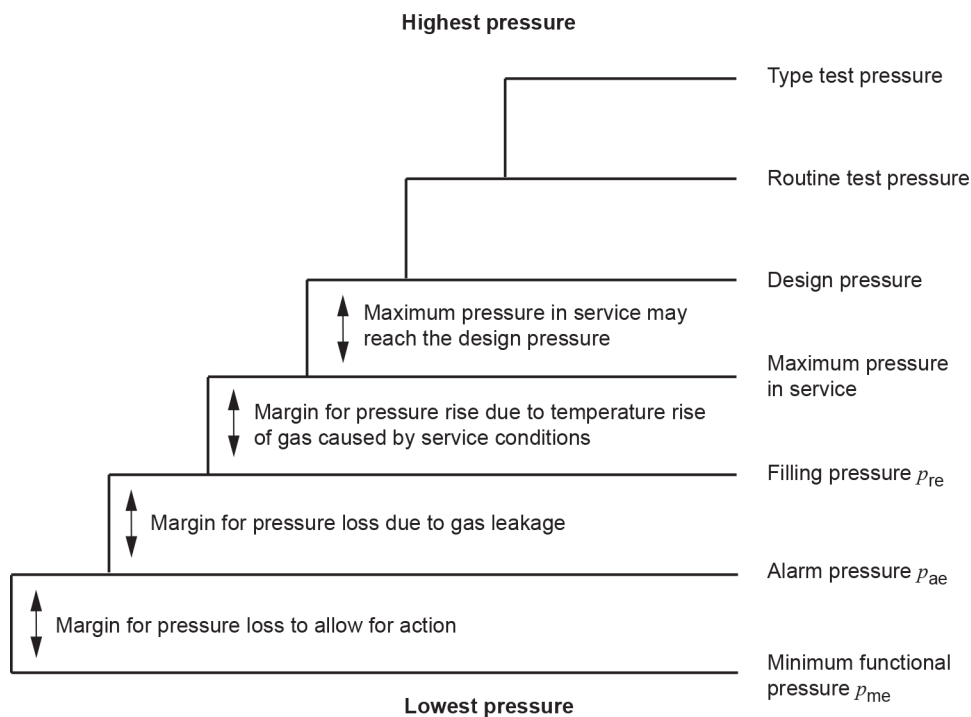
The various components contained within the enclosure are subject to their relevant standards except where modified by this document.

6.102 Pressure coordination

The pressure inside a GIS can vary from the filling pressure p_{re} due to different service conditions.

In service conditions, the mechanical stresses are associated with the internal pressure which depends on the gas temperature. Consequently, the maximum pressure in service corresponds to the filling pressure at the maximum temperature the gas can reach due to continuous current and service conditions (e.g. temperature, sun radiation).

Figure 1 shows the various pressure levels and their relationship.



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Figure 1 – Pressure coordination

The manufacturer is responsible for choosing the minimum functional pressure for insulation p_{me} and filling pressure p_{re} .

The manufacturer shall propose the alarm pressure p_{ae} which is related to both the filling pressure p_{re} and the minimum functional pressure. The alarm pressure p_{ae} will inform the user of any gas leak. For GIS using gas with a GWP > 1 000, the filling pressure p_{re} and the alarm pressure p_{ae} shall be as close as possible, considering the tolerances of the density sensors, in order to aware the user as soon as possible of gas losses.

Installation conditions (indoor, outdoor, direct solar radiations, ...), design and tolerances of the gas monitoring device shall be taken into consideration.

The time between the alarm pressure p_{ae} and the minimum functional pressure p_{me} allows corrective actions to be undertaken by the user and is dependent upon the gas leakage rate. During this time period the tolerances of the gas monitoring devices shall be taken into consideration.

6.103 Internal arc fault

6.103.1 General

A fault leading to arcing within GIS built to this document has a very low order of probability of occurrence. This results from the application of an insulating gas other than air at atmospheric pressure which will not be altered by pollution, humidity or vermin.

GIS shall be designed, manufactured and operated in order to prevent the occurrence of internal fault within GIS. All possible measures to keep a very low probability of occurrence shall be taken such as:

- insulation co-ordination;
- gas leakage limitation and control;
- control of gas quality;
- high quality of work on-site;
- interlocking of switching device.

The very low probability of such an event shall be considered. Arrangements shall be made to minimize the effects of internal faults on service continuity (e.g. high-speed protection, remote control, additional gas compartments). The internal arc shall not propagate into adjacent gas compartments.

After such an event, an intervention will be necessary in order to isolate the faulty compartment. The general partitioning of GIS design shall permit the restoration of the part of GIS which is not affected in order to satisfy the service continuity requirements when defined (see Annex F).

6.103.2 External effects of the arc

The effects of an internal arc are:

- pressure increase of gas (see Annex D);
- possible burn-through of enclosure.

The external effects of the arc shall be limited by a suitable protective system to the appearance of a hole or a tear in the enclosure without any fragmentation. The duration of the arc is related to the performance of the protective system determined by the first stage (main protection) and second stage (back-up protection).

Table 4 gives the performance criteria for the duration of the arc according to the performance of the protective system.

Table 4 – Performance criteria

Rated short-circuit current	Protection stage	Duration of short-circuit current	Performance criteria
<40 kA RMS	1	≤0,2 s	No external effect other than the operation of suitable pressure relief devices
	2	≤0,5 s	No fragmentation (burn-through is acceptable)
≥40 kA RMS	1	≤0,1 s	No external effect other than the operation of suitable pressure relief devices
	2	≤0,3 s	No fragmentation (burn-through is acceptable)

The term “no fragmentation of the enclosure” is interpreted as follows:

- no explosion of the compartment;
- no solid parts flying off from the compartment.

Exceptions are:

- parts of the pressure relief device or parts installed in these, if their ejection is directed;
- glowing particles and molten material resulting from burn-through of the enclosure.

Additionally, manufacturer and user can define a time during which an arc due to an internal fault up to a given value of short-circuit current will cause no external effects. The definition of this time shall be based on test results or an acknowledged calculation procedure. See Equation (D.1).

The duration of current without burn-through for different values of the short-circuit current can be estimated from an acknowledged calculation procedure like CIGRE Technical Brochure 602 [24], CIGRE Session 1998 – WG 21/23/33-03 [28] and RGE: 04/82 [29].

6.103.3 Internal fault location

The manufacturer of the GIS should propose appropriate methods for the determination of the location of a fault, if required by the user.

6.104 Enclosures

6.104.1 General

The enclosure shall be capable of withstanding the normal and transient pressures to which it is subjected in service.

6.104.2 Design of enclosures

The design of the enclosure shall be made in accordance with established standards for pressurized enclosures of gas-filled high-voltage switchgear and controlgear with inert, non-corrosive, low pressurized gases. For further information, see EN 50052 [15], EN 50064 [16], EN 50068 [17], EN 50069 [18].

Methods for the calculation of the thickness and the construction of enclosures either by welding or casting shall be based on the design pressure (see definition in 3.114).

When designing an enclosure, account shall also be taken of the following:

- a) the possible recovery or evacuation of gas or air in the enclosure as part of the normal filling process;
- b) the full differential pressure possible across the enclosure walls or partitions;
- c) the resulting pressure in the event of an accidental leak between the compartments in the case of adjacent compartments having different service pressures if overpressure is not monitored;
- d) the possibility of the occurrence of an internal fault (see 6.103);
- e) the corrosive impact on enclosures shall be considered by appropriate measures (e.g. filter material to adsorb humidity and decomposition products).

In determining the design pressure, the gas temperature shall be taken as the mean of the upper limits of the enclosure temperature and the main circuit conductor temperature with rated continuous current flowing unless the design pressure can be established from existing continuous current test records.

For enclosures and parts thereof, the strength of which has not been fully determined by calculation, proof tests (see 7.103) shall be performed to demonstrate that they fulfil the requirements.