

Australian Standard[®]

High-voltage switchgear and controlgear

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



This Australian Standard® was prepared by Committee EL-007, Power Switchgear. It was approved on behalf of the Council of Standards Australia on 10 August 2012. This Standard was published on 27 August 2012.

The following are represented on Committee EL-007:

- Australian British Chamber of Commerce
 - Australian Industry Group
 - Energy Australia
 - Energy Networks Association
 - Engineers Australia
 - University of New South Wales
-

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Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

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Australian Standard[®]

High-voltage switchgear and controlgear

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

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PREFACE

This Standard was prepared by the Standards Australia Committee EL-007, Power Switchgear to supersede AS 62271.203—2005, *High-voltage switchgear and controlgear*, Part 203: *Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV* (IEC 62271-203, Ed.1.0 (2003) MOD).

The objective of this Standard is to specify requirements for gas-insulated metal-enclosed switchgear in which the insulation is obtained, at least partly, by an insulating gas 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.

This Standard should be read in conjunction with IEC 62271-1:2007 (adopted as AS 62271.1—2012), to which it refers and which is applicable unless otherwise specified. In order to simplify the indication of corresponding requirements, the same numbering of clauses and subclauses is used as in IEC 62271-1 (AS 62271.1). Amendments to these clauses and subclauses are given under the same numbering, whilst additional subclauses, are numbered from 101.

This Standard is identical with, and has been reproduced from IEC 62271-203, Ed.2.0 (2011), *High-voltage switchgear and controlgear—Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*.

Common numbering of Standards falling under the responsibility of EL-007

In accordance with the decision taken by EL-007, a common numbering system will be established in order to align the numbering of Australian Standards falling under the responsibility of EL-007 with the IEC Standards. All high-voltage switchgear and controlgear Standards will, at their next revision (or as equivalent Standards become available in IEC), become parts of the AS 62271 (*High-voltage switchgear and controlgear*) series. The table below gives the relationship between AS 62271 numbering and original Standard numbers. Standards current at the time of publication of this Standard are marked with an asterisk (*).

AS 62271 series part number	High-voltage switchgear and controlgear	Previous AS number
100*	High-voltage alternating-current circuit-breakers	AS 2006
102*	Alternating current disconnectors and earthing switches	AS 1306
103	Switches for rated voltages above 1 kV and less than 52 kV	*AS/NZS 60265.1
104	Switches for rated voltages of 52 kV and above	*AS 60265.2
105	Alternating current switch-fuse combinations	*AS 2024
106	Alternating current contractors and contractor-based motor-starters	*AS 60470
110*	Inductive load switching	AS 4372
200*	AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV	AS 2264
201*	AC insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV	AS 2264
202*	High-voltage/low-voltage prefabricated substations	AS 61330
203*	Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV	AS 2263
301*	Dimensional standardization of terminals	AS 2395
303	Use and handling of sulphur hexafluoride (SF ₆) in high-voltage switchgear and controlgear	*AS 2791
304	Additional requirements for enclosed switchgear and controlgear from 1 kV to 72.5 kV to be used in severe climactic conditions	*AS 4243
308*	Guide for asymmetrical short-circuit breaking test duty T100a	

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number appears on the cover and title page while the International Standard number appears only on the cover.
- (b) In the source text ‘this part of IEC 62271’ should read ‘this part of AS 62271’.
- (c) A full point substitutes for a comma when referring to a decimal marker.

Only normative references in the source document that have been adopted as Australia or Australia/New Zealand Standards have been listed as follows:

<i>Reference to International Standard</i>		<i>Australian or Australian/New Zealand Standard</i>	
IEC		AS	
60044	Instrument transformers	60044	Instrument transformers
60044-1	Part 1: Current transformers	60044.1	Part 1: Current transformers
60044-2	Part 2: Inductive voltage transformers	60044.2	Part 2: Inductive voltage transformers
60068	Basic environmental testing procedures	60068	Environmental testing
60068-2-11	Part 2.11: Tests—Test Ka: Salt mist	60068.2.11	Part 2.11: Tests—Test Ka: Salt mist
60270	High-voltage test techniques—Partial discharge measurements	60270	High-voltage test techniques—Partial discharge measurements
		AS/NZS	
60137	Insulated bushings for alternating voltages above 1000 V	60137	Insulated bushings for alternating voltages above 1000 V
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	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

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AUSTRALIAN STANDARD

High-voltage switchgear and controlgear**Part 203:****Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV****1 General****1.1 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 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 standard, the terms “GIS” and “switchgear” are used for “gas-insulated metal-enclosed switchgear”.

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

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

1.2 Normative references

The following referenced documents are indispensable for the application 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 60044-1:1996, *Instrument transformers – Part 1: Current transformers*

IEC 60044-2:1997, *Instrument transformers – Part 2: Inductive voltage transformers*

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

IEC 60137:2008, *Insulating 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-insulated, metal-sheathed cables and accessories for alternating voltages up to and including 400 kV*

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

IEC 60376, *Specification of technical grade sulfur hexafluoride (SF₆) for use in electrical equipment*

IEC 60480, *Guidelines for the checking and treatment of sulfur hexafluoride (SF₆) taken from electrical equipment and specification for its re-use*

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/TR 61639:1996, *Direct connection between power transformers and gas-insulated metal-enclosed switchgear for rated voltages of 72,5 kV and above*

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 62271-1:2007, *High-voltage switchgear and controlgear – Part 1: Common specifications*

IEC 62271-100:2008, *High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers*

IEC 62271-102:2001, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

IEC 62271-209:2007, *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/TR 62271-303, *High-voltage switchgear and controlgear – Part 303: Use and handling of sulphur hexafluoride (SF_6)*

ISO 3231, *Paints and varnishes – Determination of resistance to humid atmospheres containing sulfur dioxide*

2 Normal and special service conditions

Clause 2 of IEC 62271-1 is applicable with the following additions:

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

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

2.1 Normal service conditions

Subclause 2.1 of IEC 62271-1 is applicable, taking into account Table 1 of this standard.

2.2 Special service conditions

Subclause 2.2 of IEC 62271-1 is applicable, taking into account Table 1 of this standard.

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

Table 1 – Reference table of service conditions relevant to GIS

Item	Normal		Special	
	Indoor	Outdoor	Indoor	Outdoor
Ambient air temperature:				
Minimum (°C)	–5 or –25	–25 or –40	–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	1, 10 or 20	Not applicable	>20
Wind (m/s)	Not applicable	34	Not applicable	>34
Humidity (%)	95	100	98	100
Condensation or precipitation	Occasional	Yes	Yes	Yes
Vibration class	Not applicable	Not applicable	IEC 62271-207 IEC/TR 62271-300	IEC 62271-207 IEC/TR 62271-300
NOTE The user's specification may 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.				

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62271-1, as well as the following, apply.

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

[IEC 60050-441:1984, 441-12-04]

3.102

gas-insulated metal-enclosed switchgear

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

[IEC 60050-441:1984, 441-12-05]

NOTE 1 This term generally applies to high-voltage switchgear and controlgear.

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

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

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 The enclosure can be single-phase or three-phase.

3.104**removable link**

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

3.105**compartment**

part of gas-insulated metal-enclosed switchgear, totally enclosed except for openings necessary for interconnection and control

NOTE A compartment may be designated by the main component contained therein, e.g. circuit-breaker compartment, busbar compartment.

3.106**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.)

3.107**support insulator**

internal insulator supporting one or more conductors

3.108**partition**

support insulator of gas-insulated metal-enclosed switchgear separating one compartment from other compartments

3.109**bushing**

device that enables one or several conductors to pass through a partition such as a wall or a tank, and insulate the conductors from it

NOTE The means of attachment (flange or fixing device) to the partition form part of the bushing.

[IEC 60050-471:2007, 471-02-01, modified]

3.110**main circuit**

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

[IEC 60050-441:1984, 441-13-02, modified]

3.111**auxiliary circuit**

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

NOTE The auxiliary circuits of gas-insulated metal-enclosed switchgear include the control and auxiliary circuits of the switching devices.

3.112**design temperature of enclosures**

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

3.113**design pressure of enclosures**

relative pressure used to determine the design of the enclosure

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

3.114

design pressure of partitions

relative pressure across the partition

NOTE 1 It is at least equal to the maximum relative pressure across the partition during maintenance activities.

NOTE 2 The transient pressure occurring during and after a breaking operation (e.g. circuit-breaker) is not to be considered in the determination of the design pressure.

3.115

operating pressure of pressure relief device

relative pressure chosen for the opening operation of pressure relief devices

3.116

routine test pressure of enclosures and partitions

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

3.117

type test pressure of enclosures and partitions

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

3.118

fragmentation

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

NOTE 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, if their ejection is directed;
- glowing particles and molten material resulting from burn-through of the enclosure.

3.119

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

3.120

service period

time until a maintenance, including opening of the gas compartments, is required

3.121

transport unit

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

4 Ratings

Clause 4 of IEC 62271-1 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:

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

4.1 Rated voltage (U_r)

Subclause 4.1 of IEC 62271-1 is applicable with the following addition:

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

4.2 Rated insulation level

Subclause 4.2 of IEC 62271-1 is applicable with the following addition:

Tables 1 and 2 in Subclause 4.2 of IEC 62271-1 are replaced by Tables 2 and 3 below.

For rated voltages above 800 kV, see Annex G.

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 1 According to CIGRE studies the natural ratio between the withstand voltages under standard tests, for SF₆ gas insulation is $U_d / U_p = 0,45$ and $U_s / U_p = 0,75$. The values U_d shown in Table 3 are calculated with these factors.

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

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 should 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

Rated voltage for equipment U_r kV (r.m.s. value)	Rated short-duration power-frequency withstand voltage U_d kV (r.m.s. 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

Rated voltage for equipment U_r kV (r.m.s. value)	Rated short-duration power-frequency withstand voltage U_d kV (r.m.s. 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 (Note 3)	Across open switching device and/or isolating distance (Note 3)	Phase-to-earth and across open switching device	Between phases (Notes 3 and 4)	Across isolating distance (Notes 1, 2 and 3)	Phase-to-earth and between phases	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)

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

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 60071-1:2006.

4.3 Rated frequency (f_r)

Subclause 4.3 of IEC 62271-1 is applicable.

4.4 Rated normal current and temperature rise

4.4.1 Rated normal current (I_r)

Subclause 4.4.1 of IEC 62271-1 is applicable with the following addition:

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

4.4.2 Temperature rise

Subclause 4.4.2 of IEC 62271-1 is applicable with the following addition:

The temperature rise of components contained in the GIS which are subject to standards not covered by the scope of IEC 62271-1 shall not exceed the temperature-rise limits permitted in the relevant standard for those components.

NOTE When applying a temperature rise equal to or higher than 65 K for parts of the enclosure not accessible to the operator, every precaution should be taken to ensure that no damage is caused to the surrounding insulating materials.

4.5 Rated short-time withstand current (I_k)

Subclause 4.5 of IEC 62271-1 is applicable.

4.6 Rated peak withstand current (I_p)

Subclause 4.6 of IEC 62271-1 is applicable with the following addition:

NOTE In principle, the rated short-time withstand current and the rated peak withstand current of a main circuit cannot exceed the corresponding rated values of the weakest of its series connected components.

4.7 Rated duration of short-circuit (t_k)

Subclause 4.7 of IEC 62271-1 is applicable.

4.8 Rated supply voltage of closing and opening devices and of auxiliary and control circuits (U_a)

Subclause 4.8 of IEC 62271-1 is applicable.

4.9 Rated supply frequency of closing and opening devices and of auxiliary circuits

Subclause 4.9 of IEC 62271-1 is applicable.

4.10 Rated pressure of compressed gas supply for controlled pressure systems

Subclause 4.10 of IEC 62271-1 is not applicable.

4.11 Rated filling levels for insulation and/or operation

Subclause 4.11 of IEC 62271-1 is applicable.

5 Design and construction

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 rating and construction which may need to be replaced shall be interchangeable.

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

5.1 Requirements for liquids in switchgear and controlgear

Subclause 5.1 of IEC 62271-1 is not applicable.

5.2 Requirements for gases in switchgear and controlgear

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

Recommendation for dew-point measurements and adequate corrections shall be supplied by the manufacturer. Refer to E.4

5.3 Earthing of switchgear and controlgear

Subclause 5.3 of IEC 62271-1 is applicable.

5.3.101 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 may 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 live;
- 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 live.

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

5.3.102 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 may 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 rated current and located at the appropriate location according to the layout of the GIS installation.

5.4 Auxiliary and control equipment

Subclause 5.4 of IEC 62271-1 is applicable.

5.5 Dependent power operation

Subclause 5.5 of IEC 62271-1 is applicable.

5.6 Stored energy operation

Subclause 5.6 of IEC 62271-1 is applicable.

5.7 Independent manual or power operation (independent unlatched operation)

Subclause 5.7 of IEC 62271-1 is applicable.

5.8 Operation of releases

Subclause 5.8 of IEC 62271-1 is applicable.

5.9 Low- and high-pressure interlocking and monitoring devices

Subclause 5.9 of IEC 62271-1 is applicable with the following addition:

For GIS only gas density is of importance.

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

NOTE 1 When the rated filling density differs between adjacent compartments, an additional alarm indicating over pressure or density may be used.

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, should be considered.

NOTE 3 Checking of gas monitoring may initiate wrong alarms which may 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 should be given to safety and accessibility when choosing the location.

5.10 Nameplates

Subclause 5.10 of IEC 62271-1 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 4 of this standard. 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 total amount of SF₆ contained in the entire GIS installation either on the nameplate or on a label placed in a visible location. If required, more information regarding the SF₆ amount shall be provided in the instruction manual.

5.11 Interlocking devices

Subclause 5.11 of IEC 62271-1 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.

Earthing switches having a short-circuit making capacity less than the rated peak withstand current of the circuit should be interlocked with the associated disconnectors.

Earthing switches having a short-circuit making capacity less than the rated peak withstand current, or a breaking capacity less than the rated normal current, and disconnectors should be interlocked with the associated circuit-breaker to prevent opening or closing of the switch or disconnector unless the associated circuit-breaker is open. However, on-load bus-transfer switching operations at multiple busbar substations shall be possible.

5.12 Position indication

Subclause 5.12 of IEC 62271-1 is applicable with the following addition:

Subclause 5.104.3.1 of IEC 62271-102:2001 is applicable.

5.13 Degrees of protection by enclosures

Subclause 5.13 of IEC 62271-1 is applicable.

5.14 Creepage distances for outdoor insulators

Subclause 5.14 of IEC 62271-1 is applicable with the following addition:

This applies to bushings only.

5.15 Gas and vacuum tightness

Subclause 5.15 of IEC 62271-1 is applicable with the following addition:

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

Leakage losses and handling losses shall be considered separately.

NOTE 1 The objective is to achieve a total loss (leakage and handling) as low as possible. A value of less than 15 % averaged over all gas compartments and for the service period of minimum 25 years should be achieved.

NOTE 2 The cause of abnormal leakage in service should be investigated carefully and corrective actions should be considered.

5.15.1 Controlled pressure systems for gas

Subclause 5.15.1 of IEC 62271-1 is not applicable.

5.15.2 Closed pressure systems for gas

Subclause 5.15.2 of IEC 62271-1 is applicable with the following addition:

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

5.15.3 Sealed pressure systems

Subclause 5.15.3 of IEC 62271-1 is applicable.

5.15.101 Leakage

In accordance with standardized procedure defined in Annex E of IEC 62271-1, the manufacturer shall demonstrate that the leakage rate from any compartment of GIS or between compartments complies with 5.15.2 or 5.15.3.

5.15.102 Gas handling

The GIS shall be designed so as to minimize gas-handling losses during service life. The manufacturer shall specify test and maintenance procedures for minimizing gas-handling losses and shall identify the gas loss associated with each procedure.

The manufacturer shall recommend procedures for SF₆ handling according to IEC 60480 and IEC/TR 62271-303.

5.16 Liquid tightness

Subclause 5.16 of IEC 62271-1 is not applicable.

5.17 Fire hazard (flammability)

Subclause 5.17 of IEC 62271-1 is applicable.

5.18 Electromagnetic compatibility (EMC)

Subclause 5.18 of IEC 62271-1 is applicable.

5.19 X-Ray emission

Subclause 5.19 of IEC 62271-1 is applicable with the following addition:

This applies only to circuit breakers with vacuum interrupters.

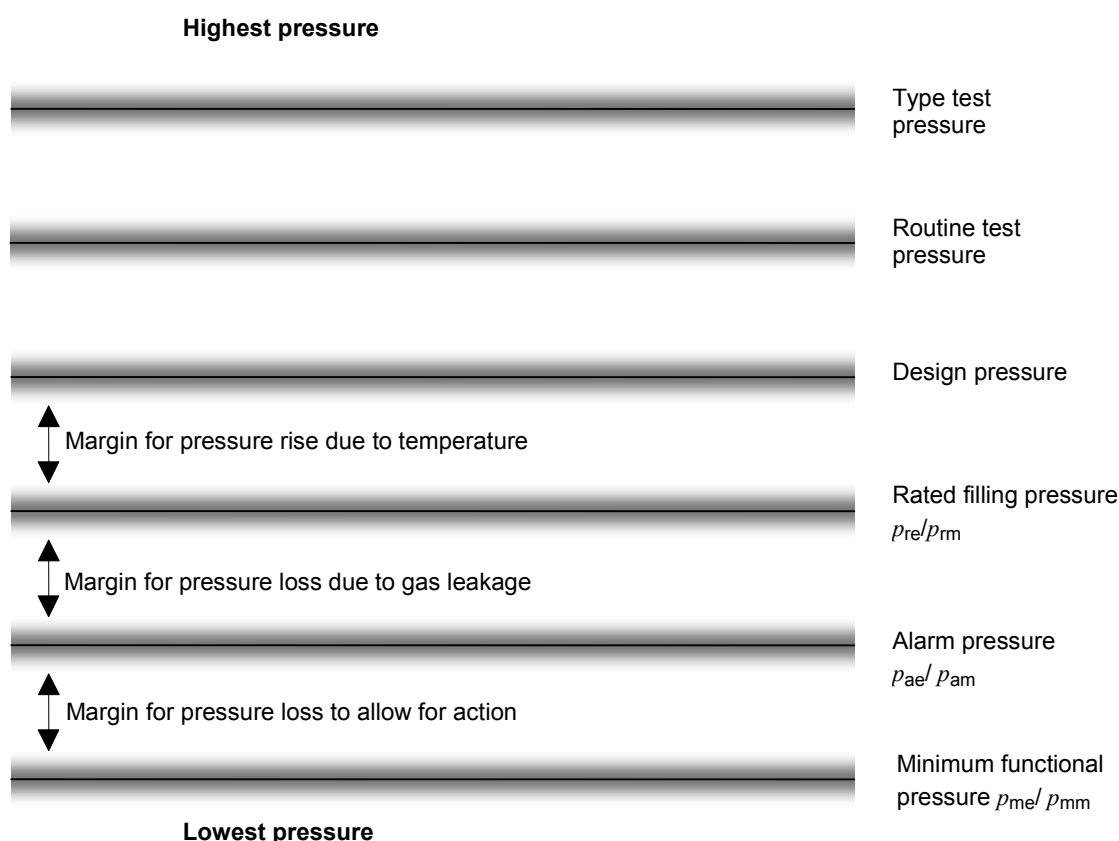
5.20 Corrosion

Subclause 5.20 of IEC 62271-1 is applicable with the following addition:

The continuity of the earthing circuits shall be ensured taking into account the corrosion of bolted and screwed assemblies.

5.101 Pressure coordination

The pressure inside a GIS may vary from the rated filling pressure level due to different service conditions. Pressure increase due to temperature and leakage between compartments may impose additional mechanical stresses. Pressure decrease due to leakage may reduce the insulation properties. 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 operation p_{mm} . The alarm pressures p_{ae}/p_{am} are related to the rated filling pressures p_{re}/p_{rm} by the specified leakage rate in order to achieve the minimum requirements for the re-filling period specified in IEC 62271-1 and by the user.

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

In service conditions, the mechanical stresses are associated with the internal pressure which depends on the gas temperature. Consequently, the design pressure corresponds to the rated filling pressure at the maximum temperature the gas can reach.

Routine test pressure and type test pressure are based on design pressure taking into account material and manufacturing process factors.

5.102 Internal fault

5.102.1 General

A fault leading to arcing within GIS built to this standard has a very low order of probability. 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,
- 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). The internal arc shall not propagate into adjacent gas compartments.

After such an event, an intervention should 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 are not affected in order to satisfy the service operation requirements when defined (see Annex F).

5.102.2 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 to the appearance of a hole or a tear in the enclosure without any fragmentation (by a suitable protective system).

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 current	Performance criteria
<40 kA r.m.s.	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 r.m.s.	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)

Manufacturer and user may 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 may be estimated from an acknowledged calculation procedure. See Bibliography.

5.102.3 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.

5.103 Enclosures

5.103.1 General

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

5.103.2 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, consult the bibliography.

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 3.113).

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

- a) the possible evacuation of 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 5.102).

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 normal current flowing unless the design pressure can be established from existing temperature-rise test records.

For enclosures and parts thereof, the strength of which has not been fully determined by calculation, proof tests (see 6.103) shall be performed to demonstrate that they fulfil the requirements.

Materials used in the construction of enclosures shall be of known and certified minimum physical properties on which calculations and/or proof tests are based. The manufacturer shall be responsible for the selection of the materials and the maintenance of these minimum properties, based on certification of the material supplier, or tests conducted by the manufacturer, or both.

5.104 Partitions

5.104.1 Design of partitions

Partitions shall be used to separate compartments of the GIS and shall be gas tight such that contamination between adjacent compartments cannot occur. Partitions shall be made of material having insulating and mechanical properties so as to insure proper operation over the lifetime of the GIS. Partitions shall maintain their dielectric withstand strength at service voltage when contaminated by SF₆ by-products generated from normal load switching or short-circuit fault breaking.

The design pressure of a partition is defined by maintenance situation. During maintenance activities, the partition is normally pressurized on one side and maintenance is being carried out on the other side at atmospheric pressure. In this case the pressure to be considered on the pressurized side of the partition is the pressure at maximum ambient temperature with solar radiation effects (where applicable) and rated continuous current (where applicable). The pressure so derived is the design pressure of the partition.

For safety reasons, during maintenance activities, the gas pressure may be lowered to a specified and controlled pressure below the rated pressure. In such cases this reduced pressure on one side of the partition can be used when determining the design pressure. Warning notices and gas handling procedures shall be written in the operating and maintenance manuals.

Beyond the design pressure, account shall be taken of the following, if applicable:

- evacuation of a gas compartment on one side of the partition with service pressure on the other, as part of the filling process; if there is a pressure differential limitation, or a time limitation related to the pressure differential, these shall be clearly stated by the manufacturer;
- a controlled enhanced pressure, in excess of the maximum gas pressure, on one side of the partition with service pressure on the other side during electrical testing of the equipment and associated circuits;
- for non-symmetrical partitions, as far as the pressure on the partition is concerned, the worst-case pressure direction;
- superimposed loads and vibration;
- the possibility of maintenance being carried out adjacent to a pressurized partition, with special care to avoid rupture of the partition and the risk of injuries for maintenance people.

NOTE Enhanced pressure due to internal fault is not considered to establish the pressure design since in such situation, partition will be closely inspected and replaced if necessary.

5.104.2 Partitioning

The selection of the electrical single-line diagram is the primary consideration to fulfil service continuity requirements. Layout arrangements and introduction of dismantling facilities will influence service continuity during maintenance, repair and extension.

Partitioning of a GIS is influenced by the service continuity requirements during maintenance, repair and extension. Local health and safety requirements also have to be considered, refer to Clause 11.

Annex F provides guidance for specifying service continuity.

GIS shall be divided into compartments in such a manner that:

- during various activities requiring de-energization of parts of the GIS, compartments to be taken out of service comply with the user's service continuity requirements. These activities include:
 - maintenance,
 - repair,
 - extension;
- the effects of an arc inside a compartment is limited to that compartment (see 5.102.1);
- duration of unavailability in case of major failure shall be in accordance with the user's service continuity requirements;
- the gas compartment can be evacuated and filled in a reasonable time considering the gas handling devices available.

NOTE For on-site dielectric tests (after maintenance, repair or extension), refer to 10.2.101.2

Partitions are generally of insulating material. They are not intended to provide electrical safety of personnel. For this purpose, other means such as separating by an isolating distance and earthing of the equipment may be necessary.

Partitions provide mechanical safety against the gas pressure still present in the adjacent compartment during maintenance, repair and extension. During such activities, other mechanical stresses than pressure should be considered on partitions, such as shock of any piece, or transient mechanical stresses from conductors in order to define the safety rules and avoid health risk for people.

Where a GIS bus-duct pass between indoor and outdoor locations (for example, GIS installed within a building with outdoor bushings), the gas compartment may be provided with a partition close to the wall, separating the compartment between the indoor and outdoor environments to prevent problems arising from false alarms of the gas monitoring devices and condensation occurring due to indoor and outdoor temperature differences.

Each compartment shall be equipped with the following accessories:

- filling valve;
- gas monitoring device (see 5.9).

Depending on the GIS design or on users request each compartment may be equipped with the following accessories:

- pressure relief device (see 5.105.3);
- desiccant;
- internal fault arc location detector (see 5.102.3).

Figure 2 gives an example of an arrangement of enclosures and partitions for different types of adjacent compartments.