High-voltage switchgear and controlgear –
Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV

Appareillage à haute tension –
Partie 203: Appareillage sous enveloppe métallique à isolation gazeuse de tensions assignées supérieures à 52 kV
INTERNATIONAL STANDARD

NORME INTERNATIONALE

High-voltage switchgear and controlgear –
Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV

Appareillage à haute tension –
Partie 203: Appareillage sous enveloppe métallique à isolation gazeuse de tensions assignées supérieures à 52 kV
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

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

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

This second edition of IEC 62271-203 cancels and replaces the first edition of IEC 62271-203, published in 2003, and constitutes a technical revision.

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

- adopting the structure and the content to IEC 62271-1,
- harmonisation with IEEE C37.122,
- addition of the new Annex F and the new Annex G.
The text of this standard is based on the following documents:

<table>
<thead>
<tr>
<th>FDIS</th>
<th>Report on voting</th>
</tr>
</thead>
<tbody>
<tr>
<td>17C/512/FDIS</td>
<td>17C/524/RVD</td>
</tr>
</tbody>
</table>

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

This International Standard should be read in conjunction with IEC 62271-1:2007, 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. Amendments to these clauses and subclauses are given under the same numbering, whilst additional subclauses, are numbered from 101.

A list of all the parts of IEC 62271 series can be found under the general title High-voltage switchgear and controlgear, on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.
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 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 (Uₘ = 36 kV) up to 150 kV (Uₘ = 170 kV) – Test methods and requirements
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

<table>
<thead>
<tr>
<th>Item</th>
<th>Normal</th>
<th>Special</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indoor</td>
<td>Outdoor</td>
</tr>
<tr>
<td>Ambient air temperature:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum (°C)</td>
<td>–5 or –25</td>
<td>–25 or –40</td>
</tr>
<tr>
<td>Maximum (°C)</td>
<td>+40</td>
<td>+40</td>
</tr>
<tr>
<td>Solar radiation (W/m²)</td>
<td>Not applicable</td>
<td>1 000</td>
</tr>
<tr>
<td>Altitude (m)</td>
<td>1 000</td>
<td>1 000</td>
</tr>
<tr>
<td>Site pollution severity a</td>
<td>Not applicable</td>
<td>c</td>
</tr>
<tr>
<td>Ice coating (mm)</td>
<td>Not applicable</td>
<td>1, 10 or 20</td>
</tr>
<tr>
<td>Wind (m/s)</td>
<td>Not applicable</td>
<td>34</td>
</tr>
<tr>
<td>Humidity (%)</td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td>Condensation or precipitation</td>
<td>Occasional</td>
<td>Yes</td>
</tr>
<tr>
<td>Vibration class</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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, disconnector, 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 SF\(_6\) 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

<table>
<thead>
<tr>
<th>Rated voltage for equipment $U_r$ kV (r.m.s. value)</th>
<th>Rated short-duration power-frequency withstand voltage $U_d$ kV (r.m.s. value)</th>
<th>Rated lightning impulse withstand voltage $U_p$ kV (peak value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phase-to-earth, across open switching device and between phases (1)</td>
<td>Across the isolating distance (2)</td>
</tr>
<tr>
<td></td>
<td>Phase-to-earth, across open switching device and between phases (4)</td>
<td>Across the isolating distance (5)</td>
</tr>
<tr>
<td>72,5</td>
<td>140</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td></td>
<td>325</td>
</tr>
<tr>
<td>100</td>
<td>185</td>
<td>210</td>
</tr>
<tr>
<td></td>
<td></td>
<td>450</td>
</tr>
<tr>
<td>123</td>
<td>230</td>
<td>265</td>
</tr>
<tr>
<td></td>
<td></td>
<td>550</td>
</tr>
<tr>
<td>145</td>
<td>275</td>
<td>315</td>
</tr>
<tr>
<td></td>
<td></td>
<td>650</td>
</tr>
<tr>
<td>170</td>
<td>325</td>
<td>375</td>
</tr>
<tr>
<td></td>
<td></td>
<td>750</td>
</tr>
<tr>
<td>245</td>
<td>460</td>
<td>530</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 050</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 200</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>Rated voltage for equipment $U_r$ kV (r.m.s. value)</th>
<th>Rated short-duration power-frequency withstand voltage $U_d$ kV (r.m.s. value)</th>
<th>Rated switching impulse withstand voltage $U_s$ kV (peak value)</th>
<th>Rated lightning impulse withstand voltage $U_p$ kV (peak value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phase-to-earth and between phases (Note 3)</td>
<td>Across open switching device and/or isolating distance (Note 3)</td>
<td>Across open switching device and/or isolating distance (Note 2 and 3)</td>
</tr>
<tr>
<td></td>
<td>Phase-to-earth and across open switching device (Note 3)</td>
<td>Between phases (Notes 3 and 4)</td>
<td>Between phases (Notes 1, 2 and 3)</td>
</tr>
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<td></td>
<td>Across isolating distance (Note 1 and 3)</td>
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<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
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<td>300</td>
<td>460</td>
<td>595</td>
<td>850</td>
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<td>1 275</td>
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<td>700 (+245)</td>
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<tr>
<td>362</td>
<td>520</td>
<td>675</td>
<td>950</td>
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<td>1 425</td>
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<td>800 (+295)</td>
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<td>1 175</td>
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<td></td>
<td></td>
<td></td>
<td>1 175 (+205)</td>
</tr>
<tr>
<td>420</td>
<td>650</td>
<td>815</td>
<td>1 050</td>
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<td>1 575</td>
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<td>900 (+345)</td>
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<td>1 425</td>
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<td></td>
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<td>1 425 (+240)</td>
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<tr>
<td>550</td>
<td>710</td>
<td>925</td>
<td>1 175</td>
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<td>900 (+450)</td>
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<td>1 550</td>
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<td></td>
<td></td>
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<td>1 550 (+315)</td>
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<tr>
<td>800</td>
<td>960</td>
<td>1 270</td>
<td>1 425</td>
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<td>2 420</td>
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<td>1 100 (+650)</td>
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<td>2 100</td>
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<tr>
<td></td>
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<td>2 100 (+455)</td>
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</table>
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 $U_{r3}/\sqrt{2}$ applied to the opposite terminal (combined voltage).

In column (8), values in brackets are the peak values of the power-frequency voltage $0.7U_{r3}/\sqrt{3}$ 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), (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.