IEC 62271-204

Edition 2.0 2022-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

High-voltage switchgear and controlgear –
Part 204: Rigid gas-insulated transmission lines for rated voltage above 52 kV

Appareillage à haute tension –
Partie 204: Lignes de transport rigides à isolation gazeuse de tension assignée supérieure à 52 kV

IEC 62271-204:2022-05(en-fr)

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 204: Rigid gas-insulated transmission lines for rated voltage above 52 kV

FOREWORD

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IEC 62271-204 has been prepared by subcommittee 17C: Assemblies, of IEC technical committee 17: High-voltage switchgear and controlgear. It is an International Standard.

This second edition cancels and replaces the first 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) update to be in line with IEC 62271-1:2017 and alignment of the voltage ratings and the test voltages.
b) addition of new information for welds on pressurized parts and gas tightness.

The text of this document is based on the following documents:

Draft	Report on voting
17C/840/FDIS	17C/846/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.

This document is to be read in conjunction with IEC 62271-1:2017 and IEC 62271-203:2022, to which it refers and which are 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 62271-1:2017 and IEC 62271-203:2022. Amendments to these clauses and subclauses are given under the same numbering, whilst additional subclauses are numbered from 101.

A list of all parts of the 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 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 204: Rigid gas-insulated transmission lines for rated voltage above 52 kV

1 Scope

This part of IEC 62271 applies to rigid HV gas-insulated transmission lines (GIL) 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, and for service frequencies up to and including 60 Hz.

This document is applicable where the provisions of IEC 62271-203 do not cover the application of GIL (see Note 3).

At each end of the HV gas-insulated transmission line, a specific element is used for the connection between the HV gas-insulated transmission line and other equipment like bushings, power transformers or reactors, cable boxes, metal-enclosed surge arresters, voltage transformers or GIS, covered by their own specification.

Unless otherwise specified, the HV gas-insulated transmission line is designed to be used under normal service conditions.

NOTE 1 In this document, the term "HV gas-insulated transmission line" is abbreviated to "GIL".

NOTE 2 In this document, the word "gas" means gas or gas mixture, as defined by the manufacturer.

NOTE 3 Examples of GIL applications:

– where all or part of the HV gas-insulated transmission line is directly buried;

– where the HV gas-insulated transmission line is located, wholly or partly, in an area accessible to public;

– where the HV gas-insulated transmission line is long (typically longer than 500 m) and the typical gas compartment length exceeds the common practice of GIS technology.

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 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60229:2007, *Electric cables – Tests on extruded oversheaths with a special protective function*

IEC 60287-3-1:2017, *Electric cables – Calculation of the current rating – Part 3-1: Operating conditions – Site reference conditions*

IEC 60376, *Specification of technical grade sulfur hexafluoride (SF_6) and complementary gases to be used in its mixtures for use in electrical equipment*

IEC 60480, *Specifications for the re-use of sulfur hexafluoride (SF_6) and its mixtures in electrical equipment*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013

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

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

IEC 62271-4:2013, *High-voltage switchgear and controlgear – Part 4: Handling procedures for sulphur hexafluoride (SF_6) and its mixtures*

ISO 9606 (all parts), *Qualification test of welders – Fusion welding*

ISO 9712, *Non-destructive testing – Qualification and certification of NDT personnel*

ISO 14732, *Welding personnel – Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials*

ISO 15609 (all parts), *Specification and qualification of welding procedures for metallic materials – Welding procedure specification*

ISO 15614 (all parts), *Specification and qualification of welding procedures for metallic materials – Welding procedure test*

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:

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

3.101
area accessible to public
area accessible without restriction to any person

Note 1 to entry: A GIL installed above the ground and outside a substation is considered to be "installed in an area accessible to public".

3.102
gas-insulated transmission lines
GIL
metal-enclosed lines in which the insulation is obtained, at least partly, by an insulating gas other than air at atmospheric pressure, with the external enclosure intended to be earthed

3.103
GIL enclosure
part of GIL retaining the insulating gas under the required conditions protecting the equipment against external influences and providing a high degree of protection to personnel

3.104
compartment
part of GIL totally gastight enclosed except for openings necessary for interconnection and control

3.105
partition
gas tight support insulator of gas-insulated metal-enclosed switchgear separating two adjacent compartments

3.106
main circuit
all the conductive parts of GIL included in a circuit which is intended to transmit electrical energy

[SOURCE: IEC 60050-441:1984, 441-13-02, modified – Replacement of “an assembly" by “GIL".]

3.107
ambient air temperature
temperature, determined under required conditions, of the air surrounding the external GIL enclosure in case of installation in open air, open trenches or tunnels

[SOURCE: IEC 60050-441:1984, 441-11-13, modified – Replacement of “complete switching device or fuse" by “external GIL enclosure in case of installation in open air, open trenches or tunnels".]

3.108
design temperature of the enclosure
maximum temperature which can be reached on a GIL enclosure under service conditions

3.109
design pressure of the enclosure
relative pressure used to determine the design of the enclosure

Note 1 to entry: It is at least equal to the maximum relative pressure in the enclosure at the design temperature of the enclosure.

3.110
design pressure of the partitions
relative pressure across the partition

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

3.111
disconnecting unit
unit to electrically isolate one side from another of the main circuit, mainly for site testing or maintenance

3.112
disruptive discharge
phenomenon associated with the failure of insulation under electric stress, in which the discharge completely bridges the insulation, reducing the voltage between the electrodes to zero or almost zero

Note 1 to entry: The term applies to discharges in solid, liquid and gaseous dielectrics and to combinations of these.

Note 2 to entry: A disruptive discharge in a solid dielectric produces permanent loss of dielectric strength (non-self-restoring insulation); in a liquid or gaseous dielectric, the loss can be only temporary (self-restoring insulation).

Note 3 to entry: The term "sparkover" is used when a disruptive discharge occurs in a gaseous or liquid dielectric. The term "flashover" is used when a disruptive discharge occurs over the surface of a solid dielectric in a gaseous or liquid medium. The term "puncture" is used when a disruptive discharge occurs through a solid dielectric.

3.113
GIL section
part of GIL which is defined by operational or other requirements such as maximum length for dielectric testing or installation sequence

Note 1 to entry: A GIL can consist on the assembly of several GIL sections.

Note 2 to entry: It can consist of one or more compartments.

Note 3 to entry: Sections can be segregated by disconnecting units.

4 Normal and special service conditions

4.1 Normal service conditions

4.1.1 General

Subclause 4.1.1 of IEC 62271-1:2017 is applicable with the following addition.

The normal service conditions which apply to a GIL depending on the installation conditions are given in 4.101, 4.102 and 4.103. When more than one of these installation conditions apply, the relevant subclause shall apply to each section of the GIL.

4.1.2 Indoor switchgear and controlgear

Subclause 4.1.2 of IEC 62271-1:2017 is applicable.

4.1.3 Outdoor switchgear and controlgear

Subclause 4.1.3 of IEC 62271-1:2017 is applicable.

4.2 Special service conditions

Subclause 4.2 of IEC 62271-1:2017 is applicable.

4.101 Installation in open air

For determining the ratings of GIL for open air installation, the normal service conditions of IEC 62271-1:2017 shall apply. These are also valid for open trenches.

If the actual service conditions differ from the normal service conditions, the ratings shall be adapted accordingly.

4.102 Buried installation

General values for thermal resistivity and soil temperature are:

– 1,2 K · m/W, and 20 °C in summer;
– 0,85 K · m/W, and 10 °C in winter.

For guidance, values given in IEC 60287-3-1 can be considered.

For long distance transmission lines (several kilometres), site measurement of soil resistivity should also be considered.

NOTE 1 The use of controlled backfill with a given soil thermal resistivity can also be considered.

NOTE 2 A risk of thermal runaway exists if the soil surrounding the buried GIL becomes dry. In order not to dry out the soil, a maximum service temperature of the enclosure in the range of 50 °C to 60 °C is generally considered acceptable.

The depth of laying should be agreed between manufacturer and user. The determination of depth of laying shall take into account thermo mechanical stresses, safety requirements and local regulations.

4.103 Installation in tunnel, shaft or similar situation

Forced cooling is an adequate method to handle with the waste heat and can be used in case of tunnel, shaft or similar installations.

In the case of long vertical shafts and inclined tunnels or sections thereof, attention shall be paid to thermal and density gradients.

5 Ratings

5.1 General

Subclause 5.1 of IEC 62271-1:2017 is not applicable and is replaced as follows.

The rating of a GIL consists of the following:

a) rated voltage (U_r);

b) rated insulation level (U_d, U_p, U_s);

c) rated frequency (f_r);

d) rated continuous current (I_r);

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);

g) rated duration of short-circuit (t_k);

h) rated supply voltage of auxiliary and control circuits (U_a);

i) rated supply frequency of auxiliary and control circuits.

5.2 Rated voltage (U_r)

Subclause 5.2 of IEC 62271-1:2017 is applicable.

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:

Rated insulation levels shall be chosen from IEC 62271-203 on the basis of insulation coordination study for the specific installation in order to consider parameters like overvoltages, voltage reflections, etc. Specific insulation coordination studies are recommended for each installation. For more information, see [1][1].

Although internal arcing faults can largely be avoided by the choice of a suitable insulation level, measures to limit external overvoltages at each end of the installation (e.g. surge arresters) should be considered.

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1 Numbers in square brackets refer to the Bibliography.

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:

The rated continuous current is defined for a single or a three-phase GIL installed above ground with an ambient air temperature at 40 °C. For other installation conditions, the maximum allowable continuous current can differ from the rated continuous current. See Annex A.

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 not applicable.

6 Design and construction

Clause 6 of IEC 62271-1:2017 is applicable, except as follows.

Any GIL equipment which requires routine preventive maintenance or diagnostic testing should be easily accessible.

GIL should be designed so that normal service, inspection and maintenance operations can be carried out safely, including the checking of phase sequence after erection and extension.

The equipment should be designed such that the mechanical stress caused by all relevant loads, for example thermal expansion, agreed permitted movement of foundations, external vibration, earthquakes, soil loading, wind and ice, do not impair the assigned performance of the equipment.

6.1 Requirements for liquids in GIL

Subclause 6.1 of IEC 62271-1:2017 is not applicable.

6.2 Requirements for gases in GIL

Subclause 6.2 of IEC 62271-1:2017 is applicable. In case a gas mixture is used, the manufacturer should provide information about the gas characteristics such as dielectric strength, mixing ratio, process of mixing and filling pressure.

NOTE See references [2], [3] and [4].

6.3 Earthing

Subclause 6.3 of IEC 62271-1:2017 is applicable, with the following additions.

6.3.101 Earthing of the main circuits

To ensure safety during maintenance work, all parts of the main circuits to which access is required or provided shall be capable of being earthed. In addition, it shall be possible, after the opening of the enclosure, to connect earth electrodes to the conductor for the duration of the work.

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 live;
b) earthing switches without a short-circuit making capability or with a short-circuit making capability lower than the rated peak withstand current, if there is a certainty that the circuit connected is not live, or
c) removable earthing devices, only by agreement between manufacturer and user.

Each part being capable of being disconnected shall be capable of being earthed.

Consideration should be given to the ability of the first operated earthing device to dissipate the maximum level of trapped charge on the isolated circuit.

Where the earthing switches form part of the plant connected to the transmission line, the user shall ensure that they comply with the above items a) to c).

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

6.3.102 Earthing of the enclosure

The enclosures shall be capable of being connected to earth. All metal parts intended to be earthed, which do not belong to a main or an auxiliary circuit, shall be connected to earth. For the interconnection of enclosures, frames, etc., fastening (e.g. bolting or welding) is generally acceptable for providing electrical continuity. If the fastening is done by bolting, provisions shall be given in order that a proper electrical contact is provided. If not, the mechanical joint shall be by-passed by a proper electrical connection such as copper or aluminum leads of proper cross section.

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

It is envisaged that most GIL installation will be solidly bonded and earthed at both ends. The particular design has an influence on heat dissipation, step and touch voltages and the external magnetic field. These are discussed in Annex B.

The design of the earthing of the enclosure shall be compatible with the measures for corrosion protection when the GIL is buried.

6.4 Auxiliary and control equipment

Subclause 6.4 of IEC 62271-1:2017 is applicable.

6.5 Dependent power operation

Subclause 6.5 of IEC 62271-1:2017 is not applicable.

6.6 Stored energy operation

Subclause 6.6 of IEC 62271-1:2017 is not applicable.

6.7 Independent manual or power operation (independent unlatched operation)

Subclause 6.7 of IEC 62271-1:2017 is not applicable.

6.8 Manually operated actuators

Subclause 6.8 of IEC 62271-1:2017 is not applicable.

6.9 Operation of releases

Subclause 6.9 of IEC 62271-1:2017 is not applicable.

6.10 Pressure/level indication

Subclause 6.10 of IEC 62271-1:2017 is applicable.

6.11 Nameplates

Subclause 6.11 of IEC 62271-1:2017 is not applicable and is replaced as follows:

6.11.1 General

For outdoor installation, the nameplates and their fixings shall be weather-proof and corrosion proof.

A complete nameplate shall be provided at each end of the installation, and at each point where service is needed. These nameplates shall contain the following information:

– manufacturer's name or trademark
– type designation and serial number
– rated voltage U_r
– rated lightning impulse withstand voltage U_p
– rated switching impulse withstand voltage U_s
– rated short-duration power-frequency withstand voltage U_d
– rated continuous current I_r
– rated short-time withstand current I_k
– rated peak withstand current I_p
– rated frequency f_r
– rated duration of short-circuit t_k
– filling pressure for insulation; minimum functional pressure for insulation; design pressure for enclosures

– type of gas
– mass of gas

NOTE The word "rated" is optional on the nameplates.

6.11.2 Application

Subclause 6.11.2 of IEC 62271-1:2017 is not applicable and is replaced as follows:

Since characteristics of different sections can be different, a marking shall be provided on the enclosure for equipment identification, or on the coating of the enclosure, if any. The maximum distance between two identification markings should be agreed between manufacturer and user.

Markings shall be durable and clearly legible and shall contain the following information:

– manufacturer's name or trademark;
– type designation;
– rated voltage;
– type of gas and filling pressure for insulation.

6.12 Locking devices

Subclause 6.12 of IEC 62271-1:2017 is applicable.

6.13 Position indication

Subclause 6.13 of IEC 62271-1:2017 is applicable.

6.14 Degree of protection provided by enclosures

6.14.1 General

Subclause 6.14.1 of IEC 62271-1:2017 is applicable with the following additions.

No specification applies to the main circuit and parts directly connected thereto, because of the gas tightness of the enclosure.

Degrees of protection according to IEC 60529 shall be specified for all enclosures of appropriate low-voltage control and/or auxiliary circuits.

The degrees of protection apply to the service conditions of the equipment.

6.14.2 Protection of persons against access to hazardous parts and protection of the equipment against ingress of solid foreign objects (IP coding)

Subclause 6.14.2 of IEC 62271-1:2017 is applicable with the following additions:

Protection means are applicable only for control and/or auxiliary circuits. The first characteristic numeral shall be 3 or higher.