IEC 62271-204

Edition 2.0 2022-05
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

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

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FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62271-204:2011. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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.

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

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

~~1 General~~

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 ~~a non-corrosive insulating gas,~~ 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 ~~intended that this international standard be used~~ 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 ~~may be~~ 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 60050-151, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices*~~

~~IEC 60050-441:1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*~~

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

IEC 60287-3-1:~~1995~~2017, *Electric cables – Calculation of the current rating – Part 3-1: ~~Sections on~~ Operating conditions – ~~Reference operating conditions and selection of cable type~~ 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, ~~*Guidelines for the checking and treatment of sulfur hexafluoride (SF_6) taken from electrical equipment and specification or its re-use*~~ *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:~~2007~~2017, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*

IEC 62271-203:~~2011~~2022, *High-voltage switchgear and controlgear – Part 203: AC gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*[1]

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

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

~~ISO/IEC Guide 51, *Safety aspects – Guidelines for their inclusion in standards*~~

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 60050-441, IEC 60050-151,~~ IEC 62271-1:2017 and the following apply.

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[1] ~~To be published.~~

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
~~access not restricted to authorized personnel~~
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 ~~gas-insulated line~~ GIL retaining the insulating gas under the ~~prescribed~~ required conditions ~~necessary to maintain safely the rated insulation level,~~ protecting the equipment against external influences and providing a high degree of protection to personnel

3.104
compartment
part of ~~gas-insulated line,~~ GIL totally gastight enclosed except for openings necessary for interconnection and control

3.105
partition

~~part of gas-insulated line separating one compartment from other compartments~~

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

3.106
main circuit
all the conductive parts of ~~gas-insulated line~~ 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 ~~(of gas-insulated line)~~
temperature, determined under ~~prescribed~~ required conditions, of the air surrounding the external GIL enclosure ~~of gas-insulated line~~ 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**~~)~~
~~highest~~ maximum temperature which can be reached ~~by the~~ 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 ~~highest temperature that the gas used for isolation can reach under specified maximum service conditions~~ design temperature of the enclosure.

3.110
design pressure ~~(~~of the partitions~~)~~
relative pressure ~~used to determine the design of~~ 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 ~~separate gas compartments~~ 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 ~~under test~~, 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 ~~may~~ 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
~~a 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 ~~1~~ 2 to entry: It ~~may~~ can consist of one or more compartments.

Note ~~2~~ 3 to entry: Sections ~~may~~ 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.

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

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. ~~Typical rating conditions~~ These are also valid for open trenches.

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

~~Unless otherwise specified by the user, the special service conditions given in the IEC 62271-1 shall apply.~~

4.102 Buried installation

~~Typical~~ 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 ~~may~~ can be considered.

~~NOTE 1~~ For long distance transmission lines (several kilometres), site measurement of soil resistivity should also be considered.

NOTE ~~2~~ 1 The use of controlled backfill with a given soil thermal resistivity ~~may~~ can also be considered.

NOTE ~~3~~ 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 ~~shall~~ 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 ~~inclinated~~ inclined tunnels or sections thereof, attention shall be paid to thermal and density gradients~~, especially if a gas mixture is used~~.

5 Ratings

5.1 General

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

The rating of a GIL consists of the following:

a) rated voltage (U_r) ~~and number of phases~~;

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

c) rated frequency (f_r);

d) rated ~~normal~~ continuous current (I_r) ~~(for main circuits)~~;

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 values of the components forming part of a GIL, including auxiliary equipment;~~

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

~~i) rated filling pressure of insulating gas.~~

i) rated supply frequency of auxiliary and control circuits.

5.2 Rated voltage (U_r)

Subclause ~~4.1 of IEC 62271-203~~ 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][2].

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.

5.4 Rated frequency (f_r)

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

~~**4.4 Rated normal current and temperature rise**~~

5.5 Rated ~~normal~~ continuous current (I_r)

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

The rated ~~normal~~ continuous current is defined for a single~~,~~ or a three-phase ~~circuit~~ 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.

~~**4.4.2 Temperature rise**~~

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

[2] Numbers in square brackets refer to the Bibliography.

~~The temperature of the enclosure shall not exceed the maximum allowable temperature of the anti-corrosion coating if applicable.~~

~~The temperature rise of components contained in the GIL 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.~~

~~For open air, tunnel and shaft installations, the maximum temperature of the enclosure shall not exceed 80 °C. Parts normally touched during operation not to exceed 70 °C. Reference is made to Clause 11 of this standard.~~

~~For direct buried installation, the maximum temperature of the enclosure shall be limited to minimise soil drying. A temperature in the 50 °C and 60 °C range is generally considered applicable.~~

~~4.4.3 Particular points of Table 3~~

~~Subclause 4.4.3 of IEC 62271-1 is applicable.~~

~~4.4.101 Particular requirements for temperature rise~~

~~Where a non-oxidizing gas is used as the dielectric, the limits of the temperature and temperature rise shall be as specified for SF_6 in Table 3 of IEC 62271-1.~~

~~Where compressed air is used as the dielectric, the limits of the temperature and temperature rise shall be as specified for air in Table 3 of IEC 62271-1.~~

~~Where an oxidizing gas (other than air) is used as the dielectric, lower limits of temperature and temperature rise shall be agreed between manufacturer and user.~~

5.6 Rated short-time withstand current (I_k)

Subclause 5.6 of IEC 62271-1:2017 is applicable~~, with the following addition~~.

~~In selecting a rated short-time withstand current for an installation, or part of an installation, consideration may be given to the fact that the maximum fault current in a circuit reduces as the distance from the substation increases.~~

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 closing and opening devices and~~ of auxiliary and control circuits (U_a)

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

5.10 Rated supply frequency ~~of closing and opening devices and~~ of auxiliary and control circuits

Subclause 5.10 of IEC 62271-1:2017 is applicable ~~with the following addition:~~.

~~The rated supply frequency of auxiliary circuits is the frequency at which the conditions of operation and temperature rise of these devices and circuits are determined.~~

5.11 Rated pressure of compressed gas supply for controlled pressure systems

Subclause 5.11 of IEC 62271-1:2017 is not applicable.

~~**4.11 Rated filling levels for insulation and/or operation**~~

~~Subclause 4.11 of IEC 62271-1 is applicable.~~

6 Design and construction

Clause 6 of IEC 62271-1:2017 is ~~not~~ applicable, except as follows.

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

GIL ~~shall~~ 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 ~~shall~~ 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.

~~All components of the same rating and construction which may need to be replaced shall be interchangeable.~~

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, ~~except as follows~~ 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 ~~may~~ can be made by

a) earthing switches with a making ~~current~~ capacity equal to the rated peak withstand current, if there is ~~no certainty~~ still a possibility that the circuit connected is ~~not~~ live;