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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

Appareillage à haute tension – Partie 209: Raccordement de câbles pour appareillage sous enveloppe métallique à isolation gazeuse de tension assignée supérieure à 52 kV – Câbles remplis d'un fluide ou à isolation extrudée – Extrémité de câble sèche ou remplie d'un fluide

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IEC Central Office
3, rue de Varembé
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Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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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

FOREWORD

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International Standard IEC 62271-209 has been prepared by subcommittee 17C: High-voltage switchgear and controlgear assemblies, of IEC technical committee 17: Switchgear and controlgear.

This first edition of IEC 62271-209 cancels and replaces the second edition of IEC/TS 60859 and constitutes a technical revision. The changes from IEC/TS 60859 are as follows:

– the minimum voltage rating was changed from "72,5 kV" to "above 52 kV";

– the current rating was increased to 3150 A;

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– simplifications and modifications of the dimension tables in Figure 2 and Figure 4 such as diameters for 123 kV to 170 kV have been adopted in order to accommodate larger cable cross-sections; new dimensions accept old terminations, new terminations may not meet old GIS standards;

– the following dimensions have been deleted: l1, l3 as well as note 3 on Figure 4;

– in Figure 4, new dimensions have been adopted for the voltage range from 245 kV to 300 kV, interchangeability for 245 kV to 300 kV is not maintained due to reduction in GIS cable termination housing;

– the lengths l7 and l8 have been modified;

– changes in the text in relation to minimum functional pressure for insulation p_{me} (Table 1 has been removed);

– the limit of 170 kV for 3-phase application was deleted (Subclause 5.2);

– Figure 5 was deleted.

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

FDIS	Report on voting
17C/405/FDIS	17C/412/RVD

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.

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

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

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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

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1 Scope

This standard covers the connection assembly of fluid-filled and extruded cables to gas-insulated metal enclosed switchgear (GIS), in single- or three-phase arrangements where the cable-terminations are fluid-filled or dry type and there is a separating insulating barrier between the cable insulation and the gas insulation of the switchgear.

The purpose of this standard is to establish electrical and mechanical interchangeability between cable-terminations and the gas-insulated metal-enclosed switchgear and to determine the limits of supply. It complements and amends, if necessary, the relevant IEC standards. For the purpose of this standard the term "switchgear" is used for "gas-insulated metal enclosed switchgear".

It does not cover directly immersed cable terminations, as described in CIGRE brochure 89.

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 60038:1983, *IEC standard voltages* [1]
Amendment 1 (1994)
Amendment 2 (1997)

IEC 60141 (all parts), *Tests on oil-filled and gas-pressure cables and their accessories*

IEC 60141-1:1993, *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 60141-2:1963, *Tests on oil-filled and gas-pressure cables and their accessories – Part 2: Internal gas-pressure cables and accessories for alternating voltages up to 275 kV*

IEC 60694:1996, *Common specifications for high-voltage switchgear and controlgear standards*

IEC 60840:2004, *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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[1] There exists a consolidated version (2002) including Amendment 1 and 2.

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IEC 62067:2001, *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*
Amendment 1 (2006)

IEC 62271-203:2003, High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV

Report of CIGRE WG 23-10, ELECTRA 151, December 1993, *Earthing of GIS – An Application Guide*

CIGRE brochure 89: *Accessories for HV Extruded Cables, CIGRE WG 21.06, 1995, Chapter 2.1.5 Directly Immersed Metal Enclosed GIS Termination*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
cable-termination
equipment fitted to the end of a cable to ensure electrical connection with other parts of the system and to maintain the insulation up to the point of connection. Two types are described in this standard.

3.1.1
fluid-filled cable-termination
cable-termination which comprises of a separating insulating barrier between the cable insulation and the gas insulation of switchgear. The cable-termination includes an insulating fluid as part of the cable connection assembly.

3.1.2
dry-type cable-termination
cable-termination which comprises an elastomeric electrical stress control component in intimate contact with a separating insulating barrier (insulator) between the cable insulation and the gas insulation of the switchgear. The cable-termination does not require any insulating fluid.

3.2
main-circuit end terminal
part of the main circuit of a gas-insulated metal enclosed switchgear forming part of the connection interface

3.3
cable connection enclosure
part of the gas-insulated metal-enclosed switchgear which houses the cable-termination and the main-circuit end terminal

3.4
cable connection assembly
combination of a cable-termination, a cable connection enclosure and a main-circuit end terminal, which mechanically and electrically connects the cable to the gas-insulated metal enclosed switchgear

3.5
design pressure
pressure used to determine the thickness of the enclosure and the components of the cable termination subjected to that pressure (according to IEC 62271-203:2003)

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3.6
fluid/insulating fluid
the term "fluid" means a liquid or a gas for insulation purposes

3.7
cable system
a cable with installed accessories

4 Limits of supply

4.1 General

The limits of supply of gas-insulated metal-enclosed switchgear and the cable-termination shall be in accordance with Figure 2 for fluid-filled cable terminations and Figure 4 for dry-type cable-terminations.

4.2 Over-voltage protection

If a metallic earth connection between parts 6 or 11 and part 13 of Figure 2 for fluid-filled cable terminations and Figure 4 for dry-type cable-terminations is not feasible, non-linear resistors (part 15) may be connected across the insulated junction to limit the voltage under transient conditions. The number and characteristics of the non-linear resistors shall be determined and supplied by the cable termination manufacturer, taking into consideration the requirements of the user and the switchgear manufacturer. For further details refer to report of CIGRE WG 23-10: ELECTRA 151, 1993.

5 Rating

5.1 General

When dimensioning the cable connection assembly, the following rated values shall apply:

a) the rated voltage;
b) the number of phases in one enclosure;
c) the rated insulation level;
d) the rated normal current and temperature rise;
e) the rated short-time and peak withstand currents;
f) the rated duration of the short circuit.

5.2 Rated voltage

The rated voltage for the equipment (U_r) of the cable connection is equal to the lowest of the values for the cable and the gas-insulated metal-enclosed switchgear and shall be selected from the following standard values:

72,5 kV – 100 kV – 123 kV – 145 kV – 170 kV – 245 kV – 300 kV – 362 kV – 420 kV – 550 kV

For cables, the rated voltage U_r corresponds to the highest voltage for equipment U_m.

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5.3 Rated insulation level

The rated insulation level for the cable connection assembly shall be selected from the values given in IEC 60038 (IEC standard voltages) as well as IEC 62271-203:2003.

5.4 Rated normal current and temperature rise

The connection interface of the main circuit shown in Figures 2 and 3 for fluid-filled cable-terminations and Figures 4 and 5 for dry-type cable-terminations is applicable at rated normal currents up to 3 150 A. The normal current-carrying contact surfaces of the connection interface shall be silver- or copper-coated or solid copper.

For full interchangeability of the cable-termination, the connection interface shall be designed so that at a current equal to the cable rated current corresponding to a maximum temperature of 90 °C, no heat transfer from the GIS main circuit end terminal to the cable-termination will occur.

NOTE As the maximum conductor temperature for cables is limited by the maximum operating temperature for the insulation, there are certain cable dielectrics which cannot withstand the maximum temperature specified for gas-insulated metal-enclosed switchgear if there is heat transfer across the connection interface to the cable terminations.

For cases when the design value of 90 °C at rated normal current of the cable system cannot be achieved, the manufacturer of the switchgear should provide the necessary data on temperature rise of the main-circuit end terminal and of the insulating gas (SF_6) as a function of current.

5.5 Rated short-time and peak withstand currents and rated duration of short circuit

Short-time and peak withstand currents as well as the duration of short circuit shall refer to the levels provided by the cable system, not exceeding the values given in IEC 60694.

5.6 Rated filling pressure of insulating gas in the cable connection enclosure

If SF_6 is used as the insulating gas, the minimum functional pressure for insulation p_{me} used to determine the design of the cable-termination insulation shall not exceed p_{me}= 0,35 MPa (absolute) at 20 °C for maximum rated voltages up to 300 kV. For maximum rated voltages exceeding 300 kV the minimum functional pressure for insulation p_{me} used to determine the design of the cable-termination insulation shall not exceed p_{me} 0,4 MPa (absolute) at 20 °C.

The rated filling pressure p_{re} of gas for insulating is assigned by the switchgear manufacturer but shall in no case be lower than p_{me}. If a gas other than SF_6 is used, the minimum functional pressure shall be chosen to give the same dielectric strength while being lower than the maximum recommended operating pressure as per 6.1.

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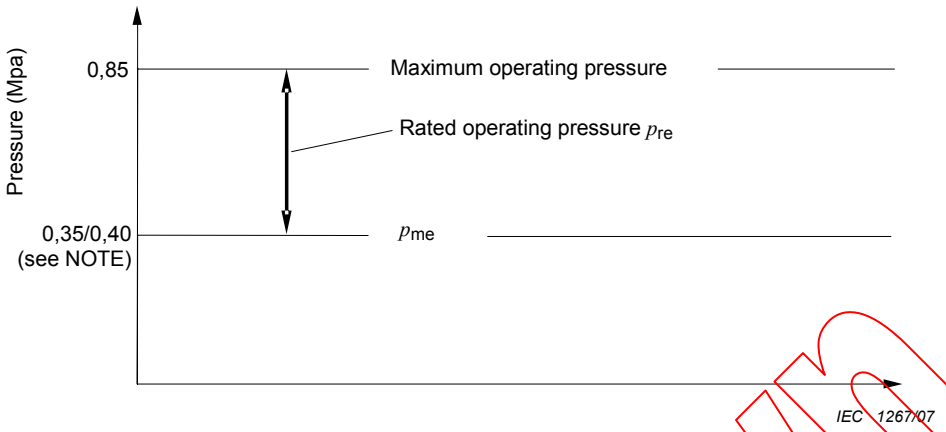

p_{re} rated filling pressure of gas for insulating (not lower than p_{me})

p_{me} minimal functional pressure for insulation

NOTE 0,35 MPa for voltages up to 300 kV

0,40 MPa for voltages exceeding 300 kV

Figure 1 — Operating pressure of the gas insulation in the cable connection enclosure

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6 Design and construction requirements

6.1 Pressure withstand requirements

The design pressure (absolute) for the outside of the cable termination is 0,85 MPa at 20 °C. The cable-termination shall be capable of withstanding the vacuum conditions when the cable connection enclosure is evacuated as part of the gas filling process.

6.2 Mechanical forces on cable-terminations

The manufacturer of the cable-termination in a three-phase connection shall take into account the total dynamic forces generated during short-circuit conditions. These forces consist of those generated within the cable-termination and those coming from the main circuit of the switchgear. The maximum additional force applied from the switchgear to the connection interface (Figure 2 or 4) transversely and then being transferred from the main circuit end terminal shall not exceed 5 kN. For single-phase connections, taking into account lack of symmetry, it is considered that this additional force is small. However, a total mechanical force of 2 kN applied to the connection interface transversely, should be assumed. It is the responsibility of the manufacturer of the switchgear to ensure that the specified forces are not exceeded.

For both single-phase and three-phase connections, additional forces and movements from the switchgear can be experienced due to temperature variations and vibrations in service. These forces can act on both switchgear and cable-termination and depend largely on the switchgear layout, termination installation, cable design and the methods of mechanical support. The design of any support structure shall take into account these forces and movements. It is particularly important that the support for the switchgear shall not be affixed to the insulator collar and/or clamping flange, parts 9 and 11 of Figure 2 or 4.

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