



IEC 62271-204 EXV

Edition 2.0 2022-09
EXTENDED VERSION

INTERNATIONAL STANDARD



This extended version of IEC 62271-204:2022 includes the content of the references made to IEC 62271-1:2017+AMD1:2021 CSV and IEC 62271-203:2022

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.130.10

ISBN 978-2-8322-5677-0

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	10
1 Scope	12
2 Normative references	12
3 Terms and definitions	15
3.1 General terms and definitions	15
3.2 Assemblies of switchgear and controlgear	18
3.3 Parts of assemblies	18
3.4 Switching devices	19
3.5 Parts of switchgear and controlgear	19
3.6 Operational characteristics of switchgear and controlgear	23
3.7 Characteristic quantities	26
3.8 Index of definitions	27
4 Normal and special service conditions	31
4.1 Normal service conditions	31
4.1.1 General	31
4.1.2 Indoor switchgear and controlgear	31
4.1.3 Outdoor switchgear and controlgear	31
4.2 Special service conditions	32
4.2.1 General	32
4.2.2 Altitude	32
4.2.3 Exposure to pollution	32
4.2.4 Temperature and humidity	33
4.2.5 Exposure to abnormal vibrations, shock or tilting	33
4.2.6 Wind speed	33
4.2.7 Other parameters	33
4.101 Installation in open air	33
4.102 Buried installation	33
4.103 Installation in tunnel, shaft or similar situation	34
5 Ratings	34
5.1 General	34
5.2 Rated voltage (U_r)	34
5.2.1 General	34
5.2.2 Range <i>I</i> for rated voltages of 245 kV and below	35
5.2.3 Range <i>II</i> for rated voltages above 245 kV	35
5.3 Rated insulation level (U_d , U_p , U_s)	35
5.4 Rated frequency (f_r)	39
5.5 Rated continuous current (I_r)	39
5.6 Rated short-time withstand current (I_k)	40
5.7 Rated peak withstand current (I_p)	40
5.8 Rated duration of short-circuit (t_k)	40
5.9 Rated supply voltage of auxiliary and control circuits (U_a)	41
5.9.1 General	41
5.9.2 Rated supply voltage (U_a)	41

5.10	Rated supply frequency of auxiliary and control circuits	41
5.11	Rated pressure of compressed gas supply for controlled pressure systems	41
6	Design and construction	42
6.1	Requirements for liquids in GIL	42
6.2	Requirements for gases in GIL	42
6.3	Earthing	42
6.3.101	Earthing of the main circuits	43
6.3.102	Earthing of the enclosure	43
6.4	Auxiliary and control equipment	43
6.4.1	General	43
6.4.2	Protection against electric shock	44
6.4.3	Components installed in enclosures	45
6.5	Dependent power operation	47
6.6	Stored energy operation	47
6.7	Independent manual or power operation (independent unlatched operation)	48
6.8	Manually operated actuators	48
6.9	Operation of releases	48
6.10	Pressure/level indication	48
6.10.1	Gas pressure	48
6.10.2	Liquid level	48
6.11	Nameplates	48
6.11.1	General	48
6.11.2	Application	49
6.12	Locking devices	49
6.13	Position indication	49
6.14	Degree of protection provided by enclosures	49
6.14.1	General	49
6.14.2	Protection of persons against access to hazardous parts and protection of the equipment against ingress of solid foreign objects (IP coding)	49
6.14.3	Protection against ingress of water (IP coding)	50
6.14.4	Protection against mechanical impact under normal service conditions (IK coding)	50
6.15	Creepage distances for outdoor insulators	50
6.16	Gas and vacuum tightness	50
6.16.1	General	50
6.16.2	Controlled pressure systems for gas	50
6.16.3	Closed pressure systems for gas	51
6.16.4	Sealed pressure systems	51
6.16.5	Internal partitions	52
6.17	Tightness of liquid systems	52
6.18	Fire hazard (flammability)	52
6.19	Electromagnetic compatibility (EMC)	52
6.20	X-ray emission	52
6.21	Corrosion	52
6.21.101	Corrosion protection for buried installations	52
6.21.102	Corrosion protection for not buried installations	52
6.22	Filling levels for insulation, switching and/or operation	52
6.101	Minimizing of internal fault effects	53

6.101.1	General.....	53
6.101.2	External effects of the arc.....	53
6.101.3	Internal fault location	53
6.102	Enclosures	54
6.102.1	General.....	54
6.102.2	Design of enclosures	54
6.103	Partitions and partitioning	55
6.104	Sections of a GIL system	55
6.105	Pressure relief.....	56
6.105.1	General.....	56
6.105.2	Limitation of maximum filling pressure.....	56
6.105.3	Pressure relief devices to limit pressure rise in the case of an internal fault...56	
6.106	Compensation of thermal expansion.....	56
6.107	External vibrations.....	57
6.108	Supporting structures for non-buried GIL.....	57
6.108.1	General.....	57
6.108.2	Conditions of the design	57
6.108.3	Types of supporting structures.....	57
7	Type tests.....	58
7.1	General.....	58
7.1.1	Basics.....	58
7.1.2	Information for identification of test objects	58
7.1.3	Information to be included in type-test reports	58
7.1.101	Mandatory type tests	59
7.1.102	Special type tests.....	59
7.2	Dielectric tests.....	60
7.2.1	General.....	60
7.2.2	Ambient air conditions during tests.....	60
7.2.3	Wet test procedure	60
7.2.4	Arrangement of the equipment	60
7.2.5	Criteria to pass the test.....	60
7.2.6	Application of test voltage and test conditions	61
7.2.7	Test of switchgear and controlgear of $U_r \leq 245$ kV.....	61
7.2.8	Test of switchgear and controlgear of $U_r > 245$ kV.....	61
7.2.9	Artificial pollution tests for outdoor insulators.....	62
7.2.10	Partial discharge tests	62
7.2.11	Dielectric tests on auxiliary and control circuits.....	63
7.2.12	Voltage test as condition check.....	63
7.3	Radio interference voltage (RIV) test.....	63
7.4	Measurement of the resistance of circuits.....	63
7.4.1	Measurement of the resistance of auxiliary contacts class 1 and class 2	64
7.4.2	Measurement of the resistance of auxiliary contacts class 3.....	64
7.4.3	Electrical continuity of earthed metallic parts test	64
7.4.4	Resistance measurement of contacts and connections in the main circuit as a condition check.....	64
7.5	Continuous current test.....	65
7.5.1	Condition of the test object	65
7.5.2	Arrangement of the equipment	65

7.5.3	Test current and duration.....	66
7.5.4	Temperature measurement during test	67
7.5.5	Resistance of the main circuit	68
7.5.6	Criteria to pass test	68
7.6	Short-time withstand current and peak withstand current tests	73
7.6.1	General.....	73
7.6.2	Arrangements of the GIL and of the test circuit	73
7.6.3	Test current and duration.....	73
7.6.4	Conditions of the GIL after test	74
7.7	Verification of the protection	74
7.7.1	Verification of the IP coding	74
7.7.2	Verification of the IK coding	75
7.8	Tightness tests	75
7.8.1	General.....	75
7.8.2	Controlled pressure systems for gas	76
7.8.3	Closed pressure systems for gas	77
7.8.4	Sealed pressure systems.....	77
7.8.5	Liquid tightness tests.....	77
7.9	Electromagnetic compatibility tests (EMC).....	78
7.10	Additional test on auxiliary and control circuits.....	78
7.11	X-radiation test procedure for vacuum interrupters.....	78
7.101	Proof tests for enclosures	78
7.101.1	General.....	78
7.101.2	Destructive pressure tests	78
7.101.3	Non-destructive pressure test	79
7.102	Pressure test on partitions	80
7.103	Passive corrosion protection tests for buried installation	80
7.103.1	Passive corrosion protection	80
7.103.2	Electrical testing.....	80
7.103.3	Mechanical testing.....	80
7.103.4	Thermal testing	80
7.104	Special mechanical test on sliding contacts	81
7.105	Test under conditions of arcing due to internal fault	81
7.106	Weatherproofing test	82
8	Routine tests	82
8.1	General.....	82
8.2	Dielectric test on the main circuit.....	83
8.3	Tests on auxiliary and control circuits.....	83
8.3.1	Inspection of auxiliary and control circuits, and verification of conformity to the circuit diagrams and wiring diagrams.....	83
8.3.2	Functional tests.....	84
8.3.3	Verification of protection against electrical shock.....	84
8.3.4	Dielectric tests	84
8.4	Measurement of the resistance of the main circuit.....	84
8.5	Tightness test.....	84
8.5.1	General.....	84
8.5.2	Controlled pressure systems for gas	84
8.5.3	Closed pressure systems for gas	85
8.5.4	Sealed pressure systems.....	85

8.5.5	Liquid tightness tests	85
8.6	Design and visual checks	85
8.101	Partial discharge measurement	85
8.102	Pressure tests of factory made enclosures	85
9	Guide to the selection of GIL (informative)	86
9.1	General	86
9.2	Selection of rated values	86
9.3	Cable-interface considerations	86
9.4	Continuous or temporary overload due to changed service conditions	86
9.5	Environmental aspects	86
9.5.1	Service conditions	86
9.5.2	Clearances affected by service conditions	87
9.5.3	High humidity	87
9.5.4	Solar radiation	87
9.101	Short time overload capability	87
9.102	Forced cooling	87
10	Information to be given with enquiries, tenders and orders (informative)	87
10.101	Information with enquiries and orders	87
10.101.1	General	87
10.101.2	Particulars of the system	88
10.101.3	Environmental conditions	88
10.101.4	Service conditions	88
10.101.5	Particulars of the installation	88
10.101.6	Particulars of the auxiliary devices	88
10.101.7	Specific conditions	89
10.102	Information with tenders and contract documentation	89
10.102.1	General	89
10.102.2	Rated values and characteristics	89
10.102.3	Further particulars of the transmission line and its components	89
10.102.4	Type test certificate or reports	89
10.102.5	Particulars of the auxiliary devices	89
10.102.6	List of recommended essential spare parts	89
11	Transport, storage, installation, operating instructions and maintenance	89
11.1	General	89
11.2	Conditions during transport, storage and installation	90
11.3	Installation	90
11.3.1	General	90
11.3.2	Unpacking and lifting	91
11.3.3	Assembly	91
11.3.4	Mounting	91
11.3.5	Connections	91
11.3.6	Information about gas and gas mixtures for controlled and closed pressure systems	91
11.3.7	Final installation inspection	92
11.3.8	Basic input data by the user	92
11.3.9	Basic input data by the manufacturer	93
11.3.101	Constructional features	93
11.4	Operating instructions	93
11.4.101	Voltage test on the main circuits	94

11.4.102	Measurement of gas conditions.....	95
11.4.103	Measurement of the resistance of the main circuit	95
11.4.104	Tests on enclosures welded on site.....	96
11.4.105	Periodic testing of the enclosure	96
11.4.106	Checks and verifications.....	96
11.4.107	Tests on corrosion protection for directly buried GIL	96
11.5	Maintenance.....	97
11.5.1	General.....	97
11.5.2	Information about fluids and gas to be included in maintenance manual	97
11.5.3	Recommendations for the manufacturer	97
11.5.4	Recommendations for the user.....	98
11.5.5	Failure report	99
11.5.101	Maintenance of GIL	100
11.5.102	Gas handling.....	100
12	Safety.....	101
12.1	General.....	101
12.2	Precautions by manufacturers.....	101
12.3	Precautions by users	102
12.101	Mechanical aspects	102
12.102	Thermal aspects.....	103
12.103	Maintenance aspects.....	103
13	Influence of the product on the environment.....	103
Annex A	(normative) Identification of test objects	104
A.1	General.....	104
A.2	Data.....	104
A.3	Drawings.....	104
Annex B	(informative) Determination of the equivalent RMS value of a short-time current during a short-circuit of a given duration	106
Annex C	(normative) Method for the weatherproofing test for outdoor switchgear and controlgear	107
Annex D	(informative) References for auxiliary and control circuit components.....	110
Annex E	(normative) Tolerances on test quantities during tests	112
Annex F	(informative) Information and technical requirements to be given with enquiries, tenders and orders.....	115
F.1	General.....	115
F.2	Normal and special service conditions (refer to Clause 4)	115
F.3	Ratings (refer to Clause 5).....	116
F.4	Design and construction (refer to Clause 6).....	116
F.5	System information.....	117
F.6	Documentation for enquiries and tenders.....	117
Annex G	(informative) List of symbols.....	118
Annex H	(informative) Electromagnetic compatibility on site	120
Annex I	(informative) List of notes concerning certain countries.....	121
Annex J	(informative) Extension of validity of type tests.....	122
J.1	General.....	122

J.2	Dielectric tests.....	122
J.3	Short-time withstand current tests	122
J.4	Continuous current test.....	122
J.5	Electromagnetic immunity test on auxiliary and control circuits.....	123
J.6	Environmental tests on auxiliary and control circuits	123
Annex K (informative) Exposure to pollution		124
K.1	General	124
K.2	Pollution levels	124
K.3	Minimum requirements for switchgear	124
Annex A (informative) Estimation of continuous current		126
A.1	General	126
A.2	Symbols	126
A.3	Reference values.....	126
A.3.1	General.....	126
A.3.2	General type test values	127
A.3.3	AC resistances	127
A.3.4	Dissipation	127
A.3.5	Thermal resistances	128
A.3.6	Thermal coefficient	128
A.4	Estimation of current rating	128
A.4.1	General.....	128
A.4.2	Maximum temperature rise.....	128
A.4.3	Heat input	129
A.4.4	Thermal resistances	129
A.4.5	Estimated maximum temperature rise.....	129
A.4.6	Permissible temperature rises	130
A.4.7	Estimated continuous current.....	130
A.4.8	Informal documents	130
Annex B (informative) Earthing		131
B.1	General	131
B.2	Safe limits on potential rise	131
B.3	Enclosures	131
B.4	Earth electrodes	131
B.5	Conductors of earthing system.....	131
B.6	Earth continuity	132
B.7	Induced voltages	132
B.8	Transient enclosure voltage	132
B.9	Non-linear resistors	132
B.10	Bonding and earthing.....	133
B.10.1	General.....	133
B.10.2	Cross-bonding.....	133
B.11	Application to directly buried installations	133
B.12	Informal documents	134
Annex C (informative) Long-term testing of buried installations		135
C.1	Assessment of long-term behaviour.....	135
C.1.1	General.....	135

C.1.2	Thermomechanical performance	135
C.1.3	Corrosion protection of the enclosures	135
C.2	Summary of long-term tests	135
Annex D (normative)	Requirements for welds on pressurized parts	137
D.1	General	137
D.2	Process and personal qualifications	137
D.3	Non-destructive tests of welding	137
Bibliography		139
Figure 1	– Examples of classes of contacts	47
Figure B.1	– Determination of short-time current	106
Figure C.1	– Arrangement for weatherproofing test	108
Figure C.2	– Nozzle for weatherproofing test	109
Figure B.1	– Example of earthing system together with active anti-corrosion system in the case of solid bonding of the enclosure at both ends	134
Table 1	– Rated insulation levels for rated voltages of range <i>I</i> , series <i>I</i>	36
Table 2	– Rated insulation levels for rated voltages of range <i>I</i> , series <i>II</i> (based on current practice in some countries, including US)	37
Table 3	– Rated insulation levels for rated voltages of range <i>II</i>	38
Table 4	– Additional rated insulation levels for range <i>II</i> , based on current practice in some countries, including US	39
Table 5	– Peak factors for rated peak withstand current	40
Table 6	– Direct current voltage	41
Table 7	– Alternating current voltage	41
Table 8	– Auxiliary contact classes	46
Table 1	– Second characteristic numeral of IP coding	50
Table 6	– Test voltage for measuring PD intensity	63
Table 14	– Limits of temperature and temperature rise for various parts, materials and dielectrics of high-voltage switchgear and controlgear	69
Table 15	– Permissible leakage rates for gas systems	76
Table D.1	– List of reference documents for auxiliary and control circuit components	110
Table E.1	– Tolerances on test quantities for type test	112
Table K.1	– Environmental examples by site pollution severity (SPS) class	125
Table K.2	– Minimum nominal specific creepage distance by pollution level	125
Table D.1	– Quantity of NDTs	137
Table D.2	– Acceptance criteria of imperfections	138

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

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

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This extended version (EXV) of the official IEC Standard provides the user with a comprehensive content of the Standard.

IEC 62271-204:2022 EXV includes the content of the references made to IEC 62271-1:2017+AMD1:2021 CSV and IEC 62271-203:2022.

Particular subclauses of IEC 62271-1:2017+AMD1:2021 CSV and IEC 62271-203:2022 are displayed in the content on a blue background.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 60038:2009, *IEC standard voltages*

IEC 60050-131:2002, *International Electrotechnical Vocabulary (IEV) – Part 131: Circuit theory*

IEC 60050-151:2001, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices*

IEC 60050-192:2015, *International Electrotechnical Vocabulary (IEV) – Part 192: Dependability*

IEC 60050-351, *International Electrotechnical Vocabulary (IEV) – Part 351: Control technology*

IEC 60050-441:1984, *International Electrotechnical Vocabulary (IEV) – Part 441: Switchgear, controlgear and fuses*
IEC 60050-441:1984/AMD1:2000

IEC 60050-551, *International Electrotechnical Vocabulary (IEV) – Part 551: Power electronics*

IEC 60050-581:2008, *International Electrotechnical Vocabulary (IEV) – Part 581: Electromechanical components for electronic equipment*

IEC 60050-601, *International Electrotechnical Vocabulary (IEV) – Chapter 601: Generation, transmission and distribution of electricity – General*

IEC 60050-605, *International Electrotechnical Vocabulary (IEV) – Chapter 605: Generation, transmission and distribution of electricity – Substations*

IEC 60050-614:2016, *International Electrotechnical Vocabulary (IEV) – Part 614: Generation, transmission and distribution of electricity – Operation*

IEC 60050-811, *International Electrotechnical Vocabulary (IEV) – Part 811: Electric traction*

IEC 60050-826:2004, *International Electrotechnical Vocabulary (IEV) – Part 826: Electrical installations*

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 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60071-1:2006, *Insulation co-ordination – Part 1: Definitions, principles and rules*
IEC 60071-1:2006/AMD1:2010

IEC 60071-2:1996, *Insulation co-ordination – Part 2: Application guide*

IEC 60085:2007, *Electrical insulation – Thermal evaluation and designation*

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

IEC 60255-21-1:1988, *Electrical relays – Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Section One: Vibration tests (sinusoidal)*

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

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

IEC 60296, *Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear*

IEC 60376, *Specification of technical grade sulfur hexafluoride (SF₆) and complementary gases to be used in its mixtures for use in electrical equipment*

IEC 60480, *Specifications for the re-use of sulfur hexafluoride (SF₆) and its mixtures in electrical equipment*

IEC 60507, *Artificial pollution tests on high-voltage ceramic and glass insulators to be used on a.c. systems*

IEC 60512-2-2, *Connectors for electronic equipment – Tests and measurements – Part 2-2: Electrical continuity and contact resistance tests – Test 2b: Contact resistance – Specified test current method*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60529:1989/AMD1:1999

IEC 60529:1989/AMD2:2013

IEC TS 60815-1:2008, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles*

IEC TS 60815-2:2008, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramic and glass insulators for a.c. systems*

IEC TS 60815-3:2008, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 3: Polymer insulators for a.c. systems*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-4-17:2009, *Electromagnetic compatibility (EMC) – Part 4-17: Testing and measurement techniques – Ripple on d.c. input power port immunity test*

IEC 61000-4-18, *Electromagnetic compatibility (EMC) – Part 4-18: Testing and measurement techniques – Damped oscillatory wave immunity test*

IEC 61000-4-29, *Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61000-6-5, *Electromagnetic compatibility (EMC) – Part 6-5: Generic standards – Immunity for equipment used in power station and substation environment*

IEC 61180, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*

IEC 61810-7:2006, *Electromechanical elementary relays – Part 7: Test and measurement procedures*

IEC 62262:2002, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

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 (SF₆) and its mixtures*

CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*

CISPR TR 18-2, *Radio interference characteristics of overhead power lines and high-voltage equipment – Part 2: Methods of measurement and procedure for determining limits*

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*

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**

CONTENTS

FOREWORD	3
1 Scope	5
2 Normative references	5
3 Terms and definitions	6
4 Normal and special service conditions	8
5 Ratings	9
6 Design and construction	10
7 Type tests	21
8 Routine tests	28
9 Guide to the selection of GIL (informative)	29
10 Information to be given with enquiries, tenders and orders (informative)	30
11 Transport, storage, installation, operating instructions and maintenance	32
12 Safety	38
13 Influence of the product on the environment	39
Annex A (informative) Estimation of continuous current	40
Annex B (informative) Earthing	45
Annex C (informative) Long-term testing of buried installations	49
Annex D (normative) Requirements for welds on pressurized parts	51
Bibliography	53
Figure B.1 – Example of earthing system together with active anti-corrosion system in the case of solid bonding of the enclosure at both ends	48
Table 1 – Second characteristic numeral of IP coding	14
Table D.1 – Quantity of NDTs	51
Table D.2 – Acceptance criteria of imperfections	52

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –**Part 204: Rigid gas-insulated transmission lines
for rated voltage above 52 kV**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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 (SF₆) and complementary gases to be used in its mixtures for use in electrical equipment*

IEC 60480, *Specifications for the re-use of sulfur hexafluoride (SF₆) 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 (SF₆) 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*

SOMMAIRE

AVANT-PROPOS	57
1 Domaine d'application	59
2 Références normatives	59
3 Termes et définitions	60
4 Conditions normales et spéciales de service.....	62
5 Caractéristiques assignées.....	63
6 Conception et construction	65
7 Essais de type	75
8 Essais individuels de série	83
9 Guide pour le choix de la LIG (informative).....	84
10 Renseignements à donner dans les appels d'offres, les soumissions et les commandes (informative)	85
11 Transport, stockage, installation, instructions de fonctionnement et maintenance	87
12 Sécurité.....	94
13 Influence du produit sur l'environnement	95
Annexe A (informative) Évaluation du courant permanent	96
Annexe B (informative) Mise à la terre	101
Annexe C (informative) Essais de longue durée des installations enterrées	105
Annexe D (normative) Exigences relatives aux soudures des parties sous pression.....	107
Bibliographie.....	109
 Figure B.1 – Exemple de schéma de mise à la terre avec système anticorrosion actif dans le cas d'une enveloppe solidement connectée aux deux extrémités	 104
 Tableau 1 – Second chiffre caractéristique du codage IP	 68
Tableau D.1 – Nombre d'END	107
Tableau D.2 – Critères d'acceptation des défauts	108

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

APPAREILLAGE À HAUTE TENSION –

**Partie 204: Lignes de transport rigides à isolation gazeuse
de tension assignée supérieure à 52 kV**

AVANT-PROPOS

- 1) La Commission Électrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. À cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
- 2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
- 3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
- 4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
- 5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
- 6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
- 7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
- 8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
- 9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets.

L'IEC 62271-204 a été établie par le sous-comité 17C: Ensembles, du comité d'études 17 de l'IEC: Appareillage haute tension. Il s'agit d'une Norme internationale.

Cette deuxième édition annule et remplace la première édition parue en 2011. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) mise à jour par rapport à l'IEC 62271-1:2017 et alignement des caractéristiques assignées de tension et des tensions d'essai;
- b) ajout de nouvelles informations relatives aux soudures sur les parties sous pression et à l'étanchéité au gaz.

Le texte du présent est issu des documents suivants:

Projet	Rapport de vote
17C/840/FDIS	17C/846/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Le présent document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Le présent document doit être utilisé conjointement avec l'IEC 62271-1:2017 et l'IEC 62271-203:2022, auxquelles il fait référence et qui sont applicables sauf spécification contraire. Pour faciliter le repérage des exigences correspondantes, ce document utilise une numérotation identique des articles et des paragraphes à celle de l'IEC 62271-1:2017 et de IEC 62271-203:2022. Les modifications à ces articles et paragraphes sont indiquées sous la même numérotation, alors que les paragraphes additionnels sont numérotés à partir de 101.

Une liste de toutes les parties de la série IEC 62271, publiées sous le titre général *Appareillage à haute tension*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu du présent document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

APPAREILLAGE À HAUTE TENSION –

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

1 Domaine d'application

La présente partie de l'IEC 62271 est applicable aux lignes de transport rigides haute tension à isolation gazeuse (LIG) dont l'isolation est réalisée, au moins partiellement, par un gaz isolant ou un mélange gazeux autre que l'air à la pression atmosphérique, pour un courant alternatif de tension assignée supérieure à 52 kV, pour des fréquences de service inférieures ou égales à 60 Hz.

Le présent document est applicable lorsque les dispositions de l'IEC 62271-203 ne couvrent pas l'application des LIG (voir la Note 3).

À chaque extrémité de la ligne de transport à isolation gazeuse HT, un élément spécifique est utilisé pour la connexion entre la ligne de transport à isolation gazeuse HT et d'autres matériels tels que les traversées, les transformateurs ou bobines d'inductance, les boîtes à câbles, les parafoudres sous enveloppe métallique, les transformateurs de tension ou les postes à isolation gazeuse, auxquels s'applique leur propre spécification.

La ligne de transport à isolation gazeuse HT est, sauf spécification contraire, conçue pour être utilisée dans les conditions normales de service.

NOTE 1 Dans le présent document, les "lignes de transport HT à isolation gazeuse" sont désignées par l'abréviation "LIG".

NOTE 2 Dans le présent document, le mot "gaz" signifie gaz ou mélange gazeux, selon la définition du constructeur.

NOTE 3 Exemples d'applications de LIG:

- lorsque tout ou partie de la ligne de transport à isolation gazeuse HT est directement enterrée;
- lorsque la ligne de transport à isolation gazeuse HT est située, entièrement ou partiellement, dans une zone accessible au public;
- lorsque la ligne de transport à isolation gazeuse HT est longue (généralement plus de 500 m) et que la longueur type du compartiment gazeux dépasse la valeur courante associée à la technologie des postes à isolation gazeuse.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60060-1:2010, *Techniques des essais à haute tension – Partie 1: Définitions et exigences générales*

IEC 60068-1:2013, *Essais d'environnement – Partie 1: Généralités et lignes directrices*

IEC 60229:2007, *Câbles électriques – Essais sur les gaines extérieures extrudées avec fonction spéciale de protection*

IEC 60287-3-1:2017, *Câbles électriques – Calcul du courant admissible – Partie 3-1: Conditions de fonctionnement – Conditions du site de référence*

IEC 60376, *Spécification de la qualité technique de l'hexafluorure de soufre (SF₆) et des gaz complémentaires à employer dans les mélanges de SF₆ pour utilisation dans les matériels électriques*

IEC 60480, *Spécifications pour la réutilisation de l'hexafluorure de soufre (SF₆) et des mélanges contenant du SF₆ dans le matériel électrique*

IEC 60529, *Degrés de protection procurés par les enveloppes (Code IP)*
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013

IEC 62271-1:2017, *Appareillage à haute tension – Partie 1: Spécifications communes pour appareillage à courant alternatif*

IEC 62271-203:2022, *Appareillage à haute tension – Partie 203: Appareillage sous enveloppe métallique à isolation gazeuse de tensions assignées supérieures à 52 kV*

IEC 62271-4:2013, *Appareillage à haute tension – Partie 4: Utilisation et manipulation de l'hexafluorure de soufre (SF₆) et des mélanges contenant du SF₆*

ISO 9606 (toutes les parties), *Épreuve de qualification des soudeurs – Soudage par fusion*

ISO 9712, *Essais non destructifs – Qualification et certification du personnel END*

ISO 14732, *Personnel en soudage – Épreuve de qualification des opérateurs soudeurs et des régisseurs en soudage pour le soudage mécanisé et le soudage automatique des matériaux métalliques*

ISO 15609 (toutes les parties), *Descriptif et qualification d'un mode opératoire de soudage pour les matériaux métalliques – Descriptif d'un mode opératoire de soudage*

ISO 15614 (toutes les parties), *Descriptif et qualification d'un mode opératoire de soudage pour les matériaux métalliques – Épreuve de qualification d'un mode de soudage*