



DPC: 23 / 30474862 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

Date: 07 June 2023

Origin: International

Latest date for receipt of comments: 26 July 2023

Project No. 2021/00287

Responsible committee: PEL/17 High voltage switchgear, controlgear and assemblies

Interested committees:

Title: BS EN IEC 62271-201 High-voltage switchgear and controlgear

Part 201: AC solid-insulation enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

- i) has any issues related to 3rd party IPR, patent or copyright
- ii) affects other national standard(s)
- iii) requires additional national guidance or information

**WARNING: THIS IS A DRAFT AND MUST NOT BE REGARDED OR USED AS A BRITISH STANDARD.
THIS DRAFT IS NOT CURRENT BEYOND 26 July 2023**

This draft is issued to allow comments from interested parties; all comments will be given consideration prior to publication. No acknowledgement will normally be sent. **See overleaf for information on the submission of comments.**

No copying is allowed, in any form, without prior written permission from BSI except as permitted under the Copyright, Designs and Patent Act 1988 or for circulation within a nominating organization for briefing purposes. Electronic circulation is limited to dissemination by e-mail within such an organization by committee members.

Further copies of this draft may be purchased from BSI Shop <http://shop.bsigroup.com> or from BSI Customer Services, Tel: +44(0) 20 8996 9001 or email cservices@bsigroup.com. British, International and foreign standards are also available from BSI Customer Services.

Information on the co-operating organizations represented on the committees referenced above may be obtained from <http://standardsdevelopment.bsigroup.com>

Responsible Committee Secretary: **Ms Nicola Young (BSI)**

Direct tel:

E-mail: nicola.young@bsigroup.com

Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
------------------	------------------------

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



17C/897/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

IEC 62271-201 ED3

DATE OF CIRCULATION:

2023-06-02

CLOSING DATE FOR COMMENTS:

2023-08-25

SUPERSEDES DOCUMENTS:

17C/851/CD, 17C/876A/CC

IEC SC 17C : ASSEMBLIES

SECRETARIAT:

Germany

SECRETARY:

Mr Mark Kuschel

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 17, SC 17A

PROPOSED HORIZONTAL STANDARD:



Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☒ ENVIRONMENT

☒ QUALITY ASSURANCE

☒ SAFETY

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE:

High-voltage switchgear and controlgear - Part 201: AC solid-insulation enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

NOTE FROM TC/SC OFFICERS:

Copyright © 2023 International Electrotechnical Commission, IEC. All rights reserved. It is permitted to download this electronic file, to make a copy and to print out the content for the sole purpose of preparing National Committee positions. You may not copy or "mirror" the file or printed version of the document, or any part of it, for any other purpose without permission in writing from IEC.

CONTENTS

1		
2		
3	FOREWORD.....	6
4	INTRODUCTION.....	8
5	1 Scope.....	9
6	2 Normative references	9
7	3 Terms and definitions	10
8	3.1 General terms and definitions	10
9	3.2 Assemblies of switchgear and controlgear	11
10	3.3 Switching devices	12
11	3.4 Parts of switchgear and controlgear	12
12	3.5 Characteristic quantities	18
13	3.6 Index of definitions	18
14	4 Normal and special service conditions.....	21
15	5 Ratings.....	21
16	5.1 General.....	21
17	5.2 Rated voltage (U_r).....	21
18	5.3 Rated insulation level(U_d , U_p , U_s).....	21
19	5.4 Rated frequency (f_r)	21
20	5.5 Rated continuous current (I_r).....	21
21	5.6 Rated short-time withstand current (I_k , I_{ke})	22
22	5.7 Rated peak withstand current (I_p , I_{pe})	22
23	5.8 Rated durations of short-circuit (t_k , t_{ke})	22
24	5.9 Rated supply voltage of auxiliary and control circuits (U_a).....	23
25	5.10 Rated supply frequency of auxiliary circuits	23
26	5.11 Rated pressure of compressed gas supply for controlled pressure systems	23
27	5.101 Classification of earthing function through main switching device	23
28	5.102 Rated cable test voltages (U_{ct} (AC), U_{ct} (DC)).....	23
29	5.103 Ratings of the internal arc classification (IAC)	24
30	6 Design and construction	25
31	6.1 Requirements for liquids in switchgear and controlgear	25
32	6.2 Requirements for gases in switchgear and controlgear	25
33	6.3 Earthing of switchgear and controlgear	25
34	6.4 Auxiliary and control equipment.....	26
35	6.5 Dependent power operation.....	26
36	6.6 Stored energy operation	26
37	6.7 Independent unlatched operation (independent manual or power operation)	26
38	6.8 Manually operated actuators.....	26
39	6.9 Operation of releases	27
40	6.10 Pressure/level indication	27
41	6.11 Nameplates.....	27
42	6.12 Locking devices	30
43	6.13 Position indication	30
44	6.14 Degrees of protection provided by enclosures	31
45	6.15 Creepage distances for outdoor insulators	31
46	6.16 Gas and vacuum tightness	31

47	6.17	Tightness for liquid systems	31
48	6.18	Fire hazard (flammability)	31
49	6.19	Electromagnetic compatibility (EMC).....	31
50	6.20	X-ray emission	31
51	6.21	Corrosion	31
52	6.22	Filling levels for insulation, switching and/or operation	32
53	6.101	General requirements for assemblies.....	32
54	6.102	Solid insulating enclosure.....	33
55	6.102.1	General	33
56	6.102.2	Covers and doors.....	33
57	6.102.3	Partition or shutter being part of the enclosure.....	34
58	6.102.4	Inspection windows	34
59	6.102.5	Ventilating openings, vent outlets	34
60	6.102.6	Protection category of the solid insulating enclosure against electric shock.....	34
62	6.102.7	Requirements for protection categories.....	35
63	6.103	High-voltage compartments	35
64	6.103.1	General	35
65	6.103.2	Fluid-filled compartments (gas or liquid)	36
66	6.103.3	Partitions and shutters	38
67	6.104	Removable parts	39
68	6.105	Provisions for dielectric tests on cables	39
69	6.106	Internal arc fault.....	39
70	7	Type tests	40
71	7.1	General.....	40
72	7.2	Dielectric tests	41
73	7.2.9	Artificial pollution tests for outdoor insulators	44
74	7.2.10	Partial discharge tests.....	44
75	7.2.101	Dielectric tests on cable testing circuits	45
76	7.3	Radio interference voltage (RIV) test	45
77	7.4	Resistance measurement	45
78	7.5	Continuous current tests	46
79	7.6	Short-time withstand current and peak withstand current tests	47
80	7.7	Verification of the protection	50
81	7.7.1	Verification of the IP coding.....	50
82	7.7.2	Verification of the IK coding.....	50
83	7.8	Tightness tests.....	50
84	7.9	Electromagnetic compatibility tests (EMC)	50
85	7.10	Additional tests on auxiliary and control circuits	50
86	7.11	X-radiation test procedures for vacuum interrupters	51
87	7.101	Verification of making and breaking capacities	51
88	7.102	Mechanical operation tests	52
89	7.103	Pressure withstand test for gas-filled compartments.....	54
90	7.104	Tests to verify the protection of persons against dangerous electrical effects.....	56
91	7.105	Internal arc test.....	57
92	7.106	Thermal stability test.....	61
93	7.107	Humidity test.....	61
94	8	Routine tests	61
95	8.1	General.....	61
96	8.2	Dielectric test on the main circuit.....	61

97	8.3	Tests on auxiliary and control circuits	62
98	8.4	Measurement of the resistance of the main circuit	62
99	8.5	Tightness test	63
100	8.6	Design and visual checks	63
101	8.101	Partial discharge measurement	63
102	8.102	Mechanical operation tests	63
103	8.103	Pressure tests of gas-filled compartments	63
104	8.104	Tests after erection on site	64
105	8.105	Measurement of fluid condition after filling on site	64
106	9	Guide to the selection of switchgear and controlgear (informative)	64
107	9.1	General.....	64
108	9.2	Selection of rated values	65
109	9.3	Cable-interface considerations	65
110	9.4	Continuous or temporary overload due to changed service conditions	65
111	9.5	Environmental aspects	65
112	9.101	Selection of design and construction.....	65
113	9.102	Ratings related to earthing circuits.....	69
114	9.103	Internal arc fault.....	69
115	9.104	Summary of technical requirements, ratings and optional tests.....	74
116	10	Information to be given with enquiries, tenders and orders (informative)	76
117	10.1	General.....	76
118	10.2	Information with enquiries and orders	76
119	10.3	Information with tenders	77
120	11	Transport, storage, installation, operating instructions and maintenance	77
121	12	Safety	78
122	13	Influence of the product on the environment	79
123	Annex A (normative)	Internal arc fault – Method to verify the internal arc classification	
124		(IAC)	80
125	A.1	Room simulation	80
126	A.2	Indicators (for assessing the thermal effects of the gases)	82
127	A.3	Tolerances for geometrical dimensions of test arrangements	83
128	A.4	Test parameters	83
129	A.5	Test procedure.....	84
130	Annex B (normative)	Partial discharge measurement	94
131	Annex C (informative)	Regional deviations	100
132	Annex D (normative)	Humidity test	101
133	D.1	General.....	101
134	D.2	Test procedure and test conditions	101
135	D.3	Test criteria and evaluation	103
136	Annex E (informative)	Protection categories	105
137	E.1	Protection category PA.....	105
138	E.2	Protection category PB.....	106
139	Annex F (informative)	List of symbols and abbreviations used in IEC 62271-201	107
140	Annex G (normative)	Flowchart categorisation procedure LSC for a given functional	
141		unit FU1 with connection compartment	108
142	Annex H (informative)	Pressure coordination chart for gas-filled compartments	109
143	Bibliography		110
144			

145	Figure 1 – LSC1	68
146	Figure 2 – LSC2	68
147	Figure 3 – LSC2	68
148	Figure 4 – LSC2	69
149	Figure 5 – LSC2A	69
150	Figure 6 – LSC2B	69
151	Figure 7 – LSC2B	69
152	Figure 8 – No LSC assigned	69
153	Figure 9 – No LSC assigned	69
154	Figure A.1 – Mounting frame for vertical indicators	87
155	Figure A.2 – Horizontal indicator	87
156	Figure A.3 – Position of the indicators	88
157	Figure A.4 – Room simulation and indicator positioning for accessibility A, classified	
158	rear side, ceiling above 2 000 mm, functional unit of any height	89
159	Figure A.5 – Ceiling height stated from the floor or false floor level where the	
160	switchgear is actually placed	90
161	Figure A.6– Indicator positioning in case of protrusion at < 2 000 mm height, at	
162	classified side	91
163	Figure A.7– Indicator positioning in case a bottom exhaust duct belonging to the	
164	assembly is defined as a walkable integrated part of the false floor	92
165	Figure A.8 – Room simulation and indicator positioning for accessibility type A, non-	
166	accessible rear side, ceiling at 2 000 mm, so functional unit ≤ 1 800 mm high	93
167	Figure B.1 – Partial discharge test circuit (three-phase arrangement)	98
168	Figure B.2 – Partial discharge test circuit (system without earthed neutral)	99
169	Figure D.1 – Test cycle	104
170	Figure D.2 – Test chamber	104
171	Figure E.1 – Possible designs for protection category PA	105
172	Figure E.2 – Possible designs for protection category PB	106
173	Figure G.1 – Flowchart categorisation procedure LSC for a given functional unit FU1	
174	with connection compartment	108
175	Figure H.1 – Example of pressure coordination chart	109
176		
177	Table 1 – Nameplate information	27
178	Table 2 – Locations, causes and examples of measures to decrease the probability of	
179	internal arc faults	70
180	Table 3 – Single-phase-to-earth arc fault current depending on the network <i>neutral</i>	
181	earthing	73
182	Table 4 – Summary of technical requirements, ratings and optional <i>tests</i> for	
183	assemblies	74
184	Table A.1 – Parameters for internal arc test according to compartment construction	86
185	Table B.1 – Test circuits and procedures	96
186		

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –



Documents
Document Sharing Hub

**Part 201: AC solid-insulation enclosed switchgear
and controlgear for rated voltages above 1 kV
and up to and including 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.

International Standard IEC 62271-201 has been prepared by subcommittee 17C: High-voltage switchgear and controlgear assemblies, of IEC technical committee 17: Switchgear and controlgear.

This third edition cancels and replaces second edition, published in 2014. This edition constitutes a technical revision.

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

- a) aligned with the third edition of IEC 62271-200 (issued in 2021) and its CD2 of AMD1, for structure, definitions, classifications, ratings and testing procedures, where appropriate;
- b) clause numbering aligned with IEC 62271-1:2017, including the adoption of the subclause names of Clause 3;
- c) in Clause 3 specific definitions are added for; "in service", "normal operating condition" and "normal use";
- d) earthing circuit is more precisely described, including ratings and test requirements;
- e) number of mechanical tests on interlocks is reduced for type testing; forces to apply during type testing are better prescribed (refer to 7.102);
- f) resistance measuring on main circuit is only needed before continuous current tests (as reference for routine tests) and not anymore needed after this continuous current test. Rationale for this deletion is that this measured resistance does not mean anything.

temperature rise test was just finished, a new temperature rise test will not give new information;

g) IEC 62271-100:2017/AMD2:2018 has been taken into account in 7.101.2;

h) IEC 62271-107:2019 and IEC IEEE 62271-37-013:2015 are also considered in 7.101.2;

i) LSC category is more precisely described, including an explaining flowchart (Annex G);

j) examples not covered by the IAC test are transferred from Clause 6 to 9.103;

k) the term “assembly” is defined in Clause 3 and used as synonym for “solid-insulation enclosed switchgear and controlgear” in this document;

l) “metallic” is replaced by “metal” where applicable;

m) a 1 s rule was introduced for Criterion 4 during IAC tests regarding hot gases versus glowing particles as cause of ignition;

n) internal arc tests for switchgear with protrusions are more precisely described in Annex A.

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

FDIS	Report on voting
17C/594/FDIS	17C/597/RVD

Full information on the voting for the approval of this document 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.

This document should be read in conjunction with IEC 62271-1:2017 and its Amendment 1:2011, to which it refers and which is applicable, unless otherwise specified. In order to simplify the indication of corresponding requirements, the same numbering of clauses and subclauses is used as in IEC 62271-1. Amendments to these clauses and subclauses are given under the same numbering, whilst additional subclauses are numbered from 101.

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

A list of all parts in the IEC 62271 series, published 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 stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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.

INTRODUCTION

285

286 High-voltage (IEC 60050-601:1985, 601-01-27) switchgear refers to rated voltages above 1 kV.
287 However, medium-voltage is commonly used for distribution systems with rated voltages above
288 1 kV and generally applied up to and including 52 kV; refer to IEC 60050-601:1985, 601-01-28

289 Although primarily dedicated to three-phase systems, this document can also be applied to
290 single-phase and two-phase systems.

291 Switchgear and controlgear assemblies having a metal enclosure are covered by
292 IEC 62271-200 [2].

293

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 201: AC solid-insulation enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

1 Scope

This part of IEC 62271 is applicable to prefabricated solid-insulation enclosed switchgear and controlgear assemblies designed for:

- alternating current;
- rated voltages above 1 kV and up to and including 52 kV;
- service frequencies up to and including 60 Hz;
- indoor installation;
- areas limited to authorized personnel;

The assembly can include air-insulated and/or fluid-filled compartments.

For components installed in a solid-insulation enclosed switchgear and controlgear, this document supplements or even replaces in some cases, the requirements as stated by the individual product standards.

The list of components which may be inside the solid-insulation enclosed switchgear and controlgear is not limited to the ones explicitly cited in this document.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at www.electropedia.org)

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

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

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

IEC 60529:1989/AMD 1:1999

IEC 60529:1989/AMD 2:2013

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 62271-1:2017/AMD1: 2021

IEC 62271-100:2021, *High-voltage switchgear and controlgear – Part 100: Alternating current circuit-breakers*

IEC 62271-102:2018, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

IEC 62271-103:2021, *High-voltage switchgear and controlgear – Part 103: Alternating current switches for rated voltages above 1 kV up to and including 52 kV*

IEC 62271-105:2021, *High-voltage switchgear and controlgear – Part 105: Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV*

IEC 62271-106:2021, *High-voltage switchgear and controlgear – Part 106: Alternating current contactors, contactor-based controllers and motor-starters*

ISO 4126-2, *Safety devices for protection against excessive pressure – Part 2: Bursting disc safety devices*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62271-1, IEC 60050-151 and IEC 60050-441, and the following apply

NOTE The classification system for definitions of IEC 62271-1:2017 is followed. Terms and definitions are referenced and prioritized in the following order:

- Clause 3 of this document;
- IEC 62271-1:2017;
- IEC 60050-441;
- IEC 60050-151.

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>

3.1 General terms and definitions

The definitions in 3.1 of IEC 62271-1:2017 are applicable, with the following additions:

3.1.101

ambient air temperature

<of an assembly> temperature, determined under specified conditions, of the air surrounding the enclosure of an assembly

[SOURCE: IEC 60050-441:1984, 441-11-13, modified – "prescribed" has been replaced by "specified", "complete switching device or fuse" by "enclosure of an assembly" and the note has been removed.]

3.1.102

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 nearly to 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 be only temporary (self-restoring insulation).

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

380 **3.1.103**

381 **relative pressure**

382 pressure that refers to the local atmospheric pressure

383 Note 1 to entry: When defining a filling level it is in reference to the standard atmospheric pressure of 101,3 kPa, as defined in
384 IEC 62271-1

385 **3.1.104**

386 **segregation**

387 <of conductors> arrangement of conductors with earthed metal interposed between them in
388 such a manner that disruptive discharges can only occur to earth

389 Note 1 to entry: A segregation can be established between the conductors as well as between the open contacts
390 of a switching device like a disconnector.

391 Note 2 to entry: This definition does not specify any mechanical protection (IP and IK).

392 [SOURCE: IEC 60050-441:1984, 441-11-11, modified – Notes to entry have been added.]

393 **3.1.105**

394 **in service**

395 <condition of an assembly> condition where at least one high voltage part in the assembly is
396 energized

397 **3.1.106**

398 **normal operating condition**

399 <of an assembly> in service condition with all doors and covers properly closed and secured

400 **3.1.107**

401 **normal use**

402 <of an assembly> use of the assembly as defined by the manufacturer's instructions reference,
403 corresponding to the conditions and operations in service

404 Note 1 to entry: "normal use" may include maintenance activities within an accessible high-voltage compartment.

405 **3.1.108**

406 **electric shock**

407 physiological effect resulting from an electric current through a human or animal body

408 [SOURCE: IEC 60050-195:1998, 195-01-04]

409 **3.2 Assemblies of switchgear and controlgear**

410 The definitions in 3.2 of IEC 62271-1:2017 are applicable, with the following additions:

411 **3.2.101**

412 **solid-insulation enclosed switchgear and controlgear 413 assembly**

414 switchgear and controlgear assemblies with an external solid insulating enclosure and
415 completely assembled, except for external connections

416 Note 1 to entry: This term generally is applicable to high-voltage switchgear and controlgear.

417 Note 2 to entry: The external insulation may be supplied with a (semi-)conducting layer.

418 Note 3 to entry: The term "external connections" corresponds to "external conductors (cables or bars) connecting
419 the assembly to the network or an external installation".

3.2.102**multi-tier design**

design of an assembly in which the main switching devices of two or more functional units are arranged vertically (one above the other) within a common enclosure Parts of assemblies

The definitions in 3.3 of IEC 62271-1:2017 are applicable.

3.3 Switching devices

The definitions in 3.4 of IEC 62271-1:2017 are applicable.

3.4 Parts of switchgear and controlgear

The definitions in 3.5 of IEC 62271-1:2017 are applicable, with the following additions:

3.4.101**enclosure**

<of an assembly> part of an assembly providing a specified degree of protection of equipment against external influences and a specified degree of protection against approach to or contact with live parts and against contact with moving parts

[SOURCE: IEC 60050-441:1984, 441-13-01]

3.4.102**solid insulating enclosure**

<of an assembly> part of an assembly providing a specified degree of protection of equipment against external influences and a specified degree of protection against electric shock by limiting the approach to or contact with live parts and against contact with moving parts

Note 1 to entry: The main part of the enclosure is of solid insulating material and may have added (semi-) conductive layers.

Note 2 to entry: If the resistance of the enclosure of the switchgear and controlgear to the earthing point provided is everywhere less than, or equal to, 100 mΩ, it is identical to the maximum electrical resistance requested by IEC 62271-200: 2021..

[SOURCE: IEC 60050-441:1984, 441-13-01, modified – “electric shock by limiting the” has been added; Notes to entry added.]

3.4.103**functional unit**

<of an assembly> part of an assembly comprising the main circuits, earthing circuit and auxiliary circuits that contribute to the fulfilment of a single function

Note 1 to entry: Functional units can be distinguished according to the function for which they are intended, for example, incoming unit, through which electrical energy is normally fed into the assembly, outgoing unit, through which electrical energy is normally supplied to one or more external circuits.

[SOURCE: IEC 60050-441:1984, 441-13-04, modified – modification of the wording]

3.4.104**component**

<of an assembly> essential part of the high-voltage or earthing circuits of an assembly which serves a specific function (e.g. circuit-breaker, disconnector, switch, fuse, earthing switch, instrument transformer, bushing, busbar)

3.4.105**main circuit**

<of an assembly> all the high-voltage conductive parts of an assembly included in a circuit which is intended to carry the rated continuous current

Note 1 to entry: Connections to voltage transformers are not considered part of the main circuit.

[SOURCE: IEC 60050-441:1984, 441-13-02, modified – "high-voltage" is added and "transmit electrical energy" is replaced by "carry the rated continuous current"; the Note has been added.]

3.4.106**auxiliary circuit**

<of an assembly> all the conductive parts of an assembly of switchgear and controlgear included in a circuit (other than the high-voltage parts) intended to control, measure, signal and regulate

Note 1 to entry: The auxiliary circuits of an assembly include the control and auxiliary circuits of the switching devices.

[SOURCE: IEC 60050-441:1984, 441-13-03, modified – "main circuit" is replaced by "high-voltage parts".]

3.4.107**earthing circuit**

<of an assembly> conductors, connections and the conducting parts of earthing devices intended to connect the high-voltage conductive parts of the assembly to the earthing point provided

Note 1 to entry: The earthing circuit can include short-circuiting circuits between poles and phase-to-earth circuits from each pole to the earthing point and/or from the short-circuiting point of phase-to-earth circuits to the earthing point provided.

3.4.108**earthing point**

<of an assembly> terminal which is provided on the assembly for connection of the intended earthed parts of the assembly to the earth system of the installation

3.4.109**high-voltage compartment**

compartment of an assembly containing high-voltage conducting parts, enclosed except for openings necessary for interconnection, control or ventilation.

Note 1 to entry: General definition of "compartment" is provided by IEC 60050-441:1984, 441-13-05, as "a part of an assembly enclosed except for openings necessary for interconnection, control or ventilation".

3.4.110**interlock-controlled accessible compartment**

high-voltage compartment designed to be opened for normal use, in which access is controlled by integral design of the assembly

3.4.111**procedure-based accessible compartment**

high-voltage compartment designed to be opened for normal use, in which access is controlled by a suitable procedure combined with locking

3.4.112**tool-based accessible compartment**

high-voltage compartment that can be opened only through the use of tools, but not designed to be opened for normal use

3.4.113**non-accessible compartment**

high-voltage compartment that is designed not to be opened by the user

Note 1 to entry: By default, every high-voltage compartment not declared accessible by the manufacturer in the manufacturer's instructions reference, is considered as a non-accessible compartment

3.4.114**fluid-filled compartment**

high-voltage compartment of an assembly, filled with a fluid, either gas, other than ambient air, or liquid, for insulation purposes

Note 1 to entry: For fluid-filled compartments with gas, the term gas-filled compartment is used.

Note 2 to entry: The pressure is maintained by one of the following systems:

- a) controlled pressure system;
- b) closed pressure system;
- c) sealed pressure system.

Note 3 to entry: For pressure systems, refer to 3.6.6 of IEC 62271-1:2017.

3.4.115**pressure relief device**

device intended to relieve overpressure from a compartment

3.4.116**partition**

part of an assembly separating one high-voltage compartment from other compartments and providing a specified degree of protection

Note 1 to entry: Partitions may be fitted with parts that allow interconnection between compartments (e.g. bushings).

Note 2 to entry: Partitions considered in this document are defined by their protection category in case they become accessible in normal use.

[SOURCE: IEC 60050-441:1984, 441-13-06, modified – high-voltage is specifically addressed including the degree of protection; Notes to entry 1 and 2 have been added]

3.4.117**bushing**

structure carrying one or more conductors through an enclosure or partition and insulating the conductors from the enclosure or partition, including the means of attachment

3.4.118**shutter**

<of an assembly> part of an assembly that can be moved from a position where it permits contacts of a removable part, or moving contact of a disconnecter, to engage fixed contacts, to a position where it becomes a part of the solid insulating enclosure or partition

[SOURCE: IEC 60050-441:1984, 441-13-07, modified – "moving contact of a disconnecter" and "solid insulating" have been added; "shielding the fixed contacts" has been removed]

3.4.119**removable part**

<of an assembly> part of an assembly that may be removed entirely from the assembly and replaced

549 [SOURCE: IEC 60050-441:1984, 441-13-08, modified – "even though the main circuit is alive"
550 has been deleted

551 **3.4.120**

552 **withdrawable part**

553 <of an assembly> removable part of an assembly that can be moved to one or more positions
554 in which an isolating distance or a segregation between open contacts is established, while the
555 part remains mechanically attached to the assembly, even though the main circuit to which it
556 was connected is live

557 [SOURCE: IEC 60050-441:1984, 441-13-09, modified – "even though the main circuit to which
558 it was connected is live" has been added; the Note has been deleted.]

559 **3.4.121**

560 **fuse-link**

561 the part of a fuse (including the fuse-element(s)) intended to be replaced after the fuse has
562 operated

563 Note 1 to entry: In this document the term is exclusively used in relation with high-voltage fuses.

564 [SOURCE: IEC 60050-441:1984, 441-18-09, modified – The Note to entry has been added.]

565 **3.4.122**

566 **connection compartment**

567 high-voltage compartment in which electrical connections are made between the main circuit
568 of the assembly and the external conductors (cables or bars) to the electrical network or high-
569 voltage apparatus of the installation

570 Note 1 to entry: A connection compartment is not needed for a solid insulation enclosed switchgear and controlgear,
571 if the external connection can be safely touched.

572 **3.4.123**

573 **solid-insulation embedded component**

574 component, the live parts of which are integrally surrounded by solid insulating material, with
575 the exception of the terminals, interfaces for driving mechanisms and secondary wiring

576 Note 1 to entry: The insulation may form part of the solid insulating enclosure. Operational characteristics of
577 switchgear and controlgear

578 The definitions in 3.6 of IEC 62271-1:2017 are applicable, with the following additions:

579 **3.4.101**

580 **loss of service continuity category**

581 **LSC**

582 <of a functional unit> category defining the possibility to keep other high-voltage compartments
583 and/or functional units energized when opening its connection compartment or any other of its
584 high-voltage compartment(s) accessible in normal use, as stated in definitions 3.5.110 and
585 3.5.111, giving access to at least part of the high-voltage circuit contained within

586 Note 1 to entry: The LSC category describes the extent to which the assembly is intended to remain operational
587 where access to a high-voltage compartment is provided. The extent to which it is considered necessary to open
588 high-voltage compartments of an installation in service might be dependent on several aspects (refer to 9.101).

589 Note 2 to entry: The LSC category does not describe or relate to different levels of reliability of assemblies (refer to
590 9.101).

591 Note 3 to entry: In relation to providing access to high-voltage compartments and the associated service continuity,
592 four categories are defined: LSC1, LSC2, LSC2A, LSC2B (refer to Annex G and Figure G.1).

3.4.102**category LSC2**

<of a functional unit> category of functional units having at least a separate accessible compartment for the high-voltage connection of that functional unit (called connection compartment), such that, when this compartment is open, at least one busbar may remain energized and all other functional units of the assembly may be operated normally

3.4.103**category LSC2A**

<of a functional unit> category of functional units of category LSC2 such that, when any accessible compartment (other than its connection compartment and the busbar compartment of single-busbar assemblies) is open, at least one busbar may remain energized and all other functional units of the assembly may be operated normally

3.4.104**category LSC2B**

<of a functional unit> category of functional units of category LSC2A, where the high-voltage connections (e.g. cable connections) to the functional unit may remain energized when any other accessible high-voltage compartment (other than its connection compartment and the busbar compartment of single-busbar assemblies) of the corresponding functional unit is open

3.4.105**category LSC1**

<of a functional unit> category of functional units having one or more high-voltage accessible compartments, such that, when any of these accessible high-voltage compartments is open, at least one other functional unit shall not remain energized

3.4.106**service position****connected position**

<of a removable part> position of a removable part in which it is fully connected for its intended function

[SOURCE: IEC 60050-441:1984, 441-16-25]

3.4.107**test position**

<of a withdrawable part> position of a withdrawable part in which an isolating distance or segregation is established in the main circuit and in which the auxiliary circuits are connected

[SOURCE: IEC 60050-441:1984, 441-16-27]

3.4.108**disconnected position****isolated position**

<of a withdrawable part> position of a withdrawable part in which an isolating distance or segregation is established in all the circuits of the withdrawable part, that part remaining mechanically attached to the assembly

Note 1 to entry: In enclosed high-voltage switchgear and controlgear, the auxiliary circuits are generally not disconnected.

[SOURCE: IEC 60050-441:1984, 441-16-28, modified – In the Note 1 to entry, "may not be" has been replaced by "are generally not".]

3.4.109**removed position**

<of a removable part> position of a removable part when it is outside and mechanically and electrically separated from the assembly

[SOURCE: IEC 60050-441:1984, 441-16-29]

3.4.110**minimum functional level**

<of fluid-filled compartments> pressure (or density) according to definitions 3.6.5.5 and 3.6.5.6 of IEC 62271-1:2017, or liquid mass at and above which the rated values of the assembly are maintained

3.4.111**design pressure**

<of fluid-filled compartments> upper limit of the relative pressure between the pressure inside a compartment at the design temperature, under defined installation conditions, and the pressure outside that compartment, that is used to determine the design of the compartment.

Note 1 to entry: The transient pressure occurring during and after a breaking operation (e.g. circuit-breaker) is not considered in the determination of the design pressure.

3.4.112**design temperature**

<of fluid-filled compartments> highest average temperature over the compartment, which can be reached by the gas or liquid under service conditions

3.4.113**internal arc classification****IAC**

<of an assembly> classification of an assembly for which specified criteria, for protection of persons, are met in the event of internal arc for specified installation conditions, as demonstrated by type tests

Note 1 to entry: The internal arc classification is completed with the characteristics indicated in definitions 3.6.114, 3.6.115, 3.7.101 and 3.7.102.

3.4.114**type of accessibility**

<of IAC> characteristic related to the level of protection given to people accessing a defined area around the enclosure of an assembly in the event of internal arc

3.4.115**classified sides**

<of IAC> accessible sides of the assembly having a defined level of protection of persons in the event of internal arc

3.4.116**protection category against electric shock**

category of protection of the accessible solid insulating surfaces against electric shock

Note 1 to entry: This protection category against electric shock is treated separately from the degree of protection, as defined in 6.14

3.4.117**protection category PA**

category of protection against electric shock in which the insulation consists of at least one layer of solid insulating material

3.4.118**protection categories PB**

categories of protection against electric shock in which the insulation consists of at least one extra layer to the protection category PA layer

Note 1 to entry: Two different designs for PB categories are recognized, PB1 and PB2.

Note 2 to entry: The extra layer is added as a safeguard for touching, even in case the protection category PA insulation is damaged.

3.4.119**protection category PB1**

category of protection against electric shock in which an extra insulation layer is added to the category PA insulation

Note 1 to entry: One layer can consist of an insulating fluid.

3.4.120**protection category PB2**

category of protection against electric shock in which an earthed conductive layer with resistance not more than 100 mΩ is added to the category PA insulation

Note 1 to entry: The resistance not more than 100 mΩ is defined between the accessible points of the conductive layer to the earthing point provided.

3.5 Characteristic quantities

The definitions in 3.7 of IEC 62271-1:2017 are applicable, with the following additions:

3.5.101**arc fault current**

<of IAC> three-phase and, where applicable, the single-phase-to-earth RMS value of the internal arc fault current for which the assembly is designed to protect persons in the event of an internal arc

3.5.102**arc fault duration**

<of IAC> duration of the internal arc fault current for which the assembly is designed to protect persons in the event of an internal arc

3.6 Index of definitions**A - B**

Ambient air temperature	3.1.101
Assembly	3.2.101
Arc fault current	3.7.101
Arc fault duration	3.7.102
Auxiliary circuit	3.5.106

722	Bushing	3.5.117
723	C	
724	Category LSC1	3.6.105
725	Category LSC2	3.6.102
726	Category LSC2A	3.6.103
727	Category LSC2B	3.6.104
728	Classified sides	3.6.115
729	Component	3.5.104
730	Connected position	3.6.106
731	Connection compartment	3.5.122
732	D	
733	Design pressure	3.6.111
734	Design temperature	3.6.112
735	Disconnected position	3.6.118
736	Disruptive discharge	3.1.102
737	E - F	
738	Earthing circuit	3.5.107
739	Earthing point	3.5.108
740	Electric shock	3.1.108
741	Enclosure	3.5.101
742	Fluid-filled compartment	3.5.114
743	Functional unit	3.5.103
744	Fuse-link	3.5.121
745	H - I	
746	High-voltage compartment	3.5.109
747	IAC	3.6.113
748	In service	3.1.105
749	Interlock-controlled accessible compartment	3.5.110
750	Internal arc classification	3.6.113
751	Isolated position	3.6.108
752	L - M	
753	Loss of service continuity category	3.6.101
754	Main circuit	3.5.105

755	Minimum functional level	3.6.110
756	Multi-tier design	3.2.102
757	N	
758	Non-accessible compartment	3.5.113
759	Normal operating condition	3.1.106
760	Normal use	3.1.107
761	P	
762	Partition	3.5.116
763	Pressure relief device	3.5.115
764	Procedure-based accessible compartment	3.5.111
765	Protection category against electric shock	3.6.116
766	Protection category PA	3.6.117
767	Protection categories PB	3.6.118
768	Protection category PB1	3.6.119
769	Protection category PB2	3.6.120
770	R	
771	Relative pressure	3.1.103
772	Removable part	3.5.119
773	Removed position	3.6.109
774	S	
775	Segregation	3.1.104
776	Service position	3.6.106
777	Shutter	3.5.118
778	Solid insulating enclosure	3.5.102
779	Solid-insulation embedded component	3.5.123
780	Solid-insulation enclosed switchgear and controlgear	3.2.101
781	T - W	
782	Test position	3.6.107
783	Tool-based accessible compartment	3.5.112
784	Type of accessibility	3.6.114
785	Withdrawable part	3.5.120

4 Normal and special service conditions

Clause 4 of IEC 62271-1:2017 is applicable with the following addition:

Unless otherwise specified in this document, the assembly is designed to be used under normal indoor service conditions.

Assemblies, under the scope of IEC TS 62271-304 and intended to be used in service conditions more severe with respect to condensation and pollution than the normal service conditions specified in this document, can be classified with a “class 1” or “class 2” according to IEC TS 62271-304:2019 to indicate its ability to withstand such severe conditions [3].

NOTE IEC TS 62271-304:2019 proposes, to gain experience, further classes for service conditions with associated testing procedure in its informative Annex E [3].

5 Ratings

5.1 General

Subclause 5.1 of IEC 62271-1:2017 is applicable with the following additions:

- k) rated short-time withstand current for earthing circuits (I_{ke});
 - l) rated peak withstand current for earthing circuits (I_{pe});
 - m) rated duration of short-circuit for earthing circuits (t_{ke});
 - n) ratings of the components forming part of the assembly including their operating devices and auxiliary equipment;
- Optional ratings:
- o) rated voltage for AC cable test voltage ($U_{ct(AC)}$);
 - p) rated voltage for DC cable test voltage ($U_{ct(DC)}$);
 - q) rated duration for DC cable test voltage ($t_{ct(DC)}$);
 - r) ratings of the internal arc classifications (IAC).

5.2 Rated voltage (U_r)

Subclauses 5.2.1 and 5.2.2 of IEC 62271-1:2017 are applicable.

NOTE Components forming part of an assembly can have individual values of rated voltage in accordance with their relevant standards.

5.3 Rated insulation level(U_d , U_p , U_s)

Subclause 5.3 of IEC 62271-1:2017 is applicable.

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:

Some main circuits of solid-insulation enclosed switchgear and controlgear (for example, busbars, feeder circuits) may have differing values of rated continuous current.

5.6 Rated short-time withstand current (I_k, I_{ke})

For the rated short-time withstand currents I_k 5.6 of IEC 62271-1:2017 is applicable with the following additions:

5.6.101 Rated short-time withstand current (I_k)

In principle, an assembly has one rated short-time withstand current value. However, there are several situations where it is permissible to assign different rated short-time withstand current values to different portions of the main circuit, including:

- circuits protected by current-limiting fuses;
- circuits under interlocked switching devices commutating two branches of a circuit.

The rated short-time withstand current values (I_k) assigned to the assembly are also applicable to the short-circuiting parts of the related earthing circuits, including earthing devices.

5.6.102 Rated short-time phase to earth withstand current (I_{ke})

A rated short-time withstand phase-to-earth current (I_{ke}) shall be assigned to the assembly for the parts of the earthing circuit connecting each phase of the main circuit to the earthing point provided or, where applicable, connecting the short-circuiting point between phases to the earthing point provided. This value may be lower than that of the main circuit.

NOTE The short-circuit current ratings assigned to the earthing circuit define the possible earthing conditions of the system neutral of the network on which the assembly can be installed. Refer to 9.102.

5.7 Rated peak withstand current (I_p, I_{pe})

Subclause 5.7 of IEC 62271-1:2017 is applicable with the following additions:

5.7.101 Rated peak withstand current (I_p)

In principle, an assembly has one rated peak withstand current value. However, there are several situations where it's permissible to assign different rated peak withstand current values to different portions of the main circuit, including:

- circuits protected by current-limiting fuses;
- circuits under interlocked switching devices commutating two branches of a circuit.

The rated peak withstand current values (I_p) assigned to the assembly are also applicable to the short-circuiting parts of the related earthing circuits, including earthing devices.

5.7.102 Rated peak phase-to-earth withstand current (I_{pe})

A rated peak phase-to-earth withstand current (I_{pe}) shall be assigned to the assembly for the parts of the earthing circuit connecting each phase of the main circuit to the earthing point provided or, where applicable, connecting the short-circuiting point between-phases to the earthing point provided. This value may be lower than that of the main circuit.

5.8 Rated durations of short-circuit (t_k, t_{ke})

Subclause 5.8 of IEC 62271-1:2017 is applicable with the following additions:

5.8.101 Rated duration of short-circuit (t_k)

In principle, an assembly has one rated duration of short-circuit. However, there are several situations where it's permissible to assign different rated durations of short-circuit to different portions of the main circuit including:

- circuits protected by current-limiting fuses and/or circuit-breakers;
- circuits under interlocked switching devices commutating two branches of a circuit.

The rated short-time withstand current values (t_k) assigned to the assembly are also applicable to the short-circuiting parts of the related earthing circuits, including earthing devices.

5.8.102 Rated duration of phase-to-earth short-circuit (t_{ke})

A rated duration of phase-to-earth short-circuit (t_{ke}) shall also be assigned to the assembly for the parts of the earthing circuit connecting each phase of the main circuit to the earthing point provided or, where applicable, connecting the short-circuiting point between-phases to the earthing point provided. This value may be lower than that of the main circuit.

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 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 applicable.

5.101 Classification of earthing function through main switching device

When the earthing function is performed by the main switching device in combination with a class E0 earthing switch, class E1 or E2, as defined in IEC 62271-102:2018, may be assigned to that earthing function.

The classification for the earthing function is not applicable when the earthing is performed by a circuit-breaker with the protection operative until the earthed situation is attained.

5.102 Rated cable test voltages (U_{ct} (AC), U_{ct} (DC))

5.102.1 General

If the assembly is designed to allow for dielectric testing of connected high-voltage cables while the busbar(s) of the associated functional unit remain in service, one or more rated cable test voltages shall be assigned.

5.102.2 Rated power-frequency cable test voltage U_{ct} (AC)

The rated power frequency cable test voltage is the maximum AC test voltage with a duration of 1 min. that may be applied to cables when connected to the assembly, which may be in service.

5.102.3 Rated DC cable test voltage U_{ct} (DC) with rated duration t_{ct} (DC)

The rated DC cable test voltage is the maximum DC test voltage that may be applied to cables when connected to the assembly, which may be in service.

A rated DC cable test voltage is considered covering very low frequency testing (e.g. 0,1 Hz) with peak value up to the rated DC value for the same rated duration.

If no rated duration t_{ct} (DC) is specified, then by default this duration is 15 min.

NOTE Guidance can be found in IEEE 400.2 [4].

5.103 Ratings of the internal arc classification (IAC)

5.103.1 General

If an IAC classification is assigned by the manufacturer, several ratings shall be specified. These ratings shall be indicated by means of a designation as follows:

- Classification: IAC (Internal Arc Classification);
- Type of Accessibility: A;
- Classified sides of the enclosure: F, L, R;
- Rated three-phase arc fault values: current I_A [kA] and duration t_A [s];
- Rated single-phase arc fault values (where applicable): current I_{Ae} [kA] and duration t_{Ae} [s].

5.103.2 Types of accessibility

One type of accessibility to the enclosure of an assembly at the site of installation is defined:

Accessibility Type A: restricted to authorized personnel only.

NOTE IAC classification as defined in this Document does not apply to opened compartments and to arc protection between compartments, except if opening is necessary to perform switching operations. IEEE C 37.20.7 addresses these topics in Suffix B designation for opened low-voltage compartments and Suffix C designation for arc protection between compartments [5].

5.103.3 Classified sides

In case of IAC, at least the front side of the assembly shall be classified for accessibility type A, by the manufacture. The sides of the assembly which meet the criteria of the internal arc test are designated as

- F for front side
- L for lateral side
- R for rear side

The front side shall be clearly stated by the manufacturer.

5.103.4 Rated arc fault currents (I_A , I_{Ae})

The value of rated arc fault currents should be selected from the R 10 series specified in IEC 60059 [6]

Two ratings of the arc fault currents are recognised:

- a) three-phase arc fault current (I_A);
- b) single phase-to earth arc fault current (I_{Ae}), when applicable.

The manufacturer shall specify the compartments to which the single-phase-to-earth arc fault current rating is applicable. Such value may be assigned to an assembly where its construction will prevent the arc from becoming multiphase, as demonstrated during the internal arc test.

In the case where all high-voltage compartments are only designed for single-phase-to-earth arc faults, instead of I_A , the I_{Ae} rating shall be assigned.

NOTE Information about the relationship between type of network neutral earthing and the single phase-to-earth arc fault current is provided in 9.103.6.

5.103.5 Rated arc fault duration (t_A , t_{Ae})

Recommended values for the three-phase arc fault duration (t_A) are 0,1 s, 0,5 s and 1 s.

If applicable, the test duration (t_{Ae}) of the single phase-to-earth arc fault shall be stated by the manufacturer.

NOTE It is in general not possible to calculate the permissible arc duration for a current which differs from that used in the test.

6 Design and construction**6.1 Requirements for liquids in switchgear and controlgear**

Subclause 6.1 of IEC 62271-1:2017 is applicable.

6.2 Requirements for gases in switchgear and controlgear

Subclause 6.2 of IEC 62271-1:2017 is applicable.

NOTE For handling of gases and gas mixtures, refer to IEC 62271-4 [7].

6.3 Earthing of switchgear and controlgear

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

6.3.101 Earthing of the high-voltage conductive parts

All high-voltage conductive parts to which access is provided with the assembly in service, shall have the possibility of being earthed prior to becoming accessible. This is not applicable to removable parts which become accessible after being separated from the assembly and to withdrawable parts in test position or in disconnected position (refer to 6.101).

Where earthing connections shall be able to carry the full three-phase short-circuit current (as in the case of the short-circuiting connections used for earthing devices), these connections shall be dimensioned accordingly.

The connection from the short-circuiting point between phases to the earthing circuit may be dimensioned to the specifications of the earthing circuit.

6.3.102 Earthing of enclosure(s)

If enclosure(s) have conductive layers intended to be earthed, there are two options:

- for category PA and PB1, the resistance to the earthing point provided is not prescribed;
- for category PB2, the resistance from any position on these conductive layers shall not exceed 100 mΩ resistance at 30 A (DC) to the earthing point provided.

All the metallic and conductive parts intended to be earthed and not belonging to a high voltage or auxiliary circuit shall also be electrically connected to the earthing point provided.

The interconnections within each functional unit shall be made by adequate means (e.g. fastening by bolting), providing electrical continuity between conductive layers and/or metal parts intended to be earthed to the earthing point. If doors of the high voltage compartments have conductive layers intended to be earthed, they shall be electrically connected to the frame by adequate means.

NOTE 1 Enclosure and doors are considered in 6.102.

973 NOTE 2 ° EMC demands for the complete installation can require a special approach of the earthing circuit of the
974 assembly.

975 **6.3.103 Earthing of withdrawable and removable parts**

976 The normally earthed metallic parts of a withdrawable part shall remain connected to earth in
977 the test and disconnected positions and in any intermediate position. Connections to earth in
978 any position shall not exceed 100 mΩ resistance at 30 A (DC) to the earthing point provided.

979 On insertion, the normally earthed metallic parts of a removable part shall be connected to
980 earth prior to the making of the contacts of the fixed and removable parts of the main circuit.

981 If the withdrawable or removable part includes any earthing device, intended to earth the main
982 circuit, then the earthing connection in the service position shall be considered as part of the
983 earthing circuit with associated rated values (refer to 5.6, 5.7 and 5.8).

984 **6.3.104 Earthing circuit**

985 The parts of the earthing circuit of the assembly connecting each functional unit to the earthing
986 point shall be capable of carrying the rated short-time and peak phase-to-earth withstand
987 current (I_{ke} , I_{pe}) and duration (t_{ke}).

988 NOTE 1 It is assumed that the short-circuiting point between phases of the earthing circuit is within each functional
989 unit.

990 For transport units to be assembled during final installation, the resulting earthing circuit shall
991 be capable of carrying its rated short-time and peak withstand currents and duration.

992 If a dedicated earthing conductor is applied as earthing circuit of the assembly, its cross-section
993 shall be not less than 30 mm².

994 NOTE 2 If the earthing circuit consists of an earthing copper conductor extending the whole length of the assembly,
995 for the rated short-time withstand current, a current density in the earthing conductor, not exceeding 200 A/mm² for
996 a rated duration of 1 s or 125 A/mm² for a rated duration of 3 s is generally sufficient.

997 NOTE 3 A method of calculating cross-sectional areas of conductors is given in IEC 60724 [8].

998 The earthing circuit is normally designed to withstand one occurrence of a single short-circuit
999 fault, and maintenance could be needed after such an event; refer also to 9.102.

1000 **6.4 Auxiliary and control equipment**

1001 Subclause 6.4 of IEC 62271-1:2017 is applicable.

1002 **6.5 Dependent power operation**

1003 Subclause 6.5 of IEC 62271-1:2017 is applicable.

1004 **6.6 Stored energy operation**

1005 Subclause 6.6 of IEC 62271-1:2017 is applicable.

1006 **6.7 Independent unlatched operation (independent manual or power operation)**

1007 Subclause 6.7 of IEC 62271-1:2017 is applicable.

1008 **6.8 Manually operated actuators**

1009 Subclause 6.8 of IEC 62271-1:2017 is applicable.

6.9 Operation of releases

Subclause 6.9 of IEC 62271-1:2017 is applicable.

6.10 Pressure/level indication

Subclause 6.10 of IEC 62271-1:2017 is applicable with the following addition.

For gas-filled compartments where the minimum functional pressure exceeds 200 kPa (absolute pressure) an indication shall be provided when the pressure at 20 °C has fallen below the minimum functional level (refer to 3.4.110).

Closed pressure systems with minimum functional pressure above 200 kPa (absolute pressure) shall have a defined alarm pressure (density) level.

NOTE Alarm pressure (density) is defined in IEC 62271-1:2017 3.6.5.3 and 3.6.5.4

For gas-filled compartments with design pressure above 300 kPa (relative) and with minimum functional pressure for insulation above 200 kPa (absolute pressure), the requirement of continuous monitoring of density or pressure (with temperature compensation) also applies to sealed pressure systems.

6.11 Nameplates

Subclause 6.11 of IEC 62271-1:2017 is applicable, except for Table 9, with the following additions:

Assemblies shall be provided with durable and clearly legible nameplates which shall contain the information in accordance with Table 1.

Table 1 – Nameplate information

	Abbreviation	Unit	Marking (**)	Condition: Marking only required if
(1) ^{a,b}	(2) ^a	(3)	(4)	(5)
Name of manufacturer			X	
Manufacturer's type designation			X	
Serial number			X	
Manufacturer's instructions reference			X	
Year of manufacture			X	
Applicable standard			X	
Rated voltage	U_r	kV	X	
Rated frequency	f_r	Hz	X	
Rated lightning impulse withstand voltage	U_p	kV	X	
Rated power-frequency withstand voltage	U_d	kV	X	
Rated power-frequency cable test voltage	$U_{ct (AC)}$	kV	(X)	
Rated DC cable test voltage	$U_{ct (DC)}$	kV	(X)	
Rated duration for DC cable test	$t_{ct (DC)}$	min.	(X)	
Rated continuous current	I_r	A	X	
Rated short-time withstand current	I_k	kA	X	
Rated peak withstand current	I_p	kA	X	
Rated duration of short-circuit	t_k	s	X	

	Abbreviation	Unit	Marking (**)	Condition: Marking only required if
(1) ^{a,b}	(2) ^a	(3)	(4)	(5)
Rated short-time phase-to-earth withstand current	I_{ke}	kA	Y	different from I_k (main circuit)
Rated peak phase-to-earth withstand current	I_{pe}	kA	Y	different from I_p
Rated duration of phase-to-earth short-circuit	t_{ke}	s	Y	different from t_k (main circuit)
Filling level for insulation and/or switching (*)	$p_{re}, \rho_{re}, m_{re}$	kPa, kg/m ³ or kg	(X)	
Alarm level for insulation and/or switching (*)	$p_{ae}, \rho_{ae}, m_{ae}$	kPa, kg/m ³ or kg	Y	closed pressure system with minimum functional pressure above 200 kPa (abs.)
Minimum functional level for insulation and/or switching (*)	$p_{me}, \rho_{me}, m_{me}$	kPa, kg/m ³ or kg	(X)	
Filling level for operation (*)	$p_{rm}, \rho_{rm}, m_{rm}$	kPa, kg/m ³ or kg	(X)	
Alarm level for operation (*)	$p_{am}, \rho_{am}, m_{am}$	kPa, kg/m ³ or kg	Y	closed pressure system with minimum functional pressure above 200 kPa (abs.)
Minimum functional level for operation (*)	$p_{mm}, \rho_{mm}, m_{mm}$	kPa, kg/m ³ or kg	(X)	
Loss of Service Continuity category	LSC		(X)	
Internal arc classification	IAC		(X)	
Type of accessibility	A		(X)	
Classified sides	F, L, R		(X)	
Arc fault current and duration	I_A, t_A	kA, s	(X)	
Single- phase-to-earth arc fault current and duration	I_{Ae}, t_{Ae}	kA, s	(X)	
Rated supply voltage(s) of auxiliary and control circuits. Specify DC / AC (with rated frequency)	U_a	V	(X)	
Protection category (PA, PB1 or PB2)			Y	different from PA for the outside surface of the complete enclosure
Mass of solid insulating material	M_s	kg	X	
Type and mass of fluid (liquid or gas) for insulation	M_f	kg	(X)	
Mass of the assembly (including any fluid)	M	kg	Y	more than 300 kg
Minimum and maximum ambient air temperature		°C	Y	different from – 5 °C and/or 40 °C
(*) Density or absolute pressure (abs.) or relative pressure (rel.) to be stated at 20°C for gases, and mass for liquids (**) X = the marking of these values is mandatory; (X) = the marking of these values is where applicable; Y = conditions for marking of these values are given in column (5).				
^a The abbreviation in column (2) can be used instead of the terms in column (1). ^b When terms in column (1) are used, the word "rated" need not appear.				

1031 The information according to Table 1, of the complete assembly, shall be legible during normal
1032 service. If applicable, one common nameplate for the complete assembly may apply with the
1033 general information, with a separate nameplate for each functional unit, containing the specific
1034 information.

1035 Detailed information of the fixed components applied need not to be legible during normal
1036 service.

1037 The removable parts, if any, shall have a separate nameplate which, if applicable, may contain
1038 data relating to the functional unit(s) they are designed for. These nameplates need only be
1039 legible when the removable part is in the removed position.

1040 NOTE Fuses are removable devices that do not require such specific information because they respond to
1041 standardised dimensions.

6.12 Locking devices

Subclause 6.12 of IEC 62271-1:2017 is applicable with the following additions:

Interlocks between different components of the equipment are provided for reasons of protection and for convenience of operation. Interlocks shall not be damaged by attempted incorrect operations of any associated switching devices under the conditions specified in 7.102.2. The following provisions are defined for switching devices of main and earthing circuits:

a) For removable parts of assemblies:

the withdrawal or engagement of any switching device shall be prevented unless it is in the open position;

the operation of any switching device shall be prevented unless it is only in the service, disconnected, removed or test position;

the interlock shall prevent the closing of the any switching device in the service position unless all auxiliary circuits associated with the automatic opening of these devices are connected. Conversely, it shall prevent the disconnection of any auxiliary circuits with the circuit-breaker closed in the service position.

b) For other parts of assemblies:

- interlocks shall be provided to prevent operation of disconnectors under conditions other than those for which they are intended (refer to IEC 62271-102:2018). The operation of a disconnector shall be prevented unless the circuit is open. The following are exempt:

- switch-disconnector;

- double busbar system designed to have a busbar transfer without current interruption.

- the operation of the circuit-breaker, switch or contactor shall be prevented by interlocks as long as the associated switching devices, i.e. disconnector and/or earthing switch, have not reached their dedicated closed or open position;

- if earthing of a circuit is provided by the main switching device (circuit-breaker, switch or contactor) in series with an earthing switch (or any earthing device), the earthing switch shall be interlocked with the main switching device. Provision shall be made for the main switching device to be secured against unintentional opening, e.g. by disconnection of tripping circuits and/or blocking of the mechanical trip;

- earthing switches having a rated short-circuit making capacity less than the rated peak withstand current of the main circuit should be interlocked with the associated switching devices.

Regarding removable fuse-links, their withdrawal or engagement shall be prevented unless the fuse-base contacts are earthed or isolated from all sources of supply; see also 6.101.

The manufacturer shall give all necessary information on the character and function of interlocks.

NOTE For interlocks with covers and doors, refer to 6.102.2

If electrical interlocks are provided, the design shall be such that no improper situations can occur in case of lack of auxiliary supply. However, for emergency control, the manufacturer may provide additional means for manual operation without interlocking facilities. In such case, the manufacturer shall clearly identify this facility and define the procedures for operation.

6.13 Position indication

Subclause 6.13 of IEC 62271-1:2017 is applicable. In addition, for all devices involved in disconnecting and earthing functions, subclause 6.104.3 of IEC 62271-102:2018 is applicable.

1088 **6.14 Degrees of protection provided by enclosures**

1089 **6.14.1 General**

1090 Subclause 6.14.1 of IEC 62271-1:2017 is applicable

1091 **6.14.2 Protection of persons against access to hazardous parts and protection of the**
1092 **equipment against ingress of solid foreign objects (IP coding)**

1093 Subclause 6.14.2 of IEC 62271-1:2017 is not applicable. The minimum degree of protection
1094 shall be IP2X, according to IEC 60529:1989, IEC 60529:1989/AMD1:1999 and
1095 IEC 60529:1989/AMD2:2013.

1096 Additional requirements are specified in 6.102 and 6.103.

1097 **6.14.3 Protection against ingress of water (IP coding)**

1098 Subclause 6.14.3 of IEC 62271-1:2017 is applicable.

1099 **6.14.4 Protection of equipment against mechanical impact under normal service**
1100 **conditions (IK coding)**

1101 Subclause 6.14.4 of IEC 62271-1:2017 is applicable with the following addition.

1102 The minimum impact level shall be IK06 according to IEC 62262 (1 J).

1103 **6.15 Creepage distances for outdoor insulators**

1104 Subclause 6.15 of IEC 62271-1:2017 is not applicable.

1105 **6.16 Gas and vacuum tightness**

1106 Subclause 6.16 of IEC 62271-1:2017 is applicable with the following addition:

1107 Additional requirements are specified in 6.103.2.3.

1108 **6.17 Tightness for liquid systems**

1109 Subclause 6.17 of IEC 62271-1:2017 is applicable with the following addition:

1110 Additional requirements are specified in 6.103.2.3.

1111 **6.18 Fire hazard (flammability)**

1112 Subclause 6.18 of IEC 62271-1:2017 is applicable.

1113 **6.19 Electromagnetic compatibility (EMC)**

1114 Subclause 6.19 of IEC 62271-1:2017 is applicable.

1115 **6.20 X-ray emission**

1116 Subclause 6.20 of IEC 62271-1:2017 is applicable.

1117 **6.21 Corrosion**

1118 Subclause 6.21 of IEC 62271-1:2017 is applicable.

6.22 Filling levels for insulation, switching and/or operation

Subclause 6.22 of IEC 62271-1:2017 is applicable.

6.101 General requirements for assemblies

Assemblies shall be designed so that the following operations can be carried out safely. Examples of operations a manufacturer can define as normal use are:

- determination of the presence or absence of voltage related to “in service conditions” on the main circuit including the checking of phase sequence, refer to IEC 62271-213:2021 and IEC 62271-215:2021;
- earthing of connected cables, locating of cable faults, voltage tests on connected cables
- the elimination of dangerous trapped electrostatic charges;

It is necessary to take into account condensation and humidity conditions because it has to be safe for persons touching the assembly, not only in a dry state, but also with condensation on solid insulating surfaces.

In the case where a high-voltage compartment may be opened, i.e. accessible compartment, safe operation of the assembly requires (irrespective of whether of fixed or withdrawable pattern) that the high-voltage parts are isolated from all sources of supply and earthed. Exempted from this demand are:

- high-voltage parts that are moved to the disconnected position with corresponding shutters closed;
- high-voltage parts, if embedded by solid insulation material and complying with at least protection category PA.

Disconnecting devices used for isolation shall be secured against re-connection.

If a withdrawable or removable part does not include an earthing device that is intended to earth the main circuit of that removable part before becoming accessible, it shall be possible, by manual earthing means, to safely discharge trapped charges from that removable part. The manufacturer shall define the recommended procedure in the manufacturer's instructions reference.

All removable parts and components of the same type, rating, and construction shall be mechanically and electrically interchangeable.

Removable parts and components of equal or greater current and insulation ratings may be installed in place of removable parts and components of equal or lesser current and insulation ratings where the design of these removable parts and components and compartment allows mechanical interchangeability. This does not generally apply for current-limiting devices.

NOTE Installing a removable part or component of a higher rating does not necessarily increase the capabilities of a functional unit or imply that the functional unit is capable of operation at the increased ratings of the removable part or component.

Components contained in an assembly shall be in accordance with their various relevant standards. This document supplements or even replaces the standards for the individual components regarding their installation in assemblies.

For main circuits with current-limiting fuses, the manufacturer of the switchgear and controlgear may assign the maximum peak and Joule integral of the let-through current of the fuses to the main circuit downstream of the fuse.