IEC 62271-200

Edition 3.0 2021-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

Appareillage à haute tension – Partie 200: Appareillage sous enveloppe métallique pour courant alternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 52 kV

IEC 62271-200:2021-05(en-fr)

Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2021 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC online collection - oc.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC online collection - oc.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

IEC 62271-200

Edition 3.0 2021-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

Appareillage à haute tension – Partie 200: Appareillage sous enveloppe métallique pour courant alternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 52 kV

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.130.10

ISBN 978-2-8322-1007-3

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

AVA Documents
Document Sharing Hub

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

Full document details: IEC 62271-200-2021

CONTENTS

FOREWORD 6
INTRODUCTION 9
1 Scope 10
2 Normative references 10
3 Terms and definitions 11
3.1 General terms and definitions 11
3.2 Assemblies of switchgear and controlgear 13
3.3 Parts of assemblies 13
3.4 Switching devices 13
3.5 Parts of switchgear and controlgear 13
3.6 Operational characteristics of switchgear and controlgear 16
3.7 Characteristic quantities 18
3.8 Index of definitions 19
4 Normal and special service conditions 20
5 Ratings 21
5.1 General 21
5.2 Rated voltage (U_r) 21
5.3 Rated insulation level (U_d, U_p, U_s) 21
5.4 Rated frequency (f_r) 21
5.5 Rated continuous current (I_r) 21
5.6 Rated short-time withstand currents (I_k, I_{ke}) 21
5.7 Rated peak withstand currents (I_p, I_{pe}) 22
5.8 Rated durations of short-circuit (t_k, t_{ke}) 22
5.9 Rated supply voltage of auxiliary and control circuits (U_a) 23
5.10 Rated supply frequency of auxiliary and control circuits 23
5.11 Rated pressure of compressed gas supply for controlled pressure systems 23
5.101 Classification of earthing function through main switching device 23
5.102 Rated cable test voltages ($U_{ct\ (AC)}$, $U_{ct\ (DC)}$) 23
5.103 Ratings of the internal arc classification (IAC) 23
6 Design and construction 25
6.1 Requirements for liquids in switchgear and controlgear 25
6.2 Requirements for gases in switchgear and controlgear 25
6.3 Earthing of switchgear and controlgear 25
6.4 Auxiliary and control equipment and circuits 26
6.5 Dependent power operation 26
6.6 Stored energy operation 26
6.7 Independent unlatched operation (independent manual or power operation) 26
6.8 Manually operated actuators 26
6.9 Operation of releases 26
6.10 Pressure/level indication 27
6.11 Nameplates 27
6.12 Locking devices 28
6.13 Position indication 29

AVA Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

6.14 Degrees of protection provided by enclosures 29
6.15 Creepage distances for outdoor insulators 30
6.16 Gas and vacuum tightness 30
6.17 Tightness for liquid systems 30
6.18 Fire hazard (flammability) 30
6.19 Electromagnetic compatibility (EMC) 30
6.20 X-ray emission 30
6.21 Corrosion 30
6.22 Filling levels for insulation, switching and/or operation 30
6.101 General requirements for assemblies 31
6.102 Metal enclosure 31
6.103 High-voltage compartments 33
6.104 Removable parts 37
6.105 Provisions for dielectric tests on cables 37
6.106 Internal arc fault 38
7 Type tests 38
7.1 General 38
7.2 Dielectric tests 39
7.3 Radio interference voltage (RIV) test 43
7.4 Resistance measurement 43
7.5 Continuous current tests 43
7.6 Short-time withstand current and peak withstand current tests 45
7.7 Verification of the protection 47
7.8 Tightness tests 47
7.9 Electromagnetic compatibility tests (EMC) 48
7.10 Additional tests on auxiliary and control circuits 48
7.11 X-radiation test for vacuum interrupters 48
7.101 Verification of making and breaking capacities 48
7.102 Mechanical operation tests 50
7.103 Pressure withstand test for gas-filled compartments 51
7.104 Tests to verify the protection of persons against dangerous electrical effects 52
7.105 Internal arc test 53
8 Routine tests 57
8.1 General 57
8.2 Dielectric test on the main circuit 57
8.3 Tests on auxiliary and control circuits 57
8.4 Measurement of the resistance of the main circuit 58
8.5 Tightness test 58
8.6 Design and visual checks 58
8.101 Partial discharge measurement 58
8.102 Mechanical operation tests 58
8.103 Pressure tests of gas-filled compartments 59
8.104 Tests after erection on site 59
8.105 Measurement of fluid condition after filling on site 59
9 Guide to the selection of switchgear and controlgear (informative) 59
9.1 General 59
9.2 Selection of rated values 60
9.3 Cable-interface considerations 60

AVA Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

9.4 Continuous or temporary overload due to changed service conditions 60
9.5 Environmental aspects 60
9.101 Selection of design and construction 60
9.102 Ratings related to earthing circuits 64
9.103 Internal arc fault 65
9.104 Summary of technical requirements, ratings and optional tests 71
10 Information to be given with enquiries, tenders and orders (informative) 73
10.1 General 73
10.2 Information with enquiries and orders 73
10.3 Information with tenders 74
11 Transport, storage, installation, operating instructions and maintenance 75
11.1 General 75
11.2 Conditions during transport, storage and installation 75
11.3 Installation 75
11.4 Operating instructions 75
11.5 Maintenance 76
12 Safety 76
12.101 Procedures 76
12.102 Internal arc aspects 76
13 Influence of the product on the environment 77
Annex A (normative) Internal arc fault – Method to verify the internal arc classification (IAC) 78
A.1 Room simulation 78
A.2 Indicators (for assessing the thermal effects of the gases) 80
A.3 Tolerances for geometrical dimensions of test arrangements 82
A.4 Test parameters 82
A.5 Test procedure 83
Annex B (normative) Partial discharge measurement 95
B.1 General 95
B.2 Application 95
B.3 Test circuits and measuring instruments 95
B.4 Test procedure 96
B.5 Maximum permissible partial discharge quantity 97
Annex C (informative) List of notes concerning certain countries 101
Annex D (normative) Flowchart categorization procedure for LSC for a given functional unit FU1 with connection compartment 102
Bibliography 103

Figure 1 – LSC1 63
Figure 2 – LSC2 63
Figure 3 – LSC2 63
Figure 4 – LSC2 64
Figure 5 – LSC2A 64
Figure 6 – LSC2B 64
Figure 7 – LSC2B 64
Figure 8 – LSC1 64

AVA Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

Figure 9 – No LSC assigned 64
Figure A.1 – Mounting frame for vertical indicators 86
Figure A.2 – Horizontal indicator 86
Figure A.3 – Position of the indicators 87
Figure A.4 – Room simulation and indicator positioning for accessibility type A, classified rear side, ceiling above 2 000 mm, functional unit of any height 88
Figure A.5 – Room simulation and indicator positioning for accessibility type A, non-accessible rear side, ceiling at 2 000 mm, so functional unit ≤ 1 800 mm high 89
Figure A.6 – Room simulation and indicator positioning for accessibility type B, classified rear side, functional unit ≥ 1 900 mm high 90
Figure A.7 – Room simulation and indicator positioning for accessibility type B, classified rear side, functional unit < 1 900 mm high 91
Figure A.8 – Ceiling height stated from the floor or false floor level where the assembly is actually placed 92
Figure A.9 – Indicator positioning in case of protrusion at < 2 000 mm height, at classified side 93
Figure A.10 – Indicator positioning in case a bottom exhaust duct belonging to the assembly is defined as a walkable integrated part of the false floor 94
Figure B.1 – Partial discharge test circuit (three-phase arrangement) 99
Figure B.2 – Partial-discharge test circuit (system without earthed neutral) 100
Figure D.1 – Flowchart categorization procedure for LSC for a given functional unit FU1 with connection compartment 102

Table 1 – Nameplate information 27
Table 2 – Locations, causes and examples of measures to decrease the probability of internal arc faults 67
Table 3 – Single-phase-to-earth arc fault current depending on the network neutral earthing 69
Table 4 – Summary of technical requirements, ratings and optional tests for assemblies 71
Table A.1 – Parameters for internal arc test according to compartment construction 85
Table B.1 – Test circuits and procedures 98

Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 200: AC metal-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.

IEC 62271-200 has been prepared by subcommittee 17C: Assemblies, of IEC technical committee 17: High-voltage switchgear and controlgear. It is an International Standard.

This third edition cancels and replaces the second 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) clause numbering aligned with IEC 62271-1:2017, including the adoption of the subclause names of Clause 3;
b) in Clause 3 specific definitions are added for "in service", "normal operating condition" and "normal use";
c) internal arc testing on pole-mounted switchgear is taken out of this document, as it is now covered by the specific standard IEC 62271-214:2019;

AVA Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

d) a more precise description of earthing circuit is given with the inclusion of ratings and test requirements;

e) number of mechanical tests on interlocks is reduced for type testing; a more precise description of forces to apply during type testing is given (refer to 7.102);

f) resistance measuring on main circuit is only needed before continuous current tests (as reference for routine tests) and no longer needed after this continuous current test. Rationale for this deletion is that this measured resistance does not mean anything; as the temperature rise test was just finished, a new temperature rise test will not give new information;

g) IEC 62271-100:2021, IEC 62271-103:2021, IEC 62271-105:2021 and IEC 62271-106:2021 are referred to in the document;

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

i) a more precise description of LSC category is given with the inclusion of an explanatory flowchart (Annex D);

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 "metal-enclosed switchgear and controlgear" in this document;

l) "metallic" is replaced by "metal" where applicable;

m) 6.105 is now covered by 7.7;

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

o) a more precise description of internal arc tests for switchgear with protrusions is given in Annex A.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
17C/782/FDIS	17C/792/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 should be read in conjunction with IEC 62271-1:2017, 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 62271-1:2017. 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.

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

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 document 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.

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

INTRODUCTION

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

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

Switchgear and controlgear assemblies having a solid-insulation enclosure are covered by IEC 62271-201.

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

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 200: AC metal-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 metal-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 and outdoor installation.

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

For components installed in a metal-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 can be inside the metal-enclosed switchgear and controlgear is not limited to the ones explicitly cited in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-151, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices* (available at http://www.electropedia.org)

IEC 60050-441, *International Electrotechnical Vocabulary (IEV) – Part 441: Switchgear, controlgear and fuses* (available at http://www.electropedia.org)

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

IEC 60270:2000, *High-voltage test techniques – Partial discharge measurements*
IEC 60270:2000/AMD1:2015

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

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*

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

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: 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*

IEC 62271-107:2019, *High-voltage switchgear and controlgear – Part 107: Alternating current fused circuit-switchers for rated voltages above 1 kV up to and including 52 kV*

IEC 62271-201:2014, *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*

IEC 62271-203:2011, *High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*

IEC 62271-213:2021, *High-voltage switchgear and controlgear – Part 213: Voltage detecting and indicating system*

IEC 62271-215:2021, *High-voltage switchgear and controlgear – Part 215: Phase comparator used with VDIS*

IEC IEEE 62271-37-013:2015, *High-voltage switchgear and controlgear – Part 37-013: Alternating-current generator circuit-breakers*

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 and/or modifications:

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

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 is applicable to discharges in solid, liquid and gaseous dielectrics and to combinations of these.

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

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

3.1.103
relative pressure
pressure that refers to the local atmospheric pressure

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 IEC 62271-1.

3.1.104
segregation
<of conductors> arrangement of conductors with earthed metal interposed between them in such a manner that disruptive discharges can only occur to earth

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

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

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

3.1.105
in service
<condition of an assembly> condition where at least one high voltage part in the assembly is energized

3.1.106
normal operating condition
<of an assembly> in service condition with all doors and covers properly closed and secured

3.1.107
normal use
<of an assembly> use of the assembly as defined by the manufacturer's instructions reference, corresponding to the conditions and operations in service

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

Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

3.2 Assemblies of switchgear and controlgear

The definitions in 3.2 of IEC 62271-1:2017 are applicable, with the following additions and/or modifications:

3.2.101
metal-enclosed switchgear and controlgear assembly
switchgear and controlgear assemblies with a metal enclosure intended to be earthed, and complete except for external connections

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

Note 2 to entry: The term "external connections" corresponds to "external conductors (cables or bars) connecting the assembly to the network or an external installation".

[SOURCE: IEC 60050-441:1984, 441-12-04, modified – The second preferred term "assembly" and Note 2 to entry have been added and in the definition "external" has been deleted.]

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

3.3 Parts of assemblies

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

3.4 Switching devices

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

3.5 Parts of switchgear and controlgear

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

3.5.101
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]

3.5.102
metal enclosure
<of an assembly> outermost enclosure made of metal, which can be composed of several elements, enclosing all high-voltage parts

3.5.103
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, e.g., 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

Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

[SOURCE: IEC 60050-441:1984, 441-13-04, modified – "of switchgear and controlgear" and "all the components of" have been deleted; "earthing circuit" has been added.]

3.5.104
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)

3.5.105
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

[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".]

3.5.106
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".]

3.5.107
earthing circuit
<of an assembly> conductors, connections, and the conducting parts of earthing devices or of the metal frame, intended to connect the high-voltage conductive parts of an 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.

3.5.108
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

3.5.109
high-voltage compartment
<of an assembly> compartment of an assembly containing high-voltage conducting parts, enclosed except for openings necessary for interconnection, control or ventilation

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

3.5.110
interlock-controlled accessible compartment
high-voltage compartment designed to be opened for normal use, in which access is controlled by the integral design of the assembly

Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

3.5.111
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

3.5.112
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

3.5.113
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.

3.5.114
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.

3.5.115
pressure relief device
device intended to relieve overpressure from a compartment

3.5.116
partition
<of an assembly> part of an assembly separating one high-voltage compartment from other compartments and providing a specified degree of protection

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

[SOURCE: IEC 60050-441:1984, 441-13-06, modified – "high-voltage" and "and providing a specified degree of protection" have been added.]

3.5.117
bushing
insulator forming a passage for a conductor through a non-insulating partition

[SOURCE: IEC 60050-151:2001, 151-15-40]

3.5.118
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 disconnector, to engage fixed contacts, to a position where it becomes a part of the enclosure or partition shielding the fixed contacts

[SOURCE: IEC 60050-441:1984, 441-13-07, modified – "moving contact of a disconnector" has been added.]

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

3.5.119
removable part
<of an assembly> part of an assembly that may be removed entirely from the assembly and replaced

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

3.5.120
withdrawable part
<of an assembly> removable part of an assembly that can be moved to one or more positions in which an isolating distance or a segregation between open contacts is established, while the part remains mechanically attached to the assembly, even though the main circuit to which it was connected is live

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

3.5.121
fuse-link
the part of a fuse (including the fuse-element(s)) intended to be replaced after the fuse has operated

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

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

3.6 Operational characteristics of switchgear and controlgear

The definitions in 3.6 of IEC 62271-1:2017 are applicable, with the following additions and/or modifications:

3.6.101
loss of service continuity category
LSC
<of a functional unit> category defining the possibility to keep other high-voltage compartments and/or functional units energized when opening an accessible high-voltage compartment, as stated in definitions 3.5.110 to 3.5.112, giving access to at least part of the high-voltage circuit contained within

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

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

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

3.6.102
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

3.6.103
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)

AVA Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

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

3.6.104
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

3.6.105
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

3.6.106
partition class
<of an assembly> class defining whether only metal or also non-metal material is used for partitions

3.6.107
class PM
<of an assembly> partition class for an assembly providing continuous metal partitions and/or shutters (if applicable), intended to be earthed, between opened accessible compartments and high-voltage live parts

3.6.108
class PI
<of an assembly> partition class for an assembly having one or more non-metal partitions or shutters between opened accessible compartments and high-voltage live parts

3.6.109
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]

3.6.110
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]

3.6.111
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".]

AVA Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

3.6.112
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]

3.6.113
degree of protection
extent of protection provided by an enclosure, partition or shutter if applicable, against access to hazardous parts, against ingress of solid foreign objects and/or ingress of water and verified by standardized test methods

Note 1 to entry: Refer to 3.3 of IEC 60529:1989.

3.6.114
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

3.6.115
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.

3.6.116
design temperature
<of fluid-filled compartments> highest average temperature over the compartment, which can be reached by the gas or liquid under service conditions

3.6.117
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 3.6.118, 3.6.119, 3.7.101 and 3.7.102.

3.6.118
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

3.6.119
classified sides
<of IAC> accessible sides of the assembly having a defined level of protection of persons in the event of internal arc

3.7 Characteristic quantities

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

Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

3.7.101
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

3.7.102
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

3.8 Index of definitions

A – B

Ambient air temperature (of an assembly) 3.1.101
Arc fault current (of IAC) 3.7.101
Arc fault duration (of IAC) 3.7.102
Assembly 3.2.101
Auxiliary circuit (of an assembly) 3.5.106
Bushing 3.5.117

C

Category LSC1 (of a functional unit) 3.6.105
Category LSC2 (of a functional unit) 3.6.102
Category LSC2A (of a functional unit) 3.6.103
Category LSC2B (of a functional unit) 3.6.104
Class PI (of an assembly) 3.6.108
Class PM (of an assembly) 3.6.107
Classified sides (of IAC) 3.6.119
Component (of an assembly) 3.5.104
Connected position (of a removable part) 3.6.109

D

Degree of protection 3.6.113
Design pressure (of fluid-filled compartments) 3.6.115
Design temperature (of fluid-filled compartments) 3.6.116
Disconnected position (of a withdrawable part) 3.6.111
Disruptive discharge 3.1.102

E – F

Earthing circuit (of an assembly) 3.5.107
Earthing point (of an assembly) 3.5.108
Enclosure (of an assembly) 3.5.101
Fluid-filled compartment 3.5.114
Functional unit (of an assembly) 3.5.103
Fuse-link 3.5.121

H – I

High-voltage compartment (of an assembly) 3.5.109
IAC (of an assembly) 3.6.117
In service (condition of an assembly) 3.1.105
Interlock-controlled accessible compartment 3.5.110
Internal arc classification (of an assembly) 3.6.117

AVA Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

Isolated position (of a withdrawable part) 3.6.111

L – M – N

Loss of service continuity category (of a functional unit) 3.6.101
LSC (of a functional unit) 3.6.101
Main circuit (of an assembly) 3.5.105
Metal-enclosed switchgear and controlgear 3.2.101
Metal enclosure (of an assembly) 3.5.102
Minimum functional level (of fluid-filled compartments) 3.6.114
Multi-tier design 3.2.102
Non-accessible compartment 3.5.113
Normal operating condition (of an assembly) 3.1.106
Normal use (of an assembly) 3.1.107

P

Partition class (of an assembly) 3.6.106
Partition (of an assembly) 3.5.116
Pressure relief device 3.5.115
Procedure-based accessible compartment 3.5.111

R

Relative pressure 3.1.103
Removable part (of an assembly) 3.5.119
Removed position (of a removable part) 3.6.112

S

Segregation (of conductors) 3.1.104
Service position (of a removable part) 3.6.109
Shutter (of an assembly) 3.5.118

T – W

Test position (of a withdrawable part) 3.6.110
Tool-based accessible compartment 3.5.112
Type of accessibility (of IAC) 3.6.118
Withdrawable part (of an assembly) 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 service conditions.

Assemblies, under the scope of IEC TS 62271-304:2019 [2] 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 as "class 1" or "class 2" according to IEC TS 62271-304:2019 to indicate its ability to withstand such severe conditions.

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

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

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 an assembly (e.g. busbars, feeder circuits) may have different values of rated continuous current.

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

Subclause 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.

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

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 currents (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 is 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 is 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

AVA Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

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 and control circuits

Subclause 5.10 of IEC 62271-1:2017 is applicable.

5.11 Rated pressure of compressed gas supply for controlled pressure systems

Subclause 5.11 of IEC 62271-1:2017 is 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 [3].

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);

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

– Type of accessibility: A, B;
– 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

Two types of accessibility to the enclosure of an assembly at the site of installation are defined:

– Accessibility Type A: restricted to authorized personnel only;
– Accessibility Type B: unrestricted accessibility, including that of the general public.

NOTE 1 For pole-mounted switchgear and controlgear, refer to IEC 62271-214 [4].

NOTE 2 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 C37.20.7 defines 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 at least accessibility type A, by the manufacturer. 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 R10 series specified in IEC 60059 [6].

Two ratings of the arc fault currents are recognized:

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 the 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 rated duration (t_{Ae}) of the single-phase-to-earth arc fault shall be assigned by the manufacturer.

AVA Documents Document Sharing Hub

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 the handling of SF_6 and its 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)

Metal enclosure(s) shall be electrically connected (directly or indirectly) to the earthing point provided. Small parts fixed to metal enclosure(s), up to a maximum of 12,5 mm in diameter, for example screw heads, need not be electrically connected to the earthing point provided. All the metallic 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 or welding), providing electrical continuity between the frame, covers, doors, metal partitions or other structural parts to the earthing point. Doors of the high-voltage compartments shall be electrically connected to the frame by adequate means.

NOTE 1 Enclosure and doors are considered in 6.102.

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

6.3.103 Earthing of withdrawable and removable parts

The normally earthed metallic parts of a withdrawable part shall remain connected to earth in the test and disconnected positions and in any intermediate position. Connections to earth in any position shall provide a current-carrying capability not less than that required for enclosures (refer to 6.102.1).

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

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

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

6.3.104 Earthing circuit

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

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

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

Parts of metal enclosures may form part of the earthing circuit.

If a dedicated earthing conductor is applied as earthing circuit of the assembly, its cross-section shall be not less than 30 mm^2.

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

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

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

6.4 Auxiliary and control equipment and circuits

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

6.5 Dependent power operation

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

6.6 Stored energy operation

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

6.7 Independent unlatched operation (independent manual or power operation)

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

6.8 Manually operated actuators

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.

AVA Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

6.10 Pressure/level indication

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

6.11 Nameplates

Subclause 6.11 of IEC 62271-1:2017 is 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	
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}, ρ_{re}, m_{re}	kPa, kg/m^3 or kg	(X)	
Alarm level for insulation and/or switching (*)	p_{ae}, ρ_{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}, ρ_{me}, m_{me}	kPa, kg/m^3 or kg	(X)	
Filling level for operation (*)	p_{rm}, ρ_{rm}, m_{rm}	kPa, kg/m^3 or kg	(X)	

AVA Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

	Abbreviation	Unit	Marking (**)	Condition: Marking only required if
(1)[a,b]	(2)[a]	(3)	(4)	(5)
Alarm level for operation (*)	p_{am}, ρ_{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}, ρ_{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 or B		(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)	
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.

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

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

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

NOTE Fuses are removable devices that do not require such specific information because they respond to standardized 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

AVA Documents Document Sharing Hub

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 any switching device in the service position unless any auxiliary circuits associated with the automatic opening of these devices are connected. Conversely, it shall prevent the disconnection of the 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, for example 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 a 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, 6.104.3 of IEC 62271-102:2018 is applicable.

6.14 Degrees of protection provided by enclosures

6.14.1 General

Subclauses 6.14.1, of IEC 62271-1:2017 is applicable.

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

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

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

Additional requirements are specified in 6.102 and 6.103.

6.14.3 Protection against ingress of water (IP coding)

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

6.14.4 Protection of equipment against mechanical impact under normal operating conditions (IK coding)

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

For indoor installation, the minimum impact level shall be IK07 according to IEC 62262 (2 J).

6.15 Creepage distances for outdoor insulators

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

6.16 Gas and vacuum tightness

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

Additional requirements are specified in 6.103.2.3.

6.17 Tightness for liquid systems

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

Additional requirements are specified in 6.103.2.3.

6.18 Fire hazard (flammability)

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

6.19 Electromagnetic compatibility (EMC)

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

6.20 X-ray emission

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

6.21 Corrosion

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.

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

6.101 General requirements for assemblies

Assemblies shall be designed so that the operations in normal use 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.

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 requirement 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 of IEC 62271-201:2014.

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 interchange ability. 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 assembly may assign the maximum peak and Joule integral of the let-through current of the fuses to the main circuit downstream of the fuse.

6.102 Metal enclosure

6.102.1 General

The walls of a room shall not be considered as parts of the enclosure. The floor surface below the installed assembly may be considered as part of the enclosure. The measures to be taken in order to obtain the degree of protection provided by floor surfaces shall be given in the installation manual.

The enclosure shall be metal. The following exceptions apply:

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

– parts of the enclosure may be of non-metal material, provided that all high-voltage parts are completely enclosed by metal partitions or shutters that are connected to the earthing circuit;
– inspection windows complying with 6.102.4;
– the floor surface below the installed assembly provided that it is solid and does not allow access underneath the assembly.

When the assembly is installed, the enclosure shall provide at least the degree of protection IP2X, according to IEC 60529:1989, IEC 60529:1989/AMD1:1999 and IEC 60529:1989/AMD2:2013. The specified degree of protection shall be provided by the enclosure with all the doors and covers closed as under normal operating conditions, irrespective of how these doors and covers are held in position.

Enclosures shall also ensure protection in accordance with the following conditions:

– Metal parts of the enclosures shall be designed to carry 30 A (DC) with a voltage drop of maximum 3 V to the earthing point provided.
– Parts of the enclosure enclosing tool-based-accessible high-voltage compartments shall be provided with a clear labelling of the electrical risk if removed or opened.
– The horizontal surfaces of enclosures, for example roof plates, are normally not designed to support personnel or additional equipment not supplied as part of the assembly. If the manufacturer states that it is necessary to stand or walk upon the assembly during operation or maintenance, the design shall be such that the relevant areas will support the weight of the operator. In such a case, the IP degree shall not be affected as well as no permanent deformation is allowed and the areas on the equipment where it is not safe to stand or walk, for example pressure relief flaps, shall be clearly identified.

6.102.2 Covers and doors

Covers and doors that are part of the enclosure shall be made of metal. However, covers and doors may be made of insulating material, provided that high-voltage parts are enclosed by metal partitions or shutters connected to the earthing point provided.

When covers and doors that are part of the enclosure are closed, they shall provide the degree of protection specified for the enclosure.

Covers and doors shall not be made of woven wire mesh, expanded metal or similar. When ventilating openings, vent outlets or inspection windows are incorporated in the cover or door, reference is made to 6.102.4 or to 6.102.5.

Covers and doors that exclusively give access to compartments which are not high-voltage compartments (e.g. low-voltage control compartment, or possible mechanism compartment), are not subject to this subclause.

Several categories of covers and doors are recognized with regard to the type of high-voltage accessible compartments they provide access to:

a) Covers and doors that give access to tool-based accessible compartments

   These covers and doors (fixed covers) need not be opened for normal use as stated by the manufacturer. It shall not be possible for them to be opened, dismantled or removed without the use of tools. Special procedures are required to safeguard that opening can only be realized if precautions to ensure electrical safety have been taken.

b) Covers and doors that give access to interlock-controlled accessible or procedure-based accessible compartments

   These covers and doors shall be provided if there is a need to access the compartment for normal use as stated by the manufacturer. These covers and doors shall not require tools for their opening or removal and shall have the following features:

   – interlock controlled accessible compartments shall be provided with interlocking devices so that opening of the compartment shall only be possible when the high-voltage parts

AVA Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

contained in the compartment being made accessible are isolated and earthed, or are in the disconnected position with corresponding shutters closed;

– procedure-based accessible compartments shall be provided with provision for locking, for example padlocking. Suitable procedures should be put in place by the user to ensure that a procedure-based accessible compartment is opened only when the high-voltage parts contained in the compartment being made accessible are isolated and earthed, or in the disconnected position with corresponding shutters closed. Procedures may be dictated by legislation of the country of installation or by user safety documentation.

If interlock-controlled or procedure-based accessible compartments have other covers that can be opened by tools, proper procedures or specific warning labels should be applied.

6.102.3 Partition or shutter being part of the enclosure

If partitions or shutters become part of the enclosure with the removable part in any of the positions defined in 3.6.110 to 3.6.112, they shall be metal, earthed and provide as minimum degree of protection IP2X.

In this respect it should be noted that:

– a partition or shutter becomes a part of the enclosure if it is accessible in any of the positions defined in 3.6.110 to 3.6.112 and if no door is provided which can be closed in the positions defined in 3.6.109 to 3.6.112;

– if a door is provided which can be closed in the positions defined in 3.6.109 to 3.6.112, the partition or shutter behind the door is not considered to be a part of the enclosure.

6.102.4 Inspection windows

Inspection windows shall provide at least the degree of protection specified for the enclosure.

They shall be covered by a transparent sheet of mechanical strength comparable to that of the enclosure. Precautions shall be taken to prevent the formation of dangerous electrostatic charges, either by clearance or by electrostatic shielding (e.g. a suitable earthed wire-mesh on the inside of the window).

The insulation between high-voltage live parts and the accessible surface of the inspection windows shall comply with the rated insulation levels U_d and U_p according to 5.3.

6.102.5 Ventilating openings, vent outlets

Ventilating openings and vent outlets shall be so arranged or shielded that the same degree of protection as that specified for the enclosure is obtained. Such openings may make use of wire mesh or the like provided that it is of suitable mechanical strength.

6.103 High-voltage compartments

6.103.1 General

High-voltage compartments may be of various types, for example:

– air insulated;

– liquid-filled (see 6.103.2);

– gas-filled (see 6.103.2).

High-voltage compartments should also be classified as accessible or non-accessible.

NOTE 1 Only accessible high-voltage compartments are considered when defining the LSC category of a functional unit.

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

A high-voltage compartment shall be designated by the main component contained therein, for example circuit-breaker compartment, busbar compartment, or by the main functionality provided, for example connection compartment.

Electrical connections between the main circuit of the assembly and the external conductors (cables or bars) to the electrical network or high-voltage apparatus of the installation shall be made within a high-voltage accessible compartment. This compartment shall be designated as a "connection compartment".

Where other main components (e.g. circuit-breakers, busbars) are contained in the connection compartment, then the designation should primarily remain as the connection compartment.

The connection compartment may be further identified according to the several components enclosed, for example connection/CT, or connection/circuit-breaker compartment. However, for the purposes of LSC categorization, the designation is "connection compartment".

The LSC category can only be assigned to functional units that include a connection compartment. This implies that a bus-sectionalizer or bus-coupler functional unit, for example, will have no LSC category, refer to Figure 9.

Busbar compartments may extend through several functional units without the need for bushings or other equivalent means. However, in the case of LSC2, LSC2A, LSC2B assemblies with accessible busbar compartments (refer to 9.101.3), separate compartments shall be provided for each set of busbars, for example in double busbar systems and for sections of switchable or disconnectable busbars.

NOTE 2 The busbar system is not considered as a functional unit.

Parts of the busbar systems, in between two high-voltage compartments of functional units, shall be considered as part of their adjacent compartments if IP2X is ensured for these "in between" parts by the enclosures of both adjacent high-voltage compartments. In case IP2X is not met, a separate compartment shall be defined for these "in-between" parts.

Parts of the busbar at the end of the busbar system shall be considered as part of the adjacent compartment if their length out of the enclosure of the high-voltage compartment is less than 12,5 mm. If this criterion is not met, a separate compartment shall be defined for these busbar extension elements.

6.103.2 Fluid-filled compartments (gas or liquid)

6.103.2.1 General

Compartments shall be capable of withstanding the normal and transient pressures to which they are subjected in service.

Gas-filled compartments, when permanently pressurized in service, are subjected to particular conditions of service which distinguish them from compressed air receivers and similar storage vessels. These conditions are such that gas-filled compartments are normally filled with a gas that is stable and non-corrosive in the conditions that prevail inside the compartment; since measures to maintain the gas in this condition with only small fluctuations in pressure are fundamental to the operation of the assembly and since the compartments will not be subjected to internal corrosion, there is no need to make allowances for these factors in determining the design of the compartments.

Gas-filled compartments with design pressures higher than 300 kPa (relative pressure) shall be designed according to the pressure requirements of IEC 62271-203.

NOTE See also Annex C.

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

6.103.2.2 Design

The design of a fluid-filled compartment shall be based on the nature of the fluid, the design temperature and when applicable, on the filling level as defined in this document.

For indoor installations, the design temperature of the fluid-filled compartment is generally the upper limit of ambient air temperature increased by the temperature rise of the fluid due to the flow of rated continuous current. For outdoor installations, other possible influences, for example solar radiation, shall be taken into account.

The design pressure of a compartment shall be at least equal to the maximum pressure difference between the fluid inside the compartment at design temperature that the fluid used for insulation can reach under specified maximum service conditions, and the surrounding media, like ambient air or insulation fluids in other compartments.

In addition to the design temperature, the design pressure calculation shall consider:

a) the full differential pressure possible across the compartment walls or partitions, including any evacuation process if used during filling or maintenance operations;
b) the resulting pressure in the event of an accidental leak between the compartments in the case of adjacent compartments having different service pressures.

6.103.2.3 Tightness

The manufacturer shall state the pressure system used and the permissible leakage rate for the fluid-filled compartments (refer to 6.16 and 6.17 of IEC 62271-1:2017). This shall take into account the relative limits fixed in Table 15 of IEC 62271-1:2017 for temporarily increased leakage rates at temperatures other than 20 ºC.

If requested by the user, in order to permit entry to a fluid-filled compartment of closed or controlled pressure systems, the permissible leakage across partitions should also be stated by the manufacturer.

For gas-filled compartments where the minimum functional pressure exceeds 100 kPa (relative pressure) an indication shall be provided when the pressure at 20 °C has fallen below the minimum functional level (refer to 3.6.114).

A partition, separating a compartment filled with insulating gas from a neighbouring compartment filled with liquid should not show any leakage affecting the dielectric properties of the two media.

6.103.2.4 Pressure relief of fluid-filled compartments

Where pressure-relief devices or designs are provided, they shall be orientated so as to minimize the danger to an operator during the time that he is performing his normal operating duties if gases or vapours are escaping under pressure. The pressure relief devices shall not operate below 1,3 times the design pressure. The pressure relief device may be a designed, deliberate weak area of the compartment or a dedicated device, for example a bursting disc.

6.103.3 Partitions and shutters

6.103.3.1 General

A compartment can contain barriers, structures or components that are designed to provide various functions, such as mechanical or dielectrical integrity, but not designed to function as a partition or enclosure.

Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

Partitions and shutters, when accessible in service, shall provide at least the degree of protection IP2X according to IEC 60529:1989, IEC 60529:1989/AMD1:1999 and IEC 60529:1989/AMD2:2013.

Conductors passing through partitions shall be provided with bushings or other equivalent means to provide the required IP level.

Openings in the enclosure of an assembly and in the partitions between compartments accessible during service, through which contacts of removable or withdrawable parts engage fixed contacts, shall be provided with automatic shutters to ensure the protection of persons in any of the positions defined in 3.6.110 to 3.6.112. Means shall be provided to ensure the reliable operation of the shutters, for example by a mechanical drive, where the movement of the shutters is positively driven by the movement of the removable or withdrawable part.

The status of shutters may not in all situations be readily confirmed from an open high-voltage compartment, (e.g. connection compartment is opened, but shutters are located in circuit-breaker compartment). In such situations, verification of the shutter status may require access to the second compartment or provision of an inspection window or reliable indicating device.

If one or more set(s) of fixed contacts can be made accessible through opened shutters (e.g. for maintenance or test purposes), then the shutters shall be provided with means of locking each set independently in the closed position.

If the automatic closing of shutters can be made inoperative in order to retain them in the open position (e.g. for maintenance or test purposes), then it shall not be possible either for the switching device to return to the service position or to close the switching device in the service position, until the automatic operation of the shutters is restored. This can be realized for example by preventing the switching device to return to its service position or by automatic restoration when returning the switching device to the service position.

It may be possible to use a temporary inserted partition to prevent the live set of fixed contacts being exposed (refer to 11.5). Insertion of such a temporary partition shall be possible before the compartment to be opened exposes the high-voltage parts that are intended to be kept energized.

For class PM, partitions and shutters between opened compartments and remaining high-voltage live parts of the assembly shall be metal; otherwise, the class is PI (refer to 3.6.106 to 3.6.108).

6.103.3.2 Metal partitions and shutters

Metal partitions and shutters or metallic parts of them shall be connected to the earthing point provided with a voltage drop of less than 3 V at 30 A (DC).

Discontinuity in the metal partitions and closed metal shutters which may become accessible shall be less than 12,5 mm.

NOTE The word "discontinuity" covers any insulating or non-earthed area, or path, through the partition.

6.103.3.3 Non-metal partitions and shutters

Non-metal partitions and shutters, made or partly made of insulating material, which may become accessible shall meet the following requirements:

a) the insulation between high-voltage live parts and the accessible surface of insulating partitions and shutters shall withstand the test voltages specified in 5.3 of IEC 62271-1:2017 for voltage tests to earth and between poles;

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

b) the insulating material shall withstand the power-frequency test voltage specified in item a). The appropriate test methods given in IEC 60243-1 [9] should be applied;

c) the insulation between high-voltage live parts and the inner surface of insulating partitions and shutters facing these shall withstand at least 150 % of the rated voltage of the equipment if a separate insulating medium, i.e. gas or liquid, is in-between;

NOTE Solid-insulation embedding high-voltage conducting parts is not considered as a partition.

d) if a leakage current can reach the accessible side of the insulating partitions and shutters by a continuous path over insulating surfaces or by a path broken only by small gaps of gas or liquid, it shall be not greater than 0,5 mA under the specified test conditions (refer to 7.104.3).

6.104 Removable parts

If the assembly incorporates removable parts which may be exchanged, for example fuse-links, then the manufacturer shall provide a reference list.

NOTE 1 For a reference list of fuse-links of switch-fuse combinations, IEC 62271-105 provides further information.

Removable parts for ensuring the isolating distance between the high-voltage conductors shall comply with IEC 62271-102:2018, except for mechanical operation tests (refer to 7.102 and 8.102). This disconnection facility is intended for maintenance purposes only.

If removable parts are intended to be used as a disconnector or intended to be removed and replaced more often than only for maintenance purposes, then testing shall also include the mechanical operation tests according to IEC 62271-102:2018.

Removable parts that are fixed, for example by bolts and/or screws, are not subject to mechanical operation tests according to 7.102.1, if not otherwise specified by the manufacturer.

The requirement that it shall be possible to know the operating position of the disconnector function or earthing switch function is met if one of the following conditions is fulfilled:

– the isolating distance is visible with the removable part removed;
– in case of a withdrawable part:
  - the position of the withdrawable part, in relation to the fixed part, is clearly visible and the positions corresponding to full connection and full isolation are clearly identified;
  - the position of the withdrawable part is indicated by a reliable indicating device.

NOTE 2 Refer to IEC 62271-102:2018 and also to Annex C.

Any removable part shall be so attached to the fixed part that its contacts will not open inadvertently due to forces which may occur in service, in particular those due to a short-circuit.

In IAC classified assemblies, the transfer of withdrawable parts to or from service position shall not reduce the specified level of protection in the event of an internal arc. This is achieved, for example when the operation is only possible when doors and covers intended to ensure personnel protection are closed. Other design measures providing equivalent level of protection are acceptable.

6.105 Provisions for dielectric tests on cables

Assemblies may be designed to allow the testing of cables while they are connected to the assembly. This may be performed either from a dedicated test connection, or from the cable terminations. In both cases the assembly shall have rated cable test voltage(s) as specified in 5.102 applied to those parts which remain connected to the cable, at the same time as the rated voltage is applied to those parts of the main circuit designed to remain live during testing cables.

Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

6.106 Internal arc fault

Assemblies that satisfy the requirements of this document are designed and manufactured, in principle, to prevent the occurrence of internal arc faults. However, where internal arc classification IAC is assigned, the assembly shall be designed to give a defined level of protection of persons in the event of an internal arc, when the assembly is in normal operating conditions.

Normal operating conditions imply that doors and covers are closed unless opening is necessary to perform switching operations.

If IAC is assigned, then this designation shall be included in the nameplate (refer to 6.11).

Some examples for designations of the IAC classification are given in 9.103.6.

7 Type tests

7.1 General

7.1.1 Basics

Subclause 7.1.1 of IEC 62271-1:2017 is applicable with the following addition:

Components contained in an assembly shall comply with their individual component standards, taking into account Clause 7.

Because of the variety of types, ratings and possible combinations of components, it is not practicable to make type tests with all the arrangements of an assembly. The validity of type tests performed on one test object with a defined set of ratings to other assemblies of the same family with a different set of ratings or different arrangements of components may be evaluated; in that case IEC TR 62271-307 [10] should be applied.

The type tests and verifications comprise:

Mandatory type tests to verify the:

a) rated insulation level of the equipment (see 7.2);
b) measurement of the resistance of circuits (see 7.4);
c) rated continuous current of any part of the equipment and measurement of the resistance of circuits (see 7.5);
d) capability of the main and earthing circuits to be subjected to the rated peak and the rated short-time withstand currents (see 7.6);
e) making and breaking capacity of the included switching devices (see 7.101);
f) mechanical operation of the included switching devices and removable parts (see 7.102);
g) IP protection code (see 7.7.1);
h) IK protection code (see 7.7.2).

Mandatory type tests, where applicable, to verify the:

i) auxiliary and control circuits (see 7.10);
j) protection of persons against dangerous electrical effects (see 7.104);
k) pressure withstand of gas-filled compartments (see 7.103);
l) tightness of gas- or liquid-filled compartments (see 7.8);
m) IAC classification (see 7.105);

Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

n) electromagnetic compatibility (EMC) (see 7.9);

o) X-radiation level for vacuum interrupters (see 7.11);

p) protection of the equipment against external effects due to weather (see 7.7.1);

q) rated cable test voltages (see 7.2.101).

Optional type tests (subject to agreement between manufacturer and user):

r) tests to evaluate the insulation of the equipment by the measurement of partial discharges (see 7.2.10).

Type tests may impair the suitability of the tested parts for subsequent use in service. Therefore, test objects used for type testing shall not be used in service without agreement between manufacturer and user.

7.1.2 Information for identification of test objects

Subclause 7.1.2 of IEC 62271-1:2017 is applicable.

7.1.3 Information to be included in type-test reports

Subclause 7.1.3 of IEC 62271-1:2017 is applicable with the following addition:

For the test report regarding continuous current tests, refer also to 7.5.101.

For the report regarding internal arc tests, refer to 7.105.6.

7.2 Dielectric tests

7.2.1 General

Subclause 7.2.1 of IEC 62271-1:2017 is applicable.

7.2.2 Ambient air conditions during tests

Subclause 7.2.2 of IEC 62271-1:2017 is applicable.

7.2.3 Wet test procedure

Subclause 7.2.3 of IEC 62271-1:2017 is not applicable.

7.2.4 Arrangement of the equipment

Subclause 7.2.4 of IEC 62271-1:2017 is applicable with the following addition:

Overvoltage protective devices shall be disconnected or removed for the test.

For assemblies using fluid (liquid or gas) for insulation, dielectric tests shall be performed on the test objects filled with the insulating fluid specified by the manufacturer, to the minimum functional level also specified by the manufacturer.

7.2.5 Criteria to pass the test

Subclause 7.2.5 of IEC 62271-1:2017 is applicable with the following modifications:

The second paragraph of item a) that refers to wet test is not applicable.

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

For fluid-filled compartments tested with test bushings that are not part of the assembly, impulses resulting in flashover along the surface of the test bushings are not considered as part of the test series.

7.2.6 Application of the test voltage and test conditions

Subclause 7.2.6 of IEC 62271-1:2017 is applicable with the exception of 7.2.6.2 and with the following additions:

Because of the great variety of designs, it is not feasible to give specific indications of the tests to be performed on the main circuit, but, in principle, they shall cover the following tests:

a) To earth and between phases

The test voltages specified in 7.2.7 shall be applied connecting each phase conductor of the main circuit in turn to the high-voltage terminal of the test supply. All other conductors of the main circuit and the auxiliary circuits shall be connected to the earthing conductor or the frame and to the earth terminal of the test supply.

If the phase conductors are segregated, only tests to earth shall apply.

The dielectric tests shall be made with all switching devices closed and all removable parts in their service position. Attention shall be given to the possibility that switching devices in their open position or removable parts in the disconnected, removed or test position may result in less favourable field conditions. Under such conditions the tests shall be repeated with such device(s) in those specific positions. However, switching devices do not need to be tested in open position when their component standard does not require to test them in this open position, and removable parts themselves shall not be subjected to these voltage tests whilst they are in the disconnected, test or removed position. The earthing of removable parts in these positions during the tests shall be as in service.

In case specific devices, such as current transformers, cable terminations or overcurrent releases/indicators, could influence the electrical fields, they shall be installed as in service during these tests. For impulse voltage tests, the arrangements according to 7.2.7.3 are allowed. In case of doubt about the most unfavourable arrangement, tests shall be repeated with alternative configurations.

In order to check compliance with the requirements of 6.102.4 and item a) of 6.103.3.3, inspection windows, partitions and shutters of insulating material shall be covered on the side accessible during operation or maintenance, in the most unfavourable situation for the test, with a circular or square metal foil having an area as large as possible but not exceeding 100 cm^2 which shall be connected to earth. In case of doubt about the most unfavourable situation, the tests shall be repeated with different situations. For convenience of testing, subject to agreement between testing station and manufacturer, more than one metal foil may be applied simultaneously, or larger parts of the insulating material may be covered.

b) Across the isolating distance

Each isolating distance of the main circuit shall be tested using the test voltages specified in 7.2.7 according to the test procedures as stated in 7.2.6.3 of IEC 62271-1:2017.

The isolating distance could be formed by:

– a disconnector in the open position;
– the distance between the two parts of the main circuit intended to be connected by a withdrawable or removable switching device;
– the sum of the clearances between several open gaps in series.

If, in the disconnected or test position, an earthed metal shutter is interposed between the disengaged contacts to ensure a segregation, the gap between the earthed metal shutter and the live parts shall withstand only the test voltages required to earth according to item a) above.

If there is no segregation between the fixed part and the withdrawable part when an isolating distance is established, the test voltages specified across the isolating distance shall be

AVA Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

applied under the following conditions: the withdrawable part shall be in whichever of the disconnected or test positions that creates the shortest distance between the fixed and movable contacts. The switching device of the withdrawable part shall be in the closed position. When it is not possible to have the switching device in the closed position (e.g. by interlocking), then two tests shall be performed as follows:

– with the withdrawable part in the position with shortest distances between the fixed and movable contacts and the switching device of the withdrawable part open;
– with the withdrawable part in the other defined position and the switching device closed.

c) Complementary tests

In order to check compliance with the requirement of item c) of 6.103.3.3, if applicable, the insulation between the high-voltage live parts and the inside of insulating partitions or shutters shall be subjected to a power-frequency test voltage of 150 % of the rated voltage U_r for 1 min. after covering the inner surface of the partition or shutter facing the live parts by an earthed metal foil as described under a) above.

7.2.7 Tests of switchgear and controlgear of U_r ≤ 245 kV

7.2.7.1 General

Subclause 7.2.7.1 of IEC 62271-1:2017 is applicable.

7.2.7.2 Power-frequency voltage tests

Subclause 7.2.7.2 of IEC 62271-1:2017 is replaced by the following provisions:

Assemblies shall be subjected to short-duration power-frequency voltage withstand tests in accordance with IEC 60060-1. The test voltage shall be raised for each test condition to the test value and maintained for 1 min.

The tests shall be performed in dry conditions.

Instrument transformers, power transformers or fuses may be replaced by replicas reproducing the field configuration of the high-voltage connections. A transformer, a coil, or a similar device normally connected between phases shall be disconnected from the pole stressed with test voltage.

At common value power-frequency voltage tests, one terminal of the test transformer shall be connected to earth and to the enclosure of the assembly.

For isolating distance power-frequency voltage tests, 7.2.6.3 of IEC 62271-1:2017, is applicable, with "frame" to be replaced by "enclosure".

For the special cases considered in 7.2.6.3 of IEC 62271-1:2017, the isolating distance may be tested as follows:

– Preferred method: In this case, neither of the two voltage values applied to the two terminals shall be higher than the rated withstand voltage phase-to-earth;
– Alternative method: The voltage to earth of the frame U_f does not need to be bonded so accurately and the frame may even be insulated from earth.

7.2.7.3 Lightning impulse voltage tests

Subclause 7.2.7.3 of IEC 62271-1:2017 is applicable with the following additions:

Instrument transformers, power transformers or fuses may be replaced by replicas reproducing the field configuration of the high-voltage connections.

Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

Current transformer secondary windings shall be short-circuited and earthed. Current transformers may have their primaries short-circuited too.

For common value lightning impulse voltage tests, one terminal of the impulse generator shall be connected to earth and to the enclosure of the assembly.

For isolating distance lightning impulse voltage tests, 7.2.6.3 of IEC 62271-1:2017, is applicable with "frame" to be replaced by "enclosure".

7.2.8 Tests of switchgear and controlgear of U_r > 245 kV

Subclause 7.2.8 of IEC 62271-1:2017 is not applicable.

7.2.9 Artificial pollution tests for outdoor insulators

Subclause 7.2.9 of IEC 62271-1:2017 is not applicable.

7.2.10 Partial discharge tests

Subclause 7.2.10 of IEC 62271-1:2017 is applicable with the following additions:

If the test is performed, it shall be according to Annex B.

NOTE It is good engineering practice to carry out a partial discharge type test on a complete functional unit or assembly (where possible).

7.2.11 Dielectric tests on auxiliary and control circuits

Subclause 7.2.11 of IEC 62271-1:2017 is applicable with the following additions:

Current transformer secondary windings may be short-circuited and disconnected from earth. Voltage transformer secondary windings may be disconnected.

Voltage-limiting devices in the auxiliary and control circuits, if any, shall be disconnected.

Functions like voltage indication or voltage detection (e.g. VPIS, VIS, VDIS and VDS) which are tested according to their relevant standards, are excluded.

7.2.12 Voltage test as condition check

Subclause 7.2.12 of IEC 62271-1:2017 is applicable.

7.2.101 Dielectric tests on cable testing circuits

This type test is applicable only to assemblies having one or more rated cable test voltage(s).

For each rated cable test voltage value, the following test voltages shall be applied:

a) the rated voltage U_r shall be applied as a single-phase voltage between all phase conductors on the busbar side connected together and earth;

b) the rated cable test voltage $U_{ct\ (AC)}$ or $U_{ct\ (DC)}$ shall be applied to each pole in turn of the cable test connection. The other two cable test connections shall be connected to earth when energizing a pole.

The test voltages defined under a) and b) shall be applied simultaneously. If, during this test, there is segregation between the cable test connections and the busbars, the test voltage on the busbar side may be omitted.

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

For AC test voltages, the two test voltages shall be in phase opposition.

For AC cable test voltages $U_{ct\ (AC)}$ the duration of the test shall be 1 min. For DC cable test voltages $U_{ct\ (DC)}$, its rated duration shall be kept for each polarity (refer to 5.102.3).

7.3 Radio interference voltage (RIV) test

Subclause 7.3 of IEC 62271-1:2017 is not applicable.

7.4 Resistance measurement

7.4.1 Measurement of the resistance of auxiliary contacts class 1 and class 2

Subclause 7.4.1 of IEC 62271-1:2017 is applicable.

7.4.2 Measurement of the resistance of auxiliary contacts class 3

Subclause 7.4.2 of IEC 62271-1:2017 is applicable.

7.4.3 Electrical continuity of earthed metallic parts test

Subclause 7.4.3 of IEC 62271-1:2017 is applicable.

7.4.4 Resistance measurement of contacts and connections in the main circuit as a condition check

Subclause 7.4.4 of IEC 62271-1:2017 is applicable with the following addition:

The maximum acceptable increase of resistance for individual switching devices within the assembly after mechanical and/or making and breaking tests is defined in the corresponding switching device standard of the IEC 62271 series.

7.5 Continuous current tests

7.5.1 Condition of the test object

Subclause 7.5.1 of IEC 62271-1:2017 is applicable.

7.5.2 Arrangement of the equipment

Subclause 7.5.2 of IEC 62271-1:2017 is applicable with the following modifications:

Where the design provides alternative components or arrangements, the test shall be performed with those components or arrangements for which the most severe conditions are obtained. The representative functional unit shall be mounted approximately as in normal service, including all normal enclosures, partitions, shutters, etc., and the covers and doors closed.

In case of functional unit(s) incorporating fuses, the test shall be performed with the fuse-links generating the highest power dissipation from the reference list provided by the assembly manufacturer.

7.5.3 Test current and duration

7.5.3.1 Test on main circuit

Subclause 7.5.3.1 of IEC 62271-1:2017 is applicable with the following modifications:

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

Each functional unit of the assembly shall be tested once at its rated continuous current, with the adjacent functional units (if any) at the maximum continuous current that the electrical scheme of the assembly and the rated continuous current of each functional unit allows. Alternatively, each functional unit may be individually tested for its rated continuous current with either heat insulation or heaters at the sides reproducing the same conditions as with the preceding testing procedure.

When testing with the fuse-links generating the highest power dissipation, the continuous current indicated on the list of fuse-links provided by the assembly manufacturer shall be applied.

7.5.3.2 Test of the auxiliary and control equipment

Subclause 7.5.3.2 of IEC 62271-1:2017 is applicable with the following exception:

This test need not be performed on circuits and components of auxiliary and control equipment which already have demonstrated their operation at ambient temperature limits during mechanical tests with the high-voltage switching devices installed inside the assembly, according to the relevant component standard, for example IEC 62271-100, IEC 62271-102 or IEC 62271-103.

7.5.4 Temperature measurement during test

Subclause 7.5.4 of IEC 62271-1:2017 is applicable with the following modifications to 7.5.4.2:

The temperature of the test conductors shall be measured at the point where they leave the enclosure and at a distance of 1 m externally along the temporary feeding connections. The temperature difference shall not exceed 5 K. However, in case this temperature difference exceeds 5 K, the test may be considered as valid if the above indicated point at 1 m from the assembly is the hottest and all criteria to pass the test defined in 7.5.6 are fulfilled.

7.5.5 Resistance of the main circuit

Subclause 7.5.5 of IEC 62271-1:2017 is applicable with the following addition:

The measured resistance, before the continuous current test, across the complete main circuit of an assembly is indicative of the proper condition of the current path. This measured resistance shall be the reference for the routine test (refer to 8.4).

7.5.6 Criteria to pass test

Subclause 7.5.6 of IEC 62271-1:2017 is applicable with the following additions to 7.5.6.1:

The temperature rise of assemblies containing components which are subject to individual component standards shall not cause these components to exceed their temperature limits as permitted in their relevant standard.

The maximum permissible temperatures and temperature rises to be taken into account for busbars are those specified for contacts, connections and metal parts in contact with insulation, as the case may be.

7.5.101 Test report

In addition to the requirements of 7.1.3, in case the test object is equipped with high-voltage fuses, the following fuse information shall be included in the test report:

- manufacturer;
- type designation;

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

- rated voltage and rated current;
- power (in watts) dissipated by each individual (1-phase) fuse-link just before the end of the test period.

NOTE 1 The power dissipated by the fuse-link is defined by the product of the applied AC continuous test current (RMS value) and the measured steady voltage drop across the fuse-link.

NOTE 2 The voltage drop is measured on the fuse-link contacts as close as possible to the point of contact with the immediate mating contact piece.

7.6 Short-time withstand current and peak withstand current tests

7.6.1 General

Subclause 7.6.1 of IEC 62271-1:2017 is applicable with the following additions:

a) Test on main circuits

Main circuits of assemblies shall be tested to verify their capability to withstand the rated short-time and peak withstand current under the intended conditions of installation and use, i.e. they shall be tested as installed in the assembly with all associated components influencing the performance or modifying the short-circuit current.

Parts of the main circuits which incorporate current-limiting fuses do not need to be tested if one of the conditions below is fulfilled:

– the making and breaking tests of the switching function incorporating the fuses have been performed within the assembly;

NOTE 1 An example of switching function incorporating current-limiting fuses is a switch-fuse combination.

– breaking tests of the fuses, when the fuses are not part of a switching function, have been performed within the assembly;

– a short-time withstand current test, with a solid metal link replacing the fuse-link, demonstrating that both the applied peak current and resulting thermal effects (i.e. Joule integral I^2t) are equal to or higher than, those which would be obtained with fuses at the rated voltage, has been performed within the assembly.

In all cases, the performed tests shall at least cover the situations of maximum breaking current (up to I_k and I_p of the branch of the assembly incorporating current-limiting fuses) and of maximum let-through I^2t for the fuses which can be used within the assembly according to the reference list provided by the manufacturer.

NOTE 2 The maximum let-through I^2t is generally obtained with a lower prospective current than I_k.

Connections to auxiliary devices (such as voltage transformers, auxiliary transformers, surge arresters, surge capacitors, voltage detection devices, and similar items) are not part of the main circuit (refer to 3.5.105).

b) Tests on earthing circuits

Earthing devices, earthing conductors, earthing connections and other conductive parts forming part of the earthing circuit of an assembly shall be tested to verify their capability to withstand their rated short-time and peak withstand currents (I_k, I_p, t_k and I_{ke}, I_{pe}, t_{ke} – as applicable). They shall be tested as installed in the assembly with all associated components influencing the performance or modifying the short-circuit current.

The short-time withstand current and peak withstand current tests shall be carried out on the short-circuiting parts of each earthing circuit according to the number of phases of the corresponding earthing device (I_k, I_p, t_k). Additionally, single-phase tests shall be performed on all parts of the earthing circuit that are designed to provide the connection between the earthing device and the earthing point provided, at the rated short-time and peak withstand currents (I_{ke}, I_{pe}, t_{ke}).

When there are removable earthing devices, the earthing connection(s) between the fixed part (of the assembly) and the removable earthing device shall be tested at the rated short-time and peak withstand currents (I_k, I_p, t_k and I_{ke}, I_{pe}, t_{ke} – as applicable). The current

AVA Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021

shall flow along the earthing conductor between the fixed part and the earthing point of the removable part. Additionally, where the earthing device in the assembly can be operated in alternative positions to the service position, the test shall be repeated for all alternative positions.

Each test shall be preceded by a no-load operation of the mechanical switching device(s) and by measurement of the resistance of the main circuit according to 7.4.4. The no-load opening operation shall be carried out at the rated value of the supply voltage in the case of power operated devices and the force/torque shall be measured in the case of dependent manually operated devices.

Earthing switches and earthing circuits are excluded from resistance measurement.

7.6.2 Arrangement of the equipment and of the test circuit

Subclause 7.6.2 of IEC 62271-1:2017 is not applicable.

The circuits of the test object shall be selected in such a way that the most onerous conditions are obtained concerning the maximum lengths of unsupported conductors, configuration of the conductors and connections within the equipment, and the assigned rated values. In the case of assemblies incorporating the same switching device at several locations, it also shall be checked that the most onerous location of the switching device is tested.

The test connections to the terminals of the assembly shall be arranged in such a way as to avoid unrealistic stressing of, or support to, the terminals. The distance between the terminals and the nearest supports of the test conductors on both sides of the assembly shall be in accordance with the manufacturer's instructions reference.

The short-time withstand current and peak withstand current tests shall be carried out according to the number of phases of the circuit under test. However, each earthing circuit shall be tested with its number of phases at its I_k, I_p and t_k, and tested single-phase at its I_{ke}, I_{pe} and t_{ke} up to the earthing point provided on the test object. These tests may be performed on different test samples. Parts of the earthing circuit already satisfactorily tested may be replaced between tests on different earthing circuits.

Current transformers and tripping devices that may be present shall be installed as in normal service, but with the release made inoperative.

Equipment which does not include any current-limiting device may be tested at any convenient voltage. Equipment which incorporates a current-limiting device shall be tested at the rated voltage of the assembly, except if the test set-up at a lower voltage results in mechanical and thermal effects that are equal to, or higher than, those with the incorporated current-limiting device at rated voltage. Refer to 7.6.1 a) for further details on fuse-link selection, and accepted alternatives to demonstrate this performance.

Self-tripping circuit-breakers, if any, shall be set on their maximum tripping values.

NOTE The definition of self-tripping circuit-breakers is provided in 3.4.113 of IEC 62271-100:2021.

Current-limiting fuses, if any, shall be provided with fuse-links having the maximum rated current specified.

The test arrangement shall be noted in the test report.

7.6.3 Test current and duration

Subclause 7.6.3 of IEC 62271-1:2017 is applicable with the following additions:

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

For equipment including current-limiting devices the prospective current (peak, RMS value and duration) shall not be less than the rated values.

The rated duration for these tests will be t_k or t_{ke}, whichever is applicable for the tested circuit.

7.6.4 Conditions of the test object after test

Subclause 7.6.4 of IEC 62271-1:2017 is applicable with the following additions:

The maximum acceptable increase of resistance for the complete main circuit of an assembly as condition check is considered to be satisfactory if this resistance increase does not exceed 20 % of the value measured before the test. If the resistance increase exceeds 20 % then a continuous current test (see 7.5) is applicable to determine if the test object can carry its rated continuous current.

After the test on each earthing circuit, some deformation and degradation of the earthing devices, earthing conductors, earthing connections and other conductive parts forming part of the earthing circuit is permissible, but the continuity of the circuit shall be preserved. Visual inspection should be sufficient to check that continuity of the circuit has been preserved. In case of doubt if certain earth connections are (still) adequate, the earthing shall be verified testing with 30 A (DC) to the earthing point provided. The voltage drop shall be lower than 3 V.

7.7 Verification of the protection

7.7.1 Verification of the IP coding

Subclause 7.7.1 of IEC 62271-1:2017 is applicable with the following additions:

For verification of the IP coding, the service condition is with all doors and covers closed, no matter how they are expected to be locked or not.

Accessible partitions and shutters, as defined by the manufacturer, shall be verified on IP2X.

7.7.2 Verification of the IK coding

Subclause 7.7.2 of IEC 62271-1:2017 is applicable with the following addition:

For verification of the IK coding, the service condition is with all doors and covers closed, no matter how they are expected to be locked or not.

7.8 Tightness tests

Subclause 7.8 of IEC 62271-1:2017 is applicable with the following additions to 7.8.1:

The tightness of each representative tight compartment shall also be tested once at the maximum ambient air temperature of the specified service conditions as defined in Clause 4 of IEC 62271-1:2017. The leakage rate shall stay within the limits defined in Table 15 of IEC 62271-1:2017.

For a defined type of switchgear and controlgear, a tight compartment design is considered to be validated if all types of sealings for a specific design are tested at least once on representative compartments.

These tests may be performed during other tests at temperature limits (if any) as specified in component standards.

Documents
Document Sharing Hub

Full document details: IEC 62271-200-2021

7.9 Electromagnetic compatibility tests (EMC)

Subclause 7.9 of IEC 62271-1:2017 is applicable with the following addition to 7.9.1.2:

Stationary emission tests should be performed on a typical lay-out of the assembly, based on the standard wiring rules of the manufacturer.

7.10 Additional tests on auxiliary and control circuits

7.10.1 General

Subclause 7.10.1 of IEC 62271-1:2017 is applicable with the following addition:

Where applicable, the tests under 7.10 shall be performed on a typical lay-out of the assembly, based on the standard wiring rules of the manufacturer.

7.10.2 Functional tests

Subclause 7.10.2 of IEC 62271-1:2017 is not applicable.

NOTE Functional tests on auxiliary and control circuits are performed as routine tests, refer to 8.3.2.

7.10.3 Verification of the operational characteristics of auxiliary contacts

Subclause 7.10.3 of IEC 62271-1:2017 is applicable with the following addition:

This subclause is not applicable to the auxiliary contacts already tested according to their own standard.

7.10.4 Environmental tests

Subclause 7.10.4 of IEC 62271-1:2017 is applicable with the following limitations:

– tests do not apply for indoor assemblies operated under normal service conditions as defined by 4.1.2 of IEC 62271-1:2017;
– when the tests as stated in 7.10.4 of IEC 62271-1:2017 have been performed on the separate components of a representative auxiliary and control circuit, no further environmental tests are needed.

7.10.5 Dielectric test

Subclause 7.10.5 of IEC 62271-1:2017 is applicable.

7.11 X-radiation test for vacuum interrupters

Subclause 7.11 of IEC 62271-1:2017 is applicable.

NOTE This test is applied to the vacuum interrupter, not to a functional unit.

7.101 Verification of making and breaking capacities

7.101.1 General

Switching devices forming part of the main circuit and earthing switches of assemblies shall be tested to verify their rated making and breaking capacities according to the relevant standards and under the proper conditions of installation and use. That is, they shall be tested as normally installed in the assembly with all associated components that may influence the performance, such as connections, supports, provisions for venting. These tests are not necessary if making and breaking tests have been performed on the switching devices installed in assemblies with identical or more onerous conditions.

Documents
Document Sharing Hub
Full document details: IEC 62271-200-2021