



BSI Standards Publication

High-voltage switchgear and controlgear

Part 202: AC prefabricated substations for rated voltages
above 1 kV and up to and including 52 kV

National foreword

This British Standard is the UK implementation of EN IEC 62271-202:2022. It is identical to IEC 62271-202:2022, incorporating corrigendum August 2023. It supersedes BS EN 62271-202:2014, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/17, High voltage switchgear, controlgear and assemblies.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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English Version

High-voltage switchgear and controlgear - Part 202: AC
prefabricated substations for rated voltages above 1 kV and up
to and including 52 kV
(IEC 62271-202:2022)

Appareillage à haute tension - Partie 202: Postes
préfabriqués pour courant alternatif de tensions assignées
supérieures à 1 kV et inférieures ou égales à 52 kV
(IEC 62271-202:2022)

Hochspannungs-Schaltgeräte und -Schaltanlagen -
Teil 202: Fabrikfertige Wechselstrom-Stationen für
Bemessungsspannungen über 1 kV bis einschließlich 52 kV
(IEC 62271-202:2022)

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European foreword

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- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2023-04-27
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2025-07-27

This document supersedes EN 62271-202:2014 and all of its amendments and corrigenda (if any).

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The text of the International Standard IEC 62271-202:2022 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61936-1:2021	NOTE	Harmonized as EN IEC 61936-1:2021 (not modified)
IEC 60059:1999	NOTE	Harmonized as EN 60059:1999 (not modified)
IEC 60076 (series)	NOTE	Harmonized as EN 60076 (series)
IEC 62271-4:2013	NOTE	Harmonized as EN 62271-4:2013 (not modified)
IEC 60364-4-41:2005	NOTE	Harmonized as HD 60364-4-41:2017 + A11:2017
IEC 60721-3-2:2018	NOTE	Harmonized as EN IEC 60721-3-2:2018 (not modified)
IEC 60068 (series)	NOTE	Harmonized as EN 60068 (series)
IEC/TR 62271-208:2009	NOTE	Harmonized as CLC/TR 62271-208:2010 (not modified)
IEC 60243-1:2013	NOTE	Harmonized as EN 60243-1:2013 (not modified)
ISO 9223	NOTE	Harmonized as EN ISO 9223

ISO 9224	NOTE	Harmonized as EN ISO 9224
IEC 60721-2-6:1990	NOTE	Harmonized as HD 478.2.6 S1:1993 (not modified)
IEC/IEEE 82079-1:2019	NOTE	Harmonized as EN IEC/IEEE 82079-1:2020 (not modified)
ISO 13732-1:2006	NOTE	Harmonized as EN ISO 13732-1:2008 (not modified)
IEC 62430:2019	NOTE	Harmonized as EN IEC 62430:2019 (not modified)
ISO 1460	NOTE	Harmonized as EN ISO 1460
ISO 1461	NOTE	Harmonized as EN ISO 1461
ISO 2081	NOTE	Harmonized as EN ISO 2081
ISO 2409	NOTE	Harmonized as EN ISO 2409
ISO 9227	NOTE	Harmonized as EN ISO 9227
ISO 11997 (series)	NOTE	Harmonized as EN ISO 11997 (series)
ISO 7784 (series)	NOTE	Harmonized as EN ISO 7784 (series)
ISO 12944 (series)	NOTE	Harmonized as EN ISO 12944 (series)
IEC 60865-1:2011	NOTE	Harmonized as EN 60865-1:2012 (not modified)
IEC 60076-3	NOTE	Harmonized as EN 60076-3
IEC 61869 (series)	NOTE	Harmonized as EN IEC 61869 (series)

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-441	-	International Electrotechnical Vocabulary. Switchgear, controlgear and fuses	-	-
IEC 60050-461	2008	International Electrotechnical Vocabulary - Part 461: Electric cables	-	-
IEC 60068-2-5	2018	Environmental testing - Part 2-5: Tests - Test S: Simulated solar radiation at ground level and guidance for solar radiation testing and weathering	EN IEC 60068-2-5	2018
IEC 60071-1	2019	Insulation co-ordination - Part 1: Definitions, principles and rules	EN IEC 60071-1	2019
IEC 60076-1	2011	Power transformers - Part 1: General	EN 60076-1	2011
IEC 60076-2	2011	Power transformers - Part 2: Temperature rise for liquid-immersed transformers	EN 60076-2	2011
IEC 60076-5	2006	Power transformers - Part 5: Ability to withstand short circuit	EN 60076-5	2006
IEC 60076-7	2018	Power transformers - Part 7: Loading guide for mineral-oil-immersed power transformers	-	-
IEC 60076-10	2016	Power transformers - Part 10: Determination of sound levels	EN 60076-10	2016
IEC 60076-11	2018	Power transformers - Part 11: Dry-type transformers	EN IEC 60076-11	2018
IEC 60076-12	2008	Power transformers - Part 12: Loading guide for dry-type power transformers	-	-
IEC 60529	1989	Degrees of protection provided by enclosures (IP Code)	EN 60529	1991
-	-		+ corrigendum May	1993
+ A1	1999		+ A1	2000
+ A2	2013		+ A2	2013

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60664-1	2020	Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests	EN IEC 60664-1	2020
IEC 60721-1	1990	Classification of environmental conditions - Part 1: Environmental parameters and their severities	EN 60721-1	1995
+ A1	1992		-	-
+ A2	1995		+ A2	1995
IEC 60721-2-2	2012	Classification of environmental conditions - Part 2-2: Environmental conditions appearing in nature - Precipitation and wind	EN 60721-2-2	2013
IEC 60721-2-4	2018	Classification of environmental conditions - Part 2-4: Environmental conditions appearing in nature - Solar radiation and temperature	EN IEC 60721-2-4	2018
-	-		+ AC	2018-12
IEC 60721-3-4	-	Classification of environmental conditions - Part 3-4: Classification of groups of environmental parameters and their severities - Stationary use at non-weatherprotected locations	EN IEC 60721-3-4	-
IEC/TS 60815-1	2008	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles	-	-
IEC 60947-1	-	Low-voltage switchgear and controlgear - Part 1: General rules	EN IEC 60947-1	-
IEC 61180-1	1992 ¹	High-voltage test techniques for low-voltage equipment -- Part 1: Definitions, test and procedure requirements	-	-
IEC 61439	series	Low-voltage switchgear and controlgear assemblies	EN IEC 61439	series
IEC 61439-1	2020	Low-voltage switchgear and controlgear assemblies - Part 1: General rules	EN IEC 61439-1	2021
IEC 62262	2002	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)	EN 62262	2002
IEC 62271-1	2017	High-voltage switchgear and controlgear - Part 1: Common specifications for alternating current switchgear and controlgear	EN 62271-1	2017
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	EN IEC 62271-200	2021

¹ This publication has been partially replaced with IEC 61180:2016.

EN IEC 62271-202:2022 (E)

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
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	EN 62271-201	2014
IEC 62271-212	2016	High-voltage switchgear and controlgear - Part 212: Compact Equipment Assembly for Distribution Substation (CEADS)	EN 62271-212	2017
ISO 1182	2010	Reaction to fire tests for products - Non-combustibility tests	-	-
ISO 1716	2018	Reaction to fire tests for products - Determination of the gross heat of combustion (calorific value)	EN ISO 1716	2018
ISO 6508-1	2016	Metallic materials - Rockwell hardness test - Part 1: Test method	EN ISO 6508-1	2016
-	-	Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels	EN 10025-2	2019

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 202: AC prefabricated substations for rated voltages above 1 kV and up to and including 52 kV

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IEC 62271-202 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 2014. This edition constitutes a technical revision.

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

- a) the whole document contents and structure are reviewed with due consideration of IEC 62271-1:2017;
- b) modification of the title and scope to include high-voltage switchgear prefabricated substations;
- c) inclusion of CEADS as a possible component of MV/LV prefabricated substation;
- d) in 7.2.101, the possible influence of surrounding elements on the dielectric performance of high-voltage components as high-voltage switchgear and controlgear and high-voltage interconnections non-metal-enclosed or without earthed screen are now considered.

- e) new informative Annex G with testing procedure to evaluate the impact of solar radiation in temperatures inside the enclosure and how to apply it;
- f) new informative Annex H for appropriate consideration of installation conditions of electronic equipment;
- g) the rated power of a prefabricated substation is now defined as a three-parameter rated value. See 5.101.1;
- h) minimum dimensions for access doors to the prefabricated substation in 6.104.4 and for free height of operation aisle in 6.105.3 have been introduced;
- i) continuous current (temperature rise) test methods have been revised/clarified where necessary;
- j) Figure D.1, which shows the mineral-oil-immersed power transformer load factor inside the enclosure, has been corrected.

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

Draft	Report on voting
17C/843/FDIS	17C/849/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

This document is to be read in conjunction with IEC 62271-1:2017, 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.

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

IMPORTANT – The "colour inside" logo on the cover page of this 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.

INTRODUCTION

A prefabricated substation is defined as a high-voltage type-tested assembly comprising an enclosure containing at least a power transformer and/or a high-voltage switchgear and controlgear, and, in general, all or some of the following main components: low-voltage switchgear and controlgear, electrical high-voltage interconnection and low-voltage interconnection. The prefabricated substation can include all necessary auxiliary and control equipment for its operation. The purpose being to supply low-voltage power from a high-voltage system and/or vice versa (high-voltage/low-voltage transformer substation) or distribute electric power in a high-voltage network (high-voltage switchgear substation).

These prefabricated substations can be in locations accessible to the public and should ensure protection not only to authorized persons but also to general public under the specified service conditions.

Therefore, in addition to the specified characteristics, ratings and relevant test procedures, particular attention has been paid to the specification concerning the protection of persons, both operators and general public. Use of type-tested components and suitable design and construction of the assembly contributes to this protection. The correct design and performance of the prefabricated substation is verified by means of relevant type and routine tests described in this document, including internal arc tests (if applicable).

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 202: AC prefabricated substations for rated voltages above 1 kV and up to and including 52 kV

1 Scope

This part of IEC 62271 specifies the service conditions, rated characteristics, general structural requirements and test methods of enclosed high-voltage prefabricated substations. These prefabricated substations are cable-connected to AC high-voltage networks with an operating voltage up to and including 52 kV and power frequencies up to and including 60 Hz. They can be manually operated from inside (walk-in type) or from outside (non-walk-in type). They are designed for outdoor installation at locations with public accessibility and where protection of personnel is provided.

These prefabricated substations can be situated at ground level or partially or completely below ground level. The last are also called "underground prefabricated substations".

In general, two types of prefabricated substations are considered in this document:

- high-voltage switchgear prefabricated substations;
- high-voltage/low-voltage transformer prefabricated substations (step-up and step-down).

A high-voltage switchgear prefabricated substation comprises an enclosure containing in general the following electrical components:

- high-voltage switchgear and controlgear;
- auxiliary equipment and circuits.

A high-voltage/low-voltage transformer prefabricated substation comprises an enclosure containing in general the following electrical components:

- power transformer(s);
- high-voltage and low-voltage switchgear and controlgear;
- high-voltage and low-voltage interconnections;
- auxiliary equipment and circuits.

However, relevant provisions of this document are applicable to designs where not all these electrical components exist (for example, a prefabricated substation consisting of power transformer and low-voltage switchgear and controlgear).

The listed electrical components of a high-voltage/low-voltage transformer prefabricated substation can be incorporated in the prefabricated substation either as separate components or as an assembly type CEADS according to IEC 62271-212.

This document covers only designs using natural ventilation. However, relevant provisions of this document are applicable to designs using other means of ventilation except the rated power of the prefabricated substation and associated class of enclosure (see 5.101), the continuous current tests (see 7.5) and all temperature rise related requirements, which would need an agreement between manufacturer and user.

NOTE 1 IEC 61936-1 [1]¹ provides general rules for the design and erection of high-voltage power installations. As well, it specifies additional requirements for the external connections, erection and operation at the place of installation of high-voltage prefabricated substations compliant with IEC 62271-202, which are regarded as a component of such installation. Non-prefabricated high-voltage substations, are generally covered by IEC 61936-1 [1].

NOTE 2 High-voltage switchgear prefabricated substations can include instrument transformers, according to IEC 61869 (all parts). These substations are not high-voltage/low-voltage transformer prefabricated substations.

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

IEC 60050-461:2008, *International Electrotechnical Vocabulary (IEV) – Part 461: Electric cables*

IEC 60068-2-5:2018, *Environmental testing – Part 2-5: Tests – Test S: Simulated solar radiation at ground level and guidance for solar radiation testing and weathering*

IEC 60071-1:2019, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60076-1:2011, *Power transformers – Part 1: General*

IEC 60076-2:2011, *Power transformers – Part 2: Temperature rise for liquid-immersed transformers*

IEC 60076-5:2006, *Power transformers – Part 5: Ability to withstand short circuit*

IEC 60076-7:2018, *Power transformers – Part 7: Loading guide for mineral-oil-immersed power transformers*

IEC 60076-10:2016, *Power transformers – Part 10: Determination of sound levels*

IEC 60076-11:2018, *Power transformers – Part 11: Dry-type transformers*

IEC 60076-12:2008, *Power transformers – Part 12: Loading guide for dry-type power transformers*

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

IEC 60529:1989/AMD1:1999

IEC 60529:1989/AMD2:2013

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

¹ Numbers in square brackets refer to the Bibliography.

IEC 60721-1:1990, *Classification of environmental conditions – Part 1: Environmental parameters and their severities*
 IEC 60721-1:1990/AMD1:1992
 IEC 60721-1:1990/AMD2:1995

IEC 60721-2-2:2012, *Classification of environmental conditions – Part 2-2: Environmental conditions appearing in nature – Precipitation and wind*

IEC 60721-2-4:2018, *Classification of environmental conditions – Part 2-4: Environmental conditions appearing in nature – Solar radiation and temperature*

IEC 60721-3-4, *Classification of environmental conditions – Part 3-4: Classification of groups of environmental parameters and their severities – Stationary use at non-weather protected locations*

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

IEC 60947-1, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 61180-1:1992, *High-voltage test techniques for low voltage equipment – Part 1: Definitions, test and procedure requirements*²

IEC 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

IEC 61439-1:2020, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

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

IEC 62271-1:2017, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*

IEC 62271-200:2021, *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*

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 62271-212:2016, *High-voltage switchgear and controlgear – Part 212: Compact Equipment Assembly for Distribution Substation (CEADS)*

ISO 1182:2010, *Reaction to fire tests for products – Non-combustibility tests*

ISO 1716:2018, *Reaction to fire tests for products – Determination of the gross heat of combustion (calorific value)*

ISO 6508-1:2016, *Metallic materials – Rockwell hardness test – Part 1: Test method*

EN 10025-2:2019, *Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels*

² This publication has been partially replaced with IEC 61180:2016.

3 Terms and definitions

Clause 3 of IEC 62271-1:2017 does not apply except where otherwise indicated.

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

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>

NOTE Terms and definitions are classified in accordance with IEC 62271-1:2017. References from other parts than IEC 60050-441 are classified so as to be aligned with the classification used in IEC 60050-441.

3.1 General terms and definitions

3.2 Assemblies of switchgear and controlgear

3.2.101

prefabricated substation

prefabricated and type-tested high-voltage assembly comprising an enclosure containing at least a power transformer and/or a high-voltage switchgear and controlgear, and usually one or several of the following components: low-voltage switchgear and controlgear, high-voltage interconnection, low-voltage interconnection, auxiliary and control equipment and circuits

Note 1 to entry: A prefabricated substation includes all main and earthing circuits to be connected through appropriate interfaces to external high-voltage and low-voltage cables and to external earthing system and (protective) bonding conductor (if any).

3.2.102

transport unit

<prefabricated substation> part of a prefabricated substation suitable for shipment without being dismantled

3.3 Parts of assemblies

3.3.101

enclosure

<prefabricated substation> part of a prefabricated substation providing protection against external influences to the substation and a specified degree of protection for operators and the general public with respect to approach to, or contact with, live parts and against contact with moving parts

[SOURCE: IEC 60050-441:1984, 441-13-01, modified – "Assembly" replaced by "prefabricated substation"; "operators and general public" are both specifically addressed.]

3.3.102

compartment

<prefabricated substation> part or zone of a prefabricated substation containing one or more main components

Note 1 to entry: A compartment of a prefabricated substation can be designated by the component contained therein, for example, power transformer, high-voltage switchgear and controlgear, low-voltage switchgear and controlgear respectively.

Note 2 to entry: A compartment of a prefabricated substation may be enclosed except for the openings necessary for interconnections, control or ventilation.

3.3.103

main component

<prefabricated substation> essential part of the prefabricated substation, which serves one or several specific functions

EXAMPLE Power transformer, high-voltage switchgear and controlgear, low-voltage switchgear and controlgear, etc.

3.3.104

high-voltage interconnection

electrical connection between the terminals of the high-voltage switchgear and controlgear and the high-voltage terminals of the high-voltage/low-voltage power transformer

Note 1 to entry: In prefabricated substations without high-voltage switchgear and controlgear it refers to the electrical connection from the external network including the protection device (if any) to the high-voltage terminals of the power transformer.

3.3.105

low-voltage interconnection

electrical connection between the low-voltage terminals of the high-voltage/low-voltage power transformer and the incoming terminals of the low-voltage switchgear and controlgear

3.3.106

partition

<prefabricated substation> part of a prefabricated substation separating one compartment from other compartments and providing a specified degree of protection

[SOURCE: IEC 60050-441:1984, 441-13-06, modified – "Assembly" replaced by "prefabricated substation"; "and providing a specific degree of protection" added.]

3.3.107

main circuit

<prefabricated substation> all conductive parts of a prefabricated substation included in a circuit intended to transmit electrical energy

3.3.108

auxiliary circuit

<prefabricated substation> all conductive parts of a prefabricated substation included in a circuit (other than the main circuit) intended to control, measure, signal, regulate, illuminate, etc.

[SOURCE: IEC 60050-441:1984, 441-13-03, modified – "Assembly of switchgear and controlgear" replaced by "prefabricated substation"; "illuminate, etc." added, note deleted.]

3.3.109

rated value

<prefabricated substation> quantity value assigned, generally by the manufacturer, for a specified operating condition of a prefabricated substation

[SOURCE: IEC 60050-441:2000, 441-18-35, modified – "Component, device or equipment" replaced by "prefabricated substation"; the note to entry is removed.]

3.3.110

main earthing conductor

<prefabricated substation> conductor which is part of the earthing arrangement of a substation and enabling the electrical connection to earth of all the individual earthing conductors of each element and main component of a prefabricated substation intended to be earthed

3.4 Switching devices

Subclause 3.4 of IEC 62271-1:2017 applies.

3.5 Parts of switchgear and controlgear

Subclause 3.5 of IEC 62271-1:2017 applies.

3.6 Operational characteristics of switchgear and controlgear

3.6.101

degree of protection

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

3.6.102

ambient air temperature

<prefabricated substation> temperature, determined under prescribed conditions, of the air surrounding the enclosure of the prefabricated substation

[SOURCE: IEC 60050-441:1984, 441-11-13, modified – "Complete switching device or fuse" replaced with "enclosure of the prefabricated substation"; Note is removed.]

3.6.103

class of enclosure

<prefabricated substation> difference of temperature rise between the power transformer in the enclosure and the same power transformer outside the enclosure at normal service conditions as defined in 4.1

Note 1 to entry: The power transformer rated values (power and losses) correspond to the highest rated power and associated rated total losses, for which the prefabricated substation is designed and tested.

3.6.104

internal arc classified prefabricated substation

IAC prefabricated substation

prefabricated substations for which prescribed criteria for protection of persons are met in the event of an internal arc in high-voltage prefabricated substation components, except power transformers, as demonstrated by type tests

3.6.105

type of accessibility

characteristic related to the level of protection given to people accessing a defined area inside or around the prefabricated substation in the event of an internal arc, as demonstrated by type tests

3.6.106

degree of protection against mechanical impacts

extent (level) of protection of the equipment provided by an enclosure against harmful mechanical impacts and verified by standardized test methods

3.6.107

normal operation

<prefabricated substation> operation of the prefabricated substation as defined by the manufacturer's instructions for use, corresponding to the normal conditions and operations in service

Note 1 to entry: "Normal operation" does not include maintenance, transport and storage.

3.7 Characteristic quantities

3.7.101

arc fault current

<IAC prefabricated substation> three-phase and – where applicable – single phase-to-earth RMS value of the short-circuit current for which the prefabricated substation is designed to protect persons in the event of an internal arc

3.7.102

arc fault duration

<IAC prefabricated substation> duration of the short-circuit current for which the prefabricated substation is designed to protect persons in the event of an internal arc

3.7.103

power transformer load factor

per unit ratio of constant current drawn from a power transformer at its rated voltage to the rated current of that power transformer

Note 1 to entry: This term is also expressed as load current/rated current at rated voltage. See IEC 60076-7 and IEC 60076-12.

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4 Normal and special service conditions

Clause 4 of IEC 62271-1:2017 is applicable, except as follows.

4.1 Normal service conditions

4.1.1 General

Subclause 4.1.1 of IEC 62271-1:2017 is applicable with following addition.

Unless otherwise specified in this document, the prefabricated substation is intended to be used in accordance with its rated characteristics and at locations compliant with the normal service conditions defined for outdoor switchgear and controlgear in 4.1.3 of IEC 62271-1:2017.

Inside the enclosure of the prefabricated substation, it is assumed that the normal indoor service conditions defined for indoor switchgear and controlgear in 4.1.2 of IEC 62271-1:2017 prevail.

Generally, the air temperature inside the enclosure of the prefabricated substation will be different from the ambient air temperature as defined in 3.6.102.

If the air temperature inside the prefabricated substation is higher than the limits fixed for the components in their respective product standards, de-rating can be necessary.

Operation under normal service conditions is considered to be covered by the type tests according to this document.

4.1.2 Indoor switchgear and controlgear

Subclause 4.1.2 of IEC 62271-1:2017 is applicable to the high-voltage switchgear and controlgear, the high-voltage interconnection, the auxiliary and control equipment and circuits, and the low-voltage interconnection inside the prefabricated substation.

4.1.3 Outdoor switchgear and controlgear

Subclause 4.1.3 of IEC 62271-1:2017 is applicable to the prefabricated substation.

4.1.101 Low-voltage switchgear and controlgear

Subclause 7.1 of IEC 61439-1:2020 is applicable to the low-voltage switchgear and controlgear with following addition.

The macro-environment corresponds to the normal service conditions inside the prefabricated substation, and the micro-environment corresponds to the conditions close to the insulating parts of the low-voltage switchgear and controlgear.

If not otherwise stated by the manufacturer, it is assumed that for the micro-environment inside the low-voltage switchgear and controlgear, the pollution degree 1 defined in 7.1.2 of IEC 61439-1:2020 applies.

4.1.102 Power transformer

IEC 60076-1:2011 is applicable for liquid-immersed power transformers and IEC 60076-11:2018 for dry-type power transformers.

A power transformer loaded with rated current inside an enclosure has a temperature rise, which is generally higher than in open-field conditions, and the temperature limits as defined in IEC 60076-2:2011 or IEC 60076-11:2018 can be exceeded.

The service conditions of the power transformer will be determined according to the local outside service conditions and the class of the enclosure (see 5.101.2).

This will enable the power transformer manufacturer or user to calculate its possible derating (see Annex D).

4.2 Special service conditions

4.2.1 General

Subclause 4.2.1 of IEC 62271-1:2017 is applicable, except as follows.

The prefabricated substation can be exposed to environmental parameters and their severities stronger than those defined by the service conditions defined in 4.1. The open-air classifications defined by IEC 60721-3-4 can be used to specify special service conditions for the prefabricated substation.

4.2.2 Altitude

Subclause 4.2.2 of IEC 62271-1:2017 is applicable, with following additions and precisions.

Altitude of the installation may also have influence on the cooling effect of ambient air and therefore on the temperature rise of the components of the prefabricated substation.

4.2.2.101 Insulation

For installation of the high-voltage switchgear and controlgear and/or interconnection at an altitude higher than 1 000 m, refer to 4.2.2 of IEC 62271-1:2017.

For installation of the low-voltage switchgear and controlgear and/or interconnection at an altitude higher than 2 000 m, refer to 7.2 of IEC 61439-1:2020.

For installation of the power transformer at an altitude higher than 1 000 m, refer to IEC 60076-2:2011 or IEC 60076-11:2018.

4.2.2.102 Temperature rise

For installation of the high-voltage switchgear and controlgear, high-voltage interconnection, low-voltage switchgear and controlgear and low-voltage interconnection at an altitude between 2 000 m and 4 000 m, the temperature rise limits of Table 14 of the IEC 62271-1:2017 shall be reduced by 1 % for every 100 m in excess of 2 000 m in altitude to not exceed the required temperature limits at 40 °C air temperature inside the prefabricated substation. This reduced temperature rise limits should be used during the continuous current type test at an altitude below 2 000 m. However, this correction is generally unnecessary due to the reduced maximum ambient air temperature at altitudes above 2 000 m. See IEC TR 60943 [2].

For installation of the power transformer at an altitude higher than 1 000 m, refer to IEC 60076-2:2011 or IEC 60076-11:2018.

4.2.3 Exposure to pollution

Subclause 4.2.3 of IEC 62271-1:2017 is applicable, except as follows.

In the cases where the insulation can be affected by the pollution inside the enclosure, the site pollution severity class should be selected having consideration that airborne salt or industrial pollution introduced via the enclosure ventilation will not be washed off by rain. The site pollution severity class inside the enclosure in such circumstances can be more onerous than existing outside the enclosure.

For prefabricated substations that are intended to be installed in environments with the site pollution severity classes c (medium), d (heavy) and e (very heavy) according to IEC TS 60815-1:2008, the exposed insulation, if any, should be designed in order to withstand these pollution levels. Examples of typical environmental levels are given in Table K.1 of IEC 62271-1:2017. Alternatively, measures should be taken in order to prevent the build-up of

pollution on the exposed surfaces of the insulation in accordance with Annex C of IEC TS 62271-304:2019 [3].

For installation of the prefabricated substation in polluted ambient air, the environmental parameters defining the degree of pollution should be specified according to IEC 60721-3-4.

4.2.3.101 Low-voltage switchgear and controlgear

Refer to IEC 60664-1:2020 and 7.2 of IEC 61439-1:2020.

4.2.3.102 Power transformer

Refer to 5.5 of IEC 60076-1:2011, except for dry-type power transformers for which 4.2 f) and 12.2 of IEC 60076-11:2018 should be referred to select appropriate environmental class.

4.2.4 Temperature and humidity

Subclause 4.2.4 of IEC 62271-1:2017 is applicable with following addition.

If the service conditions at the intended installation site do not fall within the limits of the "normal service conditions", then the limits of the temperature rise for the power transformer and/or the load factor shall be modified accordingly, taking into account the class of the enclosure. See 5.101 and Annex D.

4.2.5 Exposure to abnormal vibrations, shock or tilting

Subclause 4.2.5 of IEC 62271-1:2017 is applicable.

4.2.6 Wind speed

Subclause 4.2.6 of IEC 62271-1:2017 is applicable.

4.2.7 Other parameters

Subclause 4.2.7 of IEC 62271-1:2017 is applicable with following addition.

If the solar irradiance at the location where the prefabricated substation will be installed exceeds 1 000 W/m², an appropriate value should be specified by the user from those given in IEC 60721-2-4.

For the purposes of assessing the impact of solar radiation on the temperature rise of a prefabricated substation exposed to direct sunlight (refer to Annex G), the maximum level (power density) of solar irradiance (SI) assumed for prefabricated substations that are exposed to direct sunlight is 1,09 kW/m² in accordance with IEC 60068-2-5:2018. The selection of an alternative value may be considered depending on the actual installation location and is subject to an agreement between the user and manufacturer.

5 Ratings

5.1 General

Subclause 5.1 of IEC 62271-1:2017 is applicable, except as follows.

The ratings of a prefabricated substation are the following:

- a) rated voltage of high-voltage main circuits (U_r);
- b) rated voltage of low-voltage main circuits (U_n , where applicable);

- c) rated insulation levels (U_p , U_d and U_s , where applicable);
- d) rated frequency (f_r);
- e) rated current for low-voltage main circuits (I_{nA} , where applicable);
- f) rated continuous current for high-voltage main circuits (I_r);
- g) rated short-time withstand currents (I_k , I_{ke} , I_{cw}) for main and earthing circuits;
- h) rated peak withstand currents (I_p , I_{pe} , I_{pk}), for main and earthing circuits;
- i) rated duration of short-circuit (t_k , t_{ke}) for main and earthing circuits;
- j) rated supply voltage of closing and opening devices and auxiliary and control circuits (where applicable);
- k) rated supply frequency of closing and opening devices and auxiliary and control circuits (where applicable);
- l) rated power of the prefabricated substation (for high-voltage/low-voltage transformer prefabricated substations);
- m) rated class of enclosure (for high-voltage/low-voltage transformer prefabricated substations);
- n) ratings of the internal arc classification (IAC), if assigned by the manufacturer.

5.2 Rated voltage (U_r)

Subclause 5.2 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

Rated voltage of a prefabricated substation is defined by the rated voltages of its high-voltage switchgear and controlgear, high-voltage/low-voltage power transformer and low-voltage switchgear and controlgear.

Refer to 5.2 of IEC 62271-1:2017 for high-voltage switchgear and controlgear. This value referred as U_r corresponds to the highest voltage for the equipment (U_m).

Refer to IEC 60947-1 and 5.2 of IEC 61439-1:2020 for low-voltage switchgear and controlgear. This value referred as U_n corresponds to the nominal voltage of the electrical system (U_n) to which it is connected.

Subclause 5.4.1 of IEC 60076-1:2011 is applicable for the power transformer. This value referred as U_r is equivalent to the nominal voltage of the electrical system (U_n) to which it is connected. A power transformer has two different rated voltages, one for the high-voltage side and one for the low-voltage side.

NOTE These values are coordinated with the characteristics of the high-voltage/low-voltage power transformer. The high-voltage switchgear and controlgear rated voltage is higher than the high-voltage rated voltage of the power transformer. The low-voltage switchgear and controlgear rated voltage can be higher than the rated voltage of the power transformer.

5.3 Rated insulation level (U_d , U_p , U_s)

Subclause 5.3 of IEC 62271-1:2017 applies to components of the prefabricated substation assembly. The specific requirements and references for each component of the prefabricated substation are as follows.

Rated insulation level of a prefabricated substation is defined by the rated insulation levels of its high-voltage switchgear and controlgear and low-voltage switchgear and controlgear.

For high-voltage switchgear and controlgear, refer to 5.3 of IEC 62271-1:2017 and for low-voltage switchgear and controlgear refer to 5.2 of IEC 61439-1:2020 and to IEC 60947-1.

The rated insulation levels of the power transformer shall be compatible with the rated insulation levels of the prefabricated substation. Refer to 5.6 of IEC 60076-1:2011 about applicable insulation levels in relation with the highest voltage for the equipment (U_m).

The minimum rated lightning impulse voltage withstands of the low-voltage switchgear and controlgear shall be at least the value given for overvoltage category IV in Table F.1 of IEC 60664-1:2020. Depending on the network in different countries, it can be necessary to choose a higher insulation level.

5.4 Rated frequency (f_r)

Subclause 5.4 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

Each prefabricated substation shall have a rated frequency compatible with the rated frequencies of each of its components as defined by each component standard. In particular, for high-voltage switchgear and controlgear, refer to 5.4 of IEC 62271-1:2017, for power transformer refer to 5.4.2 of IEC 60076-1:2011 and for low-voltage switchgear and controlgear, refer to IEC 60947-1 and 5.5 of IEC 61439-1:2020.

For CEADS, refer to 4.3 of IEC 62271-212:2016.

5.5 Rated continuous current (I_r)

Subclause 5.5 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

A high-voltage/ low-voltage transformer prefabricated substation, in general, will have a rated continuous current I_r for the high-voltage interconnection (if any) and a rated current I_{nc} for the low-voltage interconnection (if any). Both will depend on the rated power of the power transformer.

A prefabricated substation will also have the assigned rated continuous currents of the high-voltage switchgear and controlgear assembly and of the low-voltage switchgear and controlgear assembly (if any).

For high-voltage switchgear and controlgear I_r , refer to 5.5 of IEC 62271-1:2017 and for low-voltage switchgear and controlgear I_{nA} , I_{nc} , I_{ng} , refer to 5.3 of IEC 61439-1:2020. For both assemblies, the rated continuous currents associated to the circuits connected to the power transformer shall be compatible with the rated continuous currents of the interconnections.

5.6 Rated short-time withstand current (I_k)

Subclause 5.6 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

For the rated short-time withstand currents I_k and I_{ke} of high-voltage switchgear and controlgear, high-voltage interconnection and earthing circuit, 5.6 of IEC 62271-1:2017 is applicable with the additions stated in 5.6.101 and 5.6.102. For low-voltage switchgear and controlgear and low-voltage interconnection, 5.6.103 applies.

5.6.101 Rated short-time withstand current of high-voltage switchgear and controlgear and high-voltage interconnection (I_k)

Rated short-time withstand current I_k shall be assigned to high-voltage switchgear and controlgear and also to high-voltage interconnection.

NOTE In principle, the rated short-time withstand current of a main circuit cannot exceed the corresponding rated values of the weakest of its series connected components. However, for each circuit, advantage can be taken of apparatus limiting the short-circuit current, such as current-limiting fuses, reactors, etc.

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

A rated short-time withstand phase to earth current shall be assigned to the earthing circuit (I_{ke}). This value may differ from that of the main circuit.

This rated value applies only to the earthing circuit intended to earth the high-voltage circuits of the prefabricated substation, i.e. from the earthing point of the high-voltage switchgear and controlgear to the earthing point of the prefabricated substation to be connected to the external earth.

NOTE The short-circuit current ratings applicable to the earthing circuit depend upon the type of system neutral earthing for which it is intended. See Table 4.

5.6.103 Rated short-time withstand currents of low-voltage switchgear and controlgear and low-voltage interconnection (I_{cw})

Refer to 5.3.5 of IEC 61439-1:2020.

5.7 Rated peak withstand current (I_p)

Subclause 5.7 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

For the rated peak withstand currents I_p and I_{pe} of high-voltage switchgear and controlgear, high-voltage interconnection and earthing circuit, 5.7 of IEC 62271-1:2017 is applicable with the additions stated in 5.7.101. For low-voltage switchgear and controlgear and low-voltage interconnection, 5.7.102 applies.

NOTE In principle, the rated peak withstand current of a main circuit cannot exceed the corresponding rated values of the weakest of its series connected components. However, for each circuit, advantage can be taken of apparatus limiting the short-circuit current, such as current-limiting fuses, reactors, etc.

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

A rated peak withstand phase to earth current shall be assigned to the earthing circuit (I_{pe}). This value may differ from that of the main circuit.

This rated value applies only to the earthing circuit intended to earth the high-voltage circuits of the prefabricated substation, i.e. from the earthing point of the high-voltage switchgear and controlgear to the earthing point of the prefabricated substation to be connected to the external earth.

5.7.102 Rated peak withstand currents of low-voltage switchgear and controlgear and low-voltage interconnection (I_{pk})

Refer to 5.3.4 of IEC 61439-1:2020.

5.8 Rated duration of short-circuit (t_k)

Subclause 5.8 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

For the rated durations of short-circuit t_k and t_{ke} for high-voltage switchgear and controlgear, high-voltage interconnection and earthing circuit 5.8 of IEC 62271-1:2017 is applicable with the additions stated in 5.8.101 and 5.8.102. For low-voltage switchgear and controlgear and low-voltage interconnection, 5.8.103 applies. For power transformer, 5.8.104 applies.

5.8.101 Rated duration of short-circuit (t_k)

A rated duration of short-circuit shall be assigned to high-voltage switchgear and controlgear and to high-voltage interconnection.

NOTE In principle, the rated duration of short-circuit for a main circuit cannot exceed the corresponding rated value of the weakest of its series connected components. However, for each circuit, advantage can be taken of apparatus limiting the duration of the short-circuit current, such as current-limiting fuses.

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

A rated duration of phase to earth short-circuit shall also be assigned to the earthing circuit (t_{ke}). This value may differ from that of the main circuit.

This rated value applies only to the earthing circuit intended to earth the high-voltage circuits of the prefabricated substation, i.e. from the earthing point of the high-voltage switchgear and controlgear to the earthing point of the prefabricated substation to be connected to the external earth.

5.8.103 Rated duration of short-circuits for low-voltage switchgear and controlgear and low-voltage interconnection

Refer to 5.3.5 of IEC 61439-1:2020 for low-voltage switchgear and controlgear and assign a rated duration of short-circuit to the low-voltage interconnection.

5.8.104 Rated duration of short-circuits for power transformers

Refer to IEC 60076-5:2006 and IEC 60076-11:2018.

5.9 Rated supply voltage of auxiliary and control circuits (U_a)

Subclause 5.9 of IEC 62271-1:2017 is applicable to the auxiliary and control circuits of the prefabricated substation.

5.10 Rated supply frequency of auxiliary and control circuits

Subclause 5.10 of IEC 62271-1:2017 is applicable to the auxiliary and control circuits of the prefabricated substation.

5.11 Rated pressure of compressed gas supply for controlled pressure systems

Subclause 5.11 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

For high-voltage switchgear and controlgear, 5.11 of IEC 62271-1:2017 is applicable.

5.101 Rated power of prefabricated substation and class of enclosure

5.101.1 Rated power of the prefabricated substation

The rated power of the prefabricated substation indicates the highest rated power S_r (in kVA), associated rated total losses (in W) and temperature rise limits (as defined in IEC 60076-1:2011 or IEC 60076-11:2018) from all the power transformers for which the prefabricated substation has been designed and type tested in accordance with 7.5. It is expressed as a three-parameter rated value, for example 630 kVA – 5 500 W – 60/65 K O/W for an oil-immersed power transformer or 630 kVA – 5 500 W – insulation class F for a dry-type power transformer.

A prefabricated substation may have more than one three-parameter rated value, if power transformers with lower rated power but with higher total losses are also an option given by the manufacturer of the prefabricated substation.

If a prefabricated substation is equipped with two or more power transformers, the manufacturer shall indicate the power transformers for which the prefabricated substation is designed and type tested, to work simultaneously at rated power and with their associated rated total losses.

5.101.2 Rated class of enclosure

The rated class of the enclosure is the class of the enclosure corresponding to the rated power of the prefabricated substation.

The rated class of the enclosure, the power transformer temperature rise limits and the service conditions are used to determine the load factor of the power transformer according to Annex D.

There are six rated classes of enclosure: classes 5, 10, 15, 20, 25 and 30 corresponding to a maximum value of difference of the temperature rise of the power transformer of 5 K, 10 K, 15 K, 20 K, 25 K and 30 K, respectively (see Figure 1 and Figure 2).

NOTE The manufacturer can assign to an enclosure several classes corresponding to different values of power and losses of the power transformer. These additional classes are confirmed by test according to 7.5 (see also 9.103).

The rated class of the enclosure only takes into account internal sources of heat, in particular from the components contained inside. The impact of an external heat source as solar radiation is treated in 6.108 and Annex G.

5.102 Ratings of the internal arc classification (IAC)

5.102.1 General

If an IAC classification is assigned by the manufacturer, several ratings shall be specified. These ratings are subdivided into type of accessibility, arc fault currents and arc fault durations.

5.102.2 Types of accessibility (A, B, AB)

Three types of accessibility in case of an internal arc are considered.

- Accessibility type A: for prefabricated substations providing protection to the operators during normal operations, standing at the declared accessible high-voltage area(s) inside or in front of the prefabricated substation with necessary door(s) required for normal operation open.

NOTE To verify the protection to the operators a distinction is made between two types of prefabricated substations, depending on their operating mode.

- Prefabricated substation operated from inside (walk-in type): authorized personnel inside the substation with the door open.
 - Prefabricated substation operated from outside (non-walk-in type): authorized personnel on the high-voltage operating side of the substation with the door open.
- Accessibility type B: for prefabricated substations providing protection to the general public in the vicinity of the prefabricated substation on all its accessible sides at any time, with closed door(s).

To qualify for this classification, unrestricted accessibility is considered to all accessible sides of the prefabricated substation with all doors closed, irrespective of the operational mode of the prefabricated substation (from the inside or from the outside). For standardisation purposes, prefabricated substation roofs with a height lower than 1,9 m above the surrounding ground level are considered accessible. See Figure A.3.

- Accessibility type AB: for prefabricated substations providing protection to both operators and the general public.

To qualify for this classification, these prefabricated substations shall comply with the requirements for type A and type B with the same value of the test current in kA and duration in second(s).

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

The standard value of rated arc fault currents should be selected from the IEC 60059:1999 [4] standard current ratings.

Two ratings of the arc fault currents are recognised:

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

When only a three-phase rating is specified, the single phase rating is by default 87 % of the three-phase rating, and need not be specified.

NOTE 1 The manufacturer specifies the compartments of the high-voltage switchgear and controlgear to which the single phase-to-earth arc fault current rating applies. Such value is assigned to switchgear and controlgear where its construction will prevent the arc from becoming multiphase, as demonstrated during the internal arc test.

NOTE 2 Rationale for this 87 % is the arc fault test with 2-phase ignition; refer to 9.104.5.

In the case where all high-voltage compartments of high-voltage switchgear and controlgear and of high-voltage interconnection are only designed and type tested for single phase-to-earth arc faults, I_A rating shall not be assigned.

NOTE 3 Information about the relationship between type of neutral earthing and the single phase-to-earth arc fault current is provided in 9.104.5, and Table 4.

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

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

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

NOTE It is in general not possible to calculate the permissible arc duration for a current which differs from that used in the test. The maximum pressure during the test will generally not decrease with a shorter arcing time and there is no universal rule according to which the permissible arc duration can be increased with a lower test current.

6 Design and construction

Clause 6 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

Prefabricated substations shall be designed so that normal operation, inspection and maintenance can be carried out safely. Additionally, the prefabricated substation shall be designed and constructed in such a manner that the risk of unauthorized access is minimized. Attention shall be paid to hinges, vent covers, locking mechanisms, etc.

The design of the prefabricated substation shall take into account the possible interactions (e.g. electrical, mechanical and thermal) in the performance of different components.

All the components shall comply with their relevant IEC standards.

In particular,

- power transformers according to the applicable documents of IEC 60076 (all parts) [5] listed in Clause 2;
- high-voltage switchgear and controlgear according to IEC 62271-200:2021 or IEC 62271-201:2014;
- low-voltage switchgear and controlgear according to IEC 60947-1 and IEC 61439 (all parts);
- compact equipment assembly for distribution substation (CEADS) according to IEC 62271-212:2016.

6.1 Requirements for liquids in switchgear and controlgear

Subclause 6.1 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

6.2 Requirements for gases in switchgear and controlgear

Subclause 6.2 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

NOTE For the handling of SF₆ in high-voltage switchgear and controlgear, refer to IEC 62271-4 [6].

6.3 Earthing of switchgear and controlgear

Subclause 6.3 of IEC 62271-1:2017 does not apply and it is replaced as follows:

The earthing arrangement of a prefabricated substation includes the following circuits:

- a) earthing circuit(s) for high-voltage switchgear and controlgear;
- b) earthing circuit(s) for all the other components of the prefabricated substation provided with earthing points (terminals);
- c) earthing circuit for metallic parts of the prefabricated substation not belonging to its main components;
- d) protective conductor (if any) of low-voltage circuits.

A main earthing conductor shall be provided to connect to the external earthing system all mentioned earthing circuits a) to c) and protective conductor d).

Annex E shows some typical examples of earthing arrangements.

If the framework of the enclosure, or the reinforcement of the concrete, is made of metallic bolted or welded material, it may serve as the main earthing conductor.

The main earthing conductor and the earthing conductor connected to the earthing point of the high-voltage switchgear and controlgear shall be capable of carrying the rated short-time and peak phase-to-earth withstand currents from that earthing point to the external earthing connection. The main earthing conductor and the protective conductor (if any) of low-voltage circuits shall as well be capable of carrying the short-circuit current and duration according to 10.11.5.6 of IEC 61439-1:2020.

NOTE 1 In general, the above requirement is fulfilled if an earthing conductor of adequate cross-section is provided extending the whole length of the prefabricated substation. As guidance, the current density in an earthing copper conductor, under the specified earth-fault conditions, does not exceed 200 A/mm² for a rated duration of short-circuit of 1 s, and 125 A/mm² for a rated duration of short-circuit of 3 s.

NOTE 2 A method of calculating cross-sectional areas of conductors is given in IEC 60724 [7].

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.

If a dedicated earthing conductor is applied as earthing circuit of the high-voltage switchgear and controlgear, its cross-section shall be not less than 30 mm².

The continuity of the earthing arrangement shall be ensured and appropriate measures preventing corrosion, loosening bolts etc. shall be taken, taking into account the thermal and mechanical stresses caused by the current it may have to carry.

NOTE 3 The users can establish procedures to check the integrity of all parts of the earthing system (internal and external) either periodically or after a short-circuit current has flown into the earthing system.

Components of the prefabricated substation to be connected to the earthing circuit shall include:

- the enclosure of the prefabricated substation if it is metallic,
- the enclosure, if metallic, of the high-voltage switchgear and controlgear from the terminal provided for that purpose,
- the metal shields and the earthing conductors of the high-voltage cables,
- the power transformer tank or metal frame of dry-type power transformers,
- the frame and/or enclosure, if metallic, of the low-voltage switchgear and controlgear, and
- the earthing connection of automatic controls and remote-control devices.

If the enclosure of the prefabricated substation is metallic, covers, doors and other accessible metallic parts of this enclosure shall be connected to the earthing circuit and designed to carry 30 A (DC) from themselves to the prefabricated substation main earthing conductor up to the point for connection to the external earthing circuit, with a voltage drop of maximum 3 V.

If the enclosure of the prefabricated substation is not metallic, then covers, doors and other accessible enclosure metallic parts shall be connected to the earthing circuit. However, this is not required for those metallic parts where there is no risk that they can become live under fault conditions, for example, by using earth shielded high-voltage conductors and connections if located close to metallic parts of the enclosure, or by providing enough safety distance between high-voltage conductors and metallic parts of the enclosure.

An appropriate installation of the prefabricated substation requires earthing measures around the prefabricated substation to prevent dangerous touch and step voltages.

NOTE 4 Local regulations as well as standards like IEC 61936-1 [1] and IEC 60479-1 [8] exist, providing guidance and rules for a correct earthing system.

6.4 Auxiliary and control equipment and circuits

6.4.1 General

Subclause 6.4.1 of IEC 62271-1:2017 applies with following addition.

Subclause 6.4 of IEC 62271-1:2017 is applicable with the exception of 6.4.2.1, 6.4.3.4.4, 6.4.3.4.5 and 6.4.3.5 which are replaced or modified by appropriate contents for the prefabricated substation.

For the low-voltage installation inside the prefabricated substation, for example illumination, auxiliary supply, etc., refer to IEC 60364-4-41:2005 [9], 8.6.2 of IEC 61439-1:2020 and 7.1.6 of IEC 61936-1:2010 [1], as appropriate.

With the widespread use of electronic devices, which may contain temperature-sensitive components, specific measures should be taken to assure the correct installation and performance of this type of equipment. The safety of persons in charge of their maintenance should be taken into consideration as well. Annex H provides guidance on both matters.

6.4.2 Protection against electric shock

6.4.2.1 Protection of auxiliary and control circuits from the main circuit

Subclause 6.4.2.1 of IEC 62271-1:2017 is replaced by the following text.

When high-voltage circuits are not surrounded by an earthed conductive enclosure, auxiliary and control circuits that are installed in proximity or on the frame supporting such high-voltage circuits shall be protected against disruptive discharge from those high-voltage circuits. This is verified during the dielectric type tests specified in 7.2.1.

6.4.2.2 Safety clearance during service

Subclause 6.4.2.2 of IEC 62271-1:2017 applies.

6.4.3 Components installed in enclosures

6.4.3.1 Selection of components

Subclause 6.4.3.1 of IEC 62271-1:2017 applies.

6.4.3.2 Accessibility

Subclause 6.4.3.2 of IEC 62271-1:2017 applies.

6.4.3.3 Identification

Subclause 6.4.3.3 of IEC 62271-1:2017 applies.

6.4.3.4 Requirements for auxiliary and control circuit components

Subclause 6.4.3.4 of IEC 62271-1:2017 applies.

6.4.3.4.1 General

Subclause 6.4.3.4.1 of IEC 62271-1:2017 applies.

6.4.3.4.2 Cables and wiring

Subclause 6.4.3.4.2 of IEC 62271-1:2017 applies.

6.4.3.4.3 Terminals

Subclause 6.4.3.4.3 of IEC 62271-1:2017 applies.

6.4.3.4.4 Auxiliary switches

Subclause 6.4.3.4.4 of IEC 62271-1:2017 applies to the auxiliary switches of high-voltage switching devices if not already specified by their component standards.

6.4.3.4.5 Auxiliary and control contacts

Subclause 6.4.3.4.5 of IEC 62271-1:2017 applies to the auxiliary and control contacts of high-voltage switching devices if not already specified by their component standards.

6.4.3.4.6 Heating elements

Subclause 6.4.3.4.6 of IEC 62271-1:2017 applies.

6.4.3.5 Operation counter

Subclause 6.4.3.5 of IEC 62271-1:2017 applies to the operation counter of high-voltage switching devices if not already specified by their component standards.

6.5 Dependent power operation

Subclause 6.5 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

6.6 Stored energy operation

Subclause 6.6 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

6.7 Independent unlatched operation (independent manual or power operation)

Subclause 6.7 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

6.8 Manually operated actuators

Subclause 6.8 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly

6.9 Operation of releases

Subclause 6.9 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

6.10 Pressure/level indication

Subclause 6.10 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

6.11 Nameplates

Subclause 6.11 of IEC 62271-1:2017 does not apply and it is replaced as follows:

Each prefabricated substation shall be provided with a durable and clearly legible nameplate, which shall contain at least the following information:

- manufacturer's name or trade mark;
- type designation;
- serial number;
- manufacturer's instructions reference(s);
- year of manufacture;
- number of this document;

and where applicable:

- class of enclosure of the prefabricated substation;
- rated power of the prefabricated substation;
- internal arc classification.

The ratings of the high-voltage switchgear and controlgear, power transformers and low-voltage switchgear and controlgear shall be provided with individual nameplates, as in their respective product standard.

6.12 Locking devices

Subclause 6.12 of IEC 62271-1:2017 does not apply and it is replaced as follows:

Interlocking can be necessary to ensure the correct sequence of operation of equipment, to minimise the risk to personnel and damage to the equipment. Interlocking can be achieved by electrical or mechanical methods. In the event of the loss of power supply, electrical interlocking schemes shall be designed to fail safely.

6.13 Position indication

Subclause 6.13 of IEC 62271-1:2017 does not apply to the prefabricated substation assembly.

6.14 Degrees of protection provided by enclosures

Subclause 6.14 of IEC 62271-1:2017 is applicable, with the following additions.