



High-voltage switchgear and controlgear

Part 202: High-voltage/low-voltage prefabricated substation (IEC 62271- 202:2014, MOD)



AS 62271.202:2019

This Australian Standard® was prepared by EL-007, Power Switchgear. It was approved on behalf of the Council of Standards Australia on 21 October 2019.

This Standard was published on 22 November 2019.

The following are represented on Committee EL-007:

- Australian Industry Group
- Energy Networks Australia
- Engineers Australia
- University of New South Wales

This Standard was issued in draft form for comment as DR AS IEC 62271.202:2019.

Keeping Standards up-to-date

Ensure you have the latest versions of our publications and keep up-to-date about Amendments, Rulings, Withdrawals, and new projects by visiting:

www.standards.org.au



High-voltage switchgear and controlgear

Part 202: High-voltage/low-voltage prefabricated substation (IEC 62271- 202:2014, MOD)

Originated as AS 61330—2005.
Revised and redesignated as AS 62271.202—2008.
Second edition 2019.

COPYRIGHT

© IEC 2019 — All rights reserved
© Standards Australia Limited 2019

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968 (Cth).

Preface

This Standard was prepared by the Standards Australia Committee EL-007, Power Switchgear, to supersede AS 62271.202—2008, *High-voltage switchgear and controlgear, Part 202: High-voltage/low-voltage prefabricated substation*.

The objective of this Standard is to specify the service conditions, rated characteristics, general structural requirements and test methods of the following:

- (a) High voltage/low voltage or low voltage/high voltage prefabricated substations, which are cable-connected, to be operated from inside (walk-in type) or outside (non-walk-in type) for alternating current of rated voltages above 1 kV and up to and including 52 kV on the high voltage side.
- (b) One or more transformers for service frequencies up to and including 60 Hz for outdoor installation at locations with public accessibility and where protection of personnel is provided.

In general, a prefabricated substation comprises an enclosure containing the following electrical components:

- (i) Power transformers.
- (ii) High voltage and low voltage switchgear and controlgear.
- (iii) High voltage and low voltage interconnections.
- (iv) Auxiliary equipment and circuits.

However, relevant provisions of this standard are applicable to designs where not all these electrical components exist (for example, an installation consisting of power transformer and low voltage switchgear).

This Standard is an adoption with national modifications, and has been reproduced from, IEC 62271-202:2014, *High-voltage switchgear and controlgear — Part 202: High-voltage/low-voltage prefabricated substation*. The modifications are additional requirements and are set out in Appendix ZZ which has been added at the end of the source text.

Appendix ZZ lists the variations to IEC 62271-202:2014 for the application of this Standard in Australia.

As this document has been reproduced from an International Standard, the following applies:

- (A) In the source text “this part of IEC 62271” should read “this Australian Standard”.
- (B) A full point substitutes for a comma when referring to a decimal marker.

Australian or Australian/New Zealand Standards that are identical adoptions of international normative references may be used interchangeably. Refer to the online catalogue for information on specific Standards.

The terms “normative” and “informative” are used in Standards to define the application of the appendices or annexes to which they apply. A “normative” appendix or annex is an integral part of a Standard, whereas an “informative” appendix or annex is only for information and guidance.

NOTES

CONTENTS

FOREWORD.....	8
INTRODUCTION.....	10
1 General	11
1.1 Scope	11
1.2 Normative references.....	11
2 Normal and special service conditions	13
2.1 Normal service conditions	13
2.1.1 Indoor switchgear and controlgear	13
2.1.1.101 Low-voltage switchgear and controlgear	13
2.1.1.102 Transformer.....	13
2.1.2 Outdoor switchgear and controlgear	14
2.2 Special service conditions.....	14
2.2.1 Altitude	14
2.2.2 Pollution	14
2.2.3 Temperature and humidity	15
2.2.4 Vibrations, shock or tilting.....	15
2.2.5 Wind speed	15
2.2.6 Other parameters	15
3 Terms and definitions	15
4 Ratings.....	17
4.1 Rated voltage (U_r)	18
4.2 Rated insulation level.....	18
4.3 Rated frequency (f_r).....	19
4.4 Rated normal current and temperature rise	19
4.4.1 Rated normal current (I_r)	19
4.4.2 Temperature rise	19
4.4.3 Particular points of Table 3	19
4.5 Rated short-time withstand current (I_k)	19
4.5.101 Rated short-time withstand current of high voltage switchgear and controlgear and high voltage interconnection (I_k).....	20
4.5.102 Rated short-time phase to earth withstand current (I_{ke}).....	20
4.5.103 Rated short-time withstand currents of low voltage switchgear and controlgear and low voltage interconnection (I_{cw}).....	20
4.6 Rated peak withstand current (I_p)	20
4.6.101 Rated peak withstand current (I_p).....	20
4.6.102 Rated peak phase to earth withstand current (I_{pe}).....	20
4.6.103 Rated peak withstand currents of low voltage switchgear and controlgear and low voltage interconnection (I_{pk})	20
4.7 Rated durations of short circuit (t_k)	20
4.7.101 Rated duration of short circuit (t_k).....	21
4.7.102 Rated duration of phase to earth short circuit (t_{ke})	21
4.7.103 Rated duration of short circuits for low voltage switchgear and controlgear and low voltage interconnection	21
4.7.104 Rated duration of short circuits for transformers	21
4.8 Rated supply voltage of closing and opening devices and auxiliary and control circuits (U_a).....	21
4.9 Rated supply frequency of closing and opening devices and of auxiliary circuits	21

4.10	Rated pressure of compressed gas supply for controlled pressure systems	21
4.11	Rated filling levels for insulation and/or operation	21
4.101	Rated maximum power and class of enclosure	22
4.101.1	Rated maximum power of the prefabricated substation	22
4.101.2	Rated class of enclosure	22
4.102	Ratings of the internal arc classification	22
4.102.1	General	22
4.102.2	Types of accessibility (A, B, AB)	22
4.102.3	Rated arc fault currents (I_A , I_{Ae})	22
4.102.4	Rated arc fault duration (t_A , t_{Ae})	23
5	Design and construction	23
5.1	Requirements for liquids in switchgear and controlgear	23
5.2	Requirements for gases in switchgear and controlgear	23
5.3	Earthing of switchgear and controlgear	24
5.4	Auxiliary and control equipment	25
5.5	Dependent power operation	25
5.6	Stored energy operation	25
5.7	Independent manual or power operation (independent unlatched operation)	25
5.8	Operation of releases	25
5.9	Low- and high-pressure interlocking and monitoring devices	25
5.10	Nameplates	25
5.11	Interlocking devices	25
5.12	Position indication	26
5.13	Degree of protection provided by enclosures	26
5.14	Creepage distances for outdoor insulators	26
5.15	Gas and vacuum tightness	26
5.16	Liquid tightness	26
5.17	Fire hazard (flammability)	26
5.18	Electromagnetic compatibility (EMC)	26
5.101	Protection of the prefabricated substation against mechanical stress	26
5.102	Protection of the environment due to internal defects	27
5.103	Internal arc fault	27
5.104	Enclosure	28
5.104.1	General	28
5.104.2	Fire behaviour	28
5.104.3	Corrosion	29
5.104.4	Covers and doors	30
5.104.5	Ventilation openings	30
5.104.6	Partitions	30
5.105	Other provisions	31
5.105.1	Provisions for dielectric tests on cables	31
5.105.2	Accessories	31
5.105.3	Operation aisle	31
5.105.4	Labels	31
5.106	Sound emission	31
5.107	Electromagnetic fields	31
6	Type tests	31

6.1	General.....	31
6.1.1	Grouping of tests	32
6.1.2	Information for identification of specimens	32
6.1.3	Information to be included in type-test reports	32
6.2	Dielectric tests	33
6.2.1	Ambient air conditions during tests	33
6.2.2	Wet test procedure	33
6.2.3	Conditions of switchgear and controlgear during dielectric tests	33
6.2.4	Criteria to pass the test	33
6.2.5	Application of the test voltage and test conditions.....	33
6.2.6	Tests of switchgear and controlgear of $U_r \leq 245$ kV	33
6.2.7	Tests of switchgear and controlgear of $U_r > 245$ kV	33
6.2.8	Artificial pollution tests for outdoor insulators.....	33
6.2.9	Partial discharge tests	33
6.2.10	Dielectric tests on auxiliary and control circuits.....	34
6.2.11	Voltage test as condition check	34
6.2.101	Tests on the high-voltage interconnection.....	34
6.2.102	Tests on low-voltage interconnection	35
6.3	Radio interference voltage (r.i.v.) test	36
6.4	Measurement of the resistance of circuits	36
6.5	Temperature-rise tests	36
6.5.101	General	36
6.5.102	Test conditions	37
6.5.103	Test methods.....	38
6.5.104	Measurements	41
6.5.105	Acceptance criteria	42
6.6	Short-time withstand current and peak withstand current tests	43
6.7	Verification of the protection	43
6.8	Tightness tests	43
6.9	Electromagnetic compatibility tests (EMC)	43
6.10	Additional tests on auxiliary and control circuits	44
6.10.1	General	44
6.10.2	Functional tests	44
6.10.3	Electrical continuity of earthed metallic parts test	44
6.10.4	Verification of the operational characteristics of auxiliary contacts.....	44
6.10.5	Environmental tests	44
6.10.6	Dielectric test	44
6.11	X-radiation test procedures for vacuum interrupters	44
6.101	Calculations and mechanical tests	44
6.101.1	Wind pressure	44
6.101.2	Roof loads	45
6.101.3	Mechanical impacts	45
6.102	Internal arc test.....	45
6.102.1	General	45
6.102.2	Test conditions	45
6.102.3	Arrangement of the equipment.....	46
6.102.4	Test procedure	46

6.102.5	Criteria to pass the test	46
6.102.6	Test report.....	47
6.102.7	Transferability of tests results.....	48
6.103	Measurement or calculation of electromagnetic fields	48
7	Routine tests	48
	<i>Replacement:</i>	49
7.101	Dielectric test on the high voltage interconnection.....	49
7.102	Voltage withstand tests on auxiliary circuits	49
7.103	Functional tests	49
7.104	Verification of correct wiring.....	49
7.105	Tests after assembly on site	49
8	Guide to the selection of prefabricated substation	49
	<i>Replacement:</i>	49
8.101	General.....	49
8.102	Selection of rated values.....	50
8.103	Selection of class of enclosure.....	50
8.104	Internal arc fault.....	50
	8.104.1 General	50
	8.104.2 Causes and preventive measures	51
	8.104.3 Supplementary protective measures	51
	8.104.4 Considerations for the selection and installation	53
	8.104.5 Internal arc test	53
	8.104.6 IAC classification.....	53
8.105	Summary of technical requirements, ratings and optional tests	54
9	Information to be given with enquiries, tenders and orders	58
9.1	Information with enquiries and orders	58
9.2	Information with tenders.....	59
10	Transport, storage, installation, operation, maintenance	60
10.1	Conditions during transport, storage and installation	60
10.2	Installation	60
	10.2.1 Unpacking and lifting	61
	10.2.2 Assembly.....	61
	10.2.3 Mounting	61
	10.2.4 Connections	61
	10.2.5 Final installation inspection.....	61
	10.2.6 Basic input data by the user	61
	10.2.7 Basic input data by the manufacturer	61
10.3	Operation.....	61
10.4	Maintenance	62
10.101	Dismantling, recycling and disposal at the end-of-service life	62
11	Safety.....	62
11.101	Electrical aspects.....	62
11.102	Mechanical aspects	62
11.103	Thermal aspects	62
11.104	Internal arc aspects	62
12	Influence of the product on the environment	63
Annex AA (normative)	Internal arc fault – Method to verify the internal arc classification (IAC)	64

AA.1	General.....	64
AA.2	Room simulation	64
AA.3	Indicators (for assessing the thermal effects of the gases).....	64
AA.3.1	General	64
AA.3.2	Arrangement of indicators.....	65
AA.4	Tolerances for geometrical dimensions of test arrangements	66
AA.5	Test parameters.....	67
AA.6	Test procedure.....	67
Annex BB	(normative) Test to verify the sound level of a prefabricated substation	76
BB.1	Purpose	76
BB.2	Test specimen	76
BB.3	Test method.....	76
BB.4	Measurements	76
BB.5	Presentation and calculation of the results	76
Annex CC	(normative) Mechanical impact test	78
CC.1	Test for the verification of the resistance to mechanical impact.....	78
CC.2	Apparatus for the verification of the protection against mechanical damage.....	78
Annex DD	(informative) Rating of transformers in an enclosure	80
DD.1	General.....	80
DD.2	Liquid-filled transformer	80
DD.3	Dry-type transformer	81
DD.4	Example.....	85
Annex EE	(informative) Examples of earthing circuits	88
Annex FF	(informative) Characteristics of enclosure materials	91
FF.1	Metals.....	91
FF.1.1	Coatings	91
FF.1.2	Paints	91
FF.2	Concrete	91
Bibliography	93
Figure 101	– Measurement of transformer temperature rise in ambient air: Δt_1	37
Figure 102	– Measurement of transformer temperature rise in an enclosure: Δt_2	37
Figure 103	– Diagram of the preferred temperature-rise test method	39
Figure 104	– Diagram of the alternative temperature-rise test method	40
Figure 105	– Diagram for open-circuit test	41
Figure AA.1	– Mounting frame for vertical indicators	68
Figure AA.2	– Horizontal indicators.....	68
Figure AA.3	– Arrangement of indicators.....	71
Figure AA.4	– Selection of tests on high voltage switchgear for class IAC-A	72
Figure AA.5	– Selection of tests on high voltage switchgear for class IAC-B	73
Figure AA.6	– Selection of tests on high voltage interconnections for class IAC-A	74
Figure AA.7	– Selection of tests on high voltage interconnections for class IAC-B	75
Figure CC.1	– Impact test apparatus.....	79
Figure DD.1	– Liquid-filled transformer load factor in an enclosure	81
Figure DD.2	– Dry-type transformer load factor outside of the enclosure.....	81

Figure DD.3 – Insulation class 105 °C (A) dry-type transformers load factor in an enclosure.....	82
Figure DD.4 – Insulation class 120 °C (E) dry-type transformers load factor in an enclosure.....	82
Figure DD.5 – Insulation class 130 °C (B) dry-type transformers load factor in an enclosure.....	83
Figure DD.6 – Insulation class 155 °C (F) dry-type transformers load factor in an enclosure.....	83
Figure DD.7 – Insulation class 180 °C (H) dry-type transformers load factor in an enclosure.....	84
Figure DD.8 – Insulation class 200 °C (H) dry-type transformers load factor in an enclosure.....	84
Figure DD.9 – Insulation class 220 °C (H) dry-type transformers load factor in an enclosure.....	85
Figure EE.1 – Example of earthing circuits.....	88
Figure EE.2 – Example of earthing circuits.....	89
Figure EE.3 – Example within the framework serving as the main earthing conductor.....	90
Table 101 – Synthetic material characteristics.....	29
Table 102 – Locations, causes and examples of measures decreasing the probability of internal arcs.....	52
Table 103 – Single phase-to-earth arc fault current depending on the network neutral earthing.....	54
Table 104 – Summary of technical requirements and ratings for prefabricated substations (1 of 4).....	55
Table FF.1 – Treatment of coatings.....	91
Table FF.2 – Tests of coatings.....	91
Table FF.3 – Test of concrete.....	92

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 202: High-voltage/low-voltage prefabricated substation

FOREWORD

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

International Standard IEC 62271-202 has been prepared by subcommittee 17C: High-voltage switchgear and controlgear assemblies, of IEC technical committee 17: Switchgear and controlgear.

This second edition cancels and replaces the first edition published in 2006. This edition constitutes a technical revision.

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

- a) regarding temperature-rise test an alternative method for liquid filled transformers is (re)introduced and the temperature-rise test method for dry-type transformers is specified more precisely;
- b) testing procedure for short time and peak withstand current tests are specified more precisely;
- c) assessment of electromagnetic fields is considered including a type test (optional) according IEC/TR 62271-208:2009;

- d) influence of the product on the environment is considered (Clause 12);
- e) internal arc test requirements have been adapted to IEC 62271-200:2011 and requirements for the assessment of pressure relief volumes below the floor / ground has been assigned;
- f) the method for defining the load factor in an enclosure for liquid filled transformers is extended with different temperature rises for the transformer outside the enclosure (Annex DD);
- g) for the calculation of the load factor of dry-type transformers in an enclosure the insulation systems according to IEC 60076-1:2011, Tables B.1 and B.2 are worked out in detail.

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

FDIS	Report on voting
17C/595/FDIS	17C/598/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This standard should be read in conjunction with IEC 62271-1:2007 and its Amendment 1:2011, to which it refers and which is applicable, unless otherwise specified. In order to simplify the indication of corresponding requirements, the same numbering of clauses and subclauses is used as in IEC 62271-1. Amendments to these clauses and subclauses are given under the same numbering, whilst additional subclauses are numbered from 101.

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 publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

The contents of the corrigendum of April 2015 have been included in this copy.

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

INTRODUCTION

Prefabricated substations are defined as a type-tested assembly comprising an enclosure containing in general transformers, low-voltage and high-voltage switchgear, connections and auxiliary equipment to supply low-voltage energy from a high-voltage system or vice versa. These substations are in locations accessible to the public and should ensure protection to persons according to the specified service conditions.

This means that, 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 enclosure ensure this protection. The correct design and performance of the prefabricated substation are verified by means of relevant type tests described in this standard, including internal arc tests.

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 202: High-voltage/low-voltage prefabricated substation

1 General

1.1 Scope

This part of IEC 62271 specifies the service conditions, rated characteristics, general structural requirements and test methods of high voltage/low voltage or low voltage/high voltage prefabricated substations, which are cable-connected, to be operated from inside (walk-in type) or outside (non-walk-in type) for alternating current of rated voltages above 1 kV and up to and including 52 kV on the high voltage side, and for one or more transformers for service frequencies up to and including 60 Hz for outdoor installation at locations with public accessibility and where protection of personnel is provided.

Prefabricated substations can be situated at ground level or partially or completely below ground level.

In general a prefabricated substation comprises an enclosure containing the following electrical components:

- power transformers;
- high voltage and low voltage switchgear and controlgear;
- high voltage and low voltage interconnections;
- auxiliary equipment and circuits.

However, relevant provisions of this standard are applicable to designs where not all these electrical components exist (for example, an installation consisting of power transformer and low voltage switchgear).

Non-prefabricated substations should comply with the applicable requirements of IEC 61936-1:2010.

1.2 Normative references

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

IEC 60050-461 (all parts), *International Electrotechnical Vocabulary* (available at www.electropedia.org)

IEC 60068-2-75, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

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

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

IEC 60076-3:2013, *Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air*