

TECHNICAL SPECIFICATION



Power installations exceeding 1 kV a.c. and 1,5 kV d.c. –
Part 2: d.c.

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.020; 29.080.01

ISBN 978-2-8322-2304-8

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

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references	9
3 Terms and definitions	10
4 Fundamental requirements	12
4.1 General.....	12
4.1.1 General requirements	12
4.1.2 Agreements between supplier (manufacturer) and user	12
4.2 Electrical requirements	12
4.2.1 Methods of d.c. neutral point earthing	12
4.2.2 Voltage classification	13
4.2.3 Current in normal operation	13
4.2.4 Short-circuit current	13
4.2.5 Rated frequency	13
4.2.6 Corona	13
4.2.7 Electric and magnetic fields	14
4.2.8 Overvoltages	14
4.2.9 Harmonics	14
4.2.10 Galvanic separation between a.c. and d.c. systems	14
4.3 Mechanical requirements	14
4.4 Climatic and environmental conditions	14
4.4.1 General	14
4.4.2 Normal conditions	15
4.4.3 Special conditions	15
4.5 Special requirements	15
5 Insulation.....	15
5.1 General.....	15
5.2 Selection of insulation level.....	15
5.2.1 Consideration of methods of neutral earthing.....	15
5.2.2 Consideration of rated withstand voltages.....	15
5.3 Verification of withstand values.....	16
5.4 Minimum clearances of live parts	16
5.5 Minimum clearances between parts under special conditions	18
5.6 Tested connection zones	18
6 Equipment	18
6.1 General requirements	18
6.2 Specific requirements	18
6.2.1 Switching devices	18
6.2.2 Reactors.....	18
6.2.3 Prefabricated type-tested switchgear	19
6.2.4 Surge arresters.....	19
6.2.5 Capacitors	19
6.2.6 Line traps	19
6.2.7 Insulators	19
6.2.8 Insulated cables	19

6.2.9	Conductors and accessories	20
6.2.10	Rotating electrical machines	20
6.2.11	Static converters	20
6.2.12	Fuses	20
6.2.13	Electrical and mechanical Interlocking	20
6.2.14	Electronic valve devices	20
6.2.15	Valve cooling system	20
7	Installations	21
7.1	General requirements	21
7.1.1	Circuit arrangement	21
7.1.2	Documentation	21
7.1.3	Transport routes	21
7.1.4	Aisles and access areas	21
7.1.5	Lighting	21
7.1.6	Operational safety	21
7.1.7	Labelling	21
7.2	Outdoor installations of open design	21
7.2.1	Protective barrier clearances	22
7.2.2	Protective obstacle clearances	22
7.2.3	Boundary clearances	22
7.2.4	Minimum height over access area	22
7.2.5	Clearances to buildings	23
7.2.6	External fences or walls and access doors	25
7.3	Indoor installations of open design	25
7.4	Installation of prefabricated type-tested switchgear	25
7.5	Requirements for buildings	25
7.5.1	General	25
7.5.2	Structural provisions	25
7.5.3	Rooms for switchgear	26
7.5.4	Maintenance and operating areas	26
7.5.5	Doors	26
7.5.6	Draining of insulating liquids	26
7.5.7	Air conditioning and ventilation	26
7.5.8	Buildings which require special consideration	27
7.6	High voltage/low voltage prefabricated substations	27
7.7	Electrical installations on mast, pole and tower	27
8	Safety measures	27
8.1	General	27
8.2	Protection against direct contact	27
8.2.1	Measures for protection against direct contact	27
8.2.2	Protection requirements	27
8.3	Means to protect persons in case of indirect contact	28
8.4	Means to protect persons working on electrical installations	28
8.5	Protection from danger resulting from arc fault	28
8.6	Protection against direct lightning strokes	28
8.7	Protection against fire	28
8.8	Protection against leakage of insulating liquid	28
8.9	Identification and marking	28
9	Protection, control and auxiliary systems	28

10	Earthing systems	29
10.1	General.....	29
10.2	Fundamental requirements.....	29
10.2.1	Safety criteria	29
10.2.2	Functional requirements	30
10.2.3	High and low voltage earthing systems	30
10.3	Design of earthing systems	30
10.3.1	General	30
10.3.2	Power system faults.....	31
10.3.3	Lightning and transients.....	31
10.4	Construction of earthing systems	31
10.5	Measurements	31
10.6	Maintainability.....	31
10.6.1	Inspections	31
10.6.2	Measurements.....	32
11	Inspection and testing.....	32
11.1	General.....	32
11.2	Verification of specified performances.....	32
11.3	Tests during installation and commissioning	32
11.4	Trial running	32
12	Operation and maintenance manual	32
	Annex A (informative) Values of rated insulation levels and minimum clearances in air based on nominal voltage of some HVDC projects worldwide.....	33
	Annex B (normative) Method of calculating the voltage limit.....	35
	Bibliography.....	36
	Figure 1 – Approaches with buildings (within closed electrical operating areas)	24
	Figure 2 – Touch voltage limit d.c.	30

INTERNATIONAL ELECTROTECHNICAL COMMISSION

POWER INSTALLATIONS EXCEEDING 1 kV a.c. and 1,5 kV d.c. –

Part 2: d.c.

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.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 61936-2, which is a technical specification, has been prepared by technical committee 99: System engineering and erection of electrical power installations in systems with nominal voltages above 1 kV a.c. and 1,5 kV d.c., particularly concerning safety aspects.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
99/130/DTS	99/132/RVC

Full information on the voting for the approval of this technical specification 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.

A list of all parts in the IEC 61936 series, published under the general title *Power installations exceeding 1 kV a.c. and 1,5 kV d.c.*, can be found on the IEC website.

The following differences exist in the countries indicated below.

7.2.4: For live parts without protective facilities, a minimum height $H = N + 2\ 440$ mm shall be maintained. (Australia)

7.2.6: Guidance reference construction can be found at ENA Doc 015. (Australia)

7.5.4: Space for evacuation shall always be at least 600 mm, even when removable parts or open doors, which are blocked in the direction of escape, intrude into the escape routes. (Australia)

8.7.1: Fire rating of barriers must be a minimum fire rating of 120 minutes. (Australia)

8.7.2: The dimensions G_1 and G_2 are to be measured from the inside edge wall of any bund wall rather than the measured point shown in Figure 7a) and 7b) of IEC 61936-1:2010/AMD1:2014 from the transformer where the bund wall is wider than the transformer. (Australia)

8.8: Spill containment should extend by 50% of the height of the transformer. (Australia)

10: For requirements on earthing, refer to AS 2067, Substations and High Voltage Installations. (Australia)

10.2.1: HV earthing systems should be designed according to tolerable voltages based on body impedances not exceeded by 5 % of the population, as given in Table 10 of IEC TS 60479-1:2005. (United Kingdom)

10.2.1: Permissible touch and step voltages in power installations shall be in accordance with Federal law concerning electrical installations (High and low voltage) (SR 734.0) and Regulations for electrical power installations (SR 743.2 StV). (Switzerland)

10.2.1 and Annex B: Earthing requirements are based on probabilistic calculations and so much of the clause is not appropriate for Australia. (Australia)

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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.

Withdrawn

INTRODUCTION

There are few national laws, standards and internal rules dealing with the matter coming within the scope of this technical specification, and these practices have been taken as a basis for this work.

This part of IEC 61936 contains the minimum requirements valid for IEC countries and some additional information which ensures an acceptable reliability of an installation and its safe operation.

This part of IEC 61936 is published as a Technical Specification in order to welcome contribution and involvement from a wider audience. This may provide the basis for a future international standard.

The publication of this technical specification is believed to be a decisive step towards the gradual alignment all over the world of the practices concerning the design and erection of high voltage power installations.

Particular requirements for transmission and distribution installations as well as particular requirements for power generation and industrial installations are included in this technical specification.

The relevant laws or regulations of an authority having jurisdiction takes precedence.

Withdrawing

POWER INSTALLATIONS EXCEEDING 1 kV a.c. and 1,5 kV d.c. –

Part 2: d.c.

1 Scope

This part of IEC 61936 provides, in a convenient form, common rules for the design and the erection of electrical power installations in systems with nominal voltages above 1,5 kV d.c., so as to provide safety and proper functioning for the use intended.

This technical specification does not apply to the design and erection of any of the following:

- overhead and underground lines between separate installations;
- electric railways;
- mining equipment and installations;
- installations on ships and off-shore installations;
- electrostatic equipment (e.g. electrostatic precipitators, spray-painting units);
- test sites;
- medical equipment, e.g. medical X-ray equipment;
- valve hall.

This technical specification does not apply to the design of factory-built, type-tested switchgear for which separate IEC standards exist.

This technical specification does not apply to the requirements for carrying out live working on electrical installations.

This technical specification does not apply to the design of factory-built, type-tested thyristor valves, VSC valves and switchgear for which separate IEC standards exist.

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

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

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

IEC 60071-5, *Insulation co-ordination – Part 5: Procedures for high voltage direct current (HVDC) converter stations*

IEC 60079-10-1, *Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres*

IEC 60079-10-2, *Explosive atmospheres – Part 10-2: Classification of areas – Combustible dust atmospheres*

IEC TS 60479-1:2005, *Effects of current on human beings and livestock – Part 1: General aspects*

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

IEC TR 61000-5-2, *Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 2: Earthing and cabling*

IEC 61936-1:2010, *Power installations exceeding 1 kV a.c. – Part 1: Common rules*
IEC 61936-1:2010/AMD1:2014

IEC 62271-1:2007, *High-voltage switchgear and controlgear – Part 1: Common specifications*
IEC 62271-1:2007/AMD1:2011

Withdrawing