

Australian Standard[®]

High-voltage test techniques

Part 3: Definitions and requirements for on-site testing



This Australian Standard® was prepared by Committee EL-007, Power Switchgear. It was approved on behalf of the Council of Standards Australia on 8 November 2007. This Standard was published on 31 January 2008.

The following are represented on Committee EL-007:

- Australian British Chamber of Commerce
 - Australian Electrical and Electronic Manufacturers Association
 - Australian Railway Association
 - Energy Networks Association
 - Engineers Australia
 - Testing interests
-

This Standard was issued in draft form for comment as DR 07143.

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

Keeping Standards up-to-date

Australian Standards® are living documents that reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued.

Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments that may have been published since the Standard was published.

Detailed information about Australian Standards, drafts, amendments and new projects can be found by visiting **www.standards.org.au**

Standards Australia welcomes suggestions for improvements, and encourages readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at **mail@standards.org.au**, or write to Standards Australia, GPO Box 476, Sydney, NSW 2001.

Australian Standard[®]

High-voltage test techniques

Part 3: Definitions and requirements for on-site testing

First published as AS 60060.3—2008.

COPYRIGHT

© Standards Australia

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.

Published by Standards Australia GPO Box 476, Sydney, NSW 2001, Australia

ISBN 0 7337 8525 5

PREFACE

This Standard was prepared by the Standards Australia Committee EL-007, Power Switchgear.

The objective of this Standard is to provide requirements for on-site high-voltage tests with direct voltage, alternating voltage, lightning impulse voltage and switching impulse voltage on equipment with highest voltage greater than 1 kV.

This Standard is identical with, and has been reproduced from IEC 60060-3, Ed. 1 (2006), *High-voltage test techniques – Part 3: Definitions and requirements for on-site testing*.

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number does not appear on each page of text and its identity is shown only on the cover and title page.
- (b) In the source text 'IEC 60060-3' should read 'AS 60060.3'.
- (c) A full point should be substituted for a comma when referring to a decimal marker.

The terms 'normative' and 'informative' are used to define the application of the annex to which they apply. A normative annex is an integral part of a standard, whereas an informative annex is only for information and guidance.

CONTENTS

	<i>Page</i>
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Common tests and checks on a measuring system	6
4.1 Acceptance test	6
4.2 Performance test	6
4.3 Performance check	7
4.4 Record of performance	7
5 Tests with direct voltage	7
5.1 General	7
5.2 Definitions for direct voltage tests	7
5.3 Test voltage	8
5.4 Measurement of the test voltage	8
5.5 Tests and checks on measuring systems	9
5.6 Withstand voltage test procedure	9
6 Tests with alternating voltage	9
6.1 General	9
6.2 Definitions for alternating voltage tests	10
6.3 Test voltage	10
6.4 Measurement of the test voltage	11
6.5 Tests and checks on measuring systems	12
6.6 Withstand voltage test procedure	12
7 Tests with lightning impulse voltage	12
7.1 General	12
7.2 Definitions for lightning impulse voltage tests	12
7.3 Test voltage	15
7.4 Measurement of the test voltage and determination of the impulse voltage shape	15
7.5 Tests and checks on measuring systems	16
7.6 Withstand voltage test procedures	16
8 Tests with switching impulse voltage	17
8.1 General	17
8.2 Definitions for switching impulse voltage tests	17
8.3 Test voltage	20
8.4 Measurement of the test voltage and determination of the impulse shape	20
8.5 Tests and checks on measuring systems	21
8.6 Withstand voltage test procedures	21
9 Tests with very low frequency voltages	22
9.1 General	22
9.2 Definitions for very low frequency voltage tests	22
9.3 Test voltage	22
9.4 Measurement of the test voltage	23
9.5 Tests and checks on measuring systems	24
9.6 Test procedure	24

10	Tests with damped alternating voltages.....	24
10.1	General.....	24
10.2	Definitions for damped alternating voltage tests	24
10.3	Test voltage	25
10.4	Measurement of the test voltage	26
10.5	Tests and checks on measuring systems	26
10.6	Test procedure.....	27

INTRODUCTION

The requirements specified in IEC 60060-1 and IEC 60060-2 cannot always be achieved during on-site tests, due to a variety of external factors not present in factory and laboratory tests such as external electric and magnetic fields, weather conditions, etc.

On-site high-voltage tests are required:

- as withstand tests as part of a commissioning procedure on equipment to demonstrate that transport from manufacturer to site, and the erection on-site complies with manufacturer's specification;
- as withstand tests after on-site repair, to demonstrate that the equipment has been successfully repaired, and is in a suitable condition to return to service;
- for diagnostic purposes, e.g. PD measurement, to demonstrate if the insulation is still free from dangerous defects, and as an indication of life expectation.

NOTES

STANDARDS AUSTRALIA

Australian Standard

High-voltage test techniques

Part 3: Definitions and requirements for on-site testing

1 Scope

This part of IEC 60060 is applicable to the following on-site test voltages and in service stresses, which are in relation to IEC 60060-1:

- direct voltage;
- alternating voltage;
- lightning impulse voltage of aperiodic or oscillating shape;
- switching impulse voltage of aperiodic or oscillating shape.

For special tests the following voltages are used:

- very low frequency voltage;
- damped alternating voltage.

This standard is applicable to equipment with a highest voltage U_m greater than 1 kV. The selection of on-site test voltages, test procedures and test voltage levels for apparatus, equipment or installations is under the responsibility of the relevant technical committee. For special applications, on-site test voltages different from those described in this standard may be specified by the relevant technical committee.

NOTE 1 The different voltage waveforms listed above do not necessarily provide equal stress on the test object.

NOTE 2 The selection of the test voltage levels should take the larger tolerances and measuring uncertainties into account.

2 Normative references

The following referenced documents are indispensable for the application 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.

References to international standards that are struck through in this clause are replaced by references to Australian or Australian/New Zealand Standards that are listed immediately thereafter and identified by shading. Any Australian or Australian/New Zealand Standard that is identical to the International Standard it replaces is identified as such.

~~IEC 60060-1:1989, High-voltage test techniques — Part 1: General definitions and test requirements~~

AS 1931.1, *High-voltage test techniques, Part 1: General definitions and test requirements* (identical to IEC 60060-1)

~~IEC 60060-2:1994, High-voltage test techniques — Part 2: Measuring systems~~

AS 1931.2, *High-voltage test techniques, Part 2: Measuring systems* (identical to IEC 60060-2)

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. For all other definitions relating to testing procedures, see IEC 60060-1, and for those relating to measuring systems, see IEC 60060-2. Definitions of parameters are given in the relevant clauses of this standard.

3.1

on-site test

test at the place of use of the apparatus, equipment or installation that is to be tested, and with the test object as far as possible in its service condition

3.2

impulse voltage

intentionally applied aperiodic or oscillating transient voltage, which usually rises rapidly to a peak value and then its enveloping curve falls more slowly to zero

(IEC 60060-1:1989, Term 3, modified)

3.3

lightning and switching impulse voltages

a distinction is made between **lightning and switching impulse voltages** on the basis of duration of the front. Impulses with front duration up to 20 μ s are defined as **lightning impulse voltages** and those with longer fronts are defined as **switching impulse voltages**

Generally, **switching impulse voltages** are also characterized by total durations considerably longer than those of **lightning impulse voltages**.

(IEC 60060-1:1989, Term 3.1)

3.4

characteristics of the test voltage

those characteristics specified in this standard for designating the different types of voltage excursion that define the test voltage

(IEC 60060-1:1989, Term 4.2)

3.5

prospective characteristics of a test voltage

the characteristics which would have been obtained if no disruptive discharge had occurred. When a prospective characteristic is used, this shall always be stated

(IEC 60060-1:1989, Term 4.2.1)

3.6

actual characteristics of a test voltage

characteristics that occur during the test at the terminals of the test object

(IEC 60060-1:1989, Term 4.2.2)

3.7

value of the test voltage

as defined in the relevant clauses of the present standard

(IEC 60060-1:1989, Term 4.2.3)

3.8

classification of insulation in test objects

insulation systems of apparatus and high-voltage structures must basically be classified into **self-restoring** and **non-self-restoring insulation** and may consist of **external** and/or **internal insulation**

(IEC 60060-1:1989, Term 5)

3.8.1

external insulation

distances in atmospheric air, and the surfaces in contact with atmospheric air of solid insulation of the equipment which are subject to dielectric stresses and to the effects of atmospheric and other external conditions such as pollution, humidity, vermin, etc.

(IEC 60071-1:1993, Term 3.2)

3.8.2

internal insulation

internal solid, liquid or gaseous insulation, which are protected from the effects of atmospheric and other external conditions

(IEC 60071-1:1993, Term 3.3)

3.8.3

self-restoring insulation

insulation that completely recovers its insulating properties after a certain time interval following a disruptive discharge caused by the application of a test voltage

(IEC 60071-1:1993, Term 3.4, modified)

3.8.4

non-self-restoring insulation

insulation that loses its insulating properties, or does not recover them completely, after a disruptive discharge caused by the application of a test voltage

(IEC 60071-1:1993, term 3.5, modified)

NOTE In high-voltage apparatus, parts of both self-restoring and non-self-restoring insulation often operate in combination and some parts may be degraded by repeated or continued voltage applications. The behaviour of the insulation in this respect should be taken into account by the relevant technical committee when specifying the test procedures to be applied.

3.9

measuring systems and their components

3.9.1

measuring system

complete set of devices suitable for performing a high-voltage measurement

(IEC 60060-2:1994, Term 3.1.1, modified)

NOTE 1 A **measuring system** is usually comprised of the following components: a converting device with the leads required for connecting this device to the test object and the connections to earth, a transmission system connecting the output terminals of the device to the indicating or recording instruments with its attenuating, terminating and adapting impedance or networks, and indicating or recording instruments together with any connections to the HV source.

These components can be arranged in one compact unit together with the HV source. This usually applies to portable test equipment for medium-voltage apparatus.

NOTE 2 **Measuring systems** which are based on non-conventional principles are acceptable if they meet the accuracy requirements specified in this standard.

NOTE 3 The environment in which a **measuring system** functions, its clearances to live and earthed structures and the presence of electric or magnetic fields may significantly affect its accuracy.

3.9.2

record of performance of a measuring system

detailed record, established by the user, describing the system and containing evidence that the requirements given in this standard have been met. This evidence shall include the results of the initial **acceptance test** and the schedule and results of each subsequent **performance test** and **performance check**

(IEC 60060-2:1994, Term 3.1.2)

3.9.3

approved measuring system

a **measuring system** that is shown to comply with the requirements of this standard by:

- an initial performance test;
- successive **performance checks** and **performance tests**;
- inclusion of the results of these tests in the **record of performance**.

The system is approved only for the arrangements and operating conditions included in its **record of performance**

(IEC 60060-2:1994, Term 3.1.3, modified)

3.9.4

reference measuring system

measuring system having sufficient accuracy and stability for use in the approval (calibration) of other systems by making simultaneous comparative measurements with specific types of waveform and ranges of voltage or current

(IEC 60060-2:1994, Term 3.1.4)

NOTE A reference measuring system (maintained in accordance with the requirements of IEC 60060-2:1994) can be used as an approved measuring system but the converse is not true.

3.9.5

converting device

device for converting the high voltage to be measured into another quantity, compatible with the indicating or recording instrument. Usually voltage dividers or high-voltage measuring impedances are used

(IEC 60060-2:1994, Term 3.2, modified)

NOTE Other examples of converting devices are voltage transformers, optical sensors and electric-field probes.

3.9.6

transmission system

set of devices that transfers the output signal of a converting device to an indicating and/or recording instrument

NOTE 1 A transmission system generally consists of a coaxial cable with its terminating impedances, but it may include attenuators or other devices connected between the converting device and the instrument. For example, an optical link includes the transmitter, the optical cable and the receiver as well as related amplifiers.

NOTE 2 A transmission system may be partially or completely included in the converting device.

(IEC 60060-2:1994, Term 3.3)

3.9.7

indicating or recording instrument

device intended to display or provide a record of the value of a measurand or a derived quantity

(IEC 60060-2:1994, Term 3.4)

3.9.8**scale factor of a measuring system**

factor by which the value of the instrument reading is to be multiplied to obtain the value of the input quantity. The assigned scale factor is that determined at the most recent **performance test**

NOTE 1 For many measuring systems the value of the input quantity is displayed directly (i.e., the scale factor of the measuring system is unity).

NOTE 2 A measuring system may have more than one scale factor, for example, it may have different scale factors for different frequency ranges or impulse shapes.

(IEC 60060-2:1994, Term 3.5, modified)

3.9.9**dynamic behaviour of a measuring system**

behaviour of the **measuring system** in case of a transient change of the input quantity described by the step response or the amplitude/frequency response

3.9.10**uncertainty of a measurement**

parameter, associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand

3.9.11**tolerance**

permitted difference between the measured value and the specified value – to be distinguished from measuring errors, which are the differences between the measured values and the true values

NOTE 1 The measured test voltage is required to lie within the stated tolerance of the specified test level. Test levels are specified by the relevant technical committee. The true value is not exactly known; it is estimated to lie within the range of the measurement uncertainty with the stated coverage probability. The true, but unknown, value may thus lie outside the tolerance range, especially in the case when the measured value is close to the limits of the tolerance range and its uncertainty is partially outside.

NOTE 2 The measured value is the displayed value multiplied by the scale factor. The true value is unknown and would be the mean value of an infinitely large number of identical measurements.

3.9.12**rated measuring voltage**

maximum level of voltage of specified frequency or waveform for which a **measuring system** can be used, and for which it is within the uncertainty limits given in this standard

(IEC 60060-2:1994, term 3.9.1, modified)

3.9.13**operating voltage or current range**

range of voltage or current of specified frequency or waveform in which a **measuring system** can be used, and for which it is within the uncertainty limits given in this standard

(IEC 60060-2:1994, Term 3.9.2, modified)

NOTE The limits of the operating range are chosen by the user and verified by the **performance tests** specified in IEC 60060-2.

3.9.14**operating time (for direct or alternating voltages)**

time during which the **measuring system** can operate at its rated measuring voltage and for which it is within the uncertainty limits given in this standard

(IEC 60060-2:1994, Term 3.9.3, modified)