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High-voltage test techniques –

Part 3: Definitions and requirements for on-site testing

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INTERNATIONAL ELECTROECHNICAL COMMISSION

HIGH-VOLTAGE TEST TECHNIQUES –

Part 3: Definitions and requirements for on-site testing

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.
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International Standard IEC 60060-3 has been prepared by IEC technical committee 42: High-voltage testing techniques.

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

FDIS	Report on voting
42/203/FDIS	42/204/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.

Terms used throughout this standard which have been defined in Clause 3 are written in **bold type.**

IEC 60060 consists of the following parts, under the general title *High-voltage test techniques*:

Part 1: General definitions and test requirements

Part 2: Measuring systems

Part 3: Definitions and requirements for on-site testing

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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- withdrawn;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.

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

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.

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.

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

IEC 60060-2:1994, *High-voltage test techniques – Part 2: Measuring systems*

IEC 60071-1:1993, *Insulation co-ordination – Part 1: Definitions, principles and rules*

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 µs 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