IEC 60505

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INTERNATIONAL STANDARD

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Evaluation and qualification of electrical insulation systems

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Évaluation et qualification des systèmes d'isolation électrique

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IEC Central Office
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CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

EVALUATION AND QUALIFICATION OF ELECTRICAL INSULATION SYSTEMS

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International Standard IEC 60505 has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems.

This fourth edition cancels and replaces the third edition, published in 2004, and constitutes a technical revision.

The main change with respect to the previous edition is the addition of a Glossary in the form of Annex A to this standard.

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

FDIS	Report on voting
112/174/FDIS	112/184/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.

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,
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The contents of the corrigendum of March 2017 have been included in this copy.

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INTRODUCTION

The life of an electrical insulation system (EIS) or systems frequently determines the life of electrical equipment which can be affected by electrical, thermal, mechanical or environmental stresses acting either individually or in combination.

Intended, estimated or proven service life times are essential parameters for describing the life of electrical insulation systems. In the early days of electrotechnical engineering, life figures were rather vague. The limitation of the life of the insulation under thermal stress was one of the first indicators of the effect of ageing in some equipment in service. As experience in using EIS increased, it was appreciated that there was a need to select specific materials having satisfactory life time at a given temperature, to enable the required service life to be achieved and to allow for the calculation of the thermal capability of equipment.

The user of this standard may evaluate existing test methods and provide correlation with his equipment. Therefore, the user of this standard is responsible for demonstrating the validity of the existing test method in accordance with the principles of this standard.

The determination of the prospective life is a fundamental task when developing and designing an EIS. Estimated service life of an EIS needs to be established for several reasons:

– for type testing when introducing a new EIS into production;
– for quality assurance of production;
– for estimating the life expectancy of new equipment;
– for estimating the remaining life for maintenance purposes.

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“Ageing” focuses on the mechanisms affecting the EIS performance. “Evaluation” links these potential mechanisms by “Analysis” and “Diagnostics” to the design of a specific kind of evaluation test procedure.

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The keyword structure below meets such requirements and allows an easier choice of the parts of interest.

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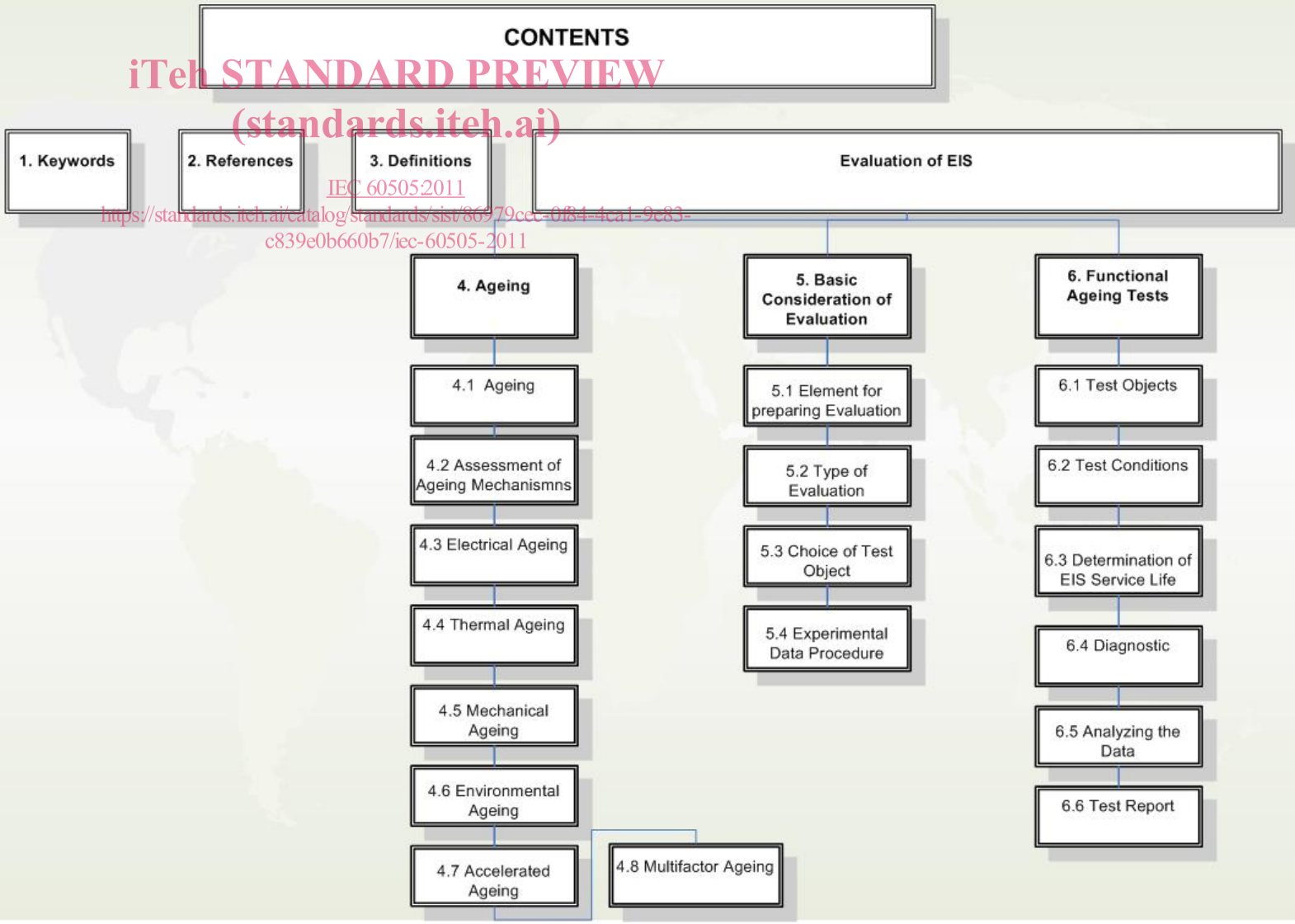

EVALUATION AND QUALIFICATION OF ELECTRICAL INSULATION SYSTEMS

1 Scope

This International Standard establishes the basis for estimating the ageing of electrical insulation systems (EIS) under conditions of either electrical, thermal, mechanical, environmental stresses or combinations of these (multifactor stresses).

It specifies the principles and procedures that shall be followed, during the development of EIS functional test and evaluation procedures, to establish the estimated service life for a specific EIS.

This standard should be used by all IEC technical committees responsible for equipment having an EIS.

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.

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IEC 60216-2, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

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IEC 60216-3, *Electrical insulating materials – Thermal endurance properties – Part 3: Instructions for calculating thermal endurance characteristics*

IEC 60216-5, *Electrical insulating materials – Thermal endurance properties – Part 5: Determination of relative thermal endurance index (RTE) of an insulating material*

IEC 60493-1, *Guide for the statistical analysis of ageing test data – Part 1: Methods based on mean values of normally distributed test results*

IEC 60544-1, *Electrical insulating materials – Determination of the effects of ionizing radiation – Part 1: Radiation interaction and dosimetry*

IEC/TS 61251, *Electrical insulating materials – AC voltage endurance evaluation – Introduction*

IEC 62539, *Guide for the statistical analysis of electrical insulation breakdown data*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 General terms

3.1.1
electrical insulation system
EIS
insulating structure containing one or more electrical insulating materials (EIM) together with associated conducting parts employed in an electrotechnical device

3.1.2
electrical insulating material
EIM
material with negligibly low electric conductivity, used to separate conducting parts at different electrical potentials

[IEC 60050-212:2010, 212-11-01, modified]

3.1.3
reference EIS
established EIS evaluated on the basis of either a known service experience record or a known comparative functional evaluation

3.1.4
candidate EIS
EIS under evaluation to determine its service capability (with regard to electrical, thermal, mechanical, environmental or multifactor stresses)

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3.1.5
intended life
design life of an EIS under service conditions

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3.1.6
estimated life
expected service life derived from either service experience or the results of tests performed in accordance with appropriate evaluation procedures, or both, as established by the responsible organization or technical committee

3.1.7
evaluation
establishment of relationships between service requirements and life data obtained from service experience analysis or from the results of functional tests

3.2 Terms related to service stresses and ageing

3.2.1
ageing stress
electrical, thermal, mechanical or environmental stress whose action on an EIS causes irreversible property changes

3.2.2
potentially destructive stress
stress in service which can cause the failure of the aged EIS, alone or in combination with other stresses

3.2.3
service conditions
combination of stresses and duty that are to be expected in a specific application of an electrical device

3.2.4
reference operating conditions
service conditions of the equipment to which the test conditions of the functional test procedure are related

3.2.5
service requirements
specified stresses, intended performance and duty of an electrical device

3.2.6
service experience
the quantitative and/or qualitative record during service, with or without failure of an EIS

3.2.7
ageing
irreversible changes of the properties of an EIS due to action by one or more stresses

NOTE 1 Some changes (e.g. hydrolytic changes) can be partly reversible if the ambient conditions change.

NOTE 2 Ageing leads to degradation of the EIS.

3.2.8
intrinsic ageing
irreversible changes of fundamental properties of an EIS caused by the action of ageing factors on the EIS

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3.2.9
extrinsic ageing
irreversible changes of properties of an EIS caused by action of ageing factors on unintentionally introduced imperfections in the EIS

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3.2.10
interaction
modifications of the type or degree of ageing produced by the combination of two or more stresses relative to their ageing effect if acting individually on separate objects

3.2.11
direct interaction
interaction between simultaneously applied stresses that differs from that occurring with sequentially applied stresses

3.2.12
indirect interaction
interaction which occurs between simultaneously applied stresses, which remains unchanged when the factors are applied sequentially

3.3 Terms related to testing

3.3.1
functional test
procedure to obtain information about the suitability of an EIS under specified conditions

3.3.2
test object
sample of original equipment or part thereof, or model representing the equipment completely or partially, including the EIS, to be used in a functional test

3.3.3
accelerated ageing
ageing resulting of an increase in the level and/or frequency of application of the stress beyond normal service conditions

3.3.4
accelerated test
functional test applying accelerated ageing to shorten testing time

3.3.5
conditioning

subjecting a specimen to an atmosphere of a specified relative humidity or complete immersion in water or other liquid, at a specified temperature for a specified period of time

3.3.6
prediagnostic conditioning
variable or fixed stresses, which can be applied continuously or periodically to an EIS to enhance the ability of a functional test to detect the degree of ageing

NOTE Prediagnostic conditioning may cause additional ageing.

3.3.7
diagnostic factor
variable or fixed stress which is applied to an EIS to establish the degree of ageing

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3.3.8
diagnostic test
periodic or continuous application of a specified level of a diagnostic factor to a test object to determine whether or when the end-point criterion has been reached

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3.3.9
end-point criterion
moment when a system is no longer able to fulfil its service purposes

3.3.10
life
time for a property to reach the end-point criterion for objects in functional tests

3.3.11
test cycle
in a test, repetitive period of application of one or more stresses, either sequentially or simultaneously, and of diagnostic factors

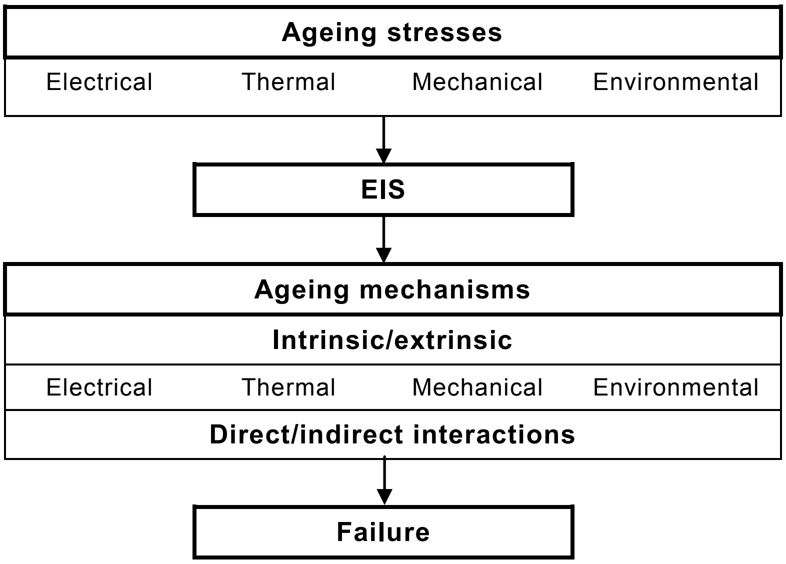
3.3.12
subcycle
defined period within test cycle

NOTE The subcycle may be, for instance, a period of application of high temperature and humidity for influencing the system properties, or application of high voltage for diagnostic purposes

4 Ageing

4.1 Ageing mechanism

Ageing is defined as the irreversible changes of the properties of an EIS due to action by one or more stresses. Ageing stresses may cause either intrinsic or extrinsic ageing. A schematic representation of the basic process is shown in Figure 1.



IEC 1231/11

Figure 1 – Ageing of an EIS

The type and level of contamination and/or the extent of imperfections in an EIS will, in many types of electrical apparatus, significantly affect the service performance. In general, the fewer and less severe the contaminant and/or defects in the EIS, the better is its performance. To avoid obtaining misleading results from functional tests, a candidate EIS should contain, as far as practicable, the full range of contaminants and/or defects expected when the actual system is used in service.

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The ageing stresses produce electrical, thermal, mechanical or environmental ageing mechanisms that eventually lead to failure. During ageing, applied stresses, which initially do not affect the EIS, can cause additional ageing and, as a result, modify the rate of degradation.

When ageing is dominated by one ageing factor, this is referred to as single-factor ageing. Multifactor ageing occurs when more than one ageing factor substantially affects the ageing of the EIS. Ageing factors can act synergistically, i.e. there can be direct interactions between the stresses. Interactions may be either positive or negative.

The ageing of a practical EIS may be complex and failure is usually caused by a combination of ageing mechanisms, even if there is only one dominant ageing factor as, for example, in single-factor ageing.

Where experience or existing knowledge of how a specific EIS will perform in service is limited, the user of this standard shall decide whether single or multifactor test procedures are appropriate for his specific equipment or apparatus.

NOTE The classification of the operational environments of electrical equipment is dealt with in IEC publications prepared by IEC technical committee 75, and methods for environmental endurance testing of electrical equipment are described in IEC publications prepared by IEC technical committee 50 (notably IEC sub-committee 50B), see bibliography.

When speaking of environmental effects, this is understood to comprise environments other than the normal standard laboratory atmospheres specified in IEC 60212.

A number of other standards that provide methods of exposure or characterization of insulation are listed in the bibliography.