IEC 61857-1

Edition 3.0 2008-09

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electrical insulation systems – Procedures for thermal evaluation – Part 1: General requirements – Low-voltage

Systèmes d'isolation électrique – Procédures d'évaluation thermique – Partie 1: Exigences générales – Basse tension

IEC 61857-1:2008

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX P

ICS 29.080.30

ISBN 978-2-88910-581-6

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ELECTRICAL INSULATION SYSTEMS – PROCEDURES FOR THERMAL EVALUATION –

Part 1: General requirements – Low-voltage

FOREWORD

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International Standard IEC 61857-1 has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems.

This third edition cancels and replaces the second edition published in 2004, and constitutes editorial revisions to make this standard compatible with Parts 21 and 22.

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

CDV	Report on voting
112/92/CDV	112/102/RVC

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

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

A list of all the parts in the IEC 61857 series, under the general title *Electrical insulation systems – Procedures for thermal evaluation*, can be found on the IEC website.

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- withdrawn,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.

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INTRODUCTION

This International Standard establishes a standardized test procedure for estimating by comparison the life expectancy of electrical insulation systems (EIS) in accordance with IEC 60505.

An EIS contains many different components selected to withstand the varying electrical, mechanical, and thermal stresses occurring in the different parts of the structure of an electrotechnical product. The useful life of an EIS depends upon the way that its individual components are arranged, their interactions upon each other, and the contribution of each component to the electrical and mechanical integrity of the EIS. Therefore, it is impossible to specify one test object to represent all electrotechnical products. It is incumbent upon the IEC equipment technical committees to address the test objects and application of this test procedure that will meet their specific needs. This work is intended to proceed by cooperation between this technical committee and other IEC technical committees to develop a series of parts, each part to address a specific test object and/or application.

This procedure permits approximate comparisons only, and cannot be relied upon to completely determine the merits of any particular EIS. Such information can be obtained only from extended service experience.

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ELECTRICAL INSULATION SYSTEMS – PROCEDURES FOR THERMAL EVALUATION –

Part 1: General requirements – Low voltage

1 Scope

This part of IEC 61857 specifies a general test procedure for the thermal evaluation and qualification of electrical insulation systems (EIS) and establishes a procedure that compares the performance of a candidate EIS to that of a reference EIS.

This standard is applicable to existing or proposed EIS used in electrotechnical products with an input voltage of up to 1 000 V where the thermal factor is the dominating ageing factor.

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 60085:2004, *Electrical insulation – Thermal classification*

IEC 60216-4-1, *Electrical insulating materials – Thermal endurance properties – Part 4-1: Ageing ovens –Single chamber ovens*

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 60505:2004, *Evaluation and qualification of electrical insulation systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60505, as well as the following definitions, apply.

3.1
electrical insulation system
EIS
insulating structure containing one or more electrical insulating materials (EIM) together with associated conducting parts employed in an electrotechnical device

[IEC 60505, definition 3.1.1]

NOTE EIM with different temperature indices (ATE/RTE according to IEC 60216-5) may be combined to form an EIS which has a thermal class that may be higher or lower than that of any of the individual components according to IEC 60505.

3.2
candidate EIS
EIS under evaluation to determine its service capability (thermal)

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3.3
reference EIS
established EIS evaluated on the basis of either a known service experience record or a known comparative functional evaluation

3.4
thermal class
designation of an EIS that is equal to the numerical value of the maximum use temperature in degrees Celsius (°C) for which the EIS is appropriate (see IEC 60085)

NOTE The EIS may be subjected to operating temperatures exceeding its thermal class which can result in shorter expected life.

3.5
EIS assessed thermal endurance index
EIS ATE
numerical value of temperature in degrees Celsius for the reference EIS as derived from known service experience or a known comparative functional evaluation

3.6
EIS relative thermal endurance index
EIS RTE
numerical value of the temperature in degrees Celsius for the candidate EIS which is relative to the known EIS ATE of a reference EIS, when both EIS are subjected to the same ageing and diagnostic procedures in a comparative test

3.7
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

3.8
thermal ageing factor
thermal stress that causes irreversible changes of the properties of an EIS

3.9
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.

3.10
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

3.11
end-point criterion
value of either a property or change of property defining the end of life of a test object in a functional test

3.12
end-of-life
end of a test object's life as determined by meeting its end-point criterion

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4 General information

4.1 Overview of test procedure

This thermal ageing test procedure is based on the fact that, for most materials, thermal ageing is accelerated when temperature is raised, and that often the degree of acceleration obeys the Arrhenius law on chemical reaction rates. Based on this relationship, acceptable extrapolation of the ageing test results may be used to determine the anticipated thermal performance of the candidate EIS. Accelerated thermal testing requires the verification of an identical or equivalent ageing mechanism compared under operating service conditions.

Test objects consisting of the candidate EIS are exposed to thermal ageing cycles at selected temperatures. Each cycle consists of a specific time exposure at elevated temperature and a subcycle of exposure to prediagnostic conditioning and diagnostic tests. Prediagnostic conditioning may include mechanical stress, cold shock and moisture exposure. A dielectric diagnostic test is used to determine test life. A reference EIS is tested using the same test procedure. At each ageing temperature, the test life of the EIS is determined. Based on these test life values, the thermal class of the candidate EIS is estimated relative to the performance of the reference EIS in its thermal class.

4.2 Basis of evaluation and qualification

The functional testing and evaluation, according to this test procedure, shall be made on a comparative basis, using an established EIS as a reference which is tested with the candidate EIS in equivalent fashion.

If the thermal classes for the candidate and reference EIS differ, then appropriate ageing temperatures are used for each.

4.3 Specific requirements

Separate Parts in the IEC 61857 series address specific test objects and/or applications and test procedures.

Test objects are unique to each part because testing of specific electrotechnical products, or representations thereof, may yield results that are not applicable to other electrotechnical products.

Different electrotechnical products may also require alternative methods of thermal ageing and/or diagnostic tests due to design considerations or end-use requirements.

Each Part shall specify the following:

– scope: electrotechnical products that this test object represents;
– construction of the test object (5.2);
– number of test objects required (5.3);
– test procedures: specific requirements and means of testing for
  - initial dielectric diagnostic test (6.7.1);
  - prediagnostic mechanical stress (6.4);
  - other prediagnostic conditioning, as required (6.5);
  - moisture exposure (6.6);
  - dielectric diagnostic test (6.7.2), or other diagnostic test (6.8); and the end-point criterion;
  - thermal ageing: the means of heating, if other than ovens.

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5 Test objects

5.1 General

Test objects may be actual electrotechnical products, components thereof, or non-functional models representing the products. Components and non-functional models should embody all the essential elements of the EIS used in the electrotechnical product. Identical test objects shall be used for the reference and candidate EIS.

5.2 Description

Specific test objects are described in each Part[1]. Insulation thickness, creepage distances and discharge protection, where required, shall be appropriate for the intended maximum rated voltage and equipment standards in practice.

Particular types of non-functional test objects and alternative test procedures for specific electrotechnical products that have been used successfully may be found in the applicable Part.

Test objects shall be subjected to the quality control of the normal or intended production process.

5.3 Number of test objects

The number of test objects (representative of the EIS) in a group for each ageing temperature shall not be less than five.

NOTE A minimum of five test objects is required to obtain a good statistical average for the end-point analysis of the EIS under consideration.

The actual number of test objects shall be specified in the applicable part.

6 Test procedures

6.1 General

All test objects shall be subjected to initial screening tests followed by repeated thermal endurance test cycles in the following order:

– a thermal ageing subcycle;

– a subcycle of prediagnostic mechanical stress, other prediagnostic requirements and moisture exposure, in that order;

– a dielectric diagnostic test, or other diagnostic test.

It is recognized that, depending on the test facilities available, the type of equipment employed, and other factors, slight variations in the methods of exposing the test objects may be necessary. It is all important that when any two different EIS are compared, the test objects of each shall be subjected to identical exposures and other conditions of test. Unless otherwise specified, prediagnostic conditioning and diagnostic tests shall be carried out at room temperature (25 ± 5) °C and (50 ± 10) % relative humidity.

6.2 Initial screening tests

Prior to exposure to an elevated temperature on the first thermal ageing subcycle, all test objects shall be subjected to a visual inspection and initial screening tests in order to eliminate

[1] The technical committees responsible for equipment may use this test procedure to evaluate the candidate EIS for specific electrotechnical products, or for general purposes through use of an appropriate non-functional model.

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