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Ocenjevanje po več faktorjih s povečanimi dejavniki staranja pri povišani
temperaturi**

Electrical insulation systems - Procedures for thermal evaluation - Part 33: Multifactor
evaluation with increased ageing factors at elevated temperature

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112/605/CDV

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SECRETARIAT:

Germany

SECRETARY:

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OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 2, TC 14, TC 15, TC 23, TC 42, TC 55, TC 96

PROPOSED HORIZONTAL STANDARD:



Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:

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The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting.

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Recipients of this document are invited to submit, with their comments, notification of

- any relevant patent rights of which they are aware and to provide supporting documentation,
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TITLE:

Electrical insulation systems - Procedures for thermal evaluation - Part 33: Multifactor evaluation with increased ageing factors at elevated temperature

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NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRICAL INSULATION SYSTEMS –
PROCEDURES FOR THERMAL EVALUATION –****Part 33: Multifactor evaluation with increased ageing factors
at elevated temperature****FOREWORD**

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International Standard IEC 61857-33 has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
112/XXX/FDIS	112/XXX/RVD

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

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

A list of all parts in the IEC 61857 series, published 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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

Accelerated thermal ageing of an electrical insulation system (EIS) is intended to evaluate the thermal classification of the EIS. Many applications need to include the evaluation of other ageing stresses in addition to the thermal stress.

IEC 60505 provides four categories of ageing stresses which influence the performance of products in use under a wide range of operating conditions. In IEC 60505 the stresses are presented as thermal (T), electrical (E), environmental (E) and mechanical (M). In this part of IEC 61857, environmental (E) is replaced with ambient (A) to avoid the confusion of having two stresses represented by the same letter. In this part of IEC 61857-33 the stresses are therefore presented as thermal (T), electrical (E), ambient/environmental (A) and mechanical (M).

This document follows the structure presented in the Scope of IEC 60505, the evaluation of either thermal, electrical, ambient/environmental, mechanical or combination of these as multifactor stresses.

In order to determine the thermal endurance of an EIS, ageing tests are carried out in accordance with the selected test method of IEC TR 61857-2. To obtain the results within reasonable time these tests are performed at several temperatures considerably higher than the normal service temperature. This document deals with testing where the test objects are exposed to other possible ageing stresses, such as E, A, and/or M in combination with T.

Both the reference EIS and the candidate EIS undergo thermal ageing at three or more elevated temperatures. In this document the examples use three ageing temperatures of high, middle, and low. A total of three sets of test objects for the reference EIS plus a total of three sets of test objects for the candidate EIS are used in comparisons. The preferred number of test objects per set is provided in the selected EIS test method from IEC TR 61857-2.

This document provides the structure for the evaluation of one or more of the three additional stresses E, A and M in combination with T by direct comparison to the baseline established by T. Without the baseline, analysis of the influence of the additional factors is limited.

A test is performed with thermal stress as the only ageing factor. Similar tests are then performed with one or more of the other ageing factors E, A and/or M simultaneously added. Analyses of the results are made to reveal the influence of the E, A and/or M factors.

While similar in their conception, IEC 61857-32 (Multifactor evaluation by diagnostic procedures) and IEC 61857-33 (Multifactor evaluation with increased factors at elevated temperature) have different structure and evaluation conditions. IEC 61857-32 uses thermal exposure as the only intended ageing stress and applies additional stress(es) only during the diagnostic part of each test cycle. IEC 61857-33 combines two or more ageing stresses and the combination of the stresses are applied continuously throughout the ageing process. In other words, IEC 61857-32 uses additional diagnostic procedure(s) and IEC 61857-33 uses additional ageing or stress exposure procedure(s).

ELECTRICAL INSULATION SYSTEMS – PROCEDURES FOR THERMAL EVALUATION –

Part 33: Multifactor evaluation with increased ageing factors at elevated temperature

1 Scope

This part of IEC 61857 series is applicable to the evaluation of an EIS for applications where the stresses of the application are a combination of the multifactor ageing stresses identified in IEC 60505. The increased stress factors are expected to occur during operation at elevated temperatures.

This document establishes the procedure to evaluate the influence of stresses on the performance established following the thermal classification of the EIS. The thermal classification is established in Step 1 where the only ageing stress is thermal. The candidate EIS is first evaluated based on thermal stress only. This evaluation is defined as the baseline of the candidate EIS. In Step 2, the evaluation of the additional stresses applied at elevated temperatures provides the measurement needed to establish the influence of the additional stress factors on the thermal performance of the baseline EIS established in Step 1.

This document is about thermal endurance testing with one or more stresses added during the thermal ageing process. It provides guidance regarding interpretation of the test results.

For performance requirements of any product designed and constructed using the EIS established in accordance with this document refer to the appropriate IEC Technical Committee applicable to the application.

This document is applicable to a range of established EIS test standards. IEC TR 61857-2 provides a list of many established EIS test standards which cover low-voltage [up to 1kV a.c.] and high-voltage [above 1kV a.c.]. The use of 1kV as the transition voltage point between low-voltage and high-voltage can be found in standards such as IEC TC 17 High-voltage switchgear and control gear.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60505, *Evaluation and qualification of electrical insulation systems*

IEC TR 61857-2, *Electrical insulation systems – Procedures for thermal evaluation – Part 2: Selection of the appropriate test method for evaluation and classification of electrical insulation systems*

IEC 61858-1, *Electrical insulation systems – Thermal evaluation of modifications to an established electrical insulation system (EIS) – Part 1: Wire-wound winding EIS*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1**reference EIS**

an established EIS evaluated on the base of either a known service experience record or a known comparative functional evaluation

Note to entry: Refer to IEC 60505

3.2**thermal classification of the reference EIS_{RT}**

established thermal classification of the reference EIS where the thermal index value of the reference EIS is used to establish the correlation time needed to calculate the thermal index value of the candidate EIS

3.3**thermal candidate EIS_{CT}**

EIS under evaluation to determine its service capability with regard to thermal stress

3.4**thermal classification of the candidate EIS_{CT}**

assigned thermal classification of the candidate EIS based on the comparison to the reference EIS represented as the temperature coordinate of the time/temperature graph when the time coordinate of the intercept is the value of the correlation time

3.5**Baseline EIS_T**

the designated candidate EIS after completion of the thermal classification and used to evaluate the influence of additional stresses

3.6**Multifactor candidate EIS_{TX}**

EIS under evaluation to determine its service capability with regard to thermal stress in combination with electrical, ambient/environmental, or mechanical stress(es), where "X" is replaced with E for electrical, A for environmental/ambient or M for mechanical)

3.7**5-degree uncertainty criterion**

When two sets of ageing test results are within ± 5 K of each other the analysis of the test results cannot distinguish a significant difference in long-term endurance of the EIS.

3.8**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

3.9**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

4 Procedure

Figure 1 shows an overview of the two steps of the evaluation procedure starting with the established thermal classification of the reference system EIS_{RT} and including the additional ageing influences (E, A, M) at elevated temperature of the candidate system EIS_{CT}.

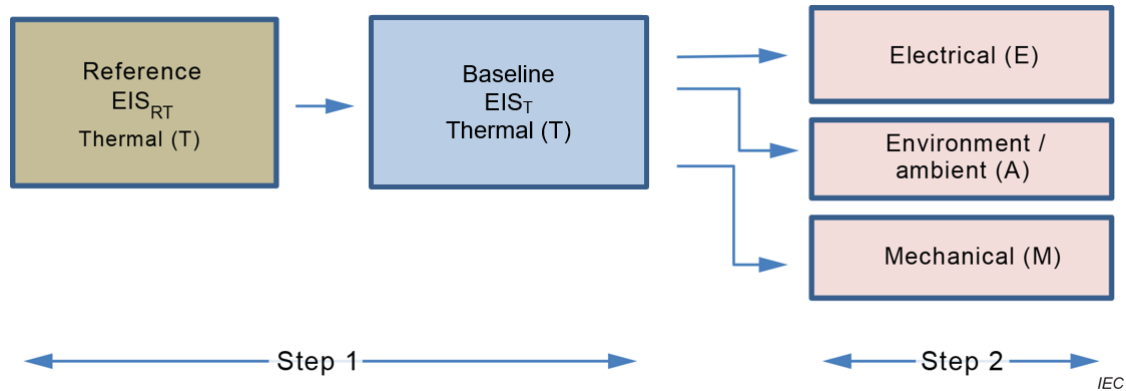


Figure 1 – Overview of the two-step evaluation procedure

The thermal classification of the baseline EIS is established in Step 1. It is derived from the reference EIS for which test data and experience exist.

Step 2 evaluates only the influence of one or more other stresses (E, A, and/or M) in combination with T but cannot alter or change the thermal classification of the baseline candidate EIS_{CT}; this procedure only evaluates the influence of the multifactor stress combination.

Further detail is provided in IEC TR 61857-2 with examples provided in 6.1 of the standard and Annex E of this document.

5 Test objects

Both the reference EIS and the candidate EIS undergo thermal ageing at three or more elevated temperatures. The examples in this document use three ageing temperatures of high, middle, and low. A total of three sets of test objects for the reference EIS plus a total of three sets of test objects for the candidate EIS are used in the examples. Test objects shall be in accordance with the test method selected from IEC TR 61857-2.

The design of the sets of test objects shall be in accordance with the test method selected. When part of the evaluation is to compare processing or alternate designs of the same functioning product, the modifications of the design or processing shall be part of the multifactor test object construction with all modifications documented in the report.

The preferred number of test objects is contained in individual test methods in IEC TR 61857-2.

6 EIS evaluation

6.1 Selection of the appropriate EIS test method

The EIS being evaluated is referred to as the candidate EIS until completion of the thermal classification. Once the thermal classification has been established the candidate is described as the baseline EIS.

IEC TR 61857-2 provides a list of EIS test methods covering a range of applications. Selection of the EIS test method should be based on the most appropriate match to the application.

EXAMPLE 1 The application is for form-wound motors with an operating voltage of 4,2 kV. An appropriate EIS test method to establish the thermal classification is IEC 60034-18-31.

EXAMPLE 2 The application is for an encapsulated low-voltage motor. An appropriate EIS test method to establish the thermal classification is IEC 61857-22.

EXAMPLE 3 The application is for oil immersed transformers. An appropriate EIS test method is either IEC TS 62332-1 or IEC TS 62332-2 depending on the selection of time and test object.

EXAMPLE 4 The application is for form-wound generators when the influence of mechanical (M) stress in the endurance of the EIS is of interest. An appropriate EIS test method is IEC 60034-18-34, a thermomechanical test.

6.2 Comparison of the reference and candidate EIS

The reference EIS and candidate EIS shall be evaluated using the same test method, ageing cycle, conditioning, and diagnostic testing. The end-point criterion of the reference and candidate shall be the same. This direct comparison is essential for analysis of the results. All sets of test objects of the reference and candidate EIS shall be of the same design and construction unless the purpose of the project is to evaluate design changes.

There is no requirement for the reference and candidate EIS to be expected to have the same thermal classification since the thermal classification of the candidate EIS cannot be known until completion of the thermal ageing. The thermal ageing shall continue in accordance with the guidelines of the selected EIS test method until both the reference and candidate EIS have completed the thermal ageing.

In a situation where no established reference EIS can be identified, a preselected time coordinate, or correlation time, is usable as the means to establish the thermal classification of the candidate EIS. The preselected time coordinate, or correlation time, is based on the application in agreement with the users.

This process establishes only the thermal classification of the candidate.

With the completion of the thermal ageing, the candidate EIS becomes the baseline EIS needed to evaluate the influence of the additional stresses.

6.3 Evaluation of the additional stresses E, A and/or M in combination with T

After the thermal classification is completed, the candidate EIS (EIS_{CT}) is defined as being the baseline EIS (EIS_T). The influence of the additional factors is determined by the comparison of the endurance of the combined stresses to the endurance of the baseline EIS (EIS_T). The evaluation as to an exposure of any combined stresses uses the two levels of analysis presented in clause 9 that consists of the analysis of the pattern in the mode(s) of insulation failure and the 5-degree uncertainty criterion in Annex H.

6.4 Variation

To minimize possible variations between equipment, all sets of test objects are expected to be in the same type of ageing chambers and conditioned using the same apparatus. When different sets of test objects cannot be placed into the same ageing chambers or conditioned using the same apparatus, all variations such as differences in ageing ovens uniformity, oven temperature stability, air change rate differences between ageing ovens at the same ageing temperature, different vibration tables – if used, different condensation chambers – if used, different electrical insulation apparatus, or any other equipment or procedure used which is not the same shall be described and included in the test report.

7 Illustration of the structure – Thermal evaluation – Step 1

7.1 Establishing the baseline thermal classification

The thermal classification of the baseline is established when the thermal ageing of both the reference EIS and the candidate EIS have completed as determined in clause 6.1. The analysis of the candidate test results is compared to the reference EIS; refer to

Figure 2. The reference EIS is used only to establish the thermal classification of what becomes the baseline EIS.

