IEC/TS 60034-18-33

Edition 2.0 2010-07

TECHNICAL SPECIFICATION

Rotating electrical machines –
Part 18-33: Functional evaluation of insulation systems – Test procedures for form-wound windings – Multifactor evaluation by endurance under simultaneous thermal and electrical stresses

IEC/TS 60034-18-33:2010(E)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE P

ICS 29.160

ISBN 978-2-88912-066-6

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ROTATING ELECTRICAL MACHINES –

Part 18-33: Functional evaluation of insulation systems – Test procedures for form-wound windings – Multifactor evaluation by endurance under simultaneous thermal and electrical stresses

FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC/TS 60034-18-33, which is a technical specification, has been prepared by IEC technical committee 2: Rotating machinery.

This new edition was originally issued as a technical report in 1995 but has been revised extensively prior to re-issue as a technical specification. The main changes with respect to the earlier version of this document are as follows.

a) the requirement to investigate the nature of interactions between thermal and electrical stresses has been abandoned;
b) the use of single stress acceleration factors has been removed;
c) the selection of stress levels has been adjusted and the temperatures are now related to the thermal class temperature of the insulation system;
d) the introduction of end-point criteria;
e) a simplified method to display results.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
2/1581/DTS	2/1601/RVC

Full information on the voting for the approval of this technical specification 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.

A list of all parts of the IEC 60034 series, published under the general title *Rotating electrical machines,* can be found on the IEC website.

NOTE A table of cross-references of all IEC TC 2 publications can be found on the IEC TC 2 dashboard on the IEC website.

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 be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

INTRODUCTION

This document is being issued as a technical specification (according to the ISO/IEC Directives, Part 1, 3.1.1.1) for provisional application in the field of insulation systems for rotating electrical machines, because there is a need for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an International Standard. It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the IEC Central Office.

Part 18-1 of IEC 60034 presents general guidelines for the evaluation and classification of insulation systems used in rotating machines.

Part 18-33 deals exclusively with insulation systems for form-wound windings and concentrates on multifactor functional evaluation under simultaneous thermal and electrical ageing.

ROTATING ELECTRICAL MACHINES –

Part 18-33: Functional evaluation of insulation systems – Test procedures for form-wound windings – Multifactor evaluation by endurance under simultaneous thermal and electrical stresses

1 Scope

This part of IEC 60034-18 describes procedures for evaluation of insulation systems by endurance testing where thermal and electrical stresses are applied simultaneously. The procedures are intended for insulation systems used, or proposed to be used, in a.c. electrical machines using form-wound windings. The test procedures provide a comparison of performance between reference and candidate systems at combinations of voltage and temperature which have been used separately to assess quality in the past and which are chosen to produce failures within a suitable timescale and at stresses within practical limits. The outcome of the test on the candidate insulation system will indicate whether it is better or worse than the reference system with proven service experience but will not enable a lifetime in service to be calculated. The evaluation described in this technical specification does not include stress grading.

The test procedures in this technical specification are not intended to establish the interaction between thermal and electrical stress in the ageing process nor endurance lines. If additional information is required on this interaction or in order to achieve endurance lines, it is necessary to undertake further tests in which electrical ageing is carried out at constant temperature and different voltages (IEC 60034-18-32) and thermal ageing is performed at different temperatures and constant voltage.

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 60034-15, *Rotating electrical machines – Part 15: Impulse voltage withstand levels of form-wound stator coils for rotating a.c. machines*

IEC 60034-18-1:2010, *Rotating electrical machines – Part 18-1: Functional evaluation of insulation systems – General guidelines*

IEC/TS 60034-18-42, *Rotating electrical machines – Part 18-42: Qualification and acceptance tests for partial discharge resistant electrical insulation systems (Type II) used in rotating electrical machines fed from voltage converters*

IEC 60085, *Electrical insulation –Thermal evaluation and designation*

IEC 60505, *Evaluation and qualification of electrical insulation systems*

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

3 General description of test procedures

3.1 Relationship to other standards

The principles of IEC 60034-18-1 and IEC 60505 shall be followed, unless the recommendations or proposals of this part indicate otherwise.

3.2 Test procedures

Testing may be performed either as a full multifactor or as a single point test procedure involving the application of temperature and voltage simultaneously. The single point test procedure provides a comparison at only one combination of thermal and electrical stress. It results in less information on the performance of the candidate system, but this may be sufficient in some cases, such as when there are minor changes in the insulation system (see 5.5). The procedure may also be used as a quality test of an existing or proven insulation system.

3.3 Reference insulation system

A reference insulation system shall be tested using a test procedure equivalent to that used for the candidate system in the same laboratory, using the same test equipment. The performance of the reference insulation system shall be established by service experience under normal operating conditions.

3.4 Characteristics of test procedures

3.4.1 General characteristics

In general, the tests are performed in cycles, each cycle consisting of ageing, conditioning and diagnostic sub-cycles.

3.4.2 Ageing sub-cycle

The ageing sub-cycle includes the simultaneous application of thermal and electrical stresses.

3.4.3 Conditioning and diagnostic sub-cycle

The conditioning sub-cycle involves the application of mechanical stress and moisture. It is followed by voltage tests and other diagnostic tests, as appropriate. When selecting the values of parameters used in this sub-cycle, the set of reference operating conditions (see 3.8) shall be used as guidance. The operations in the sub-cycle are performed in the order listed in Clause 6.

3.5 Means of heating and definition of thermal stress level

3.5.1 Methods of heating

The specimens shall be heated at a rate typical of normal service. Any appropriate means of heating may be used, such as,

a) total enclosure in an oven;

b) heating of the conductors by a high current;

c) the application of heating plates to the mainwall insulation.

Approach (c) is preferred, as it permits better control of the sample temperature within the test length and allows independent cooling of the stress grading region (see 3.6). It is likely that removal of gases (NO_x and O_3) will be required during high voltage ageing.

3.5.2 Thermal stress level

Where practicable, the thermal stress level is defined as the average conductor temperature in the central part of the slot portion. Where it is considered impracticable to make an accurate assessment of this temperature, the temperature of the outer surface of the main insulation in the middle of the slot section may be used if the conductor is not the heat source.

The method used for the measurement of thermal stress level shall be the same for the candidate and the reference systems. Where oven heating is applied, the oven temperature may provide an acceptable value of thermal stress but only when it has been validated by the procedure given in 3.5.3.

Where thermal stress is provided by current heating, the conductor temperature obtained from resistance measurements is an acceptable value of thermal stress if precautions are taken to maintain constant temperature with ± 5 K between specimens and within them.

3.5.3 Temperature measuring techniques

It is recommended that the temperature measurement be made at two stages

a) at equilibrium with only the thermal stress applied;

b) at equilibrium but after the additional application of the electrical stress.

Both temperatures are recorded for information, with the higher temperature defining the thermal stress level.

Measurement of the temperature in the second stage is most safely carried out using the extrapolated cooling curve technique, immediately after the removal of the electrical stress, or by fibre-optic sensors

Higher local temperatures can occur (for example at the stress grading area). These temperatures may be determined by using an IR detector. If failures occur systematically at these points, the ageing stresses may be too high for the stress grading system that has been used. This problem may be solved by an improvement to the stress grading system.

3.6 Means of electrical ageing

It is recommended that power frequency voltage be used to produce electrical ageing. The a.c. ageing voltage is applied between the conductors and the stator core or the outer conductive layer on the surface of the test specimen. The rms value of the test voltage shall be as shown in Table 1. Conventional stress grading materials applied to the surface of the test samples may not be able to provide satisfactory control of the electrical stress at the ends of the test length when subjected to the high voltages and temperatures proposed in Table 1. Overheating and sparking may occur. It may be necessary to apply a special stress grading system to the test coils so that failure only occurs in the mainwall insulation. Examples could be a capacitively coupled stress grading system, an increase in the mainwall thickness and the creation of stress cones. It may be necessary to apply forced air cooling to the stress grading regions. Remedial action may be taken to ensure that adequate electrical stress relief is provided throughout the test.

To reduce the duration of the test, an increased frequency up to 10 times the power frequency may be used. However, care shall be taken that the dielectric losses do not increase the temperature of the insulation so much that the results are affected. The same frequency shall be used for the candidate and reference system.

3.7 Definition of ageing sub-cycle duration

The ageing sub-cycle will be considered to start at the time when the ageing factors are applied and to end when the ageing factors cease to be applied.