



DPC: 25 / 30510055 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

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Part 18-31: Functional evaluation of insulation systems - Test procedures for form-wound windings - Thermal evaluation and classification of insulation systems used in rotating machines

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

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2/2213/CD, 2/2230/CC

IEC TC 2 : ROTATING MACHINERY

SECRETARIAT:

United Kingdom

SECRETARY:

Mr Charles Whitlock

OF INTEREST TO THE FOLLOWING COMMITTEES:

HORIZONTAL FUNCTION(S):

ASPECTS CONCERNED:

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TITLE:

Rotating electrical machines - Part 18-31: Functional evaluation of insulation systems - Test procedures for form-wound windings - Thermal evaluation and classification of insulation systems used in rotating machines

NOTE FROM TC/SC OFFICERS:

Draft enclosed

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES –

**Part 18-31: Functional evaluation of insulation systems –
Test procedures for form-wound windings –
Thermal evaluation and classification of insulation
systems used in rotating machines**

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- International Standard IEC 60034-18-31 has been prepared by IEC technical committee 2: Rotating machinery.
- This second edition cancels and replaces the first edition published in 1992, and its amendment 1 (1996), of which it constitutes a technical revision.
- The main technical changes with regard to the previous edition include:
- Definition of the test method and sub-cycles required to establish a consistent standardized platform for thermal ageing of insulation systems for form-wound windings.
 - Recommendations for establishing a thermal life curve based on confidence intervals.
 - Comparison of candidate and reference system performance for specific requirements of thermal class, within feasible limits.

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

Enquiry draft	Report on voting

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

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

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

131 The committee has decided that the contents of this publication will remain unchanged until the
132 stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to
133 the specific publication. At this date, the publication will be

- 134 • reconfirmed,
135 • withdrawn,
136 • replaced by a revised edition, or
137 • amended.

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INTRODUCTION

142 IEC 60034-18 comprises several parts, dealing with different types of functional evaluation and
143 special kinds of test procedures for insulation systems of rotating electrical machines.
144 IEC 60034-18-1 provides general guidelines for such procedures and qualification principles.
145 The subsequent parts IEC 60034-18-21, IEC 60034-18-31, IEC 60034-18-32,
146 IEC 60034-18-33, IEC 60034-18-34, IEC 60034-18-41 and IEC 60034-18-42 give detailed
147 procedures for the various types of windings.

148 IEC 60034-18-31 describes thermal evaluation and classification of insulation systems for form-
149 wound windings. It provides standard thermal ageing techniques and diagnostic test
150 procedures.

151 Parts relevant to this document are:

- 152 – IEC 60034-18-1: General guidelines
- 153 – IEC 60034-18-21: Test procedures for wire-wound windings
- 154 – IEC 60034-18-41: Qualification and type tests for Type I electrical insulation systems used
155 in rotating electrical machines fed from voltage converters
- 156 – IEC 60034-18-42: Qualification and acceptance tests for partial discharge resistant
157 electrical insulation systems (Type II) electrical insulation systems used in rotating electrical
158 machines fed from voltage converters

159

ROTATING ELECTRICAL MACHINES –

Part 18-31: Functional evaluation of insulation systems – Test procedures for form-wound windings – Thermal evaluation and classification of insulation systems used in rotating machines

1 Scope

This part of IEC 60034 describes thermal endurance test procedures for classification of insulation systems used in AC or DC rotating electrical machines up to rated voltages of 15 kV with indirect air cooling and form-wound windings.

The test performance of a candidate insulation system is compared to the test performance of a reference insulation system with proven service experience.

The test procedures described in IEC 60034-18-31 are intended to compare the thermal endurance performance of the mainwall insulation between conductor(s) and ground and, where required by the design of the coil or bar, the insulation between the turns.

The outcome of this thermal aging test is comparative and does not allow an estimate to be made, e. g. by extrapolation or calculation, of a definite lifetime in service because a combination of aging stresses or additional factors can intervene. The test is not intended to simulate the in-service mechanical stresses experienced by the endwinding bracing or support materials. It does not include the evaluation of thermo-mechanical deterioration by expansion and contraction of insulation during temperature cycling.

IEC 60034-18-1 describes in detail the general aspects and procedures for the functional evaluation of an insulation system as well as the impact of different aging factors. IEC 60034-18-1 is the leading document for the whole IEC 60034-18 series and provides as well testing principles applicable to thermal endurance testing of insulation systems used in rotating electrical machines. The principles of IEC 60034-18-1 are followed unless otherwise stated in IEC 60034-18-31. In general, the purpose of this standard is not the thermal classification of the reference system.

The thermal class for the insulation system refers to its maximum allowed ("hot spot") temperature. The average temperature measured in service should not exceed the allowed temperature rise according to IEC 60034-1.

The thermal class of an insulation system is not directly related to equipment operating or service temperatures or to service life. The limiting temperature at which an insulation system may be operated depends upon stator winding and machine design, the degree and intermittency of the loading, the degree of reliability required, and the length of the life desired.

A pure thermal classification is typically not sufficient to proof the service life. Also other load factors can have a larger influence on the aging than thermal aging. Thus, instead of performing the test described in this standard, the concept of "service proven" in operation based on records and references should be preferably used by the manufacturer to demonstrate compliance of the reference system. This is because the entire winding elements (bars or coils) must account for various components and physical factors. These include the winding itself, the fixation of the winding system within the slot, end winding insulation, its support system, cooling and ventilation conditions during operation, and heat conductivity across all areas. .

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 AC machines*

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

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

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

IEC 60216-1, *Electrical insulating materials – Properties of thermal endurance – Part 1: Ageing procedures and evaluation of test results*

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 60505, *Evaluation and qualification of electrical insulation systems*

IEC 61858-2, *Electrical insulation systems – Thermal evaluation of modifications to an established electrical insulation system (EIS) – Part 2: Form wound EIS*

3 Terms and Definitions

4 General considerations

4.1 Reference insulation system

A reference insulation system, as described in IEC 60034-18-1, shall be tested using the same procedure as that used for the candidate system.

Acceptable service life of a low voltage system does not automatically qualify a high voltage (HV) system, especially since HV systems usually feature additional materials: for example, corona suppression systems and enhanced turn insulation. These materials may affect the design and thermal endurance of the system.

In case, that

- a) no reference system with reliable service data exists,

239 b) the operational mode of the candidate system will be totally different than the service
240 experience of the reference system or

241 c) for the comparison and pre-validation of new insulation systems and manufacturing
242 processes

243 the candidate system can be tested standalone as described in Annex B. This test will result in
244 a temperature index of the insulation system following the approach of the IEC 60216 series for
245 the validation of thermal endurance properties of electrical insulation materials and simple
246 combinations of such materials.

247 4.2 Test procedures

248 Each thermal endurance test consists of a series of cycles, where each cycle comprises a
249 thermal ageing sub-cycle followed by a diagnostic sub-cycle, consisting of a conditioning
250 procedure and a diagnostic test. The conditioning procedure shall include application of
251 mechanical stress and moisture, in that order. The diagnostic tests are described in Clause 6.

252 The conditioning procedure is not considered as an additional aging stress and does not provide
253 any information about the mechanical performance of e. g. the end winding structure in service.
254 Mechanical and moisture conditioning in front of the diagnostic electrical testing is applied, to
255 determine weaknesses due to degradation of the insulation system during the thermal aging
256 cycle.

257 The mechanical conditioning requires shaking the test object on a table equipped to vibrate with
258 specified amplitude.

259 A condensation chamber is required for moisture conditioning of an unsealed insulation system.

260 For sealed systems, the diagnostic voltage withstand test is preferably performed while the
261 specimens are immersed. For unsealed systems, the diagnostic voltage test may be performed
262 outside the condensation chamber, provided that the samples are still thoroughly wetted. The
263 voltage withstand test in either case shall be applied across the mainwall insulation and
264 between turns, where appropriate to the design of the coil or bar.

265 In addition to the required tests, non-destructive informative diagnostic tests (examples see
266 Note at clause 4.4) may be used to characterize the insulation system or obtain periodic
267 measurements of its response to the thermal and diagnostic sub-cycles.

268 5 Test objects and test specimens

269 5.1 Construction of test objects

270 The various insulating materials and components of an insulation system to be evaluated by
271 these test procedures should be screened beforehand. The temperature indices (TI) of
272 insulating materials may be used, but they provide only an indication of potential performance
273 in the thermal functional tests and do not constitute qualification of insulation systems.

274 Wherever feasible, test objects should closely represent the actual construction of the insulation
275 system to be used in a rotating machine. Usually this requires coils of full cross-section which
276 are produced using representative manufacturing processes and equipment. They are mounted
277 with actual clearances and creepage distances, in a fixture that simulates the arrangement in
278 the machine. The coils or bars are the test specimens, and the complete fixture with specimens
279 in place is the test object.