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Date: 13 August 2024

Origin: International

Latest date for receipt of comments: 4 September 2024

Project No. 2024/00097

Responsible committee: PEL/2 Rotating electrical machinery

Interested committees:

Title: BS EN IEC 60034-18-31 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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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 Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.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

- **Annotated drafts are not acceptable and will be rejected.**
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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.	

PROJECT NUMBER:

IEC 60034-18-31 ED3

DATE OF CIRCULATION:

2024-08-09

CLOSING DATE FOR COMMENTS:

2024-10-04

SUPERSEDES DOCUMENTS:

2/2176/CD, 2/2194A/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:

CONTENTS

1		
2	FOREWORD	4
3	INTRODUCTION	6
4	1 Scope	7
5	2 Normative references	8
6	3 General considerations	8
7	3.1 Reference insulation system	8
8	3.2 Test procedures	9
9	4 Test objects and test specimens	9
10	4.1 Construction of test objects	9
11	4.2 Verification of effects of minor changes in insulation systems	10
12	4.3 Number of test specimens	11
13	4.4 Quality control	11
14	4.5 Initial diagnostic tests	11
15	5 Test procedures	11
16	5.1 Thermal ageing sub-cycle	11
17	5.2 Ageing temperatures and sub-cycle lengths	12
18	5.3 Method of heating	13
19	5.4 Thermal ageing of test objects	13
20	6 Diagnostic sub-cycle	14
21	6.1 Conditioning procedure	14
22	6.1.1 General	14
23	6.1.2 Mechanical conditioning	14
24	6.1.3 Moisture conditioning	14
25	6.2 Diagnostic tests	15
26	6.2.1 Voltage withstand test	15
27	6.2.2 Method	16
28	6.2.3 Turn insulation test	16
29	6.2.4 Mainwall insulation test	16
30	6.3 Informative tests	17
31	7 Reporting and functional evaluation of data from candidate and reference systems	17
32	7.1 General	17
33	7.2 Determining qualification	18
34	7.2.1 Overview	18
35	7.2.2 Case A: Qualification for the same class temperature and same	
36	expected service life	19
37	7.2.3 Case B: Qualification for the same class temperature and a different	
38	expected service life	19
39	7.2.4 Case C: Qualification for a different class temperature and same	
40	expected service life	20
41	7.2.5 Case D: Qualification for a different class temperature and different	
42	expected service life	21
43	7.2.6 Non-linearity of regression lines	22
44	7.2.7 Reduced evaluation	23
45	Annex A (informative) Example of test object (formette) construction	24
46	Annex B (informative) Temperature Index (TI) Determination of an Insulation System	30

47	8 Bibliography	32
48	Figure 1 – Candidate system qualified for the same thermal class and the same	
49	expected service life	19
50	Figure 2 – Candidate system qualified for the same thermal class and different	
51	expected service life	20
52	Figure 3 – Candidate system qualified for a different class temperature and the same	
53	expected service life	21
54	Figure 4 – Candidate system qualified for a different service life and different thermal	
55	class from the reference	22
56	Figure A.1 – Slot assembly – Example 1	25
57	Figure A.2 – Slot assembly – Example 1	26
58	Figure A.3 – Slot assembly – Example 2	27
59	Figure A.4 – Formette for testing DC armature coils.....	28
60	Figure A.5 – Test fixture for rotor slot section	29
61	Figure B.1 – TI of an insulation system, aged at temperatures of 200 °C, 220 °C and	
62	240 °C.	31
63		
64	Table 1 – Thermal classes	12
65	Table 2 – Recommended temperatures and ageing sub-cycle exposure periods	13
66	Table 3 – Conditions for qualification of candidate system	18
67		

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**

FOREWORD

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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.

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

Enquiry draft	Report on voting

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

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

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

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

- 131 • reconfirmed,
132 • withdrawn,
133 • replaced by a revised edition, or
134 • amended.

135

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138

INTRODUCTION

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

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

148 Parts relevant to this document are:

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

156

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 aircooling 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 the degree and intermittency of the loading, the degree of reliability required, and the length of the life desired.

In the context of large electrical machines, e. g. turbo generators, generators and generator/motors for hydraulic turbine applications and large ore mill motors (also called "ring motors"), a pure thermal classification is typically not sufficient. 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. Other load factors have a larger influence on the aging than thermal aging. Thus, instead of performing the test described in this standard, the concept of "time proved" in operation based on the records and references for a service life of at least

203 15 years, should be preferable used by the manufacturer to demonstrate compliance of the
204 reference system.

205 NOTE Recommended parameters for the diagnostic test may be applied according to IEC 60034-18-42 to form-
206 wound coils designed with Type II insulation systems for use in converter applications.

207 **2 Normative references**

208 The following documents, in whole or in part, are normatively referenced in this document and
209 are indispensable for its application. For dated references, only the edition cited applies. For
210 undated references, the latest edition of the referenced document (including any amendments)
211 applies.

212 IEC 60034-15:2009, *Rotating electrical machines – Part 15: Impulse voltage withstand levels*
213 *of form-wound stator coils for rotating AC machines*

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

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

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

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

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

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

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

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

228 IEC 61858-2:2014, *Electrical insulation systems – Thermal evaluation of modifications to an*
229 *established electrical insulation system (EIS) – Part 2: Form wound EIS*

230 **3 General considerations**

231 **3.1 Reference insulation system**

232 A reference insulation system, as described in 4.3 of IEC 60034-18-1, shall be tested using the
233 same procedure as that used for the candidate system.

234 Acceptable service life of a low voltage system (≤ 1000 V for AC and ≤ 1500 V for DC
235 application) does not automatically qualify a high voltage (HV) system, especially since HV
236 systems usually feature additional materials: for example corona suppression systems and
237 enhanced turn insulation. These materials may affect the design and thermal endurance of the
238 system.

239

240 In case, that

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

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

244 c) for the comparison and pre-validation of new insulation systems and manufacturing
245 processes

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

250 3.2 Test procedures

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

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

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

262 A condensation chamber is required for moisture conditioning of an unsealed insulation system.
263 The condensation chamber is required and complete immersion is preferred for moisture
264 conditioning of a sealed insulation system.

265 For sealed systems, the diagnostic voltage withstand test is preferably performed while the
266 specimens are immersed. For unsealed systems, the diagnostic voltage test may be performed
267 outside the condensation chamber, provided that the samples are still thoroughly wetted. The
268 voltage withstand test in either case shall be applied across the mainwall insulation and
269 between turns, where appropriate to the design of the coil or bar. Additional voltage withstand
270 tests may be applied as appropriate to the design.

271 In addition to the required tests, non-destructive informative diagnostic tests may be used to
272 characterize the insulation system or obtain periodic measurements of its response to the
273 thermal and diagnostic sub-cycles.

274 4 Test objects and test specimens

275 4.1 Construction of test objects

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