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Rotating electrical machines - Part 18-32: Functional evaluation of insulation systems - Electrical endurance qualification procedures for form-wound windings

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TITLE:

Rotating electrical machines – Part 18-32: Functional evaluation of insulation systems – Electrical endurance qualification procedures for form-wound windings

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES –

Part 18-32: Functional evaluation of insulation systems (Type II) –
Electrical endurance qualification procedures for form-wound windings

FOREWORD

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International Standard IEC 60034-18-32 has been prepared by IEC technical committee 2: Rotating machinery.

This third edition cancels and replaces the second edition issued in 2010 and constitutes a technical revision.

The main technical changes with regard to the previous edition are as follows.

- a) Simplification of clauses
- b) Reduction in the number of test procedures
- c) Inclusion of full bars and coils as test objects
- d) A new clause dealing with failures and failure criteria

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

FDIS	Report on voting
2/XX/FDIS	2/XX/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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date¹⁾ 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- withdrawn,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.

NOTE A table of cross-references of all IEC TC2 publications can be found in the IEC TC2 dashboard on the IEC website.

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1) The National Committees are requested to note that for this publication the maintenance result date is

1

INTRODUCTION

2 Part 1 of IEC 60034-18 presents general principles for the evaluation of insulation systems used
3 in rotating electrical machines.

4 This Standard deals exclusively with insulation systems for form-wound windings (Type II) and
5 concentrates on electrical functional evaluation.

6 In IEC 60034-18-42, tests are described for qualification of Type II insulation systems in
7 voltage-source converter operation. These insulation systems are generally used in rotating
8 machines which have form-wound windings, mostly rated above 700 V r.m.s. The two standards
9 IEC 60034-18-41 and IEC 60034-18-42 separate the systems into those which are not expected
10 to experience partial discharge activity within specified conditions in their service lives (Type I)
11 and those which are expected to experience and withstand partial discharge activity in any part
12 of the insulation system throughout their service lives (Type II).

13

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14
15
16
17
18**ROTATING ELECTRICAL MACHINES –****Part 18-32: Functional evaluation of insulation systems –
Electrical endurance qualification procedures for form-wound windings****19 1 Scope**

20 This part of IEC 60034-18 describes qualification procedures for the evaluation of electrical
21 endurance of insulation systems for use in rotating electrical machines using form-wound
22 windings. The test procedures are comparative in nature, such that the performance of a
23 candidate insulation system is compared to that of a reference insulation system with proven
24 service experience. If no reference system is available, the diagram in Annex A is available for
25 use. The qualification procedures of inverter duty insulation system for form-wound windings
26 can be found in IEC 60034-18-42 or IEC 60034-18-41.

27 2 Normative references

28 The following referenced documents are indispensable for the application of this document. For
29 dated references, only the edition cited applies. For undated references, the latest edition of
30 the referenced document (including any amendments) applies.

31 IEC 60034-1: *Rotating electrical machines – Part 1: Rating and performance*

32 IEC 60034-15: 2009, *Rotating electrical machines – Part 15: Impulse voltage withstand*
33 *levels of form-wound stator coils for rotating a.c. machines*

34 IEC 60034-18-1: 2010, *Rotating electrical machines – Part 18-1: Functional evaluation of*
35 *insulation systems – General guidelines*, Amendment 1 (1996)

36 IEC 60034-18-33: *Rotating electrical machines – Part 18-33: Functional evaluation of in-*
37 *insulation systems – Test procedures for multifunctional evaluation of form-wound windings*
38 *by endurance under combined thermal and electrical stresses of insulation systems used in*
39 *rotating machines*

40 IEC 60034-18-41: *Rotating electrical machines – Part 18-41: Partial discharge free electrical*
41 *insulation systems (Type I) used in rotating electrical machines fed from voltage converters –*
42 *Qualification and quality control tests (IEC 60034-18-41:2014)*

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

46 IEC 61251 *Electrical insulating materials – A.C. voltage endurance evaluation – Introduction*

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

48 IEC 60034-18-31: *Rotating electrical machines – Part 18-31: Functional evaluation of*
49 *insulation systems – Test procedures for form-wound windings – Thermal evaluation and*
50 *classification of insulation systems used in rotating machines*

51 IEC 60505: *Evaluation and qualification of electrical insulation systems*

52 IEC 60034-27-1: *Rotating electrical machines – Part 27-1: Off-line partial discharge*
53 *measurements on the winding insulation*

54 IEC 60034-27-3: *Rotating electrical machines – Part 27-3: Dielectric dissipation factor*
55 *measurements on stator winding insulation of rotating electrical machines*

56 3 Terms and definitions

57 For the purposes of this document, the following terms and definitions apply.

58 3.1

59 **mainwall insulation**

60 main electrical insulation that separates the conductors from the earthed stator/rotor core in
61 motor and generator windings

62 3.2

63 **strand insulation**

64 electrical insulation that covers each conductor in coils/bars

65 3.3

66 **turn insulation**

67 electrical insulation that separates the conductor turns from each other in coils/bars

68 3.4

69 **conductive slot coating**

70 conductive paint or tape layer in intimate contact with the mainwall insulation in the slot portion
71 of the coil side, often called semi-conductive coating

72 Note 1 to entry: The purpose is to prevent partial discharge from occurring between the coil/bar and the stator core.

73 3.5

74 **stress control coating**

75 paint or tape on the surface of the mainwall insulation that extends beyond the conductive slot
76 coating in high-voltage stator bars and coils

77 Note 2 to entry: The purpose of the coating is to prevent surface discharges in the end winding area.

78 3.6

79 **stress control system**

80 generic name for the combination of the conductive slot coating and stress control coating in
81 high-voltage stator bars and coils

82 3.7

83 **confidence interval**

84 a range of values so defined that there is a specified probability that the value of a parameter
85 (voltage, stress or time) lies within it

86 3.8

87 **test temperature**

88 is the temperature measured by temperature sensors either under the grounding plates or at
89 the specimens surface (oven heating) at the straight part of the coil/bar

90 4 General considerations

91 4.1 Relationship to IEC 60034-18-1

92 The principles of Part 1 of IEC 60034-18 should be followed unless the recommendations of
93 this International Standard indicate otherwise.

94 4.2 Selection and designation of test procedures

95 One or more of the procedures in this International Standard should be suitable for the majority
96 of evaluations. Evaluation is usually performed by the manufacturer of the machine/coils or by
97 a third party laboratory. It is the manufacturer's responsibility to justify the most suitable

98 procedure on the basis of past experience and knowledge of the insulation systems to be
99 compared.

100 Following test procedures are described:

- 101 • Mainwall insulation
- 102 • Turn insulation only together with the main insulation test
- 103 • Conductive slot coating
- 104 • Stress control coating
- 105 • Mainwall insulation, where voltage level and/or life time differs from the reference
106 system

107 4.3 Reference insulation system

108 A reference insulation system should be tested using a test procedure equivalent to that used
109 for the candidate system (see IEC 60034-18-1). The reference insulation system should have
110 service experience at not less than 75 % of the intended maximum rated voltage of the
111 candidate system. When extrapolation of the insulation thickness is used, information such as
112 “different insulation thickness at same electrical field stress levels by obtaining equal or similar
113 breakdown time” should be provided showing the correlation between electrical lifetime and
114 electrical stress for the different insulation thicknesses. If no reference insulation system is
115 available the diagram in Annex A shall be used as criterion.

116 4.4 Test procedures

117 4.4.1 General

118 Electrical ageing tests are usually performed at fixed voltage levels until failure (mainwall
119 insulation) or in combination with elevated temperature until signs of deterioration occur
120 (conductive slot coating system). Statistical evaluation of the results of testing should be
121 performed according to IEC 62539.

122 4.4.2 Electrical ageing of the mainwall insulation

123 From such tests, characteristic times to failure at each voltage level are obtained. The results
124 for both the candidate system and the reference system should be reported on a graph, as
125 shown by the example in Figure 2, and compared. There is no proven physical basis for
126 extrapolation of this characteristic to the service voltage level $U_N/\sqrt{3}$, where U_N is the r.m.s.
127 rated phase to phase voltage.

128 In service, electrical ageing of the mainwall insulation is primarily caused by continuous elec-
129 trical stress at power frequency. In addition, the insulation is required to withstand transient
130 overvoltages arising from switching surges or inverter supply. The ability of the mainwall
131 insulation to withstand transient overvoltages from converter supplies may be demonstrated by
132 the system’s performance using IEC 60034-18-42.

133 This standard describes electrical ageing of the mainwall insulation, carried out at power
134 frequency or higher. In order to keep acceleration of ageing in a linear progression, a maximum
135 of 10 times of the power frequencies is appropriate. Latest experiences with the application of
136 60034-18-42 show that a frequency of up to 1000 Hz can be used as well. Care shall be taken
137 that the dielectric losses do not increase the temperature of the insulation beyond the service
138 temperature to avoid additional thermal ageing effects. (IEC 60034-18-33 table 1)

139 4.4.3 Electrical ageing of the conductive slot coating

140 Ageing of conductive slot coating can be described as a successive degradation of the
141 conductive material caused by partial discharges. The conductive slot coating system shows a
142 notable dependency not only of the electrical field strength, but also of the applied temperature