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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electrical insulation systems – Procedures for thermal evaluation – Part 22: Specific requirements for encapsulated-coil model – Wire-wound electrical insulation system (EIS)

Systèmes d'isolation électriques – Procédures d'évaluation thermique – Partie 22: Exigences particulières pour modèle de bobine encapsulée – Système d'isolation électrique (SIE) à enroulements à fil

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FOREWORD

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International Standard IEC 61857-22 has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems.

This second edition cancels and replaces the first edition published in 2002, and constitutes editorial revisions to make this standard compatible with Parts 1 and 21.

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

CDV	Report on voting
112/91/CDV	112/99/RVC

Full information on the voting for the approval of this standard 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 the parts in the IEC 61857 series, 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 publication will remain unchanged until the maintenance result 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

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- withdrawn,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

INTRODUCTION

A series of parts that will make up IEC 61857 is currently being developed, each of which will address a specific test object and/or application with an associated test procedure.

Additional parts will be developed in cooperation with IEC technical committees responsible for equipment.

ELECTRICAL INSULATION SYSTEMS – PROCEDURES FOR THERMAL EVALUATION –

Part 22: Specific requirements for encapsulated-coil model – Wire-wound electrical insulation system (EIS)

1 Scope

This part of IEC 61857 provides a general-purpose procedure for the evaluation of wire-wound systems using a general purpose encapsulated-coil model (ECM) where the application is unknown.

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 61857-1:2004, *Electrical insulation systems – Procedures for thermal evaluation – Part 1: General requirements – Low voltage*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61857-1, as well as the following definitions, apply.

3.1
encapsulant
electrical insulating material (EIM) that completely encases the coil except for connections to the exterior, and is part of the electrical insulation system (EIS)

NOTE The encapsulated-coil model (ECM) does not employ a supplemental shell.

3.2
encapsulation
process of applying an encapsulant

NOTE For the purpose of evaluating an electrical insulation system (EIS), the process may consist of injection moulding, compression moulding, casting or other techniques.

3.3
bobbin
form around which a coil is wound

3.4
coil
continuous winding of insulated wire

3.5
coil-to-coil insulation
electrical insulating material (EIM) between individual coils

3.6
earth
ground (US)
make an electric connection between a given point in a system or in an installation or in equipment and a local earth

[IEV 195-01-08]

3.7
earth (ground) insulation
electrical insulating material (EIM) between a coil and earthed metal

4 Construction

4.1 General information

The ECM is useful in evaluating the compatibility of EIM used in a candidate EIS. It is equally capable of simulating the influences of actual manufacturing processes such as winding techniques, termination techniques and encapsulation.

The essential parts of the ECM are a bobbin, winding wire, wire connectors and encapsulant.

The winding wires may be connected to binding posts or to lead wires, either of which extends through the encapsulant wall.

4.2 ECM components

The components of the encapsulated-coil model are as follows:

a) Coil: the coils may be wound with two wires in parallel (bifilar winding) or may be wound with a single wire.

b) Wire: winding wire, heavy film coated; 0,4 mm to 0,6 mm diameter wire size is preferred.

c) Earth insulation: the EIM used as the bobbin and the EIM used as the encapsulant function as coil-to-earth insulation. An EIM evaluated only as a coil bobbin shall not also be used as an encapsulant material. An EIM used as an encapsulant shall be evaluated as such.

d) Tape: electrical tape may be used but unless electrically stressed and evaluated is not part of the EIS.

e) Connectors: the winding wires are connected inside the encapsulant to binding posts or lead wires. These connections are essential parts of the ECM.

f) Electrical impregnating resin/varnish: this may be part of the EIS if applied prior to the encapsulation process.

NOTE A metal frame or a lamination stack that may be incorporated into the test object is not an essential part of the test object if it does not function as a fault path.

4.3 Assembly of the ECM

Assemble the ECM as follows:

a) Wind the winding wire over the bobbin using accepted winding techniques.

b) As appropriate, use electrical grade tape or other components to secure the winding wire in place.

c) Connect the winding wire to the binding posts or lead wires.

d) If part of the candidate EIS, apply impregnating resin/varnish.

e) Apply the encapsulant material.

4.4 Similarity of reference and candidate ECM

The physical shape and assembly of the reference and candidate ECM must be similar. It is essential that the size of the winding wire used in the reference and candidate ECM be within ±0,2 mm of each other. Refer to Annex A for more information. Details of the construction of the reference and candidate ECM shall be reported according to 7.4 of IEC 61857-1:2004.

5 Number of test objects

The minimum number of test objects for each EIS and for each ageing temperature shall be ten.

6 Test procedure

6.1 General

All test objects shall be subjected to initial screening tests followed by repeated thermal endurance test cycles in the following order:

a) a thermal ageing subcycle;

b) a subcycle of pre-diagnostic mechanical stress, other pre-diagnostic requirements and moisture exposure, in that order;

c) a dielectric diagnostic test.

6.2 Initial screening test

6.2.1 General

Prior to exposure to an elevated temperature on the first thermal ageing subcycle, all test objects shall be subjected to initial screening tests in order to eliminate defective test objects. The initial screening tests shall consist of the following steps and shall be conducted in the order given:

a) visual inspection;

b) initial dielectric test (see 6.2.2);

c) mechanical stress (see 6.3.3);

d) thermal shock, as required (see 6.3.4)

e) moisture exposure (see 6.3.5);

f) dielectric diagnostic test (see 6.3.6).

6.2.2 Initial dielectric test

An initial screening test using dielectric techniques shall be performed on each ECM test object prior to application of other prediagnostic stresses and thermal ageing, see Table 1.

Table 1 – Initial dielectric tests for ECM

Test	Method	Voltage V	Acceptance criteria
Wire in a single strand coil	Change of resistance	Apply a direct current voltage that will result in a maximum admissible current density at which the active resistance of the winding can be measured. [a]	<3 % reduction of the resistance for the coil design
Wires in bifilar coils	Conductor to conductor	400 ± 40	0,5 A to 0,75 A
Coil-to-coil (for multiple coil constructions)	Dielectric withstand	2 000 ± 100	(40 ± 10) mA
Earth insulation	Dielectric withstand	2 000 ± 100	(40 ± 10) mA
[a] Maximum 1 A/mm^2 of cross-section.			

The following procedure shall then be followed:

- an initial dielectric test voltage shall be applied for a minimum of 60 s;
- failure shall be current flow as defined above prior to completion of the time period;
- frequency of the test voltage shall be between 48 Hz and 62 Hz.

NOTE Instantaneous application of full voltage is not recommended. It is recommended that surge protectors be included in the test circuit to eliminate unintended high voltage spikes.

For test objects evaluated by applied voltage, pre-calibrated electromechanical over-current circuit-breakers with a trip time of 2 s to 3 s have been used successfully to detect failure.

The cause of failure shall be determined. When the failure is within the EIS, it shall eliminate that ECM from further testing. When the failure is not within the EIS and it can be repaired without disturbing the EIS, the ECM may be retested and returned to the test programme if it passes.

6.3 Thermal endurance test

6.3.1 Endurance test cycle

Following the initial screening tests, all test objects shall be subjected to repeated thermal endurance test cycles in the following order:

a) thermal ageing subcycle;
b) mechanical stress subcycle;
c) thermal shock subcycle;
d) moisture exposure subcycle;
e) dielectric diagnostic test.

6.3.2 Thermal ageing

Thermal ageing, comprising selection of ageing temperature, initial ageing periods and ageing procedures shall be conducted in accordance with 6.3 of IEC 61857-1:2004.

Ovens shall be used in accordance with 6.3.4 of IEC 61857-1:2004.

6.3.3 Mechanical stress

Mechanical stress shall be applied by mounting the test objects on a vibration table and exposing them between 55 min to 65 min of sinusoidal vibration at a frequency between 48 Hz and 62 Hz, with a constant acceleration of (14,7 ± 3) ms^{-2}. No voltage shall be applied during this period.

6.3.4 Thermal shock

Unless agreed to by all interested parties, both the reference and candidate EIS shall be exposed to a low-temperature thermal shock. Thermal shock shall be applied by placing ECMs directly from ambient conditions into a low-temperature chamber at (–20 ± 5) °C for at least 2 h. No voltage shall be applied during this period.

6.3.5 Moisture exposure

Moisture exposure with visible condensation shall be applied in accordance with 6.6 of IEC 61857-1:2004.

6.3.6 Dielectric diagnostic test

Following each ageing cycle and conditioning described in 6.3.3 through 6.3.5, evaluate the ECM specimens in accordance with the dielectric diagnostic test given in Table 2.

Table 2 – Dielectric diagnostic tests for ECM

Test	Method	Voltage V	End-of-life
Wire in a single strand coil	Change of resistance	Apply a direct current voltage that will result in a maximum admissible current density at which the active resistance of the winding can be measured. [a]	≥10 % reduction of the resistance for the coil design
Wires in bifilar coils	Conductor to conductor	110 ± 10	0,5 A to 0,75 A
Coil-to-coil (for multiple coil constructions)	Dielectric withstand	600 ± 30	0,5 A to 0,75 A
Earth insulation	Dielectric withstand	2 000 ± 100	(40 ± 10) mA

[a] Maximum 1 A/mm^2 of cross-section.

The following steps shall then be taken:

- dielectric diagnostic test voltages, except for the change of resistance measurement, shall be applied for a minimum of 10 min.
- dielectric diagnostic test voltage for the change of resistance shall be applied for a minimum of 60 s;
- failure shall be current flow as defined above prior to completion of the time period.
- the frequency of the test voltage shall be between 48 Hz and 62 Hz.

NOTE Instantaneous application of full voltage is not recommended. It is recommended that surge protectors be included in the test circuit to eliminate unintended high voltage spikes.

For test objects evaluated by applied voltage, pre-calibrated electromechanical over-current circuit breakers with a trip time of 2 s to 3 s have been used successfully to detect failure.