

TECHNICAL REPORT

**Electrical insulation systems – Thermal evaluation of modifications to an established electrical insulation system (EIS)
Part 3: Clarification of electrical insulating materials (EIMs) and auxiliary materials**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRICAL INSULATION SYSTEMS – THERMAL EVALUATION OF
MODIFICATIONS TO AN ESTABLISHED ELECTRICAL
INSULATION SYSTEM (EIS)****Part 3: Clarification of electrical insulating
materials (EIMs) and auxiliary materials**

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IEC TR 61858-3 has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
112/465/DTR	112/500A/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 61858 series, published under the general title *Electrical insulation systems – Thermal evaluation of modifications to an established electrical insulation system (EIS)*, can be found on the IEC website.

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

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- replaced by a revised edition, or
- amended.

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INTRODUCTION

This part of IEC 61858 describes procedures for the evaluation of changes to an established electrical insulation system (EIS) and the effect of these changes on the thermal classification of the established EIS.

Part 1 of IEC 61858 covers wire-wound winding EISs. Part 2 of IEC 61858 addresses modifications of form-wound winding EISs.

This Part 3 provides guidance for the selection of appropriate procedures (as defined in Part 1 and Part 2) for the evaluation of changes of individual materials, which have functions of different importance in the EIS, also known as "major" electrical insulating materials (EIMs) and "minor" (auxiliary) materials.

General principles for the evaluation and qualification of EISs can be found in IEC 60505. Unless the procedures of this document indicate otherwise, the principles of IEC 60505 should be followed.

The thermal classification of an EIS is established either by known service life, in accordance with IEC 60505, or evaluated in accordance with IEC 61857 (all parts).

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ELECTRICAL INSULATION SYSTEMS – THERMAL EVALUATION OF MODIFICATIONS TO AN ESTABLISHED ELECTRICAL INSULATION SYSTEM (EIS)

Part 3: Clarification of electrical insulating materials (EIMs) and auxiliary materials

1 Scope

This part of IEC 61858 provides information on the identification of electrical insulating materials and auxiliary components for the assessment of modifications to an established insulation system and gives guidance on the selection of feasible test procedures.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 (all parts), *Electrical insulation systems – Procedures for thermal evaluation*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

insulation coordination

mutual correlation of insulation characteristics of electrical equipment taking into account the expected micro-environment and other influencing stresses

Note 1 to entry: Expected voltage stresses are characterized in terms of the characteristics defined in IEC 60664-1:2020, 3.1.7 to 3.1.16.

[SOURCE: IEC 60664-1:2020, 3.1.3]

3.2

electrical insulation system

EIS

insulating structure containing one or more electrical insulating materials (EIMs) together with associated conducting parts employed in an electrotechnical device

[SOURCE: IEC 61858-1:2014, 3.8]

3.3

generic identical material

material which, related to a specific application, shows identical chemical and physical properties or performance in regard to the thermal endurance

3.4

electrical insulating material

EIM

material with negligibly low electric conductivity, used to separate conducting parts at different electrical potentials

Note 1 to entry: Used in an electrical insulation system, EIMs are part of the electrical structure in either creep distance design or strike distance design of the specific parts in the electrical apparatus.

[SOURCE: IEC 61858-1:2014, 3.9, modified – Addition of the note to entry.]

3.5

auxiliary material

material used in an EIS which is not considered as part of the insulation coordination (additions to an insulation system)

Note 1 to entry: Auxiliary materials are typically required for mechanical reinforcement, thermal conductivity, or manufacturing processes. They are not considered essential to prevent risk of electrical shock, fire or, other hazards.

3.6

single-point thermal aging test

thermal aging test for the established EIS and the candidate EIS under one temperature

4 General information

4.1 Purpose of evaluation

This document provides relatively quick and low-cost methods by which the user can make modifications to an established EIS by selecting the following evaluation procedures:

- Procedure G: Proof of generic identical materials in accordance with 5.1;
- Procedure A: Without test;
- Procedure B: Compatibility test in accordance with 5.3;
- Procedure C: Single-point thermal aging test in accordance with 5.4;
- Procedure D: Full thermal aging test in accordance with 5.5.

The main evaluation points are the following:

- a) the impact on the thermal life of the EIS if the thickness of an EIM is changed;
- b) the compatibility, under thermal stress, of a substituted EIM;
- c) the compatibility, under thermal stress, of other components used in intimate contact with an established EIS.

4.2 Categories of evaluation

Electrical insulating materials, which are not generic identical to the original EIM shall be evaluated with a single-point or full thermal aging.

Auxiliary materials shall be evaluated by a suitable compatibility test according to 5.3 (procedure B), or if the definition of a compatibility test is not possible, with a single-point aging.

5 Evaluation procedures

5.1 Procedure G – Proof of generic identical materials

Generic identity shall be tested by molecular spectroscopy (Fourier transform infrared spectroscopy (FTIR), (preferred), near infrared spectroscopy (NIR), Raman spectroscopy (Raman), ultraviolet/visual light spectroscopy (UV/Vis)), by thermal analytical tests (thermogravimetry (TG), differential scanning calorimetry (DSC), dynamic mechanical analysis (DMA), differential thermal analysis (DTA)), supported by the determination of activation energy for thermal degradation (see IEC TS 60216-7-1) and if applicable, by specific functional tests, which are not covered by the already mentioned methods (e.g. flammability).

5.2 Procedure A – Without test

Change of EIS without test may be considered, when no material change is involved, for example geometric adoption only with increasing distances/thickness.

5.3 Procedure B – Chemical compatibility test

A chemical compatibility test analyses the possible destructive influences of thermal decomposition products of each EIM on the overall performance of the EIS by thermal conditioning of all components in a hermetic closed volume ("sealed tube"), followed by an assessment of a suitable probe.

The samples shall be conditioned in the sealed tube for $336 \text{ h} \pm 2 \text{ h}$ (14 days) at a temperature added by 25 K to the thermal class.

NOTE Hence, procedure B described in Clause 10 of IEC 61858-1:2014 allows the substitution of electrical insulating materials (bondable wires or, impregnation resin/varnishes) or, addition of impregnation resins or varnishes, or other components to an established EIS. The acceptance criterion for the chemical compatibility test in this application is the electrical strength of the insulation varnish of the winding wire (breakdown voltage of twisted pairs according to IEC 60172).

5.4 Procedure C – Standard single point thermal aging test

Representative test objects of the established EIS (reference EIS) and the candidate EIS shall be constructed and tested in accordance with the basic IEC product standard, or the applicable part of the IEC 61857 series with the following exceptions:

- the reference and candidate EIS shall be concurrently tested at the same temperature;
- the aging temperature should be selected from the full thermal aging programme of the established EIS to give an expected test life of between 1 000 h to 2 000 h;
- when an EIM, evaluated in the established EIS with multiple EIMs, is no longer available, the reference test objects shall be constructed with all remaining materials.

5.5 Procedure D – Full thermal aging

The full thermal aging test shall be evaluated in accordance with IEC 61857 (all parts).

6 EIS assessment

Before planning the substitution of a material in an EIS, the assessment of the function of this component according to the insulation coordination, the consequences of a potential failure, and the compatibility to other components in the system, is necessary.

Only components which are identified to have no function as reinforced, basic or supplementary insulation can be considered as auxiliary material. To prevent fatal hazards (e.g. electrical shock or fire), a failure of an auxiliary material shall not compromise any of the materials which are assigned as reinforced or supplementary insulation. In this case, the material shall be treated in the same manner as an EIM in the system.

Bibliography

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

IEC 60172, *Test procedure for the determination of the temperature index of enamelled and tape wrapped winding wires*

IEC TS 60216-7-1, *Electrical insulation materials – Thermal endurance properties – Part 7-1: Accelerated determination of relative thermal endurance using analytical test methods (RTEA) – Instructions for calculations based on activation energy*

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

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61858 (all parts), *Electrical insulation systems – Thermal evaluation of modifications to an established electrical insulation system (EIS)*

IEC 62477-1, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

ISO/IEC GUIDE 51:2014, *Safety aspects – Guidelines for their inclusion in standards*
