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Determination of long-term radiation ageing in polymers – Part 4: Effects of different temperatures and dose rates under radiation conditions

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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DETERMINATION OF LONG-TERM RADIATION AGEING IN POLYMERS –

Part 4: Effects of different temperatures and dose rates under radiation conditions

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The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a Technical Report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 61244-4, which is a Technical Report, has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems.

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

Draft TR	Report on voting
112/442/DTR	112/446/RVDTR

Full information on the voting for the approval of this Technical Report can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 61244 series, published under the general title *Determination of long-term radiation ageing in polymers*, 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

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

IEC 60216 (all parts) and IEC 60544 (all parts) give reference and guidance for managing accelerated thermal and radiological ageing steps for type testing procedures applicable to electrical insulating materials. The actual application of electrical equipment usually requires the consideration of effects which are a consequence of simultaneous occurrence of temperature and radiation at varying intensities.

The CIGRE WG D1.42 study presents degradation data in particular with respect to cable and wire insulation materials gathered from tests where thermal and radiation loads were applied simultaneously. Even if there is a broad range of materials available from the industry, only insulation materials commonly used were selected for this study. These materials are crosslinked polyethylene (XLPE), ethylene-propylene-rubber (EPR), silicon-rubber (SIR) and polyvinylchloride (PVC). Using these test data, power plant operators were in the position to meet requirements defined by regulatory bodies in the frame of ‘long term operation application’, showing that most insulation materials which have been in operation for 30 to 40 years were in good condition. Furthermore, material samples were collected from real positions and test results were compared with reference samples, unaged as well as artificially aged.

The main objective of the industry is to yield reliable values of the residual lifetime of the insulation materials and linked pieces of equipment made up of these materials. However more research is necessary as the in-service degradation of insulating materials appears to be deviating from estimation based on accelerated ageing tests. For a better determination of the degradation processes of insulation materials it is important to gain a wider knowledge on material degradation and linked synergistic effects at low intensities of thermal and radiological loads. Thus, this document aims to summarize the results, and in some areas update the literature references, from CIGRE WG D1.42, to provide a state-of-the-art document on qualification procedures capable to represent multifactor ageing (hereby thermal and radiological ageing).

DETERMINATION OF LONG-TERM RADIATION AGEING IN POLYMERS –

Part 4: Effects of different temperatures and dose rates under radiation conditions

1 Scope

This part of IEC 61244 provides general guidance for the evaluation/verification of electrical insulation materials (EIM) and electrical insulation systems (EIS) intended to be used in types of equipment exposed to ionizing radiation. Beside sensors, actuators/motors as well as plugs and terminals, cables are a well-known typical application of those EIM and EIS. Their type spectrum covers low voltage power cables, control cables and instrumentation cables. Because of their comparable simple design, cables are the ideal type of equipment to study EIM and EIS degradation processes. But the results of these studies can be easily transferred to the enumerated types of equipment.

Nonetheless, this document provides a state-of-the art report on qualification/verification procedures used to simulate simultaneous effects of temperature and radiation at varying intensities rather than give detailed test programmes valid for specific test methods.

NOTE 1 Use of this document with specific products can require specification of additional product related procedures.

NOTE 2 Some of the procedures described in this document are emerging technologies. Therefore, specified prerequisites, former experiences as well as boundary conditions can be additionally taken into account.

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 60544 (all parts), *Electrical insulating materials – Determination of the effects of ionizing radiation*

IEC TS 61244 (all parts), *Determination of long-term radiation ageing in polymers*