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Nuclear power plants — Instrumentation and control important to safety — Electrical equipment condition monitoring methods

Part 5: Optical time domain reflectometry

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Nuclear power plants – Instrumentation and control important to safety – Electrical equipment condition monitoring methods – Part 5: Optical time domain reflectometry

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NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY – ELECTRICAL EQUIPMENT CONDITION MONITORING METHODS –

Part 5: Optical time domain reflectometry

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International Standard IEC/IEEE 62582-5 has been prepared by subcommittee 45A: Instrumentation, control and electrical systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation, in cooperation with the Nuclear Power Engineering Committee of the IEEE Power & Energy Society[1], under the IEC/IEEE Dual Logo Agreement between IEC and IEEE.

This publication is published as an IEC/IEEE Dual Logo standard.

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

FDIS	Report on voting
45A/1008A/FDIS	45A/1021/RVD

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 parts in the IEC/IEEE 62582 series, published under the general title *Nuclear power plants – Instrumentation and control important to safety – Electrical equipment condition monitoring methods*, can be found on the IEC website.

The IEC Technical Committee and IEEE Technical Committee have 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- withdrawn,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.

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[1] A list of IEEE participants can be found at the following URL: http://standards.ieee.org/downloads/62582/62582-5-2015/62582-5-2015_wg-participants.pdf

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INTRODUCTION

a) Technical background, main issues and organisation of the Standard

This IEC/IEEE standard specifically focuses on optical time domain reflectometer methods for condition monitoring for the management of ageing of optical fibres and cables in electrical equipment installed in nuclear power plants.

This IEC/IEEE standard is the fifth part of the IEC/IEEE 62582 series. It contains detailed descriptions of condition monitoring based on optical time domain reflectometer measurements on optical fibres and cables.

The IEC/IEEE 62582 series of standards is issued with a joint logo, which makes it applicable to management of ageing of electrical equipment qualified to IEEE as well as IEC Standards.

Historically, IEEE Std 323™-2003 introduced the concept and role that condition based qualification could be used in equipment qualification as an adjunct to qualified life. In equipment qualification, the condition of the equipment for which acceptable performance was demonstrated is the qualified condition. The qualified condition is the condition of equipment, prior to the start of a design basis event, for which the equipment was demonstrated to meet the design requirements for the specified service conditions.

Significant research has been performed on condition monitoring techniques and the use of these techniques in equipment qualification as noted in NUREG/CR-6704, vol.2 (BNL-NUREG-52610) and JNES-SS-0903, 2009.

It is intended that this standard be used by test laboratories, operators of nuclear power plants, systems evaluators and licensors.

b) Situation of the current standard in the structure of the IEC SC 45A standard series

IEC/IEEE 62582-5 is the third level IEC SC 45A document tackling the specific issue of application and performance of optical time domain reflectometer measurements in management of ageing of optical fibres and cables in electrical instrument and control equipment in nuclear power plants.

IEC/IEEE 62582-5 is to be read in association with IEC/IEEE 62582-1, which provides requirements for application of methods for condition monitoring of electrical equipment important to safety of nuclear power plants.

For more details on the structure of the IEC SC 45A standard series, see item d) of this introduction.

c) Recommendations and limitations regarding the application of this standard

It is important to note that this standard establishes no additional functional requirements for safety systems.

d) Description of the structure of the IEC SC 45A standard series and relationships with other IEC documents and other bodies documents (IAEA, ISO)

The top-level document of the IEC SC 45A standard series is IEC 61513. It provides general requirements for I&C systems and equipment that are used to perform functions important to safety in NPPs. IEC 61513 structures the IEC SC 45A standard series.

IEC 61513 refers directly to other IEC SC 45A standards for general topics related to categorisation of functions and classification of systems, qualification, separation of systems,

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defence against common cause failure, software aspects of computer-based systems, hardware aspects of computer-based systems, and control room design. The standards referenced directly at this second level should be considered together with IEC 61513 as a consistent document set.

At a third level, IEC SC 45A standards not directly referenced by IEC 61513 are standards related to specific equipment, technical methods, or specific activities. Usually these documents, which make reference to second-level documents for general topics, can be used on their own.

A fourth level extending the IEC SC 45A standard series, corresponds to the Technical Reports which are not normative.

IEC 61513 has adopted a presentation format similar to the basic safety publication IEC 61508 with an overall safety life-cycle framework and a system life-cycle framework. Regarding nuclear safety, it provides an interpretation of the general requirements of IEC 61508-1, IEC 61508-2 and IEC 61508-4, for the nuclear application sector. In this framework IEC 60880 and IEC 62138 correspond to IEC 61508-3 for the nuclear application sector. IEC 61513 refers to ISO as well as to IAEA GS-R-3 and IAEA GS-G-3.1 and IAEA GS-G-3.5 for topics related to quality assurance (QA).

The IEC SC 45A standards series consistently implements and details the principles and basic safety aspects provided in the IAEA code on the safety of NPPs and in the IAEA safety series, in particular the Requirements SSR-2/1, establishing safety requirements related to the design of Nuclear Power Plants, and the Safety Guide NS-G-1.3 dealing with instrumentation and control systems important to safety in Nuclear Power Plants. The terminology and definitions used by SC 45A standards are consistent with those used by the IAEA.

NOTE It is assumed that for the design of I&C systems in NPPs that implement conventional safety functions (e.g., to address worker safety, asset protection, chemical hazards, process energy hazards) international or national standards would be applied that are based on the requirements of a standard such as IEC 61508.

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NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY – ELECTRICAL EQUIPMENT CONDITION MONITORING METHODS –

Part 5: Optical time domain reflectometry

1 Scope and object

This part of IEC/IEEE 62582 contains methods for monitoring the attenuation condition of optical fibres and cables in instrumentation and control systems using optical time domain reflectometer (OTDR) measurements in the detail necessary to produce accurate and reproducible measurements. It includes the requirements for the measurement system and conditions, and the reporting of the measurement results.

The different parts of IEC/IEEE 62582 are measurement standards, primarily for use in the management of ageing in initial qualification and after installation. IEC/IEEE 62582-1 includes requirements for the application of the other parts of IEC/IEEE 62582 and some elements which are common to all methods. Information on the role of condition monitoring in qualification of equipment important to safety is found in IEEE Std 323. Detailed descriptions of methods for OTDR measurement of the quality and functionality of fibre optic cables are given in IEC 61280-4-1 for multimode attenuation and in IEC 61280-4-2 for single-mode attenuation.

2 Normative references

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

IEC 61746-1, *Calibration of optical time-domain reflectometers (OTDR) – Part 1: OTDR for single mode fibres*

IEC 61746-2, *Calibration of optical time-domain reflectometers (OTDR) – Part 2: OTDR for multimode fibres*

3 Terms and definitions

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

3.1
annealing <of radiation-induced attenuation>
recovery of radiation-induced attenuation of an optical fibre by temperature (thermal annealing) and/or transmission light power (photobleaching)

Note 1 to entry: Annealing is related to fibre material and to dose rate and exposure.

3.2
attenuation annealing time
time that is necessary to decrease the attenuation to a certain fraction (e.g., ½ or 1/e) of the attenuation immediately after the end of the irradiation

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