BS IEC 62765-2:2019

BSI Standards Publication

Nuclear powers plants - Instrumentation and control important to safety - Management of ageing of sensors and transmitters

Part 2: Temperature sensors

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National foreword

This British Standard is the UK implementation of IEC 62765-2:2019.

The UK participation in its preparation was entrusted to Technical Committee NCE/8, Instrumentation, Control & Electrical Systems of Nuclear Facilities.

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

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Nuclear powers plants – Instrumentation and control important to safety – Management of ageing of sensors and transmitters – Part 2: Temperature sensors

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NUCLEAR POWERS PLANTS – INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY – MANAGEMENT OF AGEING OF SENSORS AND TRANSMITTERS –

Part 2: Temperature sensors

FOREWORD

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International Standard IEC 62765-2 has been prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
45A/1218/FDIS	45A/1227/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.

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

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A list of all parts in the IEC 62765 series, published under the general title *Nuclear power plants – Instrumentation and control important to safety – Management of ageing of sensors and transmitters*, 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- withdrawn,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.

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INTRODUCTION

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

With the majority of NPPs over 30 years old, the management of ageing of temperature sensors is currently a relevant topic, especially for those plants that have extended their operating licenses or are considering this option. This standard is intended to be used by operators of NPPs (utilities), systems evaluators, vendors, and by licensors. In the international temperature measurement, the scale of temperature has been updated with ITS-90 since it was published in 1990, so it is necessary that ITS-90 should be addressed in the standard to cover the calibration of measuring and test equipment for temperature sensors.

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

IEC 62765 is the third level IEC SC 45A document comprised of several parts to tackle the specific issue of management of ageing of sensors and transmitters in nuclear power plants (NPPs) for I&C systems important to safety. Part 2 of IEC 62675 is dedicated to temperature sensors.

IEC 62342 is the second level standard of SC 45A covering the domain of the management of ageing of nuclear instrumentation systems used in NPPs to perform functions important to safety. IEC 62342 is the introduction to a series of standards to be developed by IEC SC 45A covering the management of the ageing of specific I&C systems or components such as electrical cabling systems (IEC 62465), and sensors and transmitters (IEC 62765).

IEC 62765-2 is to be read in association with IEC 62342 and IEC TR 62096, which is the appropriate IEC SC 45A Technical Report that provides guidance on the decision for modernisation when the management of ageing techniques is no longer successful. 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. Ageing mechanisms have to be prevented and thus identified by performance measurements in order to minimize their impact on sensor reliability. Aspects for which special recommendations and limitations have been provided in this standard are:

- criteria for the evaluation of ageing of temperature sensors in NPPs;
- steps to be followed to establish the temperature sensor testing requirements for an ageing management program for NPP instrumentation systems; and
- relationships between on-going qualification analysis and ageing management program with regard to temperature sensors.

It is recognised that testing and monitoring techniques used to evaluate the ageing condition of NPPs' sensors and transmitters are continuing to develop at a rapid pace and that it is not possible for a standard such as this to include references to all modern technologies and techniques.

This standard identifies minimum requirements aimed at ensuring that any potential impacts on NPP safety due to the ageing of temperature sensors of NPPs can be identified and that suitable actions are undertaken to demonstrate that the safety of the plant will not be impaired. To ensure that this standard will continue to be relevant in future years, the emphasis has been placed on issues of principle, rather than specific technologies.

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 documents of the IEC SC 45A standard series are IEC 61513 and IEC 63046. IEC 61513 provides general requirements for I&C systems and equipment that are used to perform functions important to safety in NPPs. IEC 63046 provides general requirements for electrical power systems of NPPs; it covers power supply systems including the supply

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systems of the I&C systems. IEC 61513 and IEC 63046 are to be considered in conjunction and at the same level. IEC 61513 and IEC 63046 structure the IEC SC 45A standard series and shape a complete framework establishing general requirements for instrumentation, control and electrical systems for nuclear power plants.

IEC 61513 and IEC 63046 refer directly to other IEC SC 45A standards for general topics related to categorization of functions and classification of systems, qualification, separation, defence against common cause failure, control room design, electromagnetic compatibility, cybersecurity, software and hardware aspects for programmable digital systems, coordination of safety and security requirements and management of ageing. The standards referenced directly at this second level should be considered together with IEC 61513 and IEC 63046 as a consistent document set.

At a third level, IEC SC 45A standards not directly referenced by IEC 61513 or by IEC 63046 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.

The IEC SC 45A standards series consistently implement and detail the safety and security principles and basic aspects provided in the relevant IAEA safety standards and in the relevant documents of the IAEA nuclear security series (NSS). In particular this includes the IAEA requirements SSR-2/1, establishing safety requirements related to the design of nuclear power plants (NPPs), the IAEA safety guide SSG-30 dealing with the safety classification of structures, systems and components in NPPs, the IAEA safety guide SSG-39 dealing with the design of instrumentation and control systems for NPPs, the IAEA safety guide SSG-34 dealing with the design of electrical power systems for NPPs and the implementing guide NSS17 for computer security at nuclear facilities. The safety and security terminology and definitions used by SC 45A standards are consistent with those used by the IAEA.

IEC 61513 and IEC 63046 have adopted a presentation format similar to the basic safety publication IEC 61508 with an overall life-cycle framework and a system life-cycle framework. Regarding nuclear safety, IEC 61513 and IEC 63046 provide the 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, IEC 62138 and IEC 62566 correspond to IEC 61508-3 for the nuclear application sector. IEC 61513 and IEC 63046 refer to ISO as well as to IAEA GS-R part 2 and IAEA GS-G-3.1 and IAEA GS-G-3.5 for topics related to quality assurance (QA). At level 2, regarding nuclear security, IEC 62645 is the entry document for the IEC SC 45A security standards. It builds upon the valid high level principles and main concepts of the generic security standards, in particular ISO/IEC 27001 and ISO/IEC 27002; it adapts them and completes them to fit the nuclear context and coordinates with the IEC 62443 series. At level 2, IEC 60964 is the entry document for the IEC/SC 45A control rooms standards and IEC 62342 is the entry document for the ageing management standards.

NOTE 1 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.

NOTE 2 IEC SC 45A domain was extended in 2013 to cover electrical systems. In 2014 and 2015 discussions were held in IEC SC 45A to decide how and where general requirements for the design of electrical systems were to be considered. IEC SC 45A experts recommended that an independent standard be developed at the same level as IEC 61513 to establish general requirements for electrical systems. Project IEC 63046 is now launched to cover this objective. When IEC 63046 is published this NOTE 2 of the introduction of IEC SC 45A standards will be suppressed.

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NUCLEAR POWERS PLANTS – INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY – MANAGEMENT OF AGEING OF SENSORS AND TRANSMITTERS –

Part 2: Temperature sensors

1 Scope

This part of IEC 62765 identifies minimum requirements and applicable practices for correcting and preventing any potential impacts on nuclear power plant (NPP) safety due to the ageing of temperature sensors, such as NPP resistance temperature detectors (RTDs) and thermocouples (TCs).

This document provides strategies, technical requirements, and recommended practices for the management of the ageing of temperature sensors important to safety in nuclear power plants (NPPs) to ensure that ageing can be identified and that suitable remedial actions are undertaken as necessary to demonstrate that the safety of the plant will not be impaired. This document is aligned with IEC 62342, which provides guidance on ageing management for instrumentation and control (I&C) systems important to safety in NPPs.

IEC 62765 standard series covers pressure transmitters (Part 1) and temperature sensors (Part 2). Part 1 covers pressure transmitter (PT), level transmitter (LT) and flow transmitter (FT). Part 2 consists of resistance temperature detector (RTD) and thermocouple (TC) with respect to instrumentation and control (I&C) important to safety. Detector of neutron power (Part 3) will be covered in a separate standard.

Interfaces of temperature sensors with processes such as thermowells, seals, sheathes, extension/compensating cables, and connectors are within the scope of this document. Ageing management of temperature sensors used as M&TEs are beyond the scope of this document.

Temperature units of this document are in terms of International Temperature Scale-1990 (ITS- 90), because of consistency with normative references.

IAEA SSR-2/1 and SSR-2/2 address the requirements of ageing management in the design, as well as in the operation of the lifetime of the plant.SSG-39 recommends design consideration for ageing management specific to I&C system.

The requirements of temperature sensors for industrial and nuclear application in the normative references are indispensable to this document whereas this document focuses on the ageing management of temperature sensors to meet the requirements.

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 60584-1:2013, *Thermocouples – Part 1: EMF specifications and tolerances*

IEC 60584-3:2007, *Thermocouples – Part 3: Extension and compensating cables – Tolerances and identification system*

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IEC 60671:2007, *Nuclear power plants – Instrumentation and control systems important to safety – Surveillance testing*

IEC 60737:2010, *Nuclear power plants – Instrumentation important to safety – Temperature sensors (in-core and primary coolant circuit) – Characteristics and test methods*

IEC 60751:2008, *Industrial platinum resistance thermometers and platinum temperature sensors*

IEC/IEEE 60780-323:2016, *Nuclear facilities – Electrical equipment important to safety – Qualification*

IEC 61226:2009, *Nuclear power plants – Instrumentation and control important to safety – Classification of instrumentation and control functions*

IEC 61515:2016, *Mineral insulated metal-sheathed thermocouple cables and thermocouples*

IEC 62138:2004, *Nuclear power plants – Instrumentation and control important to safety – Software aspects for computer-based systems performing category B or C functions*

IEC 62342:2007, *Nuclear power plants – Instrumentation and control systems important to safety – Management of ageing*

IEC 62385:2007, *Nuclear power plants – Instrumentation and control important to safety – Methods for assessing the performance of safety system instrument channels*

IEC 62397:2007, *Nuclear power plants – Instrumentation and control important to safety – Resistance temperature detectors*

IEC 62465:2010, *Nuclear power plants – Instrumentation and control important to safety – Management of ageing of electrical cabling system*

IEC/IEEE 62582-1:2011, *Nuclear power plants – Instrumentation and control important to safety – Electrical equipment condition monitoring methods – Part 1: General*

IEC 62651:2013, *Nuclear power plants – Instrumentation important to safety – Thermocouples: Characteristics and test methods*

IAEA Safety Standard Series No. SSR-2/1:2016, *Safety of Nuclear Power Plant: Design, specific safety requirements*

IAEA Safety Standard Series No. SSR-2/2:2016, *Safety of Nuclear Power Plant: Commissioning and Operation, specific safety requirements*

IAEA Safety Standard Series No. NS-G-2.12:2009, *Ageing management for nuclear power plants: safety guide*

IAEA Specific Safety Guide No. SSG-39:2016, *Design of instrumentation and control systems for nuclear power plants*

3 Terms and definitions

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

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