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Nuclear facilities – Instrumentation and control important to safety – Radiation monitoring systems (RMS): Characteristics and life cycle

Installations nucléaires – Instrumentation et contrôle commande importants pour la sûreté – Systèmes de surveillance des rayonnements (RMS): Caractéristiques et cycle de vie



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**NUCLEAR FACILITIES – INSTRUMENTATION AND CONTROL
IMPORTANT TO SAFETY – RADIATION MONITORING SYSTEMS (RMS):
CHARACTERISTICS AND LIFECYCLE**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 62705 has been prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation. It is an International Standard.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Modification of the title.
- b) To be consistent with the categorization of the accident condition.
- c) To update the references to new standards published since the first edition.
- d) To update the terms and definitions.

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

Draft	Report on voting
45A/1442/FDIS	45A/1451/RVD

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 International Standard 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.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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.

INTRODUCTION

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

This IEC standard sets out the requirements for the lifecycle management of radiation monitoring systems (RMS) installed in the nuclear facilities (e.g. nuclear power plants, nuclear fuel storage and processing sites).

This document is applicable to the equipment of RMS and intended for use during normal operations, anticipated operational occurrence (AOO), design basis accidents (DBA) and design extension conditions (DEC) including severe accidents (SA).

The document is intended for use by operators of nuclear facilities (utilities), systems evaluators and by licensors.

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

IEC 62705 is the third level in the hierarchy of SC 45A standards. This document provides guidance on the application of existing IEC/ISO standards covering design and qualification of system and equipment for RMS. This document is an application supplement of IEC 61513 as shown in Annex B, and it is not intended that this document limits the application of other IEC 61513 requirements to RMS lifecycle.

For general requirements and guidance, the following standards provide requirements and guidance for RMS. IEC 61513 is the first level standard of SC 45A standards, and provides general requirements for I&C systems and equipment that are used to perform functions important to safety in nuclear facilities. IEC 61226 provides the criteria for classification of instrumentation and control functions. Most modern RMSs contain computer-based equipment. Hence RMS should often be treated as computer-based system. So the following standards required for computer-based system are generally applicable to RMS. IEC 60880 provides the software requirements for category A functions and IEC 62138 provides the software requirements for Category B or C functions. IEC 60987 provides hardware design requirements for computer-based systems. IEC 62566 provides the requirements for HDL-Programmed Device (HPD) for systems performing category A functions. IEC 62645 provides security requirements for computer based I&C systems. For qualification testing, the following SC 45A standards are applicable. IEC/IEEE 60780-323 provides guidance for the environmental qualification and IEC/IEEE 60980-344 provides guidance for seismic qualification for equipment performing category A or B functions. IEC 62003 provides the requirements for electromagnetic compatibility testing. In addition, IEC 61250 specifies the leak detection requirements by using RMS.

For radiation monitoring specific requirements, the following standards provide requirements and guidance for RMS. The IEC 60951 series provides guidance on the design and testing of radiation monitoring equipment used for anticipated operational occurrences (AOO), design basis accidents (DBA) and design extension conditions (DEC) including severe accident (SA). The IEC 60761 series provide requirements for equipment for continuous on-line monitoring of radioactivity in gaseous effluent in normal conditions. Some of the SC 45B standards (e.g. Gas offline: IEC 62302, Tritium: IEC 62303) are now replacing the IEC 60761 series. IEC 60861 provides requirements for equipment continuous off-line monitoring of radioactivity in liquid effluent in normal conditions. IEC 60768 provides requirements for equipment for continuous in-line and on-line monitoring of radioactivity in process stream in normal and incident conditions. IEC 61031 provides requirements for equipment for area radiation monitor in normal conditions in conjunction with IEC 60532. IEC 61504 provides requirements for centralized system for plant-wide radiation monitoring in conjunction with the IEC 61559 series which specifies the requirements for centralized system. If the centralized system is a part of the safety parameter display system, IEC 60960 provides the functional design criteria. ISO 2889 gives guidance on gas and particulate sampling. The ISO 4037 series provides calibration methodology for radiation monitors.

The relationship between these various standards is given in Table 1.

IEC 63147/IEEE Std 497™ provides general guidance for accident monitoring instrumentation. IEEE Std 497™ was directly adopted as a joint logo standard and a technical report, IEC TR 63123, was prepared to discuss the application of the joint standard within the IEC context.

The structure of this standard is adapted from the structure of IEC 63147/IEEE Std 497™, and the technical requirements of this standard are consistent with the requirements given in IEC 63147/IEEE Std 497™ together with the application guidance given in IEC TR 63123.

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

Table 1 – Overview of the standards covering the domain of radiation monitoring

Developer	ISO		IEC		SC45A		SC45B
	Sampling (Normal operation)	Calibration (Normal operation)	Normal operation, AOO	DBA	DEC	Normal operation	
Radioactive noble gas off-line monitoring	ISO 2889	ISO 4037-1, ISO 4037-3	N/A	IEC 60951-1, IEC 60951-2	N/A	IEC 60303, IEC 60761-1, IEC 60761-3	
Radioactive aerosol off-line monitoring	ISO 2889	ISO 4037-1, ISO 4037-3	N/A	IEC 60951-1, IEC 60951-2	N/A	IEC 60761-1, IEC 60761-2	
Radioactive iodine off-line monitoring	ISO 2889	ISO 4037-1, ISO 4037-3	N/A	IEC 60951-1, IEC 60951-2	N/A	IEC 60761-1, IEC 60761-4	
Liquid off-line monitoring	N/A	N/A	N/A	N/A	N/A	IEC 60861	
Tritium off-line monitoring	N/A	N/A	N/A	N/A	N/A	IEC 62303, IEC 60761-1, IEC 60761-5	
On-line or in-line monitoring	N/A	ISO 4037-1, ISO 4037-3	IEC 60768	IEC 60951-1, IEC 60951-4	N/A	N/A	
Area monitoring	N/A	ISO 4037-1, ISO 4037-3	IEC 61551	IEC 60951-1, IEC 60951-3		IEC 60532	
Centralized system	N/A	N/A	IEC 61504, IEC 60960		N/A	IEC 61559-1	
Classification/basic requirements	N/A	N/A	IEC 61513, IEC 60880, IEC 60987, IEC 61226, IEC 62138, IEC 62566, IEC 62566-2, IEC 62645, IEC 61250		N/A	N/A	
Qualification	N/A	N/A	IEC/IEEE 60780-323, IEC/IEEE 60980-344, IEC 62003		N/A	IEC 62706	

c) Recommendation and limitations regarding the application of this Standard

It is important to note that this document establishes no additional functional requirements for systems important to safety. Where requirements are given in this standard, they refer generally to the need to apply other IEC and ISO Standards and specific functional and technical requirements contained in these standards.

To ensure that the document 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 IEC SC 45A standard series comprises a hierarchy of four levels. The top-level documents of the IEC SC 45A standard series are IEC 61513 and IEC 63046.

IEC 61513 provides general requirements for instrumentation and control (I&C) systems and equipment that are used to perform functions important to safety in nuclear power plants (NPPs). IEC 63046 provides general requirements for electrical power systems of NPPs; it covers power supply systems including the supply 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 power systems for nuclear power plants.

IEC 61513 and IEC 63046 refer directly to other IEC SC 45A standards for general requirements for specific topics, such as categorization of functions and classification of systems, qualification, separation, defence against common cause failure, control room design, electromagnetic compatibility, human factors engineering, 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 requirements for specific equipment, technical methods or activities. Usually these documents, which make reference to second-level documents for general requirements, can be used on their own.

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

The IEC SC 45A standards series consistently implements and details 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, the IAEA safety guide SSG-51 dealing with human factors engineering in the design of NPPs and the implementing guide NSS17 for computer security at nuclear facilities. The safety and security terminology and definitions used by the 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 9001 as well as to IAEA GSR part 2 and IAEA GS-G-3.1 and IAEA GS-G-3.2 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, IEC 6335 is the entry document for the human factors engineering 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 TR 64000 provides a more comprehensive description of the overall structure of the IEC SC 45A standards series and of its relationship with other standards bodies and standards.

NUCLEAR FACILITIES – INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY – RADIATION MONITORING SYSTEMS (RMS): CHARACTERISTICS AND LIFECYCLE

1 Scope

This document gives requirements for the lifecycle management of radiation monitoring systems (RMS) and gives guidance on the application of existing IEC standards covering the design and qualification of systems and equipment.

The purpose of this document is to lay down requirements for the lifecycle management of RMSs and give application guidance. This document is intended to be consistent with the latest versions of International Standards dealing with radiation monitors, sampling of radioactive materials, instruments calibration, hardware and software design, classification, and qualification. Unless otherwise specified in this document, top level IEC SC 45A standard, IEC 61513, and the second level IEC SC 45A standards apply to RMSs.

This document is applicable to RMSs installed in nuclear facilities intended for use during normal operation, anticipated operational occurrences (AOO), design basis accidents (DBA) and design extension conditions (DEC), including severe accidents (SA). The technical guidance contained in this document applies to nuclear facilities, although the specific functions of individual facilities are considered during the design and operational lifecycle of RMSs.

Laboratory analysis and associated sample extraction, which are essential to a complete programme of effluent monitoring, and investigation for fuel removal are not in the scope of this document.

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 60532, *Radiation protection instrumentation – Installed dose rate meters, warning assemblies and monitors – X and gamma radiation of energy between 50 keV and 7 MeV*

IEC 60761-1, *Equipment for continuous monitoring of radioactivity in gaseous effluents – Part 1: General requirements*

IEC 60761-2, *Equipment for continuous monitoring of radioactivity in gaseous effluents – Part 2: Specific requirements for radioactive aerosol monitors including transuranic aerosols*

IEC 60761-3, *Equipment for continuous monitoring of radioactivity in gaseous effluents – Part 3: Specific requirements for radioactive noble gas monitors*

IEC 60761-4, *Equipment for continuous monitoring of radioactivity in gaseous effluents – Part 4: Specific requirements for radioactive iodine monitors*

IEC 60761-5, *Equipment for continuous monitoring of radioactivity in gaseous effluents – Part 5: Specific requirements for tritium monitors*