

INTERNATIONAL STANDARD



**Nuclear ~~power plants~~ facilities –
Instrumentation and control important to safety – Radiation monitoring
systems (RMS): Characteristics and lifecycle**

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**NUCLEAR ~~POWER PLANTS~~ 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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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62705:2014. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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.

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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 system (RMS) installed in the nuclear power plants (NPPs). This standard is applicable to the equipment of RMS and intended to be used during normal operations and anticipated operational occurrences, as well as, for certain monitors, in accident conditions. This standard may be applicable to other nuclear facilities (e.g. nuclear fuel storage and processing sites) by evaluating the differences from NPPs.~~

~~It is intended that the Standard be used by operators of NPPs (utilities), systems evaluators and by licensors.~~

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 ~~NPPs~~ 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 ~~accident and post-accident conditions~~ 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 off-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 in NPPs

Developer	ISO		IEC		
			SC 45A	SC 45B	
Scope	Sampling	Calibration	Accident and post accident conditions	Normal conditions	
Radioactive noble gas off-line monitoring	ISO 2889	ISO 4037-1, ISO 4037-3	IEC 60951-1, IEC 60951-2	N/A	IEC-62302-/ IEC-60761-1, IEC-60761-3
Radioactive aerosol off-line monitoring	ISO 2889	ISO 4037-1, ISO 4037-3	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	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	IEC-60861
Tritium off-line monitoring	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 60951-1, IEC 60951-4	IEC-60768	N/A
Area monitoring	N/A	ISO 4037-1, ISO 4037-3	IEC 60951-1, IEC 60951-3	IEC-61031	IEC-60532
Centralized system	N/A	N/A	IEC 61504, IEC 60960		IEC 61559-1
Classification/basic requirements	N/A	N/A	IEC 61513, IEC 60880, IEC 60987, IEC 61226, IEC 62138, IEC 62566, IEC 62645, IEC 61250		N/A
Qualification	N/A	N/A	IEC 60780, IEC 60980, IEC 62003		IEC-62706

Developer	ISO		IEC			
				SC45A		SC45B
Scope	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 62302, 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 61031	IEC 60951-1, IEC 60951-3		IEC 60532
Centralized system	N/A	N/A	IEC 61504, IEC 60960		N/A	IEC 61559-1
Classification/basi c 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

~~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 document establishes no additional functional requirements for ~~safety~~ 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 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 categorization of functions and classification of systems, qualification, separation of systems, 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 the interpretation of the general requirements of IEC 61508-1, IEC 61508-2 and IEC 61508-4, for the nuclear application sector, regarding nuclear safety. 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 NS-R-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.~~

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-3.5 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, IEC 63351 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, ~~that are based on the requirements of a standard such as IEC 61508.~~

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.

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

1 Scope

~~This International Standard applies to radiation monitoring system (RMS) installed in the nuclear power plants (NPPs).~~ 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.

~~This International Standard is applicable to RMSs intended to be used during normal operations and anticipated operational occurrences, and to be used during and/or after accident conditions. The technical guidance contained in this Standard applies to NPPs, although the specific functions of individual facilities shall be considered during the design and operational lifecycle of RMS.~~ 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 standard may be applicable to other nuclear facilities (e.g. nuclear fuel storage and processing sites) by evaluating the differences from NPPs.~~

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*

IEC 60768, *Nuclear power plants – Instrumentation important to safety – Equipment for continuous in-line or on-line monitoring of radioactivity in process streams for normal and incident conditions*

~~IEC 60780:1998, Nuclear power plants – Electrical equipment of the safety system – Qualification~~

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

IEC 60861, *Equipment for monitoring of radionuclides in liquid effluents and surface waters*

IEC 60880, *Nuclear power plants – Instrumentation and control systems important to safety – Software aspects for computer-based systems performing category A functions*

IEC 60951-1:2022, *Nuclear power plants – Instrumentation important to safety – Radiation monitoring for accident and post-accident conditions – Part 1: General requirements*

IEC 60951-2, *Nuclear power plants – Instrumentation important to safety – Radiation monitoring for accident and post-accident conditions – Part 2: Equipment for continuous off-line monitoring of radioactivity in gaseous effluents and ventilation air*

IEC 60951-3, *Nuclear power plants – Instrumentation important to safety – Radiation monitoring for accident and post-accident conditions – Part 3: Equipment for continuous high range area gamma monitoring*

IEC 60951-4, *Nuclear power plants – Instrumentation important to safety – Radiation monitoring for accident and post-accident conditions – Part 4: Equipment for continuous in-line or on-line monitoring of radioactivity in process streams*

IEC 60960, *Functional design criteria for a safety parameter display system for nuclear power stations*

~~IEC 60980, Recommended practices for Seismic qualification of electrical equipment of the safety system for nuclear generating stations~~

IEC/IEEE 60980-344, *Nuclear facilities – Equipment important to safety – Seismic qualification*

IEC 60987, *Nuclear power plants – Instrumentation and control important to safety – Hardware ~~design~~ requirements ~~for computer-based systems~~*

IEC 61031, *Nuclear facilities – Instrumentation and control systems – Design, location and application criteria for installed area gamma radiation dose rate monitoring equipment for use ~~in nuclear power plants~~ during normal operation and anticipated operational occurrences*

IEC 61226:2009/2020, Nuclear power plants – ~~Instrumentation and control important to safety – Classification of instrumentation and control functions~~ Instrumentation, control and electrical power systems important to safety – Categorization of functions and classification of systems

IEC 61250, Nuclear reactors – Instrumentation and control systems important for safety – Detection of leakage in coolant systems

IEC 61504, Nuclear ~~power plants~~ facilities – Instrumentation and control systems important to safety – ~~Plant-wide radiation monitoring~~ Centralized systems for continuous monitoring of radiation and/or levels of radioactivity

IEC 61513:2011, Nuclear power plants – Instrumentation and control important to safety – General requirements for systems

IEC 61559 (all parts), Radiation protection instrumentation in nuclear facilities – Centralized systems for continuous monitoring of radiation and/or levels of radioactivity

IEC 62003, Nuclear power plants – ~~Instrumentation and control important to safety~~ Instrumentation, control and electrical power systems – Requirements for electromagnetic compatibility testing

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

IEC 62302, Radiation protection instrumentation – Equipment for sampling and monitoring radioactive noble gases

IEC 62303, Radiation protection instrumentation – Equipment for monitoring airborne tritium

IEC 62566:2012, Nuclear power plants – Instrumentation and control important to safety – Development of HDL-programmed integrated circuits for systems performing category A functions

IEC 62566-2, Nuclear power plants – Instrumentation and control systems important to safety – Development of HDL-programmed integrated circuits – Part 2: HDL-programmed integrated circuits for systems performing category B or C functions

IEC 63147:2017/IEEE Std 497™, Criteria for accident monitoring instrumentation for nuclear power generating stations

ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories

ISO 2889, Sampling airborne radioactive materials from the stacks and ducts of nuclear facilities

ISO 4037-1, Radiological protection – X and gamma reference radiation for calibrating dosimeters and dose rate meters and for determining their response as a function of photon energy – Part 1: Radiation characteristics and production methods

ISO 4037-3, Radiological protection – X and gamma reference radiation for calibrating dosimeters and dose rate meters and for determining their response as a function of photon energy – Part 3: Calibration of area and personal dosimeters and the measurement of their response as a function of energy and angle of incidence

3 Terms and definitions

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

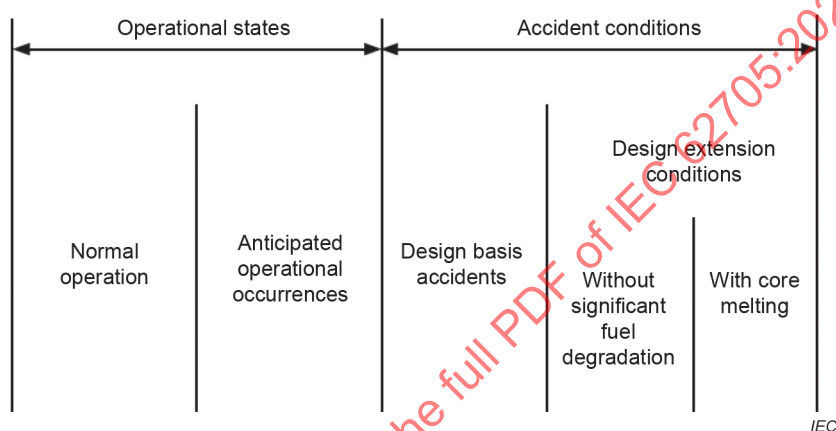
ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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

3.1

accident conditions

deviations from normal operation that are less frequent and more severe than anticipated operational occurrences described by the following figure



Note 1 to entry: Accident conditions comprise design basis accidents and design extension conditions.

[SOURCE: IAEA Safety Glossary, 2018 edition]

3.2

alarm assembly

assembly which is initiated by the processing assembly, and provides audible and/or visual alarms, normally local to detector assembly

3.3

anticipated operational occurrence

AOO

deviation of an operational process from normal operation that is expected to occur at least once during the operating lifetime of a facility but which, in view of appropriate design provisions, does not cause any significant damage to items important to safety or lead to accident conditions

[SOURCE: IAEA Safety Glossary, 2018 edition]

3.4

calibration

set of operations that establish, under specified conditions the relationship between values of quantities indicated by a measuring instrument or a measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards

[SOURCE: IEC 62397:2007, 3.2]

3.5**category of an I&C function**

one of three possible safety assignments (A, B, C) of I&C functions resulting from considerations of the safety relevance of the function to be performed. An unclassified assignment may be made if the function has no importance to safety

[SOURCE: IEC 61513:2011, 3.4]

3.6**centralized system****centralizer**

central processing and control system for the calculation, display, and storage of data from the processing assembly

3.7**class of an I&C system**

one of three possible assignments (1, 2, 3) of I&C systems important to safety resulting from consideration of their requirement to implement I&C functions of different safety importance. An unclassified assignment is made if the I&C system does not implement functions important to safety

[SOURCE: IEC 61513:2011, 3.6]

3.8**decision threshold**

value of the estimator of the measurand, which, when exceeded by the result of an actual measurement using a given measurement procedure of a measurand quantifying a physical effect, is used to decide that the physical effect is present

Note 1 to entry: The decision threshold is defined such that in cases where the measurement result, y , exceeds the decision threshold, y^* , the probability of a wrong decision, namely that the true value of the measurand is not zero if in fact it is zero, is less or equal to a chosen probability α .

Note 2 to entry: If the result, y , is below the decision threshold, y^* , it is decided to conclude that the result cannot be attributed to the physical effect; nevertheless, it cannot be concluded that it is absent.

[SOURCE: ISO 11929-1:2019, 3.12]

3.9**design basis accident****DBA**

a postulated accident leading to accident conditions for which a facility is designed in accordance with established design criteria and conservative methodology, and for which releases of radioactive material are kept within acceptable limits

[SOURCE: IAEA Safety Glossary, 2018 edition]

3.10**design extension conditions****DEC**

postulated accident conditions that are not considered for design basis accidents, but that are considered in the design process of the facility in accordance with best estimate methodology, and for which releases of radioactive material are kept within acceptable limits

Note 1 to entry: Design extension conditions comprise conditions in events without significant fuel degradation and conditions in events with melting of the reactor core including severe accident.

[SOURCE: IAEA Safety Glossary, 2018 edition]

3.11

detection limit

smallest true value of the measurand which ensures a specified probability of being detectable by the measurement procedure

Note 1 to entry: With the decision threshold according to 3.8, the detection limit is the smallest true value of the measurand for which the probability of wrongly deciding that the true value of the measurand is zero is equal to a specified value, β , when, in fact, the true value of the measurand is not zero. The probability of being detectable is consequently $(1-\beta)$.

Note 2 to entry: The terms detection limit and decision threshold are used in an ambiguous way in different standards (e.g. standards related to chemical analysis or quality assurance). If these terms are referred to one has to state according to which standard they are used.

[SOURCE: ISO 11929-1:2019, 3.13]

3.12

detector assembly

detector and associated electronics (amplifier, discriminator, output pulse shaper), and can also include hydraulic and programmable electronic circuits

3.13

hardware description language

HDL

language used to formally describe the functions and/or the structure of an electronic component for documentation, simulation or synthesis

Note 1 to entry: The most widely used HDLs are VHDL (IEEE 1076) and Verilog (IEEE 1364).

[SOURCE: IEC 62566:2012, 3.6]

3.14

HDL-Programmed Device

HPD

integrated circuit configured (for NPP I&C systems), with Hardware Description Languages and related software tools

Note 1 to entry: HDLs and related tools (e.g. simulator, synthesizer) are used to implement the requirements in a proper assembly of pre-developed micro-electronic technologies.

Note 2 to entry: The development of HPDs can use Pre-Developed Blocks.

Note 3 to entry: HPDs are typically based on blank FPGAs, ~~PLDs~~ (Field Programmable gate Arrays) or similar micro-electronic technologies.

[SOURCE: IEC 62566:2012, 3.7]

3.15

in-line monitoring

monitoring of the radioactivity in fluid by the detector located directly in the process stream (pipe, stack, duct, etc.)

3.16

monitoring assembly

combinations of processing, alarm, and detector assemblies

3.17

network equipment

equipment supporting communication among assemblies of RMS and external equipment

3.18**off-line monitoring**

monitoring of the ~~radioactivity~~ activity in fluid by sample drawn from the process stream to the detector located at some distance

3.19**on-line monitoring**

monitoring of the radioactivity in fluid by the detector directly facing the process stream

3.20**processing assembly**

assembly which converts the output signal from the detector assemblies into a form, generally digital, suitable for transmission down a data link to the central computer, centralized system, and/or which generates alarm outputs to the alarm units at present signal levels

3.21**radiation monitor**

device designed to measure the level of ionizing radiation and able to emit a warning signal

Note 1 to entry: A radiation monitor may also provide quantitative information.

3.22**sampling assembly**

set of interconnected instruments (devices) for collecting a representative sample

[SOURCE: IEC 60951-1:2009/2022, 3.23]

3.23**severe accident****SA**

accident more severe than a design basis accident and involving significant core degradation

[SOURCE: IAEA Safety Glossary, 2018 edition]

3.24**volumetric activity**

activity per unit volume of the sample

Note 1 to entry: For a gas, it is necessary to indicate the temperature and pressure conditions for which the volumetric activity, expressed in becquerels per cubic metre, is measured, for example standard temperature and pressure.

Note 2 to entry: This quantity is expressed in becquerels per cubic metre (Bq/m³).

[SOURCE: IEC 60050-395:2014, 395-01-09]

4 Symbols and abbreviated terms

AOO Anticipated Operational Occurrence

BWR Boiling Water Reactor

DBA Design Basis Accident

DEC Design Extension Condition

FPGA Field-Programmable Gate Array

HPD HDL (Hardware Description Language) -Programmed Device

I&C Instrumentation and Control

IAEA International Atomic Energy Agency

IEC International Electrotechnical Commission
 ISO International Organization for Standardization
 MRA Multi Recognition Agreement

~~NPP: Nuclear Power Plant~~

NSLR National Standardizing Laboratory of a country for Radioactivity measurement
 PLD Programmable Logic Device
 PWR Pressurized Water Reactor
 RMS Radiation Monitoring System
 SA Severe Accident

5 RMS categorization and classification

5.1 Function categorization for RMS

RMS in nuclear power plants provides continuous information about the radiological conditions in ~~NPP~~ nuclear facilities by measuring the radiation levels in specific areas, on certain process lines and at gaseous and liquid release points. It provides alarms and can initiate automatic actions when the monitored radioactivity reaches levels that have been determined to be abnormal. The plant safety design base assigns the individual RMS functions important to safety into one of three categories A, B or C, considering the relationships to other systems to be connected. The main ~~design~~ technical requirements for the systems and equipment associated with these categories are consistent with those of Clause 7 of IEC 61226:2009/2020. The category shall be assigned during system requirement specification phase.

5.2 System classification for RMS

RMS shall be classified according to its suitability to implement I&C functions up to a defined category during the system specification phase as shown in 6.2.3 of IEC 61513:2011. Examples of the classification for RMS installed in PWR and BWR plants are shown in Annex A.

According to the category of the function, the following standards shall be applied to each system and equipment.

a) System and equipment performing category A functions

Any software in RMS performing category A function shall be designed and maintained in accordance with IEC 60880. Any HDL-Programmed Device (HPD) in the equipment of RMS performing category A function shall be designed and maintained in accordance with IEC 62566. Any hardware in RMS performing category A function and including software or HPD shall be designed and maintained in accordance with IEC 60987.

b) System and equipment performing category B or C functions

Any software in RMS performing category B or C function shall be designed and maintained in accordance with IEC 62138. Any hardware in RMS performing category B or C function and including software shall be designed and maintained in accordance with IEC 60987. ~~Hardware performing category C function shall be designed, selected and maintained according to the supplier's requirements which can meet the application specific qualification requirements.~~ HDL-programmed integrated circuits for system performing category B or C function shall be designed and maintained in accordance with IEC 62566-2.

5.3 Criteria for identifying the plant-specific variables

The selection criteria for identifying the plant-specific variables (Type A-F) for accident monitoring instrumentation are provided in Clause 4 of IEC 63147:2017/IEEE Std 497™. RMS shall be designed appropriately in accordance with IEC 63147:2017/IEEE Std 497™ when the criteria corresponds to design basis accident (DBA) or design extension condition (DEC).

6 RMS detailed design and implementation

6.1 General

RMS generally consists of a combination of following equipment:

- detector assembly
- sampling assembly
- monitoring assembly
- processing assembly
- alarm assembly
- centralized system
- network equipment
- cable

The above equipment may have ~~resident~~ embedded software.

The RMS ~~shall be~~ is designed and implemented in accordance with appropriate requirements shown in the following standards.

6.2 Radioactive noble gas off-line monitoring

RMS for radioactive noble gas off-line monitoring is used for the following purposes:

- to measure the volumetric activity of radioactive noble gases in gaseous effluents at the discharge point and the variation of volumetric activity. The monitor may also be used for the determination of the total discharge of radioactive noble gas over a given period;
- to measure the volumetric activity, (S-1, A, etc.) in air or gas systems (control room ventilation, reactor leakage collection, drywell ventilation exhaust, fuel handling building ventilation exhaust, reactor building ventilation purge exhaust) and detect any significant increase of radioactivity.

For RMS designed only for normal operation condition, the design and testing of RMS shall be performed in accordance with IEC 60761-1 and IEC 60761-3. As an alternative, IEC 62302 may be used instead of the set of IEC 60761-1 and IEC 60761-3, ~~IEC 62302 may be used alternatively.~~

For RMS designed for ~~accident conditions~~ design basis accidents (DBA), the design and testing of RMS shall be performed in accordance with IEC 60951-1 and IEC 60951-2. Sampling assembly for RMS used for this monitoring shall be designed and tested in accordance with ISO 2889.

6.3 Radioactive aerosol off-line monitoring

RMS for radioactive aerosol off-line monitoring is used for the following purposes:

- to measure the volumetric activity of radioactive aerosols in gaseous effluents at the discharge point and the variation of volumetric activity. The monitor may also be used for the determination of the total discharge of radioactive aerosol over a given period;
- to measure the volumetric activity in air or gas systems (control room ventilation, reactor leakage collection, drywell ventilation exhaust, fuel handling building ventilation exhaust, reactor building ventilation purge exhaust) and detect any significant increase of radioactivity.

For RMS designed only for normal operation condition, the design and testing of RMS shall be performed in accordance with IEC 60761-1 and IEC 60761-2. For RMS designed for ~~accident conditions~~ design basis accidents (DBA), the design and testing of RMS shall be performed in

accordance with IEC 60951-1 and IEC 60951-2. Sampling assembly for RMS used for this monitoring shall be designed and tested in accordance with ISO 2889.

6.4 Radioactive iodine off-line monitoring

RMS for radioactive iodine off-line monitoring is used for the following purposes:

- to measure the volumetric activity of radioactive iodines in gaseous effluents at the discharge point and the variation of volumetric activity. The monitor may also be used for the determination of the total discharge of radioactive iodine over a given period;
- to measure the volumetric activity in air or gas systems (control room ventilation, reactor leakage collection, drywell ventilation exhaust, fuel handling building ventilation exhaust, reactor building ventilation purge exhaust) and detect any significant increase of ~~radioactivity~~ activity.

For RMS designed only for normal operation condition, the design and testing of RMS shall be performed in accordance with IEC 60761-1 and IEC 60761-4. For RMS designed for ~~accident conditions~~ design basis accidents (DBA), the design and testing of RMS shall be performed in accordance with IEC 60951-1 and IEC 60951-2. Sampling assembly for RMS used for this monitoring shall be designed and be tested in accordance with ISO 2889.

6.5 Liquid off-line monitoring

RMS for continuous liquid off-line monitoring is used for following purposes:

- to measure the volumetric activity in liquid at the discharge point or the surface water and the variation of volumetric activity. The monitor may also be used for the determination of the total discharge of radioactive materials in liquid over a given period.

The design and testing of RMS shall be performed in accordance with IEC 60861.

6.6 Tritium off-line monitoring

RMS for continuous radioactive tritium off-line monitoring is used for following purposes:

- to measure the volumetric activity of tritium in gaseous effluents at the discharge point and the variation of volumetric activity. The monitor may also be used for the determination of the total discharge of tritium over a given period.

The design and testing of RMS shall be performed in accordance with IEC 60761-1 and IEC 60761-5. ~~As an alternative, IEC 62303 may be used instead of the set of IEC 60761-1 and IEC 60761-5, IEC 62303 can be used alternatively.~~

6.7 On-line or in-line monitoring

RMS for on-line or in-line monitor ~~is required to~~ shall provide continuous measurement; this is normally achieved by positioning the detectors in the process stream (e.g. immersed in, or adjacent to the process stream, in a pipe or tank). For RMS designed only for normal operation condition, the design and testing of RMS shall be performed in accordance with IEC 60768. For RMS designed for ~~accident conditions~~ design basis accidents (DBA), the design and testing of RMS shall be performed in accordance with IEC 60951-1 and IEC 60951-4.

6.8 Area monitoring

RMS for area monitoring is used to monitor ~~levels~~ dose rate of gamma radiation in ~~NPP~~ nuclear facilities. For RMS designed only for normal operation condition, the design and testing of RMS shall be performed in accordance with IEC 61031 in conjunction with IEC 60532. For RMS designed for ~~accident conditions~~ design basis accidents (DBA) and design extension conditions (DEC) including severe accident (SA), the design and testing of RMS shall be performed in accordance with IEC 60951-1 and IEC 60951-3.

6.9 Centralized system

The centralized system receives data from plant-wide monitored radiation information. The centralized system provides the information to operations personnel and performs data recording, data validation, data display, and system control functions. The design and testing for centralized system shall be performed in accordance with IEC 61504 in conjunction with the IEC 61559 series which specifies the requirements for centralized ~~system~~ radiation monitoring systems. If the centralized system is a part of the safety parameter display system, the design shall be performed in accordance with IEC 60960.

6.10 Leak detection

In addition to the above requirements, RMS shall be designed and tested in accordance with IEC 61250 if the RMS is intended to be used for the leak detection in ~~NPPs~~ nuclear facilities.

7 RMS integration and validation

7.1 RMS integration

System integration is performed by assembling and interconnecting the equipment of RMS as designed.

7.2 RMS validation

After the system integration, it shall be demonstrated that the integrated system complies with the functional, performance and interface specifications. Validation shall comprise tests performed on the system in the final equipment configuration. During system validation, the interface to other systems, not only to I&C systems, but also to piping, mechanical components shall be validated.

8 RMS installation

After the system integration and validation, the equipment of RMS is installed in the specified location in the ~~NPP~~ nuclear facilities. It shall be confirmed that the location conditions for environmental, seismic, and electromagnetic interference are within the qualification envelope as shown in Clause 10.

During and after the installation, the installation testing ~~will~~ shall be done to demonstrate the compliance to the requirements, which includes the interface confirmation to other systems, not only to I&C systems, but also to piping and mechanical components.

The installed location of the equipment of RMS ~~shall be~~ is designed in accordance with appropriate specific RMS standards shown in Clause 6 or ~~NPP~~ nuclear facilities location design.

~~Before RMS is placed in service in NPP, calibration shall be performed. The calibration records obtained in accordance with the specific RMS standards shown in Clause 6 may be acceptable for the part of calibration records. The initial calibration may be performed during installation activities.~~

9 RMS design modification

Modifications to the design of RMS may be required due to the identification of new system requirements or due to the discovery of system design defects during the evaluation of operation records and reports. The following activities are needed for the modification:

- the implementation of a modification to a system shall be carried out in accordance with defined procedures;

- testing of the correct operation of the system shall be done after a modification in accordance with the applicable referenced documents identified in Clause 6;
- no hardware/software modification, other than those specified in the maintenance procedures, shall be allowed as a matter of routine;
- should replacement hardware be required, it shall be demonstrated/justified that the replacement meets the specification of the original hardware.

10 RMS qualification

10.1 General

The qualification envelope of the equipment of RMS shall comply with the environmental requirements of the installed locations in ~~NPP nuclear facilities~~. The justification shall be done to show the compliance between the qualification envelope of the equipment of RMS and the environmental requirements of the installed locations in ~~NPP nuclear facilities~~. The following qualification requirements supersede the qualification requirements defined in each radiation monitor standards listed in Clause 6, although individual standard may define the qualification requirements.

10.2 Environmental qualification

RMS shall maintain the specified accuracy and performance for the range of the environmental conditions at the equipment locations during normal plant operations. If RMS is required to provide the information during and after ~~the accident conditions, RMS shall maintain the specified accuracy and performance for the range of the environmental conditions at the equipment locations during and after the accident conditions~~ design basis accidents (DBA) and design extension conditions (DEC) including severe accident (SA), RMS shall maintain its safety functions as specified during and after these conditions. The environment qualification for RMS shall be performed in accordance with IEC/IEEE 60780-323 for the equipment performing category A or B functions.

The equipment performing category C functions only, for which specific environmental qualification is required (e.g. resistance to seismic conditions, or operation under specific environmental conditions), may be qualified to industrial standards. Claims for operation in abnormal environmental conditions, seismic qualification to industrial standards or other credited functional performances shall be justified by documentary evidence. Where significant ageing factors exist, and when qualified life cannot be demonstrated in accordance with the definition given in IEC/IEEE 60780-323, an on-going qualification program shall be proposed and justified compliant with IEC/IEEE 60780-323.

10.3 Seismic qualification

If RMS is designed to withstand seismic events, RMS shall maintain the specified accuracy and performance features during and/or after the seismic event. The seismic qualification shall be performed in accordance with IEC/IEEE 60980-344 for the equipment performing category A or B functions.

10.4 Electromagnetic interference

Precautions shall be taken against the effects of electromagnetic interference either received or emitted by the equipment. Unless otherwise agreed upon between the purchaser and manufacturer, electromagnetic interference shall be evaluated in accordance with IEC 62003.

11 Calibration

11.1 General

Calibration of RMS is performed as a part of the maintenance activities in accordance with this Clause. The overall operation and maintenance activities for RMS which are not specified in this Clause shall be performed in accordance with IEC 61513.

11.2 Periodical calibration and functional check

11.2.1 General

RMS shall maintain the specified accuracy and performance features during operating period. For this purpose, calibration checks and functional checks shall be performed periodically.

11.2.2 Calibration check after installation

After the installation, calibration check shall be performed periodically. If the RMS equipment, especially the detector assembly, cannot be removed from the installed location for the duration of the calibration period, then measures for the calibration checks shall be provided without the need to remove equipment of RMS from the installed location. Before RMS is placed in service in nuclear facilities, calibration shall be performed. The calibration records obtained in accordance with the specific RMS standards shown in Clause 6 may be acceptable for the part of calibration records. The initial calibration may be performed during installation activities.

11.2.3 Functional check

The functions of RMS shall be checked periodically. The procedure of the functional check shall be determined according to the equipment standards shown in Clause 6 or the instruction manual that the manufacturer provides.

11.2.4 Countermeasures to loss of monitoring during calibration or functional check

If the loss of monitoring functions during calibration or functional check period is not permitted, additional measures, such as alternative monitoring, shall be provided.

11.3 Radiation calibration

Radiation calibration shall be performed in accordance with equipment standards shown in Clause 6. ISO 4037-1 and ISO 4037-3 are also referenced in the specific RMS standards as appropriate. The quantity of radiation or radioactivity should be traceable to the National Standardizing Laboratory of a country for Radioactivity measurements (NSLR) in the country in which RMS is installed. The calibration results shall be documented in accordance with equipment standards shown in Clause 6 and ISO 4037-3.

11.4 Calibration for other quantity

Other instruments such as flow meter, pressure gauge, etc., shall be calibrated according to the manufacturers' instruction.

11.5 Traceability

When the country in which the equipment of RMS is calibrated and the country in which RMS is installed are different, the traceability of the calibration can be accepted if both countries accredit Multi Recognition Agreement (MRA) for the quantity calibrated according to ISO/IEC 17025.

Annex A (informative)

Example of safety classification for RMS important to safety

This annex provides an example (Table A.1) of safety classification for RMS important to safety. It should be noted that the actual classification of radiation monitor should be derived in accordance with the safety analysis based on the national and/or international regulations for the ~~NPP~~ nuclear facilities in which RMS is installed.

Table A.1 – Example of safety classification for RMS important to safety

Corresponding I&C functions for RMS and IEC 61226 safety category			IEC 61513 safety class	Radiation monitor	
Initiate signals to actuate safety function	Post accident monitoring Main cooling system isolation	Communication to warn of significant on- or offsite release of radioactive materials		PWR	BWR
A	(B)	(C)	1	Main control room supply air duct radiation monitor Containment high range radiation monitor	Main steam line tunnel area radiation monitor Drywell sumps discharge radiation monitor Reactor building vent exhaust radiation monitor Fuel handling area air vent exhaust radiation monitor Control building air intake radiation monitor
	B	(C)	2	Containment radioactive aerosol monitor Containment noble gas monitor	Containment atmospheric radiation monitor Drywell fission product radioactive gas radiation monitor Drywell fission product radioactive aerosol radiation monitor
		C	3	Plant vent radiation monitor Main steam line radiation monitor Turbine island vent discharge radiation monitor Steam generator blowdown radiation monitor Area radiation monitor	Standby gas treatment system offgas radiation monitor Plant stack discharge radiation monitor Turbine building vent exhaust radiation monitor Turbine gland seal condenser offgas radiation monitor Area radiation monitor

Annex B (informative)

Relation between IEC 61513 system lifecycle and IEC 62705 requirements

This annex provides the relation between IEC 61513 system lifecycle phase and IEC 62705 RMS lifecycle requirements (Table B.1). The IEC 62705 requirements are the supplements of IEC 61513 and it is not intended that IEC 62705 limits the application of other IEC 61513 requirements to RMS lifecycle.

Table B.1 – Relation between IEC 61513 system lifecycle and IEC 62705 requirements

IEC 61513 System lifecycle phase		IEC 62705 RMS lifecycle requirements	
6.2.2	System requirement specification	5.1	Function categorization for RMS
6.2.3	System specification	5.2	System classification for RMS
6.2.4	System detailed design and implementation	6	RMS detailed design and implementation
6.2.5	System integration	7.1	RMS integration
6.2.6	System validation	7.2	RMS validation
6.2.7	System installation	8	RMS Installation
6.2.8	System design modification	9	RMS design modification
6.5	System qualification	10	RMS qualification
8	Overall operation and maintenance	11.2	Periodical calibration and functional check

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IEC 61508-3, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

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IEC 62706:2019, *Radiation protection instrumentation – Recommended climatic, electromagnetic and mechanical performance requirements and methods of tests*

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ISO 11929-1:2019, *Determination of the characteristic limits (decision threshold, detection limit and limits of the coverage interval) for measurements of ionizing radiation – Fundamentals and application – Part 1: Elementary applications*

IAEA Safety Glossary, 2018 edition

IEEE Std 1076™-2019, *Standard for VHDL Language Reference Manual*

IEEE Std 1364™-2005, *Standard for Verilog Hardware Description Language*

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

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

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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.

IECNORM.COM : Click to view the full PDF of IEC 62705:2022 RVD

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 off-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
Scope	Sampling (Normal operation)	Calibration (Normal operation)	Normal operation, A00	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 62302, 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 61031	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) Recommendations 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-3.5 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, IEC 63351 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*

IEC 60768, *Nuclear power plants – Instrumentation important to safety – Equipment for continuous in-line or on-line monitoring of radioactivity in process streams for normal and incident conditions*

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

IEC 60861, *Equipment for monitoring of radionuclides in liquid effluents and surface waters*

IEC 60880, *Nuclear power plants – Instrumentation and control systems important to safety – Software aspects for computer-based systems performing category A functions*

IEC 60951-1:2022, *Nuclear power plants – Instrumentation important to safety – Radiation monitoring for accident and post-accident conditions – Part 1: General requirements*

IEC 60951-2, *Nuclear power plants – Instrumentation important to safety – Radiation monitoring for accident and post-accident conditions – Part 2: Equipment for continuous off-line monitoring of radioactivity in gaseous effluents and ventilation air*

IEC 60951-3, *Nuclear power plants – Instrumentation important to safety – Radiation monitoring for accident and post-accident conditions – Part 3: Equipment for continuous high range area gamma monitoring*

IEC 60951-4, *Nuclear power plants – Instrumentation important to safety – Radiation monitoring for accident and post-accident conditions – Part 4: Equipment for continuous in-line or on-line monitoring of radioactivity in process streams*

IEC 60960, *Functional design criteria for a safety parameter display system for nuclear power stations*

IEC/IEEE 60980-344, *Nuclear facilities – Equipment important to safety – Seismic qualification*

IEC 60987, *Nuclear power plants – Instrumentation and control important to safety – Hardware requirements*

IEC 61031, *Nuclear facilities – Instrumentation and control systems – Design, location and application criteria for installed area gamma radiation dose rate monitoring equipment for use during normal operation and anticipated operational occurrences*

IEC 61226:2020, *Nuclear power plants – Instrumentation, control and electrical power systems important to safety – Categorization of functions and classification of systems*

IEC 61250, *Nuclear reactors – Instrumentation and control systems important to safety – Detection of leakage in coolant systems*

IEC 61504, *Nuclear facilities – Instrumentation and control systems important to safety – Centralized systems for continuous monitoring of radiation and/or levels of radioactivity*

IEC 61513:2011, *Nuclear power plants – Instrumentation and control important to safety – General requirements for systems*

IEC 61559 (all parts), *Radiation protection instrumentation in nuclear facilities – Centralized systems for continuous monitoring of radiation and/or levels of radioactivity*

IEC 62003, *Nuclear power plants – Instrumentation, control and electrical power systems – Requirements for electromagnetic compatibility testing*

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

IEC 62302, *Radiation protection instrumentation – Equipment for sampling and monitoring radioactive noble gases*

IEC 62303, *Radiation protection instrumentation – Equipment for monitoring airborne tritium*

IEC 62566:2012, *Nuclear power plants – Instrumentation and control important to safety – Development of HDL-programmed integrated circuits for systems performing category A functions*

IEC 62566-2, *Nuclear power plants – Instrumentation and control systems important to safety – Development of HDL-programmed integrated circuits – Part 2: HDL-programmed integrated circuits for systems performing category B or C functions*

IEC 63147:2017/IEEE Std 497™, *Criteria for accident monitoring instrumentation for nuclear power generating stations*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO 2889, *Sampling airborne radioactive materials from the stacks and ducts of nuclear facilities*

ISO 4037-1, *Radiological protection – X and gamma reference radiation for calibrating dosimeters and dose rate meters and for determining their response as a function of photon energy – Part 1: Radiation characteristics and production methods*

ISO 4037-3, *Radiological protection – X and gamma reference radiation for calibrating dosimeters and dose rate meters and for determining their response as a function of photon energy – Part 3: Calibration of area and personal dosimeters and the measurement of their response as a function of energy and angle of incidence*

3 Terms and definitions

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

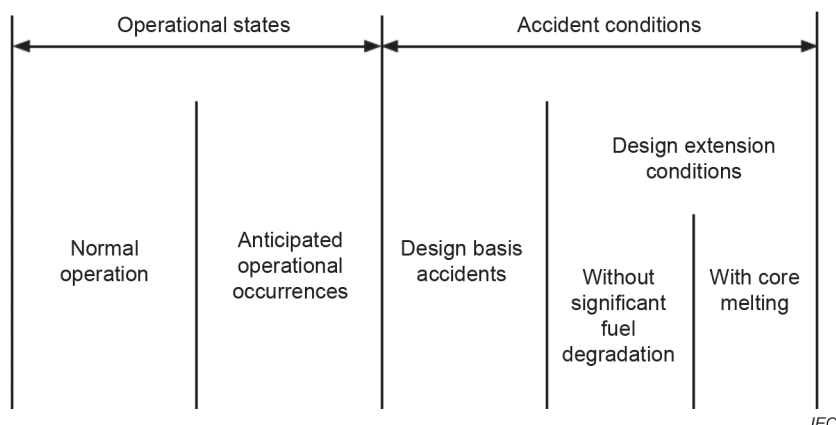
ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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

3.1

accident conditions

deviations from normal operation that are less frequent and more severe than anticipated operational occurrences described by the following figure



Note 1 to entry: Accident conditions comprise design basis accidents and design extension conditions.

[SOURCE: IAEA Safety Glossary, 2018 edition]

3.2

alarm assembly

assembly which is initiated by the processing assembly, and provides audible and/or visual alarms, normally local to detector assembly

3.3

anticipated operational occurrence

AOO

deviation of an operational process from normal operation that is expected to occur at least once during the operating lifetime of a facility but which, in view of appropriate design provisions, does not cause any significant damage to items important to safety or lead to accident conditions

[SOURCE: IAEA Safety Glossary, 2018 edition]

3.4

calibration

set of operations that establish, under specified conditions the relationship between values of quantities indicated by a measuring instrument or a measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards

[SOURCE: IEC 62397:2007, 3.2]

3.5

category of an I&C function

one of three possible safety assignments (A, B, C) of I&C functions resulting from considerations of the safety relevance of the function to be performed. An unclassified assignment may be made if the function has no importance to safety

[SOURCE: IEC 61513:2011, 3.4]

3.6

centralized system

centralizer

central processing and control system for the calculation, display, and storage of data from the processing assembly

3.7

class of an I&C system

one of three possible assignments (1, 2, 3) of I&C systems important to safety resulting from consideration of their requirement to implement I&C functions of different safety importance. An unclassified assignment is made if the I&C system does not implement functions important to safety

[SOURCE: IEC 61513:2011, 3.6]

3.8

decision threshold

value of the estimator of the measurand, which, when exceeded by the result of an actual measurement using a given measurement procedure of a measurand quantifying a physical effect, is used to decide that the physical effect is present

Note 1 to entry: The decision threshold is defined such that in cases where the measurement result, y , exceeds the decision threshold, y^* , the probability of a wrong decision, namely that the true value of the measurand is not zero if in fact it is zero, is less or equal to a chosen probability α .

Note 2 to entry: If the result, y , is below the decision threshold, y^* , it is decided to conclude that the result cannot be attributed to the physical effect; nevertheless, it cannot be concluded that it is absent.

[SOURCE: ISO 11929-1:2019, 3.12]

3.9

design basis accident

DBA

a postulated accident leading to accident conditions for which a facility is designed in accordance with established design criteria and conservative methodology, and for which releases of radioactive material are kept within acceptable limits

[SOURCE: IAEA Safety Glossary, 2018 edition]

3.10

design extension conditions

DEC

postulated accident conditions that are not considered for design basis accidents, but that are considered in the design process of the facility in accordance with best estimate methodology, and for which releases of radioactive material are kept within acceptable limits

Note 1 to entry: Design extension conditions comprise conditions in events without significant fuel degradation and conditions in events with melting of the reactor core including severe accident.

[SOURCE: IAEA Safety Glossary, 2018 edition]

3.11

detection limit

smallest true value of the measurand which ensures a specified probability of being detectable by the measurement procedure

Note 1 to entry: With the decision threshold according to 3.8, the detection limit is the smallest true value of the measurand for which the probability of wrongly deciding that the true value of the measurand is zero is equal to a specified value, β , when, in fact, the true value of the measurand is not zero. The probability of being detectable is consequently $(1-\beta)$.

Note 2 to entry: The terms detection limit and decision threshold are used in an ambiguous way in different standards (e.g. standards related to chemical analysis or quality assurance). If these terms are referred to one has to state according to which standard they are used.

[SOURCE: ISO 11929-1:2019, 3.13]

3.12

detector assembly

detector and associated electronics (amplifier, discriminator, output pulse shaper), and can also include hydraulic and programmable electronic circuits

3.13

hardware description language

HDL

language used to formally describe the functions and/or the structure of an electronic component for documentation, simulation or synthesis

Note 1 to entry: The most widely used HDLs are VHDL (IEEE 1076) and Verilog (IEEE 1364).

[SOURCE: IEC 62566:2012, 3.6]

3.14

HDL-Programmed Device

HPD

integrated circuit configured (for NPP I&C systems), with Hardware Description Languages and related software tools

Note 1 to entry: HDLs and related tools (e.g. simulator, synthesizer) are used to implement the requirements in a proper assembly of pre-developed micro-electronic technologies.

Note 2 to entry: The development of HPDs can use Pre-Developed Blocks.

Note 3 to entry: HPDs are typically based on blank FPGAs (Field Programmable gate Arrays) or similar micro-electronic technologies.

[SOURCE: IEC 62566:2012, 3.7]

3.15

in-line monitoring

monitoring of the radioactivity in fluid by the detector located directly in the process stream (pipe, stack, duct, etc.)

3.16

monitoring assembly

combinations of processing, alarm, and detector assemblies

3.17

network equipment

equipment supporting communication among assemblies of RMS and external equipment

3.18

off-line monitoring

monitoring of the activity in fluid by sample drawn from the process stream to the detector located at some distance

3.19

on-line monitoring

monitoring of the radioactivity in fluid by the detector directly facing the process stream

3.20

processing assembly

assembly which converts the output signal from the detector assemblies into a form, generally digital, suitable for transmission down a data link to the central computer, centralized system, and/or which generates alarm outputs to the alarm units at present signal levels

3.21**radiation monitor**

device designed to measure the level of ionizing radiation and able to emit a warning signal

Note 1 to entry: A radiation monitor may also provide quantitative information.

3.22**sampling assembly**

set of interconnected instruments (devices) for collecting a representative sample

[SOURCE: IEC 60951-1:2022, 3.23]

3.23**severe accident****SA**

accident more severe than a design basis accident and involving significant core degradation

[SOURCE: IAEA Safety Glossary, 2018 edition]

3.24**volumetric activity**

activity per unit volume of the sample

Note 1 to entry: For a gas, it is necessary to indicate the temperature and pressure conditions for which the volumetric activity, expressed in becquerels per cubic metre, is measured, for example standard temperature and pressure.

Note 2 to entry: This quantity is expressed in becquerels per cubic metre (Bq/m³).

[SOURCE: IEC 60050-395:2014, 395-01-09]

4 Symbols and abbreviated terms

AOO	Anticipated Operational Occurrence
BWR	Boiling Water Reactor
DBA	Design Basis Accident
DEC	Design Extension Condition
FPGA	Field-Programmable Gate Array
HPD	HDL (Hardware Description Language) -Programmed Device
I&C	Instrumentation and Control
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
MRA	Multi Recognition Agreement
NSLR	National Standardizing Laboratory of a country for Radioactivity measurement
PLD	Programmable Logic Device
PWR	Pressurized Water Reactor
RMS	Radiation Monitoring System
SA	Severe Accident

5 RMS categorization and classification

5.1 Function categorization for RMS

RMS in nuclear power plants provides continuous information about the radiological conditions in nuclear facilities by measuring the radiation levels in specific areas, on certain process lines and at gaseous and liquid release points. It provides alarms and can initiate automatic actions when the monitored radioactivity reaches levels that have been determined to be abnormal. The plant safety design base assigns the individual RMS functions important to safety into one of three categories A, B or C, considering the relationships to other systems to be connected. The main technical requirements for the systems and equipment associated with these categories are consistent with those of Clause 7 of IEC 61226:2020. The category shall be assigned during system requirement specification phase.

5.2 System classification for RMS

RMS shall be classified according to its suitability to implement I&C functions up to a defined category during the system specification phase as shown in 6.2.3 of IEC 61513:2011. Examples of the classification for RMS installed in PWR and BWR plants are shown in Annex A.

According to the category of the function, the following standards shall be applied to each system and equipment.

a) System and equipment performing category A functions

Any software in RMS performing category A function shall be designed and maintained in accordance with IEC 60880. Any HDL-Programmed Device (HPD) in the equipment of RMS performing category A function shall be designed and maintained in accordance with IEC 62566. Any hardware in RMS performing category A function and including software or HPD shall be designed and maintained in accordance with IEC 60987.

b) System and equipment performing category B or C functions

Any software in RMS performing category B or C function shall be designed and maintained in accordance with IEC 62138. Any hardware in RMS performing category B or C function and including software shall be designed and maintained in accordance with IEC 60987. HDL-programmed integrated circuits for system performing category B or C function shall be designed and maintained in accordance with IEC 62566-2.

5.3 Criteria for identifying the plant-specific variables

The selection criteria for identifying the plant-specific variables (Type A-F) for accident monitoring instrumentation are provided in Clause 4 of IEC 63147:2017/IEEE Std 497™. RMS shall be designed appropriately in accordance with IEC 63147:2017/IEEE Std 497™ when the criteria corresponds to design basis accident (DBA) or design extension condition (DEC).

6 RMS detailed design and implementation

6.1 General

RMS generally consists of a combination of following equipment:

- detector assembly
- sampling assembly
- monitoring assembly
- processing assembly
- alarm assembly
- centralized system
- network equipment

- cable

The above equipment may have embedded software.

The RMS is designed and implemented in accordance with appropriate requirements shown in the following standards.

6.2 Radioactive noble gas off-line monitoring

RMS for radioactive noble gas off-line monitoring is used for the following purposes:

- to measure the volumetric activity of radioactive noble gases in gaseous effluents at the discharge point and the variation of volumetric activity. The monitor may also be used for the determination of the total discharge of radioactive noble gas over a given period;
- to measure the volumetric activity (s-1, A, etc.) in air or gas systems (control room ventilation, reactor leakage collection, drywell ventilation exhaust, fuel handling building ventilation exhaust, reactor building ventilation purge exhaust) and detect any significant increase of radioactivity.

For RMS designed only for normal operation condition, the design and testing of RMS shall be performed in accordance with IEC 60761-1 and IEC 60761-3. As an alternative, IEC 62302 may be used instead of the set of IEC 60761-1 and IEC 60761-3.

For RMS designed for design basis accidents (DBA), the design and testing of RMS shall be performed in accordance with IEC 60951-1 and IEC 60951-2. Sampling assembly for RMS used for this monitoring shall be designed and tested in accordance with ISO 2889.

6.3 Radioactive aerosol off-line monitoring

RMS for radioactive aerosol off-line monitoring is used for the following purposes:

- to measure the volumetric activity of radioactive aerosols in gaseous effluents at the discharge point and the variation of volumetric activity. The monitor may also be used for the determination of the total discharge of radioactive aerosol over a given period;
- to measure the volumetric activity in air or gas systems (control room ventilation, reactor leakage collection, drywell ventilation exhaust, fuel handling building ventilation exhaust, reactor building ventilation purge exhaust) and detect any significant increase of radioactivity.

For RMS designed only for normal operation condition, the design and testing of RMS shall be performed in accordance with IEC 60761-1 and IEC 60761-2. For RMS designed for design basis accidents (DBA), the design and testing of RMS shall be performed in accordance with IEC 60951-1 and IEC 60951-2. Sampling assembly for RMS used for this monitoring shall be designed and tested in accordance with ISO 2889.

6.4 Radioactive iodine off-line monitoring

RMS for radioactive iodine off-line monitoring is used for the following purposes:

- to measure the volumetric activity of radioactive iodines in gaseous effluents at the discharge point and the variation of volumetric activity. The monitor may also be used for the determination of the total discharge of radioactive iodine over a given period;
- to measure the volumetric activity in air or gas systems (control room ventilation, reactor leakage collection, drywell ventilation exhaust, fuel handling building ventilation exhaust, reactor building ventilation purge exhaust) and detect any significant increase of activity.

For RMS designed only for normal operation condition, the design and testing of RMS shall be performed in accordance with IEC 60761-1 and IEC 60761-4. For RMS designed for design basis accidents (DBA), the design and testing of RMS shall be performed in accordance with IEC 60951-1 and IEC 60951-2. Sampling assembly for RMS used for this monitoring shall be designed and be tested in accordance with ISO 2889.

6.5 Liquid off-line monitoring

RMS for continuous liquid off-line monitoring is used for following purposes:

- to measure the volumetric activity in liquid at the discharge point or the surface water and the variation of volumetric activity. The monitor may also be used for the determination of the total discharge of radioactive materials in liquid over a given period.

The design and testing of RMS shall be performed in accordance with IEC 60861.

6.6 Tritium off-line monitoring

RMS for continuous radioactive tritium off-line monitoring is used for following purposes:

- to measure the volumetric activity of tritium in gaseous effluents at the discharge point and the variation of volumetric activity. The monitor may also be used for the determination of the total discharge of tritium over a given period.

The design and testing of RMS shall be performed in accordance with IEC 60761-1 and IEC 60761-5. As an alternative, IEC 62303 may be used instead of the set of IEC 60761-1 and IEC 60761-5.

6.7 On-line or in-line monitoring

RMS for on-line or in-line monitor shall provide continuous measurement; this is normally achieved by positioning the detectors in the process stream (e.g. immersed in, or adjacent to the process stream, in a pipe or tank). For RMS designed only for normal operation condition, the design and testing of RMS shall be performed in accordance with IEC 60768. For RMS designed for design basis accidents (DBA), the design and testing of RMS shall be performed in accordance with IEC 60951-1 and IEC 60951-4.

6.8 Area monitoring

RMS for area monitoring is used to monitor dose rate of gamma radiation in nuclear facilities. For RMS designed only for normal operation condition, the design and testing of RMS shall be performed in accordance with IEC 61031 in conjunction with IEC 60532. For RMS designed for design basis accidents (DBA) and design extension conditions (DEC) including severe accident (SA), the design and testing of RMS shall be performed in accordance with IEC 60951-1 and IEC 60951-3.

6.9 Centralized system

The centralized system receives data from plant-wide monitored radiation information. The centralized system provides the information to operations personnel and performs data recording, data validation, data display, and system control functions. The design and testing for centralized system shall be performed in accordance with IEC 61504 in conjunction with the IEC 61559 series which specifies the requirements for centralized radiation monitoring systems. If the centralized system is a part of the safety parameter display system, the design shall be performed in accordance with IEC 60960.

6.10 Leak detection

In addition to the above requirements, RMS shall be designed and tested in accordance with IEC 61250 if the RMS is intended to be used for the leak detection in nuclear facilities.

7 RMS integration and validation

7.1 RMS integration

System integration is performed by assembling and interconnecting the equipment of RMS as designed.

7.2 RMS validation

After the system integration, it shall be demonstrated that the integrated system complies with the functional, performance and interface specifications. Validation shall comprise tests performed on the system in the final equipment configuration. During system validation, the interface to other systems, not only to I&C systems, but also to piping, mechanical components shall be validated.

8 RMS installation

After the system integration and validation, the equipment of RMS is installed in the specified location in the nuclear facilities. It shall be confirmed that the location conditions for environmental, seismic, and electromagnetic interference are within the qualification envelope as shown in Clause 10.

During and after the installation, the installation testing shall be done to demonstrate the compliance to the requirements, which includes the interface confirmation to other systems, not only to I&C systems, but also to piping and mechanical components.

The installed location of the equipment of RMS is designed in accordance with appropriate specific RMS standards shown in Clause 6 or nuclear facilities location design.

9 RMS design modification

Modifications to the design of RMS may be required due to the identification of new system requirements or due to the discovery of system design defects during the evaluation of operation records and reports. The following activities are needed for the modification:

- the implementation of a modification to a system shall be carried out in accordance with defined procedures;
- testing of the correct operation of the system shall be done after a modification in accordance with the applicable referenced documents identified in Clause 6;
- no hardware/software modification, other than those specified in the maintenance procedures, shall be allowed as a matter of routine;
- should replacement hardware be required, it shall be demonstrated/justified that the replacement meets the specification of the original hardware.

10 RMS qualification

10.1 General

The qualification envelope of the equipment of RMS shall comply with the environmental requirements of the installed locations in nuclear facilities. The justification shall be done to show the compliance between the qualification envelope of the equipment of RMS and the environmental requirements of the installed locations in nuclear facilities. The following qualification requirements supersede the qualification requirements defined in each radiation monitor standards listed in Clause 6, although individual standard may define the qualification requirements.

10.2 Environmental qualification

RMS shall maintain the specified accuracy and performance for the range of the environmental conditions at the equipment locations during normal plant operations. If RMS is required to provide the information during and after design basis accidents (DBA) and design extension conditions (DEC) including severe accident (SA), RMS shall maintain its safety functions as specified during and after these conditions. The environment qualification for RMS shall be performed in accordance with IEC/IEEE 60780-323 for the equipment performing category A or B functions.

The equipment performing category C functions only, for which specific environmental qualification is required (e.g. resistance to seismic conditions, or operation under specific environmental conditions), may be qualified to industrial standards. Claims for operation in abnormal environmental conditions, seismic qualification to industrial standards or other credited functional performances shall be justified by documentary evidence. Where significant ageing factors exist, and when qualified life cannot be demonstrated in accordance with the definition given in IEC/IEEE 60780-323, an on-going qualification program shall be proposed and justified compliant with IEC/IEEE 60780-323.

10.3 Seismic qualification

If RMS is designed to withstand seismic events, RMS shall maintain the specified accuracy and performance features during and/or after the seismic event. The seismic qualification shall be performed in accordance with IEC/IEEE 60980-344 for the equipment performing category A or B functions.

10.4 Electromagnetic interference

Precautions shall be taken against the effects of electromagnetic interference either received or emitted by the equipment. Unless otherwise agreed upon between the purchaser and manufacturer, electromagnetic interference shall be evaluated in accordance with IEC 62003.

11 Calibration

11.1 General

Calibration of RMS is performed as a part of the maintenance activities in accordance with this Clause. The overall operation and maintenance activities for RMS which are not specified in this Clause shall be performed in accordance with IEC 61513.

11.2 Periodical calibration and functional check

11.2.1 General

RMS shall maintain the specified accuracy and performance features during operating period. For this purpose, calibration checks and functional checks shall be performed periodically.

11.2.2 Calibration check after installation

After the installation, calibration check shall be performed periodically. If the RMS equipment, especially the detector assembly, cannot be removed from the installed location for the duration of the calibration period, then measures for the calibration checks shall be provided without the need to remove equipment of RMS from the installed location. Before RMS is placed in service in nuclear facilities, calibration shall be performed. The calibration records obtained in accordance with the specific RMS standards shown in Clause 6 may be acceptable for the part of calibration records. The initial calibration may be performed during installation activities.

11.2.3 Functional check

The functions of RMS shall be checked periodically. The procedure of the functional check shall be determined according to the equipment standards shown in Clause 6 or the instruction manual that the manufacturer provides.

11.2.4 Countermeasures to loss of monitoring during calibration or functional check

If the loss of monitoring functions during calibration or functional check period is not permitted, additional measures, such as alternative monitoring, shall be provided.

11.3 Radiation calibration

Radiation calibration shall be performed in accordance with equipment standards shown in Clause 6. ISO 4037-1 and ISO 4037-3 are also referenced in the specific RMS standards as appropriate. The quantity of radiation or radioactivity should be traceable to the National Standardizing Laboratory of a country for Radioactivity measurements (NSLR) in the country in which RMS is installed. The calibration results shall be documented in accordance with equipment standards shown in Clause 6 and ISO 4037-3.

11.4 Calibration for other quantity

Other instruments such as flow meter, pressure gauge, etc., shall be calibrated according to the manufacturers' instruction.

11.5 Traceability

When the country in which the equipment of RMS is calibrated and the country in which RMS is installed are different, the traceability of the calibration can be accepted if both countries accredit Multi Recognition Agreement (MRA) for the quantity calibrated according to ISO/IEC 17025.

Annex A (informative)

Example of safety classification for RMS important to safety

This annex provides an example (Table A.1) of safety classification for RMS important to safety. It should be noted that the actual classification of radiation monitor should be derived in accordance with the safety analysis based on the national and/or international regulations for the nuclear facilities in which RMS is installed.

Table A.1 – Example of safety classification for RMS important to safety

Corresponding I&C functions for RMS and IEC 61226 safety category			IEC 61513 safety class	Radiation monitor	
Initiate signals to actuate safety function	Post accident monitoring Main cooling system isolation	Communication to warn of significant on- or offsite release of radioactive materials		PWR	BWR
A	(B)	(C)	1	Main control room supply air duct radiation monitor Containment high range radiation monitor	Main steam line tunnel area radiation monitor Drywell sumps discharge radiation monitor Reactor building vent exhaust radiation monitor Fuel handling area air vent exhaust radiation monitor Control building air intake radiation monitor
	B	(C)	2	Containment radioactive aerosol monitor Containment noble gas monitor	Containment atmospheric radiation monitor Drywell fission product radioactive gas radiation monitor Drywell fission product radioactive aerosol radiation monitor
		C	3	Plant vent radiation monitor Main steam line radiation monitor Turbine island vent discharge radiation monitor Steam generator blowdown radiation monitor Area radiation monitor	Standby gas treatment system offgas radiation monitor Plant stack discharge radiation monitor Turbine building vent exhaust radiation monitor Turbine gland seal condenser offgas radiation monitor Area radiation monitor

Annex B (informative)

Relation between IEC 61513 system lifecycle and IEC 62705 requirements

This annex provides the relation between IEC 61513 system lifecycle phase and IEC 62705 RMS lifecycle requirements (Table B.1). The IEC 62705 requirements are the supplements of IEC 61513 and it is not intended that IEC 62705 limits the application of other IEC 61513 requirements to RMS lifecycle.

Table B.1 – Relation between IEC 61513 system lifecycle and IEC 62705 requirements

IEC 61513 System lifecycle phase		IEC 62705 RMS lifecycle requirements	
6.2.2	System requirement specification	5.1	Function categorization for RMS
6.2.3	System specification	5.2	System classification for RMS
6.2.4	System detailed design and implementation	6	RMS detailed design and implementation
6.2.5	System integration	7.1	RMS integration
6.2.6	System validation	7.2	RMS validation
6.2.7	System installation	8	RMS Installation
6.2.8	System design modification	9	RMS design modification
6.5	System qualification	10	RMS qualification
8	Overall operation and maintenance	11.2	Periodical calibration and functional check

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

INSTALLATIONS NUCLÉAIRES – INSTRUMENTATION ET CONTRÔLE-COMMANDE IMPORTANTS POUR LA SÛRETÉ – SYSTÈMES DE SURVEILLANCE DES RAYONNEMENTS (RMS): CARACTÉRISTIQUES ET CYCLE DE VIE

AVANT-PROPOS

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Cette deuxième édition annule et remplace la première édition parue en 2014. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) le titre a été modifié;
- b) la catégorisation des conditions accidentelles a été harmonisée;

- c) les références aux nouvelles normes publiées depuis la première édition ont été mises à jour;
- d) les termes et définitions ont été mis à jour.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
45A/XX/FDIS	45A/XX/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

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INTRODUCTION

a) Contexte technique, questions importantes et structure de la Norme

La présente norme IEC établit les exigences en matière de gestion du cycle de vie des systèmes de surveillance des rayonnements (RMS) installés dans les installations nucléaires (centrales nucléaires de puissance et sites de stockage et de traitement du combustible nucléaire, par exemple).

Le présent document s'applique au matériel des RMS et est destiné à être utilisé pendant le fonctionnement normal, en cas d'incident de fonctionnement prévu (IFP), lors d'accidents de dimensionnement (DBA) et en conditions additionnelles de dimensionnement (DEC), incluant les accidents graves (SA).

Le présent document est destiné à être utilisé par les exploitants d'installations nucléaires, les évaluateurs de système, les fournisseurs et par les régulateurs.

b) Positionnement de la présente Norme dans la structure de la collection de normes du SC 45A de l'IEC

L'IEC 62705 est le troisième niveau de la hiérarchie de normes du SC 45A. Le présent document fournit des recommandations pour l'application des normes IEC/ISO existantes qui traitent de la conception et de la qualification du système et du matériel pour les RMS. Le présent document est un complément pour l'application de l'IEC 61513, comme cela est indiqué à l'Annex B, et il n'a pas pour objet de limiter l'application des autres exigences de l'IEC 61513 au cycle de vie des RMS.

Les normes suivantes fournissent les exigences et recommandations générales relatives aux RMS. L'IEC 61513 est la norme de premier niveau des normes du SC 45A et établit les exigences générales relatives aux matériels et systèmes d'instrumentation et de contrôle-commande (systèmes d'I&C) utilisés pour réaliser des fonctions importantes pour la sûreté dans les installations nucléaires. L'IEC 61226 fournit les critères de classement de l'instrumentation et des fonctions de commande. La plupart des RMS modernes contiennent des matériels informatisés. De fait, il convient souvent de traiter le RMS comme un système informatisé. Les normes suivantes exigées pour le système informatisé s'appliquent donc généralement aux RMS. L'IEC 60880 fournit les exigences relatives au logiciel pour les fonctions de catégorie A, et l'IEC 62138 fournit les exigences relatives au logiciel pour les fonctions de catégorie B ou C. L'IEC 60987 fournit les exigences applicables à la conception du matériel des systèmes informatisés. L'IEC 62566 fournit les exigences applicables au circuit intégré programmé en HDL (HDP) des systèmes qui réalisent des fonctions de catégorie A. L'IEC 62645 fournit les exigences de sécurité applicables aux systèmes d'I&C informatisés. Pour les essais de qualification, les normes suivantes du SC 45A s'appliquent. L'IEC/IEEE 60780-323 fournit des recommandations relatives à la qualification environnementale et l'IEC/IEEE 60980-344 fournit des recommandations relatives à la qualification sismique des matériels qui réalisent des fonctions de catégorie A ou B. L'IEC 62003 fournit les exigences relatives aux essais de compatibilité électromagnétique. De plus, l'IEC 61250 spécifie les exigences de détection des fuites à l'aide des RMS.

Pour les exigences particulières à la surveillance des rayonnements, les normes suivantes fournissent les exigences et recommandations applicables aux RMS. La série IEC 60951 fournit des recommandations relatives à la conception et aux essais des matériels de surveillance des rayonnements utilisés pour les incidents de fonctionnement prévus (IFP), les accidents de dimensionnement (DBA) et les conditions additionnelles de dimensionnement (DEC), incluant les accidents graves (SA). La série IEC 60761 fournit des exigences applicables aux matériels pour la surveillance en continu des rayonnements avec prélèvements dans les effluents gazeux en conditions normales. La série IEC 60761 est désormais remplacée par certaines normes du SC 45B (par exemple, prélèvements de gaz: IEC 62302, prélèvements du tritium: IEC 62303). L'IEC 60861 fournit des exigences applicables aux matériels pour la surveillance en continu des rayonnements avec prélèvements dans les effluents liquides en conditions normales. L'IEC 60768 fournit des exigences applicables aux matériels pour la surveillance en continu, interne et externe, des rayonnements au niveau des fluides de procédés pour les conditions de fonctionnement normal et incidentel. L'IEC 61031 fournit des exigences applicables aux moniteurs de surveillance des rayonnements de zone dans les conditions normales, conjointement avec l'IEC 60532. L'IEC 61504 fournit des exigences applicables aux systèmes centralisés pour

la surveillance des rayonnements sur l'ensemble du site conjointement avec la série IEC 61559 qui spécifie les exigences des systèmes centralisés. Si le système centralisé fait partie intégrante du système de visualisation des paramètres de sûreté, l'IEC 60960 fournit les critères fonctionnels de conception. L'ISO 2889 fournit des recommandations pour l'échantillonnage de gaz et de particules. La série ISO 4037 fournit la méthode d'étalonnage des moniteurs de surveillance des rayonnements.

Les relations entre ces différentes normes sont données dans le Tableau 1.

L'IEC 63147/IEEE Std 497™ fournit des recommandations générales pour l'instrumentation de surveillance des accidents. L'IEEE Std 497™ a été adoptée directement en tant que norme double logo et un rapport technique, l'IEC TR 63123, a été établi pour étudier l'application de la norme commune dans le contexte de l'IEC.

La structure de la présente norme est alignée sur la structure de l'IEC 63147/IEEE Std 497™, et les exigences techniques de la présente norme sont cohérentes avec les exigences spécifiées dans l'IEC 63147/IEEE Std 497™ ainsi qu'avec les recommandations d'application fournies dans l'IEC TR 63123.

Pour plus d'informations sur la structure de la collection de normes du SC 45A de l'IEC, voir le point d) de la présente introduction.

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Tableau 1 – Vue d'ensemble des normes qui traitent de la surveillance des rayonnements dans les installations nucléaires

Développeur	ISO		IEC			
				SC 45A		SC 45B
Domaine d'application	Echantillonnage (fonctionnement normal)	Etalonnage (fonctionnement normal)	Fonctionnement normal, IFP	DBA	DEC	Fonctionnement normal
Surveillance avec prélèvements des gaz rares radioactifs	ISO 2889	ISO 4037-1, ISO 4037-3	N/A	IEC 60951-1, IEC 60951-2	N/A	IEC 62302, IEC 60761-1, IEC 60761-3
Surveillance avec prélèvements des aérosols radioactifs	ISO 2889	ISO 4037-1, ISO 4037-3	N/A	IEC 60951-1, IEC 60951-2	N/A	IEC 60761-1, IEC 60761-2
Surveillance avec prélèvements de l'iode radioactif	ISO 2889	ISO 4037-1, ISO 4037-3	N/A	IEC 60951-1, IEC 60951-2	N/A	IEC 60761-1, IEC 60761-4
Surveillance avec prélèvements des liquides	N/A	N/A	N/A	N/A	N/A	IEC 60861
Surveillance avec prélèvements du tritium	N/A	N/A	N/A	N/A	N/A	IEC 62303, IEC 60761-1, IEC 60761-5
Surveillance interne ou externe	N/A	ISO 4037-1, ISO 4037-3	IEC 60768	IEC 60951-1, IEC 60951-4	N/A	N/A
Surveillance de zone	N/A	ISO 4037-1, ISO 4037-3	IEC 61031	IEC 60951-1, IEC 60951-3		IEC 60532
Système centralisé	N/A	N/A	IEC 61504, IEC 60960		N/A	IEC 61559-1
Exigences de classement/de base	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) Recommandations et limites relatives à l'application de la présente Norme

Il est important de noter que le présent document n'établit pas d'exigences fonctionnelles supplémentaires pour les systèmes importants pour la sûreté. Les exigences fournies par la présente norme font généralement référence à la nécessité d'appliquer d'autres normes IEC et ISO et aux exigences fonctionnelles et techniques contenues dans ces normes.

Afin d'assurer la pertinence du document pour les années à venir, l'accent est mis sur les questions de principes plutôt que sur des technologies particulières.

d) Description de la structure de la collection de normes du SC 45A de l'IEC et des relations avec d'autres documents de l'IEC, et avec les documents d'autres organisations (AIEA, ISO)

La collection de normes établies par le SC 45A de l'IEC est structurée en quatre niveaux. Les documents de niveau supérieur dans la collection de normes du SC 45A de l'IEC sont les normes IEC 61513 et IEC 63046.

La norme IEC 61513 établit les exigences générales relatives aux matériels et systèmes d'I&C utilisés pour réaliser des fonctions importantes pour la sûreté des centrales nucléaires de puissance. La norme IEC 63046 établit les exigences générales relatives aux systèmes d'alimentation électrique des centrales nucléaires de puissance; elle couvre les systèmes d'alimentation électrique y compris les alimentations des systèmes d'I&C.

Les normes IEC 61513 et IEC 63046 doivent être prises en compte ensemble et au même niveau. Les normes IEC 61513 et IEC 63046 structurent la collection de normes du SC 45A de l'IEC et forment un cadre complet qui établit les exigences générales relatives aux systèmes d'I&C et d'alimentation électrique des centrales nucléaires de puissance.

Les normes IEC 61513 et IEC 63046 font directement référence à d'autres normes du SC 45A de l'IEC qui établissent les exigences générales relatives à des sujets spécifiques, tels que la catégorisation des fonctions et le classement des systèmes, la qualification, la séparation des systèmes, la défense contre les défaillances de cause commune, la conception des salles de commande, la compatibilité électromagnétique, l'ingénierie des facteurs humains, la cybersécurité, les aspects logiciels et matériels relatifs aux systèmes numériques programmables, la coordination des exigences de sûreté et de sécurité, et la gestion du vieillissement. Il convient de considérer que ces normes, auxquelles il est fait référence à ce deuxième niveau, forment, avec les normes IEC 61513 et IEC 63046, un ensemble documentaire cohérent.

Au troisième niveau, les normes du SC 45A de l'IEC, qui ne sont généralement pas citées en référence directement par les normes IEC 61513 ou IEC 63046, établissent les exigences particulières aux matériels, méthodes techniques ou activités spécifiques. Généralement, ces documents, qui font référence aux documents de deuxième niveau pour les exigences générales, peuvent être utilisés de façon isolée.

Un quatrième niveau qui est une extension de la collection de normes du SC 45 de l'IEC correspond aux rapports techniques qui ne sont pas des documents normatifs.

Les normes de la collection du SC 45A de l'IEC mettent en œuvre de manière systématique et décrivent les principes de sûreté et de sécurité et les aspects fondamentaux donnés dans les normes de sûreté de l'AIEA pertinentes et dans les documents pertinents de la collection de l'AIEA pour la sécurité nucléaire de puissance (NSS), en particulier avec le document d'exigences SSR-2/1 qui établit les exigences de sûreté relatives à la conception des centrales nucléaires de puissance, avec le guide de sûreté SSG-30 qui traite du classement de sûreté des structures, systèmes et composants des centrales nucléaires de puissance, avec le guide de sûreté SSG-39 qui traite de la conception des systèmes d'I&C des centrales nucléaires de puissance, avec le guide de sûreté SSG-34 qui traite de la conception des systèmes d'alimentation électrique des centrales nucléaires de puissance, avec le guide de sûreté SSG-51 qui traite de l'ingénierie des facteurs humains lors de la conception des centrales nucléaires de puissance et avec le guide de mise en œuvre NSS17 qui traite de la sécurité informatique pour les installations nucléaires. La terminologie et les définitions utilisées pour la sûreté et la sécurité dans les normes établies par le SC 45A sont conformes à celles utilisées par l'AIEA.

Les normes IEC 61513 et IEC 63046 ont adopté une présentation similaire à celle de la publication fondamentale de sécurité IEC 61508, avec un cycle de vie d'ensemble et un cycle de vie des systèmes. En ce qui concerne la sûreté nucléaire, les normes IEC 61513 et IEC 63046 donnent l'interprétation des exigences générales des parties 1, 2 et 4 de l'IEC 61508 pour le secteur nucléaire. Dans ce cadre, l'IEC 60880, l'IEC 62138 et l'IEC 62566 correspondent à la partie 3 de l'IEC 61508 pour le secteur nucléaire.

Les normes IEC 61513 et IEC 63046 font référence à la norme ISO 9001, ainsi qu'aux documents AIEA GSR partie 2 et AIEA GS-G-3.1 et AIEA GS-G-3.5 pour ce qui concerne l'assurance qualité.

Au second niveau, en ce qui concerne la sûreté nucléaire, la norme IEC 62645 est le document chapeau des normes du SC 45A de l'IEC applicables à la cybersécurité. Elle se fonde sur les principes pertinents de haut niveau et sur les concepts principaux des normes génériques de sûreté, en particulier l'ISO/IEC 27001 et l'ISO/IEC 27002; elle les adapte et les complète pour qu'ils deviennent pertinents pour le secteur nucléaire; elle est coordonnée étroitement avec la norme IEC 62443. Au second niveau, la norme IEC 60964 est le document chapeau des normes du SC 45A de l'IEC applicables aux salles de commande, la norme IEC 63351 est le document chapeau des normes du SC 45A de l'IEC applicables

à l'ingénierie des facteurs humains et la norme IEC 62342 est le document chapeau des normes du SC 45A de l'IEC applicables à la gestion du vieillissement.

NOTE 1 On considère que pour la conception des systèmes d'I&C qui mettent en œuvre des fonctions de sûreté conventionnelle (par exemple, pour couvrir la sécurité des travailleurs, la protection des biens, la prévention contre les risques chimiques, la prévention contre les risques liés au procédé énergétique), des normes nationales ou internationales sont appliquées.

NOTE 2 L'IEC TR 64000 décrit plus en détail la structure générale de la collection de normes du SC 45A de l'IEC, ainsi que ses relations avec les autres organismes de normalisation et normes.

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INSTALLATIONS NUCLÉAIRES – INSTRUMENTATION ET CONTRÔLE-COMMANDE IMPORTANTS POUR LA SÛRETÉ – SYSTÈMES DE SURVEILLANCE DES RAYONNEMENTS (RMS): CARACTÉRISTIQUES ET CYCLE DE VIE

1 Domaine d'application

Le présent document établit les exigences en matière de gestion du cycle de vie des systèmes de surveillance des rayonnements (RMS) et fournit des recommandations relatives à l'application des normes IEC existantes qui couvrent la conception et la qualification des systèmes et des matériels.

Le présent document a pour objet d'établir les exigences en matière de gestion du cycle de vie des RMS et de fournir des recommandations d'application. Le présent document est destiné à être cohérent avec les dernières versions des Normes internationales relatives aux moniteurs de surveillance des rayonnements, à l'échantillonnage des matériaux radioactifs, à l'étalonnage des instruments, à la conception des matériels et logiciels, au classement et à la qualification des systèmes. Sauf spécification contraire dans le présent document, la norme de niveau supérieur du SC 45A de l'IEC, l'IEC 61513, et les normes de deuxième niveau du SC 45A de l'IEC s'appliquent aux RMS.

Le présent document s'applique aux RMS installés dans les installations nucléaires et destinés à être utilisés pendant le fonctionnement normal, en cas d'incident de fonctionnement prévu (IFP), lors d'accidents de dimensionnement (DBA) et en conditions additionnelles de dimensionnement (DEC), incluant les accidents graves (SA). Les recommandations techniques fournies dans le présent document s'appliquent aux installations nucléaires, même si les fonctions particulières de chaque installation sont prises en compte pendant la conception et le cycle de vie opérationnel des RMS.

Les analyses en laboratoire et la réalisation associée de prélèvements, essentielles pour avoir un programme complet de surveillance des effluents, ainsi que les recherches relatives au déchargement du combustible ne relèvent pas du domaine d'application du présent document.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60532, *Instrumentation pour la radioprotection – Débitmètres à poste fixe, ensembles d'alarmes et moniteurs – Rayonnements X et gamma d'énergie comprise entre 50 keV et 7 MeV*

IEC 60761-1, *Equipements de surveillance en continu de la radioactivité dans les effluents gazeux – Partie 1: Exigences générales*

IEC 60761-2, *Equipements de surveillance en continu de la radioactivité dans les effluents gazeux – Partie 2: Exigences particulières aux moniteurs d'aérosols radioactifs, y compris les aérosols transuraniens*

IEC 60761-3, *Equipements de surveillance en continu de la radioactivité dans les effluents gazeux – Partie 3: Exigences particulières aux moniteurs de gaz rares radioactifs*

IEC 60761-4, *Equipements de surveillance en continu de la radioactivité dans les effluents gazeux – Partie 4: Exigences particulières aux moniteurs d'iode radioactif*

IEC 60761-5, *Equipements de surveillance en continu de la radioactivité dans les effluents gazeux – Partie 5: Exigences particulières aux moniteurs de tritium*

IEC 60768, *Centrales nucléaires de puissance – Instrumentation importante pour la sûreté – Matériels pour la surveillance des rayonnements en continu, interne et externe, au niveau des fluides de procédés pour les conditions de fonctionnement normal et incidentel*

IEC/IEEE 60780-323:2016, *Installations nucléaires – Equipements électriques importants pour la sûreté – Qualification*

IEC 60861, *Equipements pour la surveillance des radionucléides dans les effluents liquides et les eaux de surface*

IEC 60880, *Centrales nucléaires de puissance – Instrumentation et contrôle-commande importants pour la sûreté – Aspects logiciels des systèmes programmés réalisant des fonctions de catégorie A*

IEC 60951-1:2022, *Installations nucléaires – Instrumentation importante pour la sûreté – Surveillance des rayonnements pour les conditions accidentelles et post-accidentelles – Partie 1: Exigences générales*

IEC 60951-2, *Centrales nucléaires de puissance – Instrumentation importante pour la sûreté – Surveillance des rayonnements pour les conditions accidentelles et post-accidentelles – Partie 2: Matériels pour la surveillance des rayonnements en continu avec prélèvements dans les effluents gazeux et l'air de ventilation*

IEC 60951-3, *Centrales nucléaires de puissance – Instrumentation importante pour la sûreté – Surveillance des rayonnements pour les conditions accidentelles et post-accidentelles – Partie 3: Ensemble de surveillance locale en continu des rayonnements gamma à large gamme*

IEC 60951-4, *Centrales nucléaires de puissance – Instrumentation importante pour la sûreté – Surveillance des rayonnements pour les conditions accidentelles et post-accidentelles – Partie 4: Equipement pour la surveillance en continu des rayonnements internes ou externes aux flux de procédé*

IEC 60960, *Critères fonctionnels de conception pour un système de visualisation des paramètres de sûreté pour les centrales nucléaires*

IEC/IEEE 60980-344, *Nuclear facilities – Equipment important to safety – Seismic qualification* (disponible en anglais seulement)

IEC 60987, *Centrales nucléaires de puissance – Systèmes d'instrumentation et de contrôle-commande importants pour la sûreté – Exigences applicables au matériel*

IEC 61031, *Installations nucléaires – Systèmes d'instrumentation et de contrôle-commande – Critères de conception, d'implantation et d'application pour les matériels de surveillance du débit de dose de rayonnement gamma à poste fixe, utilisés pendant le fonctionnement normal et lors d'incidents de fonctionnement prévus*

IEC 61226:2020, *Centrales nucléaires de puissance – Systèmes d'instrumentation, de contrôle-commande et d'alimentation électrique importants pour la sûreté – Catégorisation des fonctions et classement des systèmes*

IEC 61250, *Réacteurs nucléaires – Systèmes d'instrumentation et de contrôle-commande pour la sûreté – Détection des fuites dans les systèmes de refroidissement*

IEC 61504, *Installations nucléaires – Systèmes d'instrumentation et de contrôle-commande importants pour la sûreté – Systèmes centralisés pour la surveillance en continu des rayonnements et/ou des niveaux de radioactivité*

IEC 61513:2011, *Centrales nucléaires de puissance – Instrumentation et contrôle-commande importants pour la sûreté – Exigences générales pour les systèmes*

IEC 61559 (toutes les parties), *Instrumentation pour la radioprotection dans les installations nucléaires – Ensembles centralisés pour la surveillance en continu des rayonnements et/ou des niveaux de radioactivité*

IEC 62003, *Centrales nucléaires de puissance – Systèmes d'instrumentation, de contrôle-commande et d'alimentation électrique – Exigences relatives aux essais de compatibilité électromagnétique*

IEC 62138, *Centrales nucléaires – Systèmes d'instrumentation et de contrôle-commande importants pour la sûreté – Aspects logiciels des systèmes informatisés réalisant des fonctions de catégorie B ou C*

IEC 62302, *Instrumentation pour la radioprotection – Matériel pour le prélèvement et la surveillance des gaz rares radioactifs*

IEC 62303, *Instrumentation pour la radioprotection – Matériel pour la surveillance du tritium atmosphérique*

IEC 62566:2012, *Centrales nucléaires de puissance – Instrumentation et contrôle-commande importants pour la sûreté – Développement des circuits intégrés programmés en HDL pour les systèmes réalisant des fonctions de catégorie A*

IEC 62566-2, *Centrales nucléaires de puissance – Instrumentation et contrôle-commande importants pour la sûreté – Développement des circuits intégrés programmés en HDL – Partie 2: Circuits intégrés programmés en HDL pour les systèmes réalisant des fonctions de catégorie B ou C*

IEC 63147:2017/IEEE Std 497™, *Criteria for accident monitoring instrumentation for nuclear power generating stations* (disponible en anglais seulement)

ISO/IEC 17025, *Exigences générales concernant la compétence des laboratoires d'étalonnages et d'essais*

ISO 2889, *Echantillonnage des substances radioactives en suspension dans l'air dans les émissaires de rejet et les conduits des installations nucléaires*

ISO 4037-1, *Radioprotection – Rayonnements X et gamma de référence pour l'étalonnage des dosimètres et des débitmètres, et pour la détermination de leur réponse en fonction de l'énergie des photons – Partie 1: Caractéristiques des rayonnements et méthodes de production*

ISO 4037-3, *Radioprotection – Rayonnements X et gamma de référence pour l'étalonnage des dosimètres et des débitmètres, et pour la détermination de leur réponse en fonction de l'énergie des photons – Partie 3: Etalonnage des dosimètres de zone et individuels et mesurage de leur réponse en fonction de l'énergie et de l'angle d'incidence*