IEC 62705

Edition 2.0 2022-11
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

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



IEC 62705:2022-11 RLV(en)



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2022 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC 62705

Edition 2.0 2022-11
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.120.20

ISBN 978-2-8322-6126-2

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 4
INTRODUCTION 2
1 Scope 11
2 Normative references 11
3 Terms and definitions 13
4 Symbols and abbreviated terms 17
5 RMS categorization and classification 18
5.1 Function categorization for RMS 18
5.2 System classification for RMS 18
5.3 Criteria for identifying the plant-specific variables 18
6 RMS detailed design and implementation 19
6.1 General 19
6.2 Radioactive noble gas off-line monitoring 19
6.3 Radioactive aerosol off-line monitoring 19
6.4 Radioactive iodine off-line monitoring 20
6.5 Liquid off-line monitoring 20
6.6 Tritium off-line monitoring 20
6.7 On-line or in-line monitoring 20
6.8 Area monitoring 20
6.9 Centralized system 21
6.10 Leak detection 21
7 RMS integration and validation 21
7.1 RMS integration 21
7.2 RMS validation 21
8 RMS installation 21
9 RMS design modification 21
10 RMS qualification 22
10.1 General 22
10.2 Environmental qualification 22
10.3 Seismic qualification 22
10.4 Electromagnetic interference 22
11 Calibration 23
11.1 General 23
11.2 Periodical calibration and functional check 23
11.2.1 General 23
11.2.2 Calibration check after installation 23
11.2.3 Functional check 23
11.2.4 Countermeasures to loss of monitoring during calibration or functional check 23
11.3 Radiation calibration 23
11.4 Calibration for other quantity 23
11.5 Traceability 23
Annex A (informative) Example of safety classification for RMS important to safety 24
Annex B (informative) Relation between IEC 61513 system lifecycle and IEC 62705 requirements 25

Bibliography 26

Table 1 – Overview of the standards covering the domain of radiation monitoring ~~in NPPs~~ 7
Table A.1 – Example of safety classification for RMS important to safety 24
Table B.1 – Relation between IEC 61513 system lifecycle and IEC 62705 requirements 25

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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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

<table>
<tr><td rowspan="2">Developer</td><td colspan="2" rowspan="2">ISO</td><td colspan="3">IEC</td></tr>
<tr><td colspan="2">SC 45A</td><td>SC 45B</td></tr>
<tr><td>Scope</td><td>Sampling</td><td>Calibration</td><td>Accident and post accident conditions</td><td colspan="2">Normal conditions</td></tr>
<tr><td>Radioactive noble gas off-line monitoring</td><td>ISO 2889</td><td>ISO 4037-1, ISO 4037-3</td><td>IEC 60951-1, IEC 60951-2</td><td>N/A</td><td>IEC 62302 / IEC 60761-1, IEC 60761-3</td></tr>
<tr><td>Radioactive aerosol off-line monitoring</td><td>ISO 2889</td><td>ISO 4037-1, ISO 4037-3</td><td>IEC 60951-1, IEC 60951-2</td><td>N/A</td><td>IEC 60761-1, IEC 60761-2</td></tr>
<tr><td>Radioactive iodine off-line monitoring</td><td>ISO 2889</td><td>ISO 4037-1, ISO 4037-3</td><td>IEC 60951-1, IEC 60951-2</td><td>N/A</td><td>IEC 60761-1, IEC 60761-4</td></tr>
<tr><td>Liquid off-line monitoring</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>IEC 60861</td></tr>
<tr><td>Tritium off-line monitoring</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>IEC 62303 / IEC 60761-1, IEC 60761-5</td></tr>
<tr><td>On-line or in-line monitoring</td><td>N/A</td><td>ISO 4037-1, ISO 4037-3</td><td>IEC 60951-1, IEC 60951-4</td><td>IEC 60768</td><td>N/A</td></tr>
<tr><td>Area monitoring</td><td>N/A</td><td>ISO 4037-1, ISO 4037-3</td><td>IEC 60951-1, IEC 60951-3</td><td>IEC 61031</td><td>IEC 60532</td></tr>
<tr><td>Centralized system</td><td>N/A</td><td>N/A</td><td colspan="2">IEC 61504, IEC 60960</td><td>IEC 61559-1</td></tr>
<tr><td>Classification/basic requirements</td><td>N/A</td><td>N/A</td><td colspan="2">IEC 61513, IEC 60880, IEC 60987, IEC 61226, IEC 62138, IEC 62566, IEC 62645, IEC 61250</td><td>N/A</td></tr>
<tr><td>Qualification</td><td>N/A</td><td>N/A</td><td colspan="2">IEC 60780, IEC 60980, IEC 62003</td><td>IEC 62706</td></tr>
</table>

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/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

~~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.

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 generationg 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 dosemeters and doserate 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 dosemeters and doserate meters and for determining their response as a function of photon energy – Part 3: Calibration of area and personal dosemeters and the measurement of their response as a function of energy and angle of incidence*

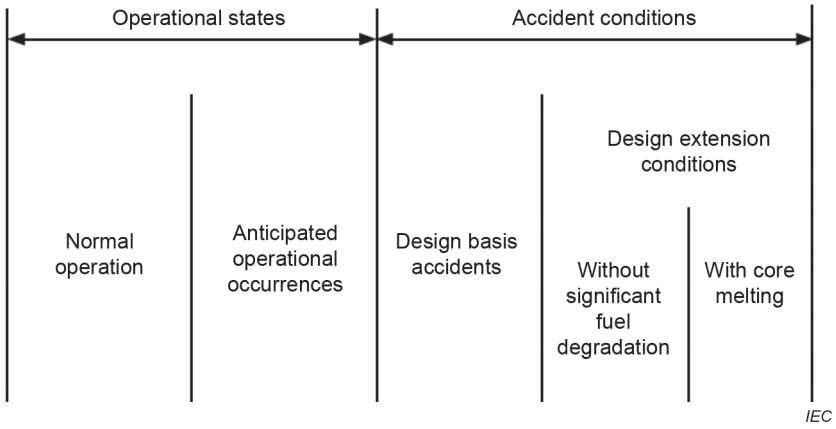
3 Terms and definitions

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-β).

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/m^3).

[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