IEC 61504

Edition 2.0 2017-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

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

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IEC 61504:2017-05(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

NUCLEAR FACILITIES – INSTRUMENTATION AND CONTROL SYSTEMS IMPORTANT TO SAFETY – CENTRALIZED SYSTEMS FOR CONTINUOUS MONITORING OF RADIATION AND/OR LEVELS OF RADIOACTIVITY

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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International Standard IEC 61504 has been prepared by subcommittee 45A: Instrumentation, control and electrical systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

This second edition cancels and replaces the first edition of IEC 61504, published in 2000, and the first edition of IEC 61559-2, published by subcommittee 45B in 2002, and constitutes a technical revision.

This standard is to be read in conjunction with IEC 61559-1.

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

a) It supplements IEC 61559-1 and integrates IEC 61559-2.

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b) It describes integration of functions including equipment such as those covered by IEC 60761-1, IEC 60761-2, IEC 60761-3, IEC 60761-4, IEC 60761-5, IEC 60768, IEC 60861, IEC 60910, IEC 60951-1 IEC 60951-2, IEC 60951-3, IEC 60951-4, IEC 60951-5, IEC 61031, IEC 61250, IEC 62302 and IEC 62303.

c) It establishes requirements for integration in centralized systems as defined by IEC 62705.

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

FDIS	Report on voting
45A/1135/FDIS	45A/1149/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

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

Advances in distributed system technology have led to the introduction of centralized programmable digital systems for radiation monitoring into nuclear facilities.

IEC 61559 was introduced in 1996 to address centralized systems for radiation monitoring in non-reactor nuclear facilities. That standard primarily focused upon category C functions, such as area monitoring and excluded nuclear power plant applications. As IEC 61559 was being released, subcommittee 45A determined that it would be useful to develop a similar standard to address nuclear power plant application of plant-wide radiation monitoring systems, at that time. The intent was that IEC 61504 would parallel IEC 61559 would integrate or directly reference the other nuclear power standards that are relevant to plant-wide radiation monitoring. IEC 61504 was published on 2000-05.

As IEC 61559 was in the final release process, subcommittee 45B recognized the need to broaden the scope of that standard to include other applications of centralized radiation monitoring in nuclear facilities. These broader applications included, for example, monitoring of plant discharges, interlock of control functions, and environmental monitoring. IEC 61559-2 was developed to cover these broader functions, including category B functions, in non-reactor nuclear facilities and was published on 2002-06.

In 2004, the scope of subcommittee 45A standards was extended from “Reactor instrumentation” to “Instrumentation and control system of nuclear facilities”.

This Standard reflects this increased scope of application and merges the extant requirements of IEC 61504 with those in IEC 61559-2. Hence this Standard comes to cover not only nuclear power plants but also nuclear facilities other than nuclear power plants.

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

IEC 61504 is the third level in the hierarchy of SC 45A standards. This standard provides centralized systems for radiation monitoring for nuclear facilities. This standard is applicable to the centralized systems for radiation monitoring to be used for functions important to safety in nuclear facilities.

IEC 62705 provides the guidance for the radiation monitoring system (RMS) on the application of existing IEC/ISO standards covering design and qualification of system and equipment for RMS. IEC 62705 is the supplements of IEC 61513 and it is not intended that IEC 62705 limits the application of other IEC 61513 requirements to RMS lifecycle.

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. IEC 61226 provides the criteria for classification of instrumentation and control functions. Most modern RMSs contain programmable digital equipment. Hence RMS should often be treated as programmable digital system. So the following standards required for programmable digital 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 programmable digital systems. IEC 62566 provides the requirements for HDL Programmed Device (HPD) for systems performing category A functions. For the qualification testing, the following SC 45A standards are applicable. IEC/IEEE 60780-323 provides the guide for the environmental qualification and IEC 60980 provides the 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. 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

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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 among these various standards is given in Table 1.

Table 1 – Overview of the standards covering the domain of radiation monitoring in nuclear facilities

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 60951-4	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, IEC 61500, IEC 61504		N/A
Qualification	N/A	N/A	IEC 60980, IEC 62003, IEC/IEEE 60780-323		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

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 standard will continue to be relevant in future years, the emphasis has been placed on issues of principle, rather than specific technologies.

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

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

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

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

At a third level, IEC SC 45A standards not directly referenced by IEC 61513 or by IEC 63046 are standards related to specific equipment, technical methods, or specific activities. Usually these documents, which make reference to second-level documents for general topics, can be used on their own.

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

The IEC SC 45A standards series consistently 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 (NPP), the IAEA safety guide SSG-30 dealing with the safety classification of structures, systems and components in NPPs, the IAEA safety guide SSG-39 dealing with the design of instrumentation and control systems for NPPs, the IAEA safety guide SSG-34 dealing with the design of electrical power systems for NPPs and the implementing guide NSS17 for computer security at nuclear facilities. The safety and security terminology and definitions used by SC 45A standards are consistent with those used by the IAEA.

IEC 61513 and IEC 63046 have adopted a presentation format similar to the basic safety publication IEC 61508 with an overall life-cycle framework and a system life-cycle framework. Regarding nuclear safety, IEC 61513 and IEC 63046 provide the interpretation of the general requirements of IEC 61508-1, IEC 61508-2 and IEC 61508-4, for the nuclear application sector. In this framework IEC 60880, IEC 62138 and IEC 62566 correspond to IEC 61508-3 for the nuclear application sector. IEC 61513 and IEC 63046 refer to ISO as well as to IAEA GS-R-3 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, regarding control rooms, IEC 60964 is the entry document for the IEC SC 45A control rooms standards and IEC 62342 is the entry document for the IEC SC 45A ageing management standards.

NOTE 1 It is assumed that for the design of I&C systems in NPPs that implement conventional safety functions (e.g. to address worker safety, asset protection, chemical hazards, process energy hazards) international or national standards would be applied.

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

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NUCLEAR FACILITIES – INSTRUMENTATION AND CONTROL SYSTEMS IMPORTANT TO SAFETY – CENTRALIZED SYSTEMS FOR CONTINUOUS MONITORING OF RADIATION AND/OR LEVELS OF RADIOACTIVITY

1 Scope

This document supplements IEC 61559-1 to include radiation monitoring functions important to safety that are not within the scope of IEC 61559-1. It applies to centralized systems having a direct role in the achievement or maintenance of radiation protection in nuclear facilities. These systems perform functions such as:

- radiation protection of plant discharge;
- interlock of control functions to prevent or to mitigate accidental release of radioactive material;
- radiation and environmental monitoring functions to support monitoring of and response to accidents;
- provide information to process control or safety systems for use in control or interlock functions.

This document defines the communication criteria to link distributed radiation monitoring equipment in the facility, integrates data processing, storage, optimization, and correlation of data flow and displays, and provides criteria for the interface between monitors of different safety classes.

It will not directly apply to the design and testing of detection and measurement assemblies except as necessary to define the interface with the central computer. Requirements for these assemblies are contained in existing standards.

This document describes the integration of functions including equipment such as those described in IEC 60761-1, IEC 60761-2, IEC 60761-3, IEC 60761-4, IEC 60761-5, IEC 60768, IEC 60861, IEC 60910, IEC 60951-1 IEC 60951-2, IEC 60951-3, IEC 60951-4, IEC 60951-5, IEC 61031, IEC 61250, IEC 62302 and IEC 62303, into a centralized system. The requirements of system-level components (central computer, subsystem computers, operator consoles, and interconnections) are discussed. For detector assemblies, processing assemblies and alarm assemblies, this document contains only the requirements needed to allow connection into the central computer. The standards referenced above contain the specific requirements for these components.

This document identifies requirements pertinent to the integration of the above functions into a centralized system. Requirements for general and design characteristics, electrical performance requirements and tests, mechanical performance and tests, software performance requirements and tests, environmental characteristics performance requirements and tests and documentation are considered by referring to IEC 62705.

Certain complete centralized systems for radiation monitoring may be entirely implemented with direct-connected analogue/relay technology. This document does not apply to such systems.

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.