IEC 60910

Edition 2.0 2022-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Nuclear power plants – Instrumentation important to safety – Containment monitoring for early detection of developing deviations from normal operation in light water reactors

Centrales nucléaires de puissance – Systèmes d'instrumentation importants pour la sûreté – Surveillance de l'enceinte de confinement pour une détection rapide des écarts par rapport au fonctionnement normal dans les réacteurs à eau légère

IEC 60910:2022-11(en-fr)

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 It also gives information on projects, replaced and withdrawn publications.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.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 60910

Edition 2.0 2022-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Nuclear power plants – Instrumentation important to safety – Containment monitoring for early detection of developing deviations from normal operation in light water reactors

Centrales nucléaires de puissance – Systèmes d'instrumentation importants pour la sûreté – Surveillance de l'enceinte de confinement pour une détection rapide des écarts par rapport au fonctionnement normal dans les réacteurs à eau légère

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 27.120.20

ISBN 978-2-8322-5926-9

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

NUCLEAR POWER PLANTS – INSTRUMENTATION IMPORTANT TO SAFETY – CONTAINMENT MONITORING FOR EARLY DETECTION OF DEVELOPING DEVIATIONS FROM NORMAL OPERATION IN LIGHT WATER REACTORS

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.

IEC 60910 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 1988. This edition constitutes a technical revision.

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

a) Modification of title;
b) Integration of new technology and knowledge;
c) Drafting directed towards monitoring conditions in containment under normal conditions.

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

Draft	Report on voting
45A/1443/FDIS	45A/1452/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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

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

INTRODUCTION

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

IEC 60910 provides recommendations for measurements that allow operator diagnosis of developing deviations from normal operation. The recommendations located herein are intended to be general so that they may apply to containment I&C systems for different types of light water reactors.

The IAEA Safety Glossary defines containment as the methods or physical structures designed to prevent or control the release and dispersion of radioactive substances. IEC 60910 uses this definition of containment.

This document is intended to monitor the parameters which, when appropriate action is taken, will prevent accident scenarios from occurring.

It is intended that this document be used by operators of NPPs (utilities), systems evaluators and by licensors.

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

IEC 60910 is a third level IEC SC 45A document covering the instrumentation important to safety in containment as defined in IEC 61513

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 the Standard

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 NSS42-G 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 POWER PLANTS – INSTRUMENTATION IMPORTANT TO SAFETY – CONTAINMENT MONITORING FOR EARLY DETECTION OF DEVELOPING DEVIATIONS FROM NORMAL OPERATION IN LIGHT WATER REACTORS

1 Scope

This document provides requirements for primary and secondary containment parameter monitoring that enable the operator to identify developing deviations from normal operation. The operator can then take corrective action at an early stage to prevent a minor failure from developing into a serious plant failure or an accident condition. This document is directed towards monitoring the primary and secondary containment under normal conditions only.

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

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

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

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

IEC TR 63123, *Nuclear power plants – Instrumentation, control, and electrical power systems – Guidance for the application of IEC 63147:2017/IEEE Std 497™-2016 in the IAEA/IEC framework*

IEC 63147, *Criteria for accident monitoring instrumentation for nuclear power generating stations*

IAEA Safety Glossary:2016, *Terminology used in nuclear safety and radiation protection,* available at https://www-pub.iaea.org/books/IAEABooks/7897/IAEA-Safety-Glossary

IAEA Safety Standard Series No. SSR-2/1 Rev:1, *Safety of Nuclear Power Plant: Design*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the IAEA Safety Glossary apply.

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

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

4 Physical parameters

4.1 General

The physical parameters that should be monitored to detect developing deviations from normal operation within containment vary with different reactor systems. The measurement sensitivities required to detect a developing deviation can be estimated by analytical methods appropriate to the individual plants. Typical conditions that introduce parameter changes are:

- Release or accidental leakage of high-temperature fluid;
- Release or accidental leakage of high-pressure fluid;
- Presence of radioactive gas or liquids;
- Fire;
- Component mechanical or electrical failure.

The following is a list of parameters and conditions which shall be monitored:

- Temperature of the containment atmosphere and of the fluid drains;
- Pressure in the containment building;
- Humidity in the containment building;
- Combustible gas concentrations in the containment building;
- Fluid level in the drains;
- Fluid flows;
- Radiation;
- Chemical analysis of drain fluids;
- Visible abnormalities;
- Noise and vibrations;
- Fire;
- Operability of existing instrumentation.

4.2 Temperature of containment atmosphere and fluid drains

4.2.1 General

The atmospheric and fluid drain temperatures shall be measured.

4.2.2 Atmospheric temperature

A sufficient number of temperature sensors should be installed to measure the atmospheric temperature distribution throughout the containment building. In addition, measurement of the fluid temperatures of the containment air coolers should be used to estimate the temperature of the atmosphere.

The data display shall present the temperature distribution and the local trends in atmospheric temperatures to the operators.

4.2.3 Drain temperatures

The temperature shall be measured in selected fluid drains (system drains, floor drains). These temperature measurements should be recorded to show trends. The data display should present the temperature distribution and the local trends in fluid temperatures to the operators.

4.3 Pressure in the containment

Leakage of gases or fluids such as compressed air, nitrogen, or water may be the cause of pressure increases. To detect such leaks, measurements of the ambient pressure shall be provided from the appropriate compartments in the containment building. These measurements shall not be significantly affected by variations in other parameters such as temperature, humidity, or ionizing or electromagnetic radiation. These pressure measurements should be recorded to show trends and shall be displayed to the operators.

4.4 Humidity in the containment

The humidity is a highly significant factor for the detection of anomalies. Parameters which indicate changes in humidity are:

- Dew point and temperature of the containment atmosphere;
- Electrical parameters (e.g. impedance, resistance, etc.) of sensors;
- Amount of condensate in the containment building air coolers.

Humidity shall be monitored in appropriate compartments in the containment building and measured values should be recorded to show trends and shall be displayed to the operators.

4.5 Combustible gas concentration in the containment

The gas composition of the containment building should be monitored during normal operation. Hydrogen gas in particular should be monitored. The combustion of hydrogen gas occurs at a threshold based on vapor and hydrogen gas concentration levels in the containment building.

The data display should present the hydrogen gas level to the operators and shall alarm if the concentration approaches the detonation threshold.

4.6 Water level in the drain sumps

Each system and drain sump, and each air cooler condensate collector shall be equipped with an indicator to measure the fluid level in the drain sumps. The level data gathered should be presented to the operators.

4.7 Fluid flow balance

The periodic calculation of a mass balance can quantitatively show the amount of identified small leaks from the primary systems. To accomplish this, fluid flows shall be measured to establish mass balance in the different systems. The mass balance data should be displayed to the operator.

4.8 Radioactivity in the containment atmosphere

Airborne radioactivity shall be monitored in the relevant compartments and should be recorded.

It shall be possible to obtain containment atmosphere samples for analysis from outside the containment building.