# IEC 60987

Edition 3.0 2021-02

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

## Nuclear power plants – Instrumentation and control important to safety – Hardware requirements

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



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

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

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# NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY – HARDWARE REQUIREMENTS

## 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 60987 has been prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

This third edition cancels and replaces the second edition published in 2007, and its Amendment 1, published in 2013. This edition constitutes a technical revision.

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

a) Title modified;
b) Take account of the fact that hardware requirements apply to all I&C technologies, including conventional hardwired equipment, programmable digital equipment or by using a combination of both types of equipment;
c) Align the standard with the new revisions of IAEA documents SSR-2/1, which include as far as possible an adaptation of the definitions;

d) Replace, as far as possible, the requirements associated with standards published since the edition 2.1, especially IEC 61513, IEC 60880, IEC 62138, IEC 62566 and IEC 62566-2;

e) Review the existing requirements and update the terminology and definitions;

f) Extend the scope of the standard to all hardware (computerized and non-computerized) and to all safety classes 1, 2 and 3;

g) Complete, update the IEC and IAEA references and vocabulary;

h) Check possible impact of other IAEA requirements and recommendations considering extension of the scope of SC 45A;

i) Highlight the use of IEC 62566 and IEC 62566-2 for HPD development;

j) Introduce specific activities for pre-existing items (selection, acceptability and/or mitigation);

k) Introduce clearer requirements for electronic module-level design, manufacturing and control;

l) Complete reliability assessment methods;

m) Introduce requirements when using automated tests or control activities;

n) Complete description of manufacturing control activities (control process, assessment of manufactured equipment, preservation of products);

o) Define and ensure the inclusion of a graded approach for dealing with the 3 different classes of equipment and related requirements.

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

| FDIS | Report on voting |
|---|---|
| 45A/1365/FDIS | 45A/1372/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.

# INTRODUCTION

## a) Technical background, main issues and organization of the standard

This International Standard provides requirements on the hardware aspects of E/E/PE items used in instrumentation and control (I&C) systems performing safety functions as defined by IEC 61226.

It is consistent with, and complementary to, IEC 61513. Activities that are mainly system level activities (for example, integration, validation and installation) are not addressed exhaustively by this document: requirements that are not specific to hardware are deferred to IEC 61513.

The basic principles for the design of nuclear instrumentation, as specifically applied to the systems important to safety of nuclear power plants, were first interpreted in nuclear standards with reference to hardwired systems in IAEA Safety Guide 50 SG D3 which has been superseded by IAEA Guide SSG-39.

IEC 60987 was first issued in 1989 to cover the hardware aspects of digital systems design for systems important to safety.

Although many of the requirements within the original issue continue to be relevant, there were significant factors which justified the development of this revised edition of IEC 60987, in particular:

– the use of different technologies that may include conventional hardwired equipment, programmable digital equipment or by using a combination of both types of equipment;
– IEC 61226 and IEC 61513 cover I&C systems performing 3 different categories of functions (A, B and C) and 3 classes of systems (class 1, 2 and 3);
– the use of pre-existing components, rather than bespoke developments, has increased significantly.

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

The first-level IEC SC 45A standard for I&C systems important to safety in nuclear power plants (NPPs) is IEC 61513. IEC 60987 is a second-level IEC SC 45A standard which addresses the generic issue of I&C systems hardware requirements.

IEC 60880 and IEC 62138 are second-level standards which together cover the software aspects of computer-based systems used to perform functions important to safety in NPPs. IEC 60880 and IEC 62138 make direct reference to IEC 60987 for I&C systems hardware requirements.

IEC 62566 and IEC 62566-2 are second-level standards which together cover the development of HPDs used to perform functions important to safety in NPPs. IEC 62566 and IEC 62566-2 make direct reference to IEC 60987 for I&C systems hardware requirements.

The requirements of IEC/IEEE 60780-323 for equipment qualification are referenced within IEC 60987.

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

It is important to note that this standard establishes no additional functional requirements for classified systems (see IEC 61226 for system classification requirements).

Aspects for which special recommendations have been produced (so as to assure the production of highly reliable systems), are:

– a general approach to the hardware safety lifecycle;
– an approach from the requirements specifications down to on-site operation and maintenance activities.

It is recognized that I&C technology is continuing to evolve and that it is not possible for a standard such as this to include references to all modern design technologies and techniques. 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 hardware design technologies. If new design techniques are developed then it is possible to assess the suitability of such techniques by adapting and applying the design principles contained within this standard.

The scope of this document covers I&C systems hardware for all classes of systems important to safety. This includes conventional hardwired equipment, programmable digital equipment or by using a combination of both types of equipment; it covers the assessment and use of pre-existing items, for example, commercial off-the-shelf items (COTS), and the development of new hardware.

This document does not explicitly address how to protect systems against those threats arising from malicious attacks, i.e. cybersecurity, for programmable digital item. IEC 62645 provides requirements for security programmes for programmable digital item for all their development phases and on-site operation.

**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 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 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 45 standard series, corresponds to the Technical Reports which are not normative.