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Edition 2.0 2018-05

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

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## Nuclear power plants – Instrumentation and control systems important to safety – Safety logic assemblies used in systems performing category A functions: Characteristics and test methods

## Centrales nucléaires de puissance – Systèmes d'instrumentation et de contrôle-commande importants pour la sûreté – Ensembles logiques de sûreté utilisés dans les systèmes réalisant des fonctions de catégorie A: Caractéristiques et méthodes d'essai

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

# NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL SYSTEMS IMPORTANT TO SAFETY – SAFETY LOGIC ASSEMBLIES USED IN SYSTEMS PERFORMING CATEGORY A FUNCTIONS: CHARACTERISTICS AND TEST METHODS

## FOREWORD

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International Standard IEC 60744 has been prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

This second edition cancels and replaces the first edition published in 1983. This edition constitutes a technical revision.

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

a) update of the references to standards published or revised since the issue of the first edition of the current standard, including IEC 61513 and IEC 61226;

b) additional requirements for operational and maintenance bypass use; requirements of voting logic; requirements for interfacing with the MCR and SCR.

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

| FDIS | Report on voting |
|---|---|
| 45A/1188/FDIS | 45A/1200/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

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# INTRODUCTION

## a) Technical background, main issues and organisation of the Standard

This standard IEC 60744 specifically focuses on safety logic assemblies used in NPPs (Nuclear Power Plants). Safety logic assemblies were originally hardwired parts of protection systems mainly used to control actuators. IEC 60744 specifically focuses on the design, including technology, interfaces with MCR and SCR, tests and qualification. It gives requirements for display of the safety system inputs and state.

IEC 60744 is the document concerning safety logic assembly functions and performance.

The use of a computer based equipment or software is covered comprehensively by other standards. The technology used to design SLAs therefore involves mainly hardwired technologies and submicronic highly integrated components (HPDs), the implementation of which is limited due to the very high safety requirements.

The document addresses the design and test characteristics of safety logic assemblies, especially regarding functional requirements, reliability issues, and associated control means including alarm, indication and control. Also it suggests the requirements for performance, testing and qualification for safety logic assemblies, and the interface requirements for communication between assemblies.

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

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

IEC 60744 is the third level IEC SC 45A document tackling the specific issue of testing and design characteristics of safety logic assemblies.

IEC 60744 is to be read in association with IEC 61513 which is the appropriate IEC SC 45A document which provides guidance on I&C safety system, and IEC 60964 which is the appropriate document for guidance on the Control Rooms, since the safety system has extensive interfaces with the MCR and SCR.

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 document establishes no additional functional requirements at safety system level.

Aspects for which special recommendations have been provided in this document are:

- The voting of partial trips to identify each safety actuation
- The output assemblies that provide the trips and actuations
- The design and test characteristics of functional requirements
- The reliability issue of safety logic assemblies
- The performance characteristics of logic assemblies
- Testing, qualification and interface requirements of safety logic assemblies

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.

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**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, defense 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.

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 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 published this NOTE 2 of the introduction of IEC SC 45A standards will be suppressed.

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# NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL SYSTEMS IMPORTANT TO SAFETY – SAFETY LOGIC ASSEMBLIES USED IN SYSTEMS PERFORMING CATEGORY A FUNCTIONS: CHARACTERISTICS AND TEST METHODS

## 1 Scope

This document provides requirements and recommendations for the design, construction and test of safety logic assemblies used in safety systems to perform category A safety functions (in accordance with IEC 61226). Safety logic assemblies include logic such as the hardwired logic assembly interfacing computer-based systems to switchgear, actuators or contactors to provide trip or engineered safety feature actuations. Safety logic assemblies are significant parts of a safety system and may include voting logic between redundant channels.

This document provides a general description of safety logic assemblies for safety actuators control. The principles to meet dependability objectives are presented. The main features relating to the design requirements are described and explained.

Various tests and their requirements are given in order to validate the design (including the qualification tests), the manufacturing and the correct installation on site.

Annex A (informative) gives a list of possible applications of safety logic assemblies.

Annex B (normative) suggests a list of possible hardwired technologies with their respective requirements to design safety logic assemblies.

Annex C (informative) gives explanations on dependability and its attributes to improve reliability and to reduce the final risk which compromises the safety and the availability of the NPP.

The scope of this document does not address the design of a protection system, it covers only the technological and architectural solutions required to design a safety logic assembly. The design of safety systems using safety logic assemblies is covered by IEC 61513.

The detailed and specific functions implemented in a safety logic assembly strongly depend on the design of each reactor and are not addressed in this document.

As this document is focused on I&C part of the system, the final voting logic made with power breakers is excluded from 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 60255 (all parts), *Measuring relays and protection equipment*

IEC 60671, *Nuclear power plants – Instrumentation and control systems important to safety – Surveillance testing*

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