

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Nuclear power plants – Instrumentation and control systems important to safety – Software aspects for computer-based systems performing category B or C functions**

**Centrales nucléaires de puissance – Systèmes d'instrumentation et de contrôle-commande importants pour la sûreté – Aspects logiciels des systèmes informatisés réalisant des fonctions de catégorie B ou C**



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## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	8
2 Normative references.....	8
3 Terms and definitions .....	9
4 Symbols and abbreviated terms .....	17
5 Key concepts and assumptions .....	17
5.1 General.....	17
5.2 Types of software.....	17
5.3 Types of configuration data .....	18
5.4 Software and system safety lifecycles.....	19
5.5 Gradation principles .....	21
6 Requirements for the software of class 2 and class 3 I&C systems .....	22
6.1 Applicability of the requirements .....	22
6.2 General requirements.....	22
6.2.1 Software safety lifecycle – Software quality assurance.....	22
6.2.2 Verification .....	23
6.2.3 Configuration management.....	24
6.2.4 Selection and use of software tools .....	25
6.2.5 Selection of languages .....	26
6.3 Selection of pre-developed software .....	27
6.3.1 General .....	27
6.3.2 Documentation for safety.....	27
6.3.3 Evidence of correctness .....	28
6.3.4 Functional suitability .....	35
6.3.5 Selection and use of digital devices of limited functionality.....	35
6.4 Software requirements specification .....	35
6.4.1 General .....	35
6.4.2 Objective .....	35
6.4.3 Inputs .....	36
6.4.4 Contents .....	36
6.4.5 Properties .....	37
6.5 Software design .....	38
6.5.1 Objectives.....	38
6.5.2 Inputs .....	38
6.5.3 Contents .....	39
6.5.4 Properties .....	40
6.6 Implementation of software.....	40
6.6.1 General requirements.....	40
6.6.2 Configuration of software and of devices containing software.....	40
6.6.3 Implementation with application-oriented languages.....	41
6.6.4 Implementation with general-purpose languages.....	41
6.7 Software aspects of system integration.....	43
6.7.1 General .....	43
6.8 Software aspects of system validation .....	43
6.8.1 General .....	43

6.9	Installation of software on site .....	45
6.9.1	General .....	45
6.10	Anomaly reports .....	45
6.11	Software modification .....	46
6.11.1	General .....	46
6.12	Defences against common cause failure due to software.....	47
Annex A (informative)	Typical list of software documentation .....	48
Annex B (informative)	Correspondence between IEC 61513:2011 and this document .....	49
Annex C (informative)	Relations of this document with IEC 61508.....	50
C.1	General.....	50
C.2	Comparison of scope and concepts .....	50
C.3	Correspondence between this document and IEC 61508-3:2010 .....	51
Bibliography	.....	52
Figure 1	– Typical software parts in a computer-based I&C system .....	18
Figure 2	– Activities of the system safety lifecycle (as defined by IEC 61513:2011) .....	19
Figure 3	– Software related activities in the system safety lifecycle .....	20
Figure 4	– Development activities of the IEC 62138 software safety lifecycle.....	21
Figure 5	– Overview of the typical qualification process for pre-developed complete operational system software.....	30
Figure 6	– Overview of the typical qualification process for pre-developed software components.....	31
Table A.1	– Typical list of software documentation.....	48
Table B.1	– Correspondence between IEC 61513:2011 and this document.....	49
Table C.1	– Correspondence between this document and IEC 61508-3:2010 .....	51

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**NUCLEAR POWER PLANTS – INSTRUMENTATION  
AND CONTROL SYSTEMS IMPORTANT TO SAFETY –  
SOFTWARE ASPECTS FOR COMPUTER-BASED SYSTEMS  
PERFORMING CATEGORY B OR C FUNCTIONS**

## 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 62138 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 2004. This edition constitutes a technical revision.

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

- a) align the standard with standards published or revised since the first edition, in particular IEC 61513, IEC 60880, IEC 62645 and IEC 62671;
- b) merge Clause 5 and Clause 6 of the first edition into a single clause in order to avoid the repetition of the vast majority of the text which proves to be extremely difficult to maintain in consistency;

- c) revise clause on the selection of pre-developed software based on experiences from the application of the first edition of the standard on industrial projects. More precise criteria are proposed for the evidence of correctness of pre-developed software;
- d) introduce requirements on traceability in consistency with IEC 61513;
- e) introduce an Annex A that gives a typical list of software documentation;
- f) introduce an Annex B that establishes relationship between IEC 61513 and this document;
- g) introduce an Annex C that establishes relationship between IEC 61508 and this document.

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

FDIS	Report on voting
45A/1201/FDIS	45A/1209/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 Directive, Part 2.

In this document, the following print types are used:

- *Requirements and recommendations applicable specifically to class 2 or to class 3 systems appear in italics in Clause 6.*

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 organisation of this document

This International Standard provides requirements on the software aspects for computer-based instrumentation and control (I&C) systems performing category B or C functions as defined by IEC 61226. It complements IEC 60880 which provides requirements for the software of computer-based I&C systems performing category A functions.

It is consistent with, and complementary to, IEC 61513:2011. 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 software are deferred to IEC 61513:2011.

This document takes into account the current practices for the development of software for I&C systems, in particular:

- the use of pre-developed software, equipment and equipment families that were not necessarily designed to nuclear industry sector standards;
- the use of application-oriented languages.

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

IEC 61513 is a first level IEC SC 45A document and gives guidance applicable to I&C at system level.

IEC 62138 is a second level IEC SC 45A document that complements IEC 61513 concerning software development of computer-based I&C systems performing category B or C functions.

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 document

This document is not intended to be used as a general-purpose software engineering guide. It applies to the software of I&C systems performing category B or C functions for new nuclear power plants as well as to I&C upgrading or back-fitting of existing plants.

For existing plants, only a subset of requirements is applicable and this subset has to be identified at the beginning of any project.

The purpose of the guidance provided by this document is to reduce, as far as possible, the potential for latent software faults to cause system failures, either due to single software failures or multiple software failures (i.e. Common Cause Failures due to software).

This document does not explicitly address how to protect software against those threats arising from malicious attacks, i.e. cybersecurity, for computer-based systems. IEC 62645 provides requirements for security programmes for computer-based systems.

To ensure that this 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 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 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 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 (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 60890, 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. 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 applicable.

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 will be suppressed.

# NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL SYSTEMS IMPORTANT TO SAFETY – SOFTWARE ASPECTS FOR COMPUTER-BASED SYSTEMS PERFORMING CATEGORY B OR C FUNCTIONS

## 1 Scope

This document specifies requirements for the software of computer-based instrumentation and control (I&C) systems performing functions of safety category B or C as defined by IEC 61226. It complements IEC 60880 which provides requirements for the software of computer-based I&C systems performing functions of safety category A.

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 software are deferred to IEC 61513.

The link between functions categories and system classes is given in IEC 61513. Since a given safety-classified I&C system may perform functions of different safety categories and even non safety-classified functions, the requirements of this document are attached to the safety class of the I&C system (class 2 or class 3).

This document is not intended to be used as a general purpose software engineering guide. It applies to the software of I&C systems of safety classes 2 or 3 for new nuclear power plants as well as to I&C upgrading or back-fitting of existing plants.

For existing plants, only a subset of requirements is applicable and this subset has to be identified at the beginning of any project.

The purpose of the guidance provided by this document is to reduce, as far as possible, the potential for latent software faults to cause system failures, either due to single software failures or multiple software failures (i.e. Common Cause Failures due to software).

This document does not explicitly address how to protect software against those threats arising from malicious attacks, i.e. cybersecurity, for computer-based systems. IEC 62645 provides requirements for security programmes for computer-based 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.

IEC 60880:2006, *Nuclear power plants – Instrumentation and control systems important to safety – Software aspects for computer-based systems performing category A functions*

IEC 61226, *Nuclear power plants – Instrumentation and control important to safety – Classification of instrumentation and control functions*

IEC 61513:2011, *Nuclear power plants – Instrumentation and control important to safety – General requirements for systems*