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TECHNICAL REPORT

colour inside

Nuclear facilities – Instrumentation, control and electrical power systems important to safety – Structure of the IEC SC 45A standards series

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NUCLEAR FACILITIES – INSTRUMENTATION, CONTROL AND ELECTRICAL POWER SYSTEMS IMPORTANT TO SAFETY – STRUCTURE OF THE IEC SC 45A STANDARDS SERIES

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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IEC TR 63400 has been prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
45A/1395/DTR	45A/1406/RVDTR

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 Technical Report 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.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

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

The IEC SC 45A series of standards include the same common description in their Introduction, item d), outlining the overall structure of the series and its relationship with other standards bodies and standards (e.g. specific IAEA safety guides and IEC 61508).

The structure of the IEC SC 45A series at the time of drafting this Technical Report could be described as a “pyramid” extending down from two top-level documents (at level 1) to other documents (at levels 2, 3 and 4).

With the gradual extension of the IEC SC 45A scope to address electrical power systems, cyber security and human factors engineering, and ongoing development of new standards, it had become apparent that the common description could no longer, on its own, adequately fulfil this objective without becoming overly extensive.

This Technical Report is therefore intended to augment the common description that is included in the Introduction, item d), of all IEC SC 45A standards and technical reports (including this Technical Report).

It was agreed at the IEC SC 45A meeting held in Paris in April 2019 that this Technical Report should be primarily for the benefit of the users of the IEC SC 45A standards (including first time users) rather than for the expert members of IEC SC 45A and its working groups.

A revision of this Technical Report should be considered after each SC 45A meeting and, if judged necessary, a revision then undertaken subject to the availability of the appropriate resources.

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

The technical report IEC TR 63400 is a fourth level IEC SC 45A document.

Item d) of this introduction describes the structure of the IEC SC 45A standard series in general terms.

This Technical Report augments that description to enable users of individual IEC SC 45A standards to obtain a more comprehensive understanding of the overall structure of the series and its relationship with other standards bodies and standards. The publication of subsequent editions of this Technical Report should also enable minor changes in the structure to be described without the need for amending the common description that is included in the Introduction, item d), of all IEC SC 45A documents.

c) Recommendations and limitations regarding the application of the Technical Report

It is important to note that a Technical Report is entirely informative in nature. It gathers data collected from different origins and it establishes no requirements.

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 SC45A 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 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, the IAEA safety guide SSG-51 dealing with human factors engineering in the design of NPPs and the implementing guide NSS17 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 GS-R 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/SC45A 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/SC45A control rooms standards, IEC 63351 (currently in preparation) is intended as 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 63400 (this document) 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 FACILITIES – INSTRUMENTATION, CONTROL AND ELECTRICAL POWER SYSTEMS IMPORTANT TO SAFETY – STRUCTURE OF THE IEC SC 45A STANDARDS SERIES

1 Scope

The IEC SC 45A series of standards include a general description in their Introduction, item d), outlining the overall structure of the series and its relationship with other standards bodies and standards (e.g. specific IAEA safety guides and IEC 61508).

This document is intended to augment that description to enable users of individual IEC SC 45A standards to obtain a more comprehensive understanding of the overall structure of the series and its relationship with other standards bodies and standards.

This document is organized as follows:

- Clause 5 outlines the scope of the IEC SC 45A standards series;
- Clause 6 describes the basic structure of the IEC SC 45A standards series, with particular reference to a hierarchy of levels and subdivision into a set of broad topic areas;
- Clause 7 presents the structure of the IEC SC 45A standards series in diagrammatic form;
- Clause 8 introduces and points to three annexes that include:
  a) the full set of IEC SC 45A standards in tabular form and numerical order,
  b) other (i.e. non IEC SC 45A) documents of particular relevance to IEC SC 45A, and
  c) the IEC SC 45A standards in tabular form for each broad topic area.

NOTE In this edition, the documents listed in the annexes and their status correspond to the situation that applied on 1st May 2021.

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 60515, *Nuclear power plants – Instrumentation important to safety – Radiation detectors – Characteristics and test methods*

IEC 60709, *Nuclear power plants – Instrumentation, control and electrical power systems important to safety – Separation*

IEC 60737, *Nuclear power plants – Instrumentation important to safety – Temperature sensors (in-core and primary coolant circuit) – Characteristics and test methods*

IEC 60772, *Nuclear power plants – Instrumentation systems important to safety – Electrical penetration assemblies in containment structures*

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

IEC 60964, *Nuclear power plants – Control rooms – Design*

IEC 60965, *Nuclear power plants – Control rooms – Supplementary control room for reactor shutdown without access to the main control room*

IEC 60987, *Nuclear power plants – Instrumentation and control important to safety – Hardware requirements*

IEC 60988, *Nuclear power plants – Instrumentation important to safety – Acoustic monitoring systems for detection of loose parts: characteristics, design criteria and operational procedures*

IEC 61031, *Nuclear facilities – Instrumentation and control systems – Design, location and application criteria for installed area gamma radiation dose rate monitoring equipment for use during normal operation and anticipated operational occurrences*

IEC 61225, *Nuclear power plants – Instrumentation, control and electrical power systems – Requirements for static uninterruptible DC and AC power supply systems*

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

IEC 61250, *Nuclear reactors – Instrumentation and control systems important for safety – Detection of leakage in coolant systems*

IEC 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 61508-2, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

IEC 61508-3, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

IEC 61508-4, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

IEC 61508-7, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 7: Overview of techniques and measures*

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

IEC 61839, *Nuclear power plants – Design of control rooms – Functional analysis and assignment*

IEC 62138, *Nuclear power plants – Instrumentation and control systems important to safety – Software aspects for computer-based systems performing category B or C functions*

IEC 62340, *Nuclear power plants – Instrumentation and control systems important to safety – Requirements for coping with common cause failure (CCF)*

IEC 62342, *Nuclear power plants – Instrumentation and control systems important to safety – Management of ageing*

IEC 62465, *Nuclear power plants – Instrumentation and control important to safety – Management of ageing of electrical cabling systems*

IEC 62566, *Nuclear power plants – Instrumentation and control important to safety – Development of HDL-programmed integrated circuits for systems performing category A functions*

IEC 62645, *Nuclear power plants – Instrumentation, control and electrical power systems – Cybersecurity requirements*

IEC 62671, *Nuclear power plants – Instrumentation and control important to safety – Selection and use of industrial digital devices of limited functionality*

IEC 62705, *Nuclear power plants – Instrumentation and control important to safety – Radiation monitoring systems (RMS): Characteristics and lifecycle*

IEC 62808, *Nuclear power plants – Instrumentation and control systems important to safety – Design and qualification of isolation devices*

IEC 62855, *Nuclear power plants – Electrical power systems – Electrical power systems analysis*

IEC 62859, *Nuclear power plants – Instrumentation and control systems – Requirements for coordinating safety and cybersecurity*

IEC 63046, *Nuclear power plants – Electrical power system – General requirements*

IEC 63272, *Nuclear facilities – Electrical power systems – AC interruptible power supply systems* (in preparation)

IEC 63298, *Nuclear power plants – Electrical power systems – Coordination and interaction with electric grid* (in preparation)

IEC 63351, *Nuclear facilities – Human Factors Engineering – Application to the design of Human Machine Interfaces* (in preparation)

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

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

IAEA Safety Glossary, 2018 Edition, IAEA, Vienna, 2019

IAEA Nuclear Security Series Glossary, Version 1.3, November 2015

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

3.1
computer-based item
item that relies on software instructions running on microprocessors or microcontrollers

Note 1 to entry: In this term and its definition, the term item can be replaced by the terms: system, or equipment, or device.

Note 2 to entry: A computer-based item is a kind of programmable digital item.

Note 3 to entry: This term is equivalent to software-based item.

Note 4 to entry: See also the definition of E/E/PE item and the associated notes.

3.2
computer-based system
I&C system whose functions are mostly dependent on, or completely performed by using microprocessors, programmed electronic equipment or computers

Note 1 to entry: See also I&C system.

3.3
Electrical/Electronic/Programmable Electronic item
E/E/PE item
item based on electrical (E) and/or electronic (E) and/or programmable electronic (PE) technology

Note 1 to entry: In this term and its definitions, the term item can be replaced by the terms: system, or equipment, or device.

Note 2 to entry: See also the definitions of programmable digital item, of computer-based item, of hardwired item, of programmable logic item and the associated notes.

Note 3 to entry: The definitions of the terms related to the technology: E/E/PE item, programmable digital item, computer-based item, hardwired item, programmable logic item are totally consistent and coherent.

3.4
electrical power system
EPS
system performing electrical power generation, transmission and distribution; performing supply functions to operate plant equipment (pumps, valves, heaters, etc.) and to I&C systems

Note 1 to entry: An electrical system can integrate E/E/PE items to perform its internal electrical control and protection.

3.5
function
specific purpose or objective to be accomplished, that can be specified or described without reference to the physical means of achieving it

3.6
hardwired item
item that relies on relays, on analogue electronic or on discrete digital logic

Note 1 to entry: In this term and its definition, the term item can be replaced by the terms: system, or equipment, or device.

Note 2 to entry: This term used by SC45A is equivalent to the term electrical/electronic item (E/E item) defined according to IEC 61508. Relays are electro-mechanical items which are not electronic items.

Note 3 to entry: Hardwired items are also usually called conventional items.

Note 4 to entry: See also the definitions of E/E/PE item and the associated notes.

3.7
HDL-programmed device
HPD
integrated circuit configured (for NPP I&C systems), with Hardware Description Languages and related software tools

Note 1 to entry: HDLs and related tools (e.g. simulator, synthesizer) are used to implement the requirements in a proper assembly of pre-developed micro-electronic resources.

Note 2 to entry: The development of HPDs can use Pre-Developed Blocks.

Note 3 to entry: HPDs are typically based on blank FPGAs (Field Programmable Gate Arrays) or similar programmable integrated circuits.

Note 4 to entry: HPD is a kind of programmable logic item.

Note 5 to entry: See also the definition of E/E/PE item and the associated notes.

3.8
I&C system
system, based on E/E/PE items, performing plant I&C functions as well as service and monitoring functions related to the operation of the system itself

Note 1 to entry: The term is used as a general term which encompasses all elements of the system, such as internal power supplies, sensors and other input devices, data highways and other communication paths, interfaces to actuators and other output devices. The different functions within a system may use dedicated or shared resources.

Note 2 to entry: The elements included in a specific I&C system are defined in the specification of the boundaries of the system.

Note 3 to entry: See also “electrical power system”. The terms “electrical power system” and “I&C system” are terms related to the main functions the systems perform; respectively “electrical power generation, transmission and distribution” and “measurement, protection, control and HMI related to the NPP process”. They have to be considered in conjunction and are totally consistent and coherent. with the general requirements established by IEC 61513 and IEC 63046 for instrumentation, control and electrical power systems for nuclear power plants.

Note 4 to entry: See also the definition of E/E/PE item and the associated notes.

Note 5 to entry: According to their typical functionality, IAEA distinguishes between automation / control systems, HMI systems, interlock systems and protection systems.

3.9
nuclear energy generation facilities
nuclear power plants (NPPs), fuel handling and processing plants, interim and final repositories for spent fuel and nuclear waste

3.10
nuclear safety
achievement of proper operating conditions, prevention of accidents and mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation risks

[SOURCE: IAEA Safety Glossary, 2018 edition]

3.11
programmable digital item
item that relies on software instructions or programmable logic to accomplish a function

Note 1 to entry: In this term and its definition, the term item can be replaced by the terms: system, or equipment, or device.

Note 2 to entry: See also the definition of E/E/PE item and the associated notes.

Note 3 to entry: The main kinds of programmable digital items are computer-based items and programmable logic items.

Note 4 to entry: This term used by IEC SC45A is equivalent to programmable electronic item (PE item) defined according to IEC 61508.

3.12
programmable logic item
item that relies on logic components with an integrated circuit that consists of logic elements with an inter-connection pattern, parts of which are user programmable

Note 1 to entry: In this term and its definition, the term item can be replaced by the terms: system, or equipment, or device.

Note 2 to entry: A programmable logic item is a kind of programmable digital item.

Note 3 to entry: See also the definition of E/E/PE item and the associated notes.

3.13
standard
document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context

Note 1 to entry: Standards should be based on the consolidated results of science, technology and experience, and aimed at the promotion of optimum community benefits.

[SOURCE: ISO/IEC Directives, Part 2:2021, 3.1.2]

3.14
international standard
standard that is adopted by an international standardizing/standards organization and made available to the public

[SOURCE: ISO/IEC Directives, Part 2:2021, 3.1.3]

3.15
technical report
TR
document published by ISO or IEC containing collected data of a different kind from that normally published as an International Standard or Technical Specification

[SOURCE: ISO/IEC Directives, Part 2:2021, 3.1.8]

4 Abbreviated terms

AC	Administrative Circular

CCF	Common Cause Failure
CBP	Computer Based Procedures
EMI	Electromagnetic Interference
EP	Electrical Power
EPS	Electrical Power System
HFE	Human Factors Engineering
HMI	Human Machine Interface
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Organization for Standardization
ITNS	Important To Nuclear Safety
I&C	Instrumentation and Control
L/C	Lifecycle
L1, L2, …	Level 1, Level 2, …
NP	New Work Item Proposal
NPEC	Nuclear Power Engineering Committee (of the IEEE)
NPP	Nuclear Power Plant
NSS	Nuclear Security Series (of the IAEA)
RFI	Radio Frequency Interference
RTD	Resistance Temperature Detector
SC	Subcommittee
TC	Technical committee
TR	Technical Report
WG	Working Group

5 IEC SC 45A scope

5.1 Technical scope

An abridged version of the IEC SC 45A technical scope is as follows:

> To prepare standards applicable to the electronic and electrical functions and associated systems and equipment used in nuclear energy generation facilities (nuclear power plants, fuel handling and processing plants, interim and final repositories for spent fuel and nuclear waste) to improve the efficiency, safety and security of nuclear energy generation.
>
> The standards cover the entire lifecycle of these instrumentation, control and electrical power systems, from conception, through design, manufacture, test, installation, commissioning, operation, maintenance, aging management, modernization and decommissioning.

Refer to the IEC website for the IEC SC 45A full technical scope statement. The following may be used to obtain information relating to IEC SC 45A and the list of IEC TCs / SCs , respectively:

https://www.iec.ch/dyn/www/f?p=103:7:::::FSP_ORG_ID:1358

https://www.iec.ch/technical-committees-and-subcommittees#tclist

NOTE For more information about IEC management and activities, see: https://www.iec.ch/homepage.