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Nuclear power plants – Instrumentation and control important to safety – Platform qualifaction for systems important to safety

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NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY – PLATFORM QUALIFACTION FOR SYSTEMS IMPORTANT TO SAFETY

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IEC TR 63084, which is a technical report, has been prepared by subcommittee 45A: Instrumentation, control and electrical systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
45A/1106/DTR	45A/1141/RVDTR

Full information on the voting for the approval of this technical report 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.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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

It is recommended that platforms are used for the development and implementation of I&C systems. These platforms are understood here as a set of hardware and software components that may work co-operatively in one or more defined architectures (configurations).

Some I&C platforms were not conceived originally for the implementation of nuclear specific, safety applications. These I&C platforms have been proven and certified for industrial applications but the qualification for the nuclear safety application has to be demonstrated.

There are standards within SC 45A and in particular WG A3 which cover the development and qualification of computer-based systems and the corresponding application functions. However, it is not clear how the standards from SC 45A can be used on the qualification of I&C platforms.

Other relevant standards of SC 45A are in WG A7 (safety categories) and in WG A9 (qualification of electrical equipment).

Annexes are included to illustrate the approaches applied in different countries and their experiences.

This Technical Report is written to support decision makers related to the issues, goals and results of the platform qualification and the system qualification.

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

IEC 63084 as a technical report is a fourth level IEC SC 45A document.

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 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 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 NPP; 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, equipment 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.

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 (NPP), the IAEA safety guide SSG-30 dealing with the safety classification of structures, systems and components in NPP, the IAEA safety guide SSG-39 dealing with the design of instrumentation and control systems for NPP, the IAEA safety guide SSG-34 dealing with the design of electrical power systems for NPP 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 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 will be published this Note 2 of the introduction of IEC SC 45A standards will be suppressed.

NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY – PLATFORM QUALIFACTION FOR SYSTEMS IMPORTANT TO SAFETY

1 Scope

1.1 General

This Technical report provides an assessment framework and activities for efficient and transparent qualification of I&C platforms for use in nuclear applications important to safety, according to nuclear standards and state of the art. The assessment aims at a pre-qualification of I&C platforms outside the framework of a specific plant design. Qualification is assumed to be pre-requisite for allowing the particular I&C platform to be used for implementation of the safety classified I&C system. It is to enable parties implementing particular plant specific I&C systems to concentrate on application functions, while for basic system functions to rely on platform qualification.

The I&C platform qualification is based on evaluation of the hardware and software functions provided by the platform ensuring safe and cost-effective life-cycle support of I&C systems. That would include tools for software engineering and software development (software module libraries), code generation, validation, maintenance, etc.

Basic means of equipment qualification, as prescribed by the IEC/IEEE 60780-323, are through analysis, type testing and documented operational experience. Other documents applicable for qualification for nuclear use include IEC 61513, IEC 60880, IEC 62138, IEC 62566, IEC 62671 and IEC 61226.

The features of the I&C platform to be qualified will be identified in requirements on the I&C platform. The requirements can vary, but in essence are based on suppliers' claims on the product scope and functionality. Those claims are normally given in platform documentation such as system descriptions and supplier's requirements for design, implementation, verification & validation. They are all based on the appropriate IEC SC 45A standards and national regulations.

1.2 Framework

This document is organized as follows:

- Clause 5 addresses the role of the platform qualification, including the conceptual design and the documentation constituting the basis for the process of platform qualification.
- Clause 6 is the main clause of this document addressing the process and methods of platform qualification. Crucial aspects of documentation and maintenance of the qualification are included.
- Clause 7 addresses platform elements necessary for safe and efficient implementation and life cycle support of plant-specific I&C systems.
- Aspects of the I&C platform qualification are further developed and exemplified in annexes. Annex A lists licensing issues of the Finnish licensing approach. Annex B discusses the qualification of Areva's TELEPERM XS platform, actualized with notes on qualification from the Finnish Olkiluoto 3 NPP. Annex C discusses the qualification of Westinghouse's FPGA-based platform of modules type ALS (Advanced Logic System). Annex D discusses the qualification of CTEC’s digital platform FirmSys for use in systems important to safety in NPP. Annex E discusses the qualification of SOOSAN ENS’s POSAFE-Q platform. Annex F discusses the qualification of Rolls-Royce’s digital safety I&C platform Spinline in the framework of the type approval for the ELSA project. The five examples given in Annexes B to F are all of platforms developed for nuclear application.

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 60780-323:2016, *Nuclear facilities – Electrical equipment important to safety – Qualification*

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

IEC 61226:2009, *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*

IEC 62138:2004, *Nuclear power plants – Instrumentation and control important for safety – Software aspects for computer-based systems performing category B or C functions*

IEC 62566:2012, *Nuclear power plants – Instrumentation and control important to safety – Development of HDL-programmed integrated circuits for systems performing category A functions*

IEC 62645:2014, *Nuclear power plants – Instrumentation and control systems – Requirements for security programmes for computer-based systems*

IEC 62671:2013, *Nuclear power plants – Instrumentation and control important to safety – Selection and use of industrial digital devices of limited functionality*

IAEA SSG-39:2016, *Specific Safety Guide: Design of Instrumentation and Control Systems for Nuclear Power Plants*