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Nuclear power plants - Instrumentation and control systems important to safety - Cable connector assemblies for harsh environment purposes

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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IEC 63423 has been prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear Instrumentation. It is an International Standard.

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

Draft	Report on voting
45A/1636/FDIS	45A/1648/RVD

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 International Standard 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/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– withdrawn, or
– revised.

INTRODUCTION

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

This document focuses on cable assemblies pertaining to components important to safety that are required to function under conditions of design basis accidents and severe accidents.

Cable assemblies are to be understood as connectors and cables that are assembled using techniques that ensure the function in case of design basis accidents and severe accidents. Since the opposite part of the connector presents the interface of a component, for instance a sensor, a junction box or an electrical penetration assembly, requirements for the cable connector assembly connector are generally valid for the interface of the connected component. This demand applies at least for counterpart of the connector of the assembly.

It is important that cable assemblies used in systems important to safety in nuclear power plants comply with various standards in order to meet their functional safety requirements throughout their qualified life. This goal is accomplished by a thorough design, qualification, manufacturing (assembling), testing, installation and commissioning.

Therefore, this IEC document focuses on the above-mentioned aspects to greater extent. Other aspects, relating to quality assurance, reliability and selection including validation and verification activities are not part of this document.

This IEC document takes into account:

– IEC/IEEE 60780-323 on qualification in general, and IEC/IEEE 60980-344 on seismic qualification.
– The testing approaches as stated in the IEC 60216 series (IEC 60216-1, IEC 60216-2 and IEC 60216-3) and the IEC 60544 series (IEC 60544-1, IEC 60544-2, IEC 60544-4, and IEC 60544-5) to respect the most relevant ageing stressors, temperature, and radiation.
– IEC documents that are specifically focused on cable and connectors.
– IEC documents on electromagnetic compatibility to respect the utilisation of digital electronic equipment in instrumentation and control (I&C) systems. Proper screening and shielding are a mandatory prerequisite to achieve a satisfactory behaviour of the complete measurement chain.
– This document does not address the design, associated calculations, and test conditions of the material aspects. These aspects are handled in product specific IEC standards.

b) Situation of the current Standard in structure of the IEC SC45A standard series

IEC 63423 is a third-level IEC SC 45A document which addresses the design, qualification, manufacturing, manufacturing testing, installation and commissioning of cable assemblies.

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

IEC/IEEE 60780-323 and IEC/IEEE 60980-344 are second-level standards that give guidance for specific aspects of functional qualification of electrical equipment important to safety; in particular to environmental and seismic qualification. IEC 63423 should be read in conjunction with these two documents.

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 technologies. Therefore, it is the task of the manufacturer, architect engineer or operator to adapt this document to the respective needs.

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 consistent set of documents organised in a hierarchy of four levels. The top-level documents of the IEC SC 45A standard series are IEC 61513 and IEC 63046, covering respectively general requirements for I&C systems and general requirements for electrical power systems of NPPs. IEC 61513 and IEC 63046 adopt an overall system life-cycle framework and constitute, along with the relevant second-level standards, the nuclear implementation of the basic safety series IEC 61508.

IEC 61513 and IEC 63046 refer directly to second-level 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.

On the 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 refer to second-level documents for general requirements and 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 NSS42-G 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 refer to ISO 9001 as well as to IAEA GSR 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/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, IEC 60964 is the entry document for the IEC/SC 45A control rooms standards, IEC 63351 is the entry document for the human factors engineering standards and IEC 62342 is the entry document for the ageing management standards.

NOTE IEC TR 63400 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.

1 Scope

This document applies to cable connector assemblies for harsh environment purposes that are important to safety. It covers the engineering safety aspects to be met in the design, qualification, fabrication, assembling, testing, and installation on site of cable connector assemblies to be operated under accident conditions.

This document can be additionally used for cable assemblies that are operated under normal conditions.

This document covers cable connector assemblies that are used for the following generic functions:

– signal transmission (AC or DC voltage/current; pulses, frequency), or
– supplying electrical energy to sensors, transducers, or other devices.

Cables in the scope of this document contain polymer materials for sheath and dielectric (polymer cables). Alternatively, cables can consist of metallic sheath and inorganic dielectric (mineral insulated cables). Attached connectors can exhibit a metallic housing and an insulation body made of ceramic or polymer. Gaskets used for the connectors can be made of metal or polymer.

Furthermore, cables and connectors in scope of this document are from the multiconductor and coaxial type.

Components which are not included in the scope are listed below:

– instrumentation and control devices that are connected to the assembly, with the exception of the connector interface;
– terminals;
– electrical penetration assemblies;
– field splices for cables;
– junction boxes in which the cable connector assemblies are installed.

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 60028, *International standard of resistance for copper*

IEC 60068-3-3, *Environmental testing - Part 3-3: Supporting documentation and guidance - Seismic test methods for equipment*

IEC 60216-1, *Electrical insulating materials - Thermal endurance properties - Part 1: Ageing procedures and evaluation of test results*

IEC 60216-2, *Electrical insulating materials - Thermal endurance properties - Part 2: Determination of thermal endurance properties of electrical insulating materials - Choice of test criteria*

IEC 60216-3, *Electrical insulating materials - Thermal endurance properties - Part 3: Instructions for calculating thermal endurance characteristics*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1, *Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests*

IEC 61156-1, *Multicore and symmetrical pair/quad cables for digital communications - Part 1: Generic specification*

IEC 61196-1-113, *Coaxial communication cables - Part 1-113: Electrical test methods - Test for attenuation constant*

IEC 61196-1-108, *Coaxial communication cables - Part 1-108: Electrical test methods - Test for characteristic impedance, phase and group delay, electrical length and propagation velocity*

IEC 60947-1:2020, *Low-voltage switchgear and controlgear - Part 1: General rules*

IEC/IEEE 60780-323:2016, *Nuclear facilities - Electrical equipment important to safety - Qualification*

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

ISO 9712, *Non-destructive testing - Qualification and certification of NDT personnel*

3 Terms, definitions and abbreviated terms

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

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

NOTE In addition, the IAEA Nuclear Safety and Security Glossary, "Terminology Used in Nuclear Safety, Nuclear Security, Radiation Protection and Emergency Preparedness and Response", 2022 (Interim) Edition, applies.

3.1 Terms and definitions

3.1.1
cable connector assembly
assembly consisting of a cable of the multicore, coaxial or triaxial type that is terminated using an appropriate connector

3.1.2
coaxial cable connector assembly
assembly of a coaxial cable consisting of inner conductor, the dielectric and the screen, and a coaxial connector consisting of inner conductor pin or socket, the dielectric, and the screen

Note 1 to entry: In case of triaxial cable connector assemblies there is an additional outer screen.

3.1.3
multiconductor cable connector assemblies
assemblies of twisted pair cables or star stranded cables and multipin connectors

Note 1 to entry: For additional screening they can be equipped with a screen, metallic film or stranded wire braid.

Note 2 to entry: For the purposes of electromagnetic immunity, cable wires are twisted in pairs to minimise the effects of magnetic fields.