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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL SYSTEMS IMPORTANT TO SAFETY – DESIGN AND QUALIFICATION OF ISOLATION DEVICES

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IEC 62808 edition 1.1 contains the first edition (2015-05) [documents 45A/1004/FDIS and 45A/1019/RVD] and its amendment 1 (2018-05) [documents 45A/1192/FDIS and 45A/1204/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 62808 has been prepared by subcommittee 45A: Instrumentation, control and electrical systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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INTRODUCTION

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

I&C (instrumentation and control) systems important to safety in nuclear power plants need to tolerate the effects of plant / equipment faults as well as internal and external hazards. IEC 60709 provides requirements to establish independence between redundant portions of safety systems, and between safety systems and systems of a lower class. Among the techniques available to increase the level of tolerability of I&C systems to such effects is the provision of isolation devices where connections are made between redundant divisions of safety equipment, or between safety equipment and systems of a lower class. This standard provides technical requirements and recommendations for the design and qualification of isolation devices that are required by IEC 60709. This standard deals with the criteria and methods used to confirm that the design of isolation devices ensures that credible failures in the connected lower class system or redundant channels will not prevent the safety systems from meeting their required functions. Isolation devices may be required on power or signal interfaces within the system.

Guidance for other aspects of isolation device qualification (e.g. electromagnetic compatibility, environmental and seismic qualification) may be found in IEC 60780.

The object of this standard is:

- in Clause 5: to establish the basic criteria for acceptability of the design and application of isolation devices;
- in Clause 6: to establish design requirements on the selection and application of suitable isolation devices;
- in Clause 7: to establish requirements on qualification testing done to validate the adequacy of the isolation device design.

It is intended that the standard be used by operators of NPPs (utilities), designers of nuclear I&C system and equipment, systems evaluators and regulators.

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

IEC 62808 is the third level IEC SC 45A document tackling the issue of isolation devices.

IEC 60709 is directly referenced by IEC 61513 in regard to physical and electrical separation being required between subsystems of different safety trains of I&C systems important to safety, and between I&C systems important to safety and those that are not important to safety.

IEC 61226 establishes the principles of categorization of I&C functions, systems and equipment according to their level of importance to safety. It then requires that adequate separation be provided between functions of different categories. IEC 61226 refers to IEC 60709 as a normative standard regarding requirements of separation.

IEC 62808 is intended to provide requirements and recommendations relating to the design and qualification of isolation devices which are identified in IEC 60709 as a means of achieving independence between systems when signals are extracted from a system for use in lower class systems, or between independent subsystems of the same classes.

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 standard

IEC 60709 applies to I&C systems and equipment important to safety. It establishes requirements for physical and electrical separation as one means to provide independence between the functions performed in those systems and equipment. IEC 60709 requires the use of isolation devices where connections between independent systems must be made. IEC 62808 provides criteria for the analysis and qualification of the the isolation device.

A fundamental criterion for isolation devices is that they be included in, and designed to, the standards of the higher class system for which they provide protection against hazards. Additional requirements relating to design and qualification of an isolation device as an element of a safety system are not given in this standard.

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 document of the IEC SC 45A standard series is IEC 61513. It provides general requirements for I&C systems and equipment that are used to perform functions important to safety in NPPs. IEC 61513 structures the IEC SC 45A standard series.

IEC 61513 refers directly to other IEC SC 45A standards for general topics related to categorization of functions and classification of systems, qualification, separation of systems, defence against common cause failure, software aspects of computer-based systems, hardware aspects of computer-based systems, and control room design. The standards referenced directly at this second level should be considered together with IEC 61513 as a consistent document set.

At a third level, IEC SC 45A standards not directly referenced by IEC 61513 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.

IEC 61513 has adopted a presentation format similar to the basic safety publication IEC 61508 with an overall safety life-cycle framework and a system life-cycle framework. Regarding nuclear safety, it provides the interpretation of the general requirements of IEC 61508-1, IEC 61508-2 and IEC 61508-4, for the nuclear application sector, regarding nuclear safety. In this framework IEC 60880 and IEC 62138 correspond to IEC 61508-3 for the nuclear application sector. IEC 61513 refers 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).

The IEC SC 45A standards series consistently implements and details the principles and basic safety aspects provided in the IAEA code on the safety of NPPs and in the IAEA safety series, in particular the Requirements SSR-2/1, establishing safety requirements related to the design of Nuclear Power Plants, and the Safety Guide NS-G-1.3 dealing with instrumentation and control systems important to safety in Nuclear Power Plants. The terminology and definitions used by SC 45A standards are consistent with those used by the IAEA.

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, that are based on the requirements of a standard such as IEC 61508.

NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL SYSTEMS IMPORTANT TO SAFETY – DESIGN AND QUALIFICATION OF ISOLATION DEVICES

1 Scope

This International Standard establishes requirements for the design, analysis and qualification of isolation devices used to ensure electrical independence of redundant safety system circuits, or between safety and lower class circuits, as specified in IEC 60709. This standard includes guidance on the determination of the maximum credible fault that is applied to the isolation devices. The maximum credible fault can be used as a basis for the test levels used in testing based on other standards (e.g. IEC TS 61000-6-5 or IEC 62003).

This standard does not address safety or CCF issues due to functional inter-dependencies and possible interferences or CCFs that may result from signal exchange or sharing between systems or sub-systems. It also does not address design or qualification issues related to digital or programmable logic in isolation devices. For isolation devices containing digital or programmable logic, additional design and qualification requirements must be considered; these requirements are outside the scope of this standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC TS 61000-6-5, *Electromagnetic compatibility (EMC) – Part 6-5: Generic standards – Immunity for power station and substation environments*

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

IEC 62003, *Nuclear power plants – Instrumentation and control important to safety – Requirements for electromagnetic compatibility testing*

3 Terms and definitions

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

3.1

barrier

device or structure interposed between redundant equipment or circuits important to safety, or between equipment or circuits important to safety and a potential source of damage to limit damage to the I&C system important to safety to an acceptable level

Note 1 to entry: The following definition is given in the IAEA Safety Glossary, edition 2007: “A physical obstruction that prevents or inhibits the movement of people, radionuclides or some other phenomenon (e.g. fire), or provides shielding against radiation”. The IAEA definition is more general and consistent with the definition given in this standard.

3.2

common mode electrical faults

voltage or current faults between both signal terminals and a common reference plane (ground)

Note 1 to entry: These faults should not be confused with common cause failures.

Note 2 to entry: This causes the potential of both signal terminals to be changed simultaneously and by the same amount relative to the common reference plane (ground).

3.3

differential mode electrical faults

voltage or current faults between signals

3.4

isolation device

device in a circuit that prevents malfunctions in one section of a circuit from causing unacceptable influences in other sections of the circuit or other circuits

Note 1 to entry: As described in IEC 60709, malfunctions can be caused by faults and normal actions.

3.5

maximum credible fault

MCF

voltage or current transient that may exist in circuits, as determined by test or analysis, taking into consideration the circuit location, routing, and interconnections combined with failures that the circuit and adjacent circuits may credibly experience

Note 1 to entry: The evaluation shall consider the impact of seismic and flooding conditions.

4 Symbols and abbreviations

AC	alternating current
CCF	common cause failure
DC	direct current
EMI	electromagnetic interference
I&C	instrumentation and control
MCF	maximum credible fault
NPP	nuclear power plant

5 General principles for isolation devices

5.1 General

The requirements for the application of isolation devices are in IEC 60709. Clause 5 is included as a summary and provides additional requirements for the isolation devices. The word "shall" identifies the additional requirements.

Isolation devices used in interfaces between I&C systems important to safety or between channels within a system important to safety may have an impact on the integrity of the overall design and in particular, on defence in depth. When used, they may be relied upon to provide electrical isolation between redundant safety functions or safety functions in different layers of defence in the overall architecture. In general, the introduction of such interfaces between systems should be considered carefully based on the principles and approaches outlined in IEC 61513. A systematic analysis of failures at system and overall I&C architecture level is required. Functional inter-dependencies are introduced between systems due to signal interfaces and their associated failure modes shall be considered carefully.