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Nuclear power plants – Electrical power systems – Coordination and interaction with electric grid

INTERNATIONAL
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Nuclear power plants – Electrical power systems – Coordination and interaction with electric grid

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NOTE FROM TC/SC OFFICERS:
FDIS prepared following resolution of comments on CDV at WGA11 meeting in London in September 2023. Circulation of FDIS in accordance with decision 45A/2023-40 made during SC45A plenary meeting in October 2023, see 45A/1509/RM.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

NUCLEAR POWER PLANTS – ELECTRICAL POWER SYSTEMS – COORDINATION AND INTERACTION WITH ELECTRIC GRID

FOREWORD

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IEC 63298 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/XX/FDIS	45A/XX/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- withdrawn, or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 organization of the standard

Nuclear power plants (NPPs) need an electric grid for the dual purpose of exporting produced energy and for a reliable power source for start-up, operation, shutdown and emergency conditions.

Owing to the electrical size of the NPP compared to the electrical size of the electric grid, it may be a challenge to safely integrate the NPP into the electric grid.

Coordination between the electric grid and the NPP is becoming increasingly important as more countries adopt a liberal energy market and responsibilities are held by multiple stakeholders (e.g., production, transmission, distribution, and trading organizations).

The purpose of this document is to define the high-level requirements and recommendations for the coordination of NPPs and electric grids to ensure the appropriate interactions between the two entities.

The specific features of the NPP and electric grid that are in scope for this document are described in Annex A.

The requirement for coordination between the electric grid operators and NPP operators is described in WANO SOER 1999-1 which focusses on significant operating experience relating to the loss of connection to the electric grid at NPPs (this event being one of the major contributors to NPP core damage frequency).

IAEA Nuclear Energy Series, NG-T-3.8, *Electric Grid Reliability And Interface With Nuclear Power Plants* describes the characteristics of the electric grid that are required for the connection and successful operation of an NPP, as well as the characteristics of an NPP that are significant for the design and operation of the electric grid.

This document focuses on technical requirements, such as the data exchange between the NPP operators and the electric grid operators, the analyses carried out by both sides and the acceptance criteria.

This document also defines the coordination requirements to ensure that operating instructions for the electric grid and the NPP are developed to provide a means of safe and reliable operation.

This document also defines the requirements for the development of a framework for any specific tests that may be deemed necessary for the electric grid and the NPP, such as testing of NPP regulation capabilities and load rejection to house load operation tests.

Finally, this document provides guidance on the need for continuous coordination between the electric grid and NPP during the NPP's design life, on topics such as operation and maintenance, design modifications and changes to grid conditions.

b) Situation of this document in the structure of the SC 45A standard series

This document is a second level document specifically addressing the topic of coordination between the NPP and electric grid.

For more details on the structure of the SC 45A standard series, see item d) of this Introduction.

c) Recommendations and limitations regarding the application of this document

This document is used in conjunction with IEC 61513, IEC 62855 and IEC 63046.

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 SC 45A 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 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 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 (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 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 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 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 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 POWER PLANTS – ELECTRICAL POWER SYSTEMS – COORDINATION AND INTERACTION WITH ELECTRIC GRID

1 Scope

1.1 General

The scope of this document is to provide high level requirements and recommendations for the coordination of NPPs and the electric grid; see also item a) of the Introduction.

The specific design requirements for components and equipment are covered by other specific IEC standards outside the scope of this document.

1.2 Use of this document

This document is intended to be used:

- for the design of new NPPs (including small modular reactors (SMRs), where applicable);
- for considering the adequacy and impact of major modifications to the electric grid for operating NPPs;
- for periodic design reviews of operating NPPs.

Pertinent parts of this document can be used as guidance for NPP operation and in general for nuclear facilities.

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 62855:2016, *Nuclear power plants – Electrical power systems – Electrical power systems analysis*

IEC 63046:2020, *Nuclear power plants – Electrical power system – General requirements*