IEC 63272

Edition 1.0 2024-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Nuclear facilities – Electrical power systems – AC interruptible power supply systems

Installations nucléaires – Systèmes d'alimentation électrique – Systèmes d'alimentation électrique interruptibles en courant alternatif

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NUCLEAR FACILITIES – ELECTRICAL POWER SYSTEMS – AC INTERRUPTIBLE POWER SUPPLY SYSTEMS

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IEC 63272 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/1528/FDIS	45A/1544/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

This International Standard is to be used in conjunction with IEC 63046.

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.

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INTRODUCTION

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

The purpose of this document is to provide high level requirements for the design of on-site AC interruptible power supply systems as part of the overall electrical distribution system in a nuclear facility.

The on-site AC interruptible electrical power system supports all plant operating functions including plant safety systems. This includes safety classified electrical distribution systems which provide interruptible power supplies to support plant safety systems. This document does not cover requirements for grid connections to the nuclear plant which is the subject of a separate standard. This document does not cover requirements for uninterruptible power supplies which are defined in IEC 61225.

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

This document is a second level document specifically addressing the particular topic of requirements for electrical supplies.

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 standard

This document defines the requirements for an electrical designer to establish the design of the AC interruptible electrical power supply for nuclear facilities. It is used in conjunction with Level 1 standard IEC 63046.

Requirements for uninterruptible power supplies are defined in Level 2 standard IEC 61225.

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.

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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.

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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.

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NOTE 1 It is assumed that for the design of I&C systems in NPPs that implements conventional safety functions (e.g. to address worker safety, asset protection, chemical hazards, process energy hazards) international or national standards are 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 standard bodies and standards.

NUCLEAR FACILITIES – ELECTRICAL POWER SYSTEMS – AC INTERRUPTIBLE POWER SUPPLY SYSTEMS

1 Scope

This document specifies the performance and functional characteristics of the on-site AC interruptible power supply systems and applies to new nuclear facilities and newly installed or upgraded on-site AC interruptible power supply systems.

The specific design requirements for the components of the power supply system are defined by the IEC standards listed in the normative references and are outside the scope of this document.

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.

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IEC 60038, *IEC standard voltages*

IEC 60076 (all parts), *Power transformers*

IEC 60076-1, *Power transformers – Part 1: General*

IEC 60709:2018, *Nuclear power plants – Instrumentation, control and electrical power systems important to safety – Separation*

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IEC 60909 (all parts), *Short-circuit currents in three phase a.c. systems*

IEC 61000 (all parts), *Electromagnetic compatibility (EMC)*

IEC 61000-4 (all parts), *Electromagnetic compatibility (EMC) — Testing and measurement techniques*

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

IEC 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

IEC 62003, *Nuclear power plants – Instrumentation, control and electrical power systems – Requirements for electromagnetic compatibility testing*

IEC 62271 (all parts), *High-voltage switchgear and controlgear*

IEC 62305 (all parts), *Protection against lightning*

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

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

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

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

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

IEC/IEEE 63332-387[1], *Nuclear facilities – Electrical power systems – Diesel generator units applied as standby power sources*

IAEA Safety Report 91, *Impact of Open Phase Conditions on Electrical Power Systems of Nuclear Power Plants*

3 Terms and definitions

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

NOTE Other terms not defined below are defined in IAEA Safety Guide SSG-34 and IAEA Safety Guide SSG-39.

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

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3.1
alternate power supply
generator reserved for the power supply to the plant during total loss of all non-battery power in the safety power systems (station blackout) and other design extension conditions

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[SOURCE: IAEA SSG-34:2016, modified – Main term “alternate AC power supply” modified to read “alternate power supply”.]

3.2
associated circuit
circuit of a lower safety class that is not physically separated or is not electrically isolated from the circuit(s) of the higher class by acceptable separation distances, safety class structures, barriers, or electrical isolation devices, but meets suitable criteria for safety

Note 1 to entry: Circuits include the interconnecting cabling and the connected loads.

[SOURCE: IEC 60709:2018, 3.1]

[1] Under preparation. Stage at the time of publication: IEC/IEEE FDIS 63332-387:2024.

3.3
common cause failure
failure of two or more structures, systems or components due to a single event or cause

Note 1 to entry: Common causes may be internal or external to an I&C system.

Note 2 to entry: The definition from IEC differs from the IAEA as follows:

1) The term "specific" was deleted because otherwise the definition of CCF is not consistent with the definition of CMF "Common mode failure". Furthermore this additional word is not necessary to understand the definition.

[SOURCE: IAEA Nuclear Safety and Security Glossary:2022, modified – the term “specific” has been removed]

3.4
defence in depth
hierarchical deployment of different levels of diverse equipment and procedures to prevent the escalation of anticipated operational occurrences and to maintain the effectiveness of physical barriers placed between a radiation source or radioactive material and workers, members of the public or the environment, in operational states and, for some barriers, in accident conditions

[SOURCE: IAEA Nuclear Safety and Security Glossary:2022]

3.5
design basis
range of conditions and events taken explicitly into account in the design of structures, systems and components and equipment of a facility, according to established criteria, such that the facility can withstand them without exceeding authorized limits

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[SOURCE: IAEA Nuclear Safety and Security Glossary:2022]

3.6
design extension conditions
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postulated accident conditions that are not considered for design basis accidents, but that are considered in the design process of the facility in accordance with best estimate methodology, and for which releases of radioactive material are kept within acceptable limits

Note 1 to entry: Design extension conditions comprise conditions in events without significant fuel degradation and conditions in events with melting of the reactor core.

[SOURCE: IAEA Nuclear Safety and Security Glossary:2022]

3.7
diversity
presence of two or more independent (redundant) systems or components to perform an identified function, where the different systems or components have different attributes so as to reduce the possibility of common cause failure, including common mode failure

[SOURCE: IAEA Nuclear Safety and Security Glossary:2022]

3.8
division
collection of items, including their interconnections, that form one redundancy of a redundant system or safety group

Note 1 to entry: Divisions may include multiple channels.

Note 2 to entry: In the context of this document, “division” includes a given system or set of components that enables the establishment and maintenance of physical, electrical and functional independence from other redundant sets of components.

[SOURCE: IAEA Nuclear Safety and Security Glossary:2022, modified – Addition of a new Note 2 to entry.]

3.9
electric grid operator
organisation operating the electric grid, which could be either the transmission system operator or distribution system operator depending on the relevant part of the electric grid

[SOURCE: IEC 63298:20─, 3.4]

3.10
electrical disturbances
all disturbing phenomena that cause the mains voltage, current or frequency profile to depart from its nominal characteristics

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Note 1 to entry: The electrical disturbances can also generate electromagnetic disturbances that can affect the AC electrical power supply system.

3.11
electrical isolation
electrical isolation is used to prevent electrical failures in one system from affecting connected systems

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Note 1 to entry: Electrical isolation controls or prevents adverse interactions between equipment and components caused by factors such as electromagnetic interference, electrostatic pickup, short circuits, open circuits, earthing, or application of the maximum credible voltage.

[SOURCE: IAEA SSG-34:2016, modified – In Note 1 to entry, “grounding” replaced with “earthing”, and “(AC or DC)” deleted at the end of Note 1 to entry.]

3.12
electrical power system
system performing electrical power generation, transmission and distribution; performing supply functions to operate plant equipment (pumps, valves, heaters, etc) and to I&C systems

[SOURCE: IEC 63046:2020, 3.12, modified – Deletion of Note 1 to entry and Note 2 to entry.]

3.13
electrical source transfer
transfer from an initial electrical power source to an alternative supply source when the initial electrical power source does not provide the performance required by the electrical power supply system

Note 1 to entry: The transfer can be initiated either manually or automatically.

[SOURCE: IEC 63046:2020, 3.15, modified – Deletion of “(automatically or manually)” in the definition, and modification of Note 1 to entry.]

3.14
equipment qualification
generation and maintenance of evidence to ensure that equipment will operate on demand, under specified service conditions, to meet system performance requirements

[SOURCE: IAEA Nuclear Safety and Security Glossary:2022]

3.15
house load operation
operation of a nuclear power plant to supply power only to its own electrical loads

[SOURCE: IEC 62855:2016, 3.2]

3.16
I&C system
system, based on electrical and/or electronic and/or programmable electronic technology, performing 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.

[SOURCE: IEC 61513:2011, 3.29, modified – deletion of Notes 1 to 3 to entry.]

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3.17
independence
condition that exists when successful completion of a system's required functions is not dependent upon any behaviour including failures and normal operation of another system, or upon any signals, data or information derived from the other system

[SOURCE: IEC 60709:2018, 3.13, modified – Deletion of Note 1 to entry.]

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3.18
interruptible power supply system
power supply of loads for which a defined power supply interruption time does not impair the mission of the safety objective

[SOURCE: IEC 63046:2020, 3.22]

3.19
item important to safety
item that is part of a safety group and/or whose malfunction or failure could lead to radiation exposure of the site personnel or members of the public

Note 1 to entry: Items important to safety include:

– those structures, systems and components whose malfunction or failure could lead to undue radiation exposure of site personnel or members of the public;
– those structures, systems and components that prevent anticipated operational occurrences from leading to accident conditions;
– safety features (for design extension conditions);
– those features that are provided to mitigate the consequences of malfunction or failures of structures, systems and components

[SOURCE: IAEA Nuclear Safety and Security Glossary:2022]