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Nuclear facilities - Human machine interfaces - Operator support systems

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Nuclear facilities - Human machine interfaces - Operator support systems

FOREWORD

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IEC 63435 has been prepared by subcommittee 45A: Instrumentation, control and electrical 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/1608/FDIS	45A/1618/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- withdrawn, or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

This document focuses on the operator support system (OSS) used by the control room staff, maintenance engineers and emergency response staff of mainly nuclear power plants (NPPs), but it is also applicable to other nuclear facilities, including fuel handling and processing plants, interim and final repositories for spent fuel and nuclear waste. OSS assists situation assessment and decision making by improving monitoring performance and analysis capability to enhance the safety, availability and operability of nuclear facilities. With the use of computer technology, applications of OSS are increasing and becoming current practice.

This document is intended to be used by nuclear facility vendors, utilities, and by licensors.

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

This document is a third level IEC SC 45A document tackling the generic issue of OSS of nuclear facilities and falls under the second level standard IEC 60964 concerning control room design.

IEC 60964 provides requirements of data acquisition and processing, display system and alarm system of the control room. In addition, operator support functions are mentioned in 8.7.2.5 of IEC 60964:2018, but the specific design requirements are not provided.

This document is intended to deal with the specific aspects of an OSS, as a supplementary to 8.7.2.5 of IEC 60964:2018.

Figure 1 shows the set of IEC SC 45A standards that collectively give requirements for control rooms, human-machine interfaces (HMI) and human factors engineering (HFE).

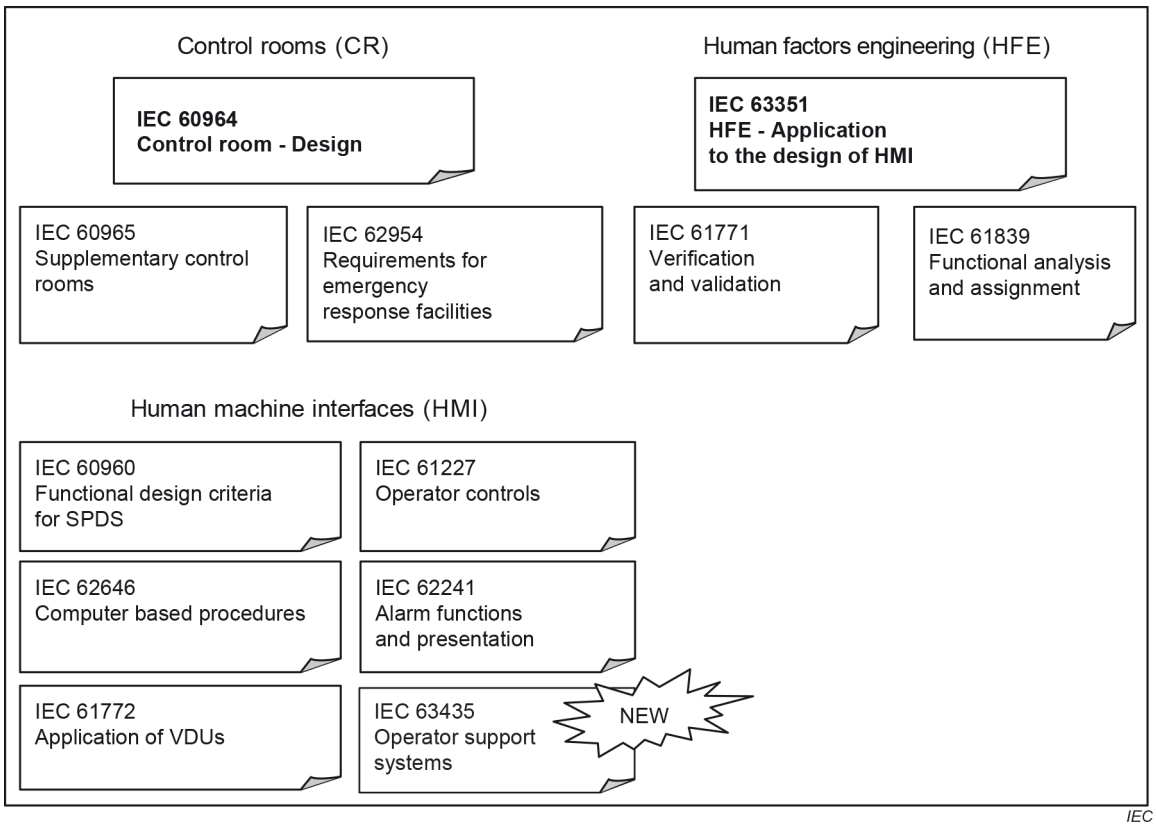


Figure 1 – IEC SC 45A standards addressing control rooms, HMI and HFE

The documents shown on the left of Figure 1 below the "IEC 60964" box constitute the existing set of control room (CR) and human-machine interface (HMI) design related standards and those on the right of the figure below the "IEC 63351" box constitute the HFE related standards.

NOTE In their current editions, IEC 61771 and IEC 61839 are described as being linked to IEC 60964. Updates are under consideration for all three documents, however, during which the descriptions of the links can be adapted to align with that shown in the figure.

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

c) Recommendations and limitations regarding the application of this document

This document is applicable to the new OSS whose conceptual design will be initiated after the publication of this document. The recommendations of this document can be used for refits, upgrades and modifications of an existing OSS.

This document establishes functional requirements for OSS and focuses on the top-level design considerations of OSS. It also provides the concept of OSS, as well as the design process following the human factors engineering (HFE) programme, the human factors guidelines and the verification and validation (V&V) requirements for OSS design. It does not provide detailed guidance on functional analysis and assignment, task analysis and human machine interface design. The system development and human performance monitoring in operational phases are out of the scope of this document. The requirements and recommendations given in the document would apply for OSS applications and OSS types that are not yet specifically mentioned in the document.

To ensure that this document will continue to be relevant in the future years, the emphasis has been placed on issues of principle, rather than on specific technologies.

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 instrumentation and control (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 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.

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 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

1.1 Object of this document

This document specifies the characteristics of operator support systems (OSS) used by the control room staff, maintenance engineers and emergency response staff, establishes general principles for OSS life cycle and requirements for OSS design following the human factors engineering (HFE) programme. This document also gives the human factors guidelines and the verification and validation (V&V) requirements for OSS design.

This document is applicable to new nuclear facilities whose conceptual design is initiated after the publication of this document but it can also be used for designing OSS in existing nuclear facilities.

1.2 Context leading to development of OSS

Enhancing safety, optimizing operator workload and increasing nuclear facility availability have always been greatly valued aims which, during nuclear facility operation, rely largely on the operating staff and on OSS.

In addition, the use of computer technology to provide operator support functions and a database of operation and maintenance for the operating staff and for teams and individuals outside of a nuclear facility, on-line and/or off-line, is increasing and becoming current practice. This can be done as diagnosis and guide formats both in normal operation and abnormal conditions. When properly implemented and kept up to date, such OSS can provide enhanced support for greater safety and effectiveness of operation and maintenance of nuclear facilities.

1.3 Use of this document with related standards

This document is intended to deal with aspects that are specific to OSS, as supplementary to the operator support function specified in IEC 60964. For functional design criteria of safety parameter display functions, see also IEC 60960; and for requirements of computer-based procedures (CBP), see also IEC 62646.

In order to design OSS efficiently and properly, some important considerations are addressed in the following related standards:

a) Control rooms design
   - IEC 60964 provides requirements and recommendations for the design of control rooms.

b) Human factors engineering (HFE)
   - IEC 63351 provides management of HFE programme, task analysis (TA) and human machine interface (HMI) design guidance.

c) Functional analysis and assignment (FA&A)
   - IEC 61839 gives rules for developing criteria for the functional assignment to either operators or systems.

d) Human factors design guidelines
   - IEC 61772 provides guidance on physical implementation of visual display units (VDUs), display formats, and implementation into the main control room (MCR);
   - ISO 11064-1, ISO 11064-4 and ISO 11064-5 provide guidance on human-centered design activities throughout the life cycle of a computer-based interactive system.

e) Verification and validation (V&V)
   - IEC 61771 provides guidance on V&V of the design of control rooms.

This document assumes simultaneous considerations of the requirements for:

– cybersecurity, which is in compliance with IEC 62645,
– categorization and classification, which are in compliance with IEC 61226,
– safety life cycle aspects, which are in compliance with IEC 61513, IEC 60880, IEC 62138 and IEC 60987 depending on the safety classification of OSS.

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

IEC 63351:2024, *Nuclear facilities - Human factors engineering - Application to the design of human machine interfaces*