

© Copyright SEK. Reproduction in any form without permission is prohibited.

Kärnkraftanläggningar – Kontrollrum

*Nuclear Power Plants –
Control Rooms –
Design*

Som svensk standard gäller europastandarden EN 60964:2010. Den svenska standarden innehåller den officiella engelska språkversionen av EN 60964:2010.

Nationellt förord

Europastandarden EN 60964:2010

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 60964, Second edition, 2009 - Nuclear Power Plants - Control Rooms - Design**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-IEC 964, utgåva 1, 1990, gäller ej fr o m 2013-03-01.

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a säkerhet, prestanda, dokumentation, utförande och skötsel av elprodukter, elanläggningar och metoder. Genom att utforma sådana standarder blir säkerhetskraven tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

English version

**Nuclear power plants -
Control rooms -
Design**
(IEC 60964:2009)

Centrales nucléaires de puissance -
Salles de commande -
Conception
(CEI 60964:2009)

Kernkraftwerke -
Warten -
Auslegung
(IEC 60964:2009)

This European Standard was approved by CENELEC on 2010-03-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of the International Standard IEC 60964:2009, prepared by SC 45A, Instrumentation and control of nuclear facilities, of IEC TC 45, Nuclear instrumentation, was submitted to the CENELEC formal vote for acceptance as a European Standard and was approved by CENELEC as EN 60964 on 2010-03-01.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2011-03-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2013-03-01

Annex ZA has been added by CENELEC.

As stated in the nuclear safety Directive 2009/71/EURATOM, Chapter 1, Article 2, Item 2, Member States are not prevented from taking more stringent safety measures in the subject-matter covered by the Directive, in compliance with Community law. In a similar manner, this European Standard does not prevent Member States from taking more stringent nuclear safety measures in the subject-matter covered by this European Standard.”

Endorsement notice

The text of the International Standard IEC 60964:2009 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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.

NOTE Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60709	-	Nuclear power plants - Instrumentation and control systems important to safety - Separation	EN 60709	-
IEC 60780	-	Nuclear power plants - Electrical equipment of the safety system - Qualification	-	-
IEC 60960	-	Functional design criteria for a safety parameter display system for nuclear power stations	-	-
IEC 60965	-	Nuclear power plants - Control rooms - Supplementary control points for reactor shutdown without access to the main control room	-	-
IEC 60980	-	Recommended practices for seismic qualification of electrical equipment of the safety system for nuclear generating stations	-	-
IEC 61225	-	Nuclear power plants - Instrumentation and control systems important to safety - Requirements for electrical supplies	-	-
IEC 61226	-	Nuclear power plants - Instrumentation and control important to safety - Classification of instrumentation and control functions	EN 61226	-
IEC 61227	-	Nuclear power plants - Control rooms - Operator controls	-	-
IEC 61513	-	Nuclear power plants - Instrumentation and control for systems important to safety - General requirements for systems	-	-
IEC 61771	-	Nuclear power plants - Main control-room - Verification and validation of design	-	-
IEC 61772	-	Nuclear power plants - Control rooms - Application of visual display units (VDUs)	-	-
IEC 61839	-	Nuclear power plants - Design of control rooms - Functional analysis and assignment	-	-
IEC 62241	-	Nuclear power plants - Main control room - Alarm functions and presentation	-	-

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
ISO 11064	Series	Ergonomic design of control centres	-	-
IAEA NS-G-1.3	-	Instrumentation and control systems important to safety in nuclear power plants	-	-
IAEA NS-G-1.9	-	Design of the reactor coolant systems and associated system in nuclear power plants	-	-
IAEA NS-G-1.11	-	Protection against internal hazards other than fires and explosions in the design of nuclear power plants : safety guide	-	-

CONTENTS

INTRODUCTION.....	6
1 Scope and object.....	8
2 Normative references	8
3 Terms and definitions	9
4 Standard use.....	12
5 Design principles for the main control room	16
5.1 Main objectives of the main control room.....	16
5.2 Functional design objectives of the main control room.....	16
5.3 Safety principles.....	16
5.4 Availability principles.....	16
5.5 Human factors engineering principles.....	17
5.6 Utility operating principles	17
5.7 Relationship with other control and management centres	17
5.8 Operational experience	18
6 Functional design of the main control room	18
6.1 General.....	18
6.2 Functional analysis.....	18
6.2.1 General	18
6.2.2 Identification of functions.....	18
6.2.3 Information flow and processing requirements	18
6.3 Assignment of functions	19
6.3.1 General	19
6.3.2 Operator capabilities	19
6.3.3 I&C system processing capabilities.....	20
6.4 Verification of function assignment.....	20
6.4.1 General	20
6.4.2 Process	20
6.5 Validation of function assignment.....	21
6.5.1 General	21
6.5.2 Process	21
6.5.3 General evaluation criteria for validation.....	21
6.6 Job analysis	21
7 Functional design specification.....	22
7.1 General.....	22
7.2 Provision of data base on human capabilities and characteristics.....	22
7.3 Location, environment and protection	22
7.3.1 Location	22
7.3.2 Environment	22
7.3.3 Protection.....	23
7.4 Space and configuration.....	24
7.4.1 Space.....	24
7.4.2 Configuration.....	24
7.5 Panel layout	25
7.5.1 Priority.....	25
7.5.2 Positioning on control desks and panels	25

7.5.3	Mirror image layout.....	25
7.6	Location aids.....	25
7.6.1	Grouping of display information and controls	25
7.6.2	Nomenclature	26
7.6.3	Coding.....	26
7.6.4	Labelling.....	27
7.7	Information and control systems	27
7.7.1	General	27
7.7.2	Information functions	28
7.7.3	Control functions	31
7.8	Control-display integration.....	32
7.9	Communication systems.....	32
7.9.1	General	32
7.9.2	Verbal communication systems.....	33
7.9.3	Non-verbal communication systems.....	34
7.10	Other requirements	34
7.10.1	Power supplies	34
7.10.2	Qualification	34
7.10.3	Maintainability	34
7.10.4	Repairs.....	35
7.10.5	Testability.....	35
8	Verification and validation of the integrated control room system.....	35
8.1	General.....	35
8.2	Control room system verification	35
8.2.1	General	35
8.2.2	Process	35
8.2.3	General evaluation criteria for integrated system verification	35
8.3	Control room system validation	35
8.3.1	General	35
8.3.2	Process	35
8.3.3	General evaluation criteria for integrated system validation	36
Annex A (informative)	Explanation of concepts	37
Figure 1	– Overview of control room system	14
Figure 2	– Overall design process and the relationship to clauses and subclauses of this standard.....	15
Table A.1	– Human and machine in functional domain and physical domain	38

INTRODUCTION

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

IEC 60964:1989 was developed to supply requirements relevant to the design of the main control room of NPPs. The first edition of IEC 60964 has been used extensively within the nuclear industry. It was however recognized that recent technical developments especially those which are based on software technology should be incorporated. It was also recognized that the relationships with derivative standards (i.e. IEC 61227, IEC 61771, IEC 61772, IEC 61839, and IEC 62241) should be clarified and conditioned.

This IEC standard specifically focuses on the functional designing of the main control room of NPPs. It is intended that the Standard be used by NPP vendors, utilities, and by licensors.

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

IEC 60964 is the second level IEC SC 45A document tackling the generic issue of control room design.

IEC 60964 is to be read in association with the derivative standards mentioned above which are the appropriate IEC SC 45A documents which provide guidance on operator controls, verification and validations of design, application of visual display units, functional analysis and assignment, and alarm functions and presentation.

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

This standard is intended for application to new control rooms whose conceptual design is initiated after the publication of this standard. The recommendations of the standard may be used for refits, upgrades and modifications.

The primary purpose of this standard is to provide functional design requirements to be used in the design of the main control room of a nuclear power plant to meet operational and safety requirements.

This standard also provides functional interface requirements which relate to control room staffing, operating procedures and the training programme which are, together with the human-machine interface, constituents of the control room system.

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.

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 45 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 and provides an interpretation of the general requirements of IEC 61508-1, IEC 61508-2 and IEC 61508-4, for the nuclear application sector. Compliance with IEC 61513 will facilitate consistency with the requirements of IEC 61508 as they have been interpreted for the nuclear industry. 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 50-C-QA (now replaced by IAEA GS-R-3) 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 NS-R-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.

NUCLEAR POWER PLANTS – CONTROL ROOMS – DESIGN

1 Scope and object

This International Standard establishes requirements for the human-machine interface in the main control rooms of nuclear power plants. The standard also establishes requirements for the selection of functions, design consideration and organization of the human-machine interface and procedures which shall be used systematically to verify and validate the functional design. These requirements reflect the application of human factors engineering principles as they apply to the human-machine interface during normal and abnormal plant conditions. This standard does not cover special purpose or normally unattended control points, such as those provided for shutdown operations from outside the main control room or for radioactive waste handling, or emergency response facilities. Detailed equipment design is outside the scope of this standard.

The primary purpose of this standard is to provide functional design requirements to be used in the design of the main control room of a nuclear power plant to meet operational and safety requirements. This standard also provides functional interface requirements which relate to control room staffing, operating procedures, and the training programmes which, together with the human-machine interface, constitute the control room system.

This standard is intended for application to new control rooms whose conceptual design is initiated after the publication of this standard. If it is desired to apply it to an existing control room, special caution must be exercised so that the design basis is kept consistent.

2 Normative references

The following referenced documents are indispensable for the application 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 60709, *Nuclear power plants – Instrumentation and control systems important to safety – Separation*

IEC 60780, *Nuclear power plants – Electrical equipment of the safety system – Qualification*

IEC 60960, *Functional design criteria for a safety parameter display system for nuclear power stations*

IEC 60965, *Supplementary control points for reactor shutdown without access to the main control room*

IEC 60980, *Recommended practices for seismic qualification of electrical equipment of the safety system for nuclear generating stations*

IEC 61225, *Nuclear power plants – Instrumentation and control systems important for safety – Requirements for electrical supplies*

IEC 61226, *Nuclear power plants – Instrumentation and control important to safety – Classification of instrumentation and control functions*

IEC 61227, *Nuclear power plants – Control rooms – Operator controls*

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

IEC 61771, *Nuclear power plants – Main control room – Verification and validation of design*

IEC 61772, *Nuclear power plants – Main control room – Application of visual display units (VDU)*

IEC 61839, *Nuclear power plants – Design of control rooms – Functional analysis and assignments*

IEC 62241, *Nuclear power plants – Main control room – Alarm functions and presentation*

ISO 11064 (all parts), *Ergonomic design of control centres*

IAEA NS-G-1.3, *Instrumentation and control systems important to safety in Nuclear Power Plants, 2002*

IAEA NS-G-1.9, *Design of the reactor coolant system and associated systems in nuclear power plants*

IAEA, NS-G-1.11, *Protection against internal hazards other than fires and explosions in the design of nuclear power plants*