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Nuclear power plants – Control rooms – Design

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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NUCLEAR POWER PLANTS – CONTROL ROOMS – DESIGN

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This Redline version provides you with a quick and easy way to compare all the changes between this standard and its previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60964 has been prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

This third edition cancels and replaces the second edition published in 2009. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) to review the usage of the term “task” ensuring consistency between IEC 60964 and IEC 61839;
b) to clarify the role, functional capability, robustness and integrity of supporting services for the MCR to promote its continued use at the time of a severe accident or extreme external hazard;
c) to review the relevance of the standard to the IAEA safety guides and IEC SC 45A standards that have been published since IEC 60964:2009 was developed;
d) to clarify the role and meaning of “task analysis”,
e) to further delineate the relationships with derivative standards (i.e. IEC 61227, IEC 61771, IEC 61772, IEC 61839, IEC 62241 and others of relevance to the control room design);
f) to consider its alignment with the Human Factors Engineering principles, specifically with the ones of IAEA safety guide on Human Factors (DS-492) to be issued.

The text of this International Standard is based on the following documents:

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IMPORTANT – The “colour inside” logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

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 and reviewed in 2009. The first two editions of IEC 60964 ~~has been~~ were 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.~~

It was however recognized that there was a need to develop an amendment for the 2009 edition to address:

- The usage of the term "task" needed to be examined.
- The role, functional capability, integrity of supporting services and robustness for the MCR should be clarified to promote its continued use at the time of a severe accident or extreme external hazard.
- The relevance of the standard to the IAEA safety guides and SC 45A standards published since 2009.

Given the size of the proposal amendment, it was decided that a new edition of IEC 60964 should be issued instead of an amendment. During the preparation of this third edition, it was agreed that the following points have to be covered:

- to clarify the role and meaning of “task analysis”,
- to further delineate the relationships with derivative standards (i.e. IEC 61227, IEC 61771, IEC 61772, IEC 61839, IEC 62241 and others of relevance to the control room design);
- to consider its alignment with the Human Factors Engineering principles, specifically with the ones of IAEA safety guide on Human Factors (DS-492) to be issued.

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 documents of the IEC SC 45A standard series ~~is~~ are IEC 61513 and IEC 63046. IEC 61513 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 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 to be 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 systems for nuclear power plants.

IEC 61513 and IEC 63046 refer~~s~~ 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, electromagnetic compatibility, 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 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 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.~~

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 and the implementing guide NSS17 for computer security at nuclear facilities. The safety and security terminology and definitions used by 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 as well as to IAEA GS-R 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 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 SC 45A domain was extended in 2013 to cover electrical systems. In 2014 and 2015 discussions were held in IEC SC 45A to decide how and where general requirements for the design of electrical systems were to be considered. IEC SC 45A experts recommended that an independent standard be developed at the same level as IEC 61513 to establish general requirements for electrical systems. Project IEC 63046 is now launched to cover this objective. When IEC 63046 is published this NOTE 2 of the introduction of IEC SC 45A standards will be suppressed.

NUCLEAR POWER PLANTS – CONTROL ROOMS – DESIGN

1 Scope ~~and object~~

This document establishes requirements for the human-machine interface in the main control rooms of nuclear power plants. The document also establishes requirements for the selection of functions, design consideration and organization of the human-machine interface and procedures which ~~shall be~~ are 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 operational states and accident conditions (including design basis and design extension conditions), as defined in IAEA SSR-2/1 and IAEA NP-T-3.16. This document 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 document.

The primary purpose of this document 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 document 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 document is intended for application to new control rooms whose conceptual design is initiated after the publication of this document. 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 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 60671, *Nuclear power plants – Instrumentation and control systems important to safety – Surveillance testing*

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

IEC/IEEE 60780-323, *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~~ room 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 (VDUs)*

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

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

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

IEC 62645, *Nuclear power plants – Instrumentation and control systems – Requirements for security programmes for computer-based systems*

IEC 62646, *Nuclear power plants – Control rooms – Computer based procedures*

IEC 62859, *Nuclear power plants – Instrumentation and control systems – Requirements for coordinating safety and cybersecurity*

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*

IAEA NP-T-3.16, *Accident Monitoring Systems for Nuclear Power Plants*

IEC 60964

Edition 3.0 2018-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Nuclear power plants – Control rooms – Design

Centrales nucléaires de puissance – Salles de commande – Conception

IEC 60964:2018-11(en-fr)

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- The usage of the term "task" needed to be examined.
- The role, functional capability, integrity of supporting services and robustness for the MCR should be clarified to promote its continued use at the time of a severe accident or extreme external hazard.
- The relevance of the standard to the IAEA safety guides and SC 45A standards published since 2009.

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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 documents of the IEC SC 45A standard series are IEC 61513 and IEC 63046. IEC 61513 provides general requirements for I&C systems and equipment that are used to perform functions important to safety in 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 to be 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 systems for nuclear power plants.

IEC 61513 and IEC 63046 refer directly to other IEC SC 45A standards for general topics related to categorization of functions and classification of systems, qualification, separation, defence against common cause failure, control room design, electromagnetic compatibility, 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 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.

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 and the implementing guide NSS17 for computer security at nuclear facilities. The safety and security terminology and definitions used by 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 as well as to IAEA GS-R 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 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 SC 45A domain was extended in 2013 to cover electrical systems. In 2014 and 2015 discussions were held in IEC SC 45A to decide how and where general requirements for the design of electrical systems were to be considered. IEC SC 45A experts recommended that an independent standard be developed at the same level as IEC 61513 to establish general requirements for electrical systems. Project IEC 63046 is now launched to cover this objective. When IEC 63046 is published this NOTE 2 of the introduction of IEC SC 45A standards will be suppressed.

NUCLEAR POWER PLANTS – CONTROL ROOMS – DESIGN

1 Scope

This document establishes requirements for the human-machine interface in the main control rooms of nuclear power plants. The document also establishes requirements for the selection of functions, design consideration and organization of the human-machine interface and procedures which are 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 plant operational states and accident conditions (including design basis and design extension conditions), as defined in IAEA SSR-2/1 and IAEA NP-T-3.16. This document 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 document.

The primary purpose of this document 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 document 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 document is intended for application to new control rooms whose conceptual design is initiated after the publication of this document. 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 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 60671, *Nuclear power plants – Instrumentation and control systems important to safety – Surveillance testing*

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

IEC/IEEE 60780-323, *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 room 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 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 (VDUs)*

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

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

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

IEC 62645, *Nuclear power plants – Instrumentation and control systems – Requirements for security programmes for computer-based systems*

IEC 62646, *Nuclear power plants – Control rooms – Computer based procedures*

IEC 62859, *Nuclear power plants – Instrumentation and control systems – Requirements for coordinating safety and cybersecurity*

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

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*

IAEA NP-T-3.16, *Accident Monitoring Systems for Nuclear Power Plants*

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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CENTRALES NUCLÉAIRES DE PUISSANCE – SALLES DE COMMANDE – CONCEPTION

AVANT-PROPOS

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La Norme internationale IEC 60964 a été établie par le sous-comité 45A: Systèmes d'instrumentation, de contrôle-commande et d'alimentation électrique des installations nucléaires, du comité d'études 45 de l'IEC: Instrumentation nucléaire.

Cette troisième édition annule et remplace la deuxième édition publiée en 2009. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) l'utilisation du terme «tâche» en garantissant la cohérence entre l'IEC 60964 et l'IEC 61839;
b) la clarification du rôle, des capacités fonctionnelles, de robustesse et d'intégrité des services support pour la salle de commande principale pour garantir sa continuité d'utilisation au moment de la survenance d'accident grave ou de risques externes extrêmes;

c) la revue de la pertinence de cette norme par rapport aux guides de sûreté de l'AIEA et aux normes de l'IEC SC 45A qui ont été publiés depuis le développement de l'IEC 60964:2009;

d) la clarification du sens et du rôle de «l'analyse des tâches»;

e) la définition des relations avec les normes dérivées (par exemple l'IEC 61227, l'IEC 61771, l'IEC 61772, l'IEC 61839, l'IEC 62241 et les autres normes pertinentes pour la conception des salles de commande);

f) l'alignement par rapport aux principes d'ergonomie, en particulier ceux du Guide de Sûreté de l'AIEA sur les facteurs humains qui doit être publié prochainement.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
45A/1214/FDIS	45A/1224/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

INTRODUCTION

a) Contexte technique, questions importantes et structure de cette norme

L'IEC 60964 publiée en 1989 avait été développée pour fournir des exigences applicables à la conception des salles de commande principales des centrales nucléaire et elle a été révisée en 2009. Les deux premières éditions ont été largement utilisées par l'industrie nucléaire. Il a été reconnu qu'il était nécessaire de développer un amendement pour l'édition de 2009 pour couvrir les points suivants:

- utilisation du terme «tâche» en garantissant la cohérence entre l'IEC 60964 et l'IEC 61839;
- clarification du rôle, des capacités fonctionnelles, de robustesse et d'intégrité des services support pour la salle de commande principale pour garantir sa continuité d'utilisation au moment de la survenance d'accident grave ou de risques externes extrêmes;
- revue de la pertinence de cette norme par rapport aux guides de sûreté de l'AIEA et des normes de l'IEC SC 45A qui ont été publiés depuis le développement de l'IEC 60964:2009.

Considérant la taille de la proposition d'amendement, il a été décidé de publier une nouvelle édition de l'IEC 60964 à la place de l'amendement. Durant la préparation de cette troisième édition il a été décidé de couvrir les points suivants:

- clarifier le sens et le rôle de «l'analyse des tâches»;
- clarifier et définir les relations avec les normes dérivées (par exemple l'IEC 61227, l'IEC 61771, l'IEC 61772, l'IEC 61839, l'IEC 62241 et les autres normes pertinentes pour la conception des salles de commande);
- considérer son alignement par rapport aux principes d'ergonomie, en particulier ceux du Guide de Sûreté de l'AIEA sur les facteurs humains qui doit être publié prochainement.

Cette norme IEC s'intéresse plus particulièrement à la conception fonctionnelle des salles de commande principales des centrales nucléaires. Cette norme a été développée pour être utilisée par les vendeurs de centrales nucléaires, les exploitants et par les régulateurs.

b) Position de la présente norme dans la collection de normes du SC 45A de l'IEC

L'IEC 60964 est le document du SC 45A de l'IEC de deuxième niveau qui traite des questions générales liées à la conception des salles de commande.

L'IEC 60964 doit être lue avec les normes dérivées citées ci-dessus qui sont les documents pertinents fournissant les recommandations relatives aux commandes opérateurs, à la vérification et à la validation de la conception, à l'utilisation des unités d'affichage, à l'analyse fonctionnelle et l'affectation des fonctions et aux fonctions et présentation des alarmes.

Pour plus de détails sur la collection de normes du SC 45A de l'IEC, voir le point d) de cette introduction.

c) Recommandations et limites relatives à l'application de cette norme

Cette norme a été développée pour être appliquée aux nouvelles salles de commande dont la conception débute après la publication de celle-ci. Les recommandations fournies par la norme peuvent être utilisées pour les rénovations, les mises à niveau et les modifications.

L'objectif principal de la norme est de fournir des exigences de conception fonctionnelles qui puissent être utilisées pour la conception des salles de commande principales des centrales nucléaires pour satisfaire aux exigences de sûreté et d'exploitation.

Cette norme fournit aussi des exigences d'interface fonctionnelle liées au personnel de la salle de commande, aux procédures d'exploitation et au programme de formation qui sont avec l'interface homme-machine des composants du système de la salle de commande.

Afin de garantir la pertinence de cette norme pour les prochaines années, l'accent a été mis sur les questions de principes plutôt que sur les questions particulières liées à la technologie.

d) Description de la structure de la collection des normes du SC 45A de l'IEC et relations avec d'autres documents de l'IEC, et d'autres organisations (AIEA, ISO)

Les documents de niveau supérieur de la collection de normes produites par le SC 45A de l'IEC sont les normes IEC 61513 et IEC 63046. La norme IEC 61513 traite des exigences générales relatives aux systèmes et équipements d'instrumentation et de contrôle-commande (systèmes d'I&C) utilisés pour accomplir les fonctions importantes pour la sûreté des centrales nucléaires. La norme 63046 traite des exigences générales relatives aux systèmes d'alimentation électrique; elle couvre les systèmes d'alimentation électrique jusqu'à et y compris les alimentations des systèmes d'I&C. Les normes IEC 61513 et IEC 63046 doivent être considérées ensemble et au même niveau. Les normes IEC 61513 et IEC 63046 structurent la collection de normes du SC 45A de l'IEC et forment un cadre complet, cohérent et consistant établissant les exigences générales relatives aux systèmes d'I&C et électriques des centrales nucléaires de puissance.

Les normes IEC 61513 et IEC 63046 font directement référence aux autres normes du SC 45A de l'IEC traitant de sujets génériques, tels que la catégorisation des fonctions et le classement des systèmes, la qualification, la séparation des systèmes, la défense contre les défaillances de cause commune, la conception des salles de commande, compatibilité électromagnétique, la cybersécurité, les aspects logiciels et matériels relatifs aux systèmes numériques programmables, la coordination des exigences de sûreté et de sécurité et la gestion du vieillissement. Il convient de considérer que ces normes, de second niveau, forment, avec les normes IEC 61513 et IEC 63046, un ensemble documentaire cohérent.

Au troisième niveau, les normes du SC 45A de l'IEC, qui ne sont généralement pas référencées directement par les normes IEC 61513 ou IEC 63046, sont relatives à des matériels particuliers, à des méthodes ou à des activités spécifiques. Généralement ces documents, qui font référence aux documents de deuxième niveau pour les activités génériques, peuvent être utilisés de façon isolée.

Un quatrième niveau qui est une extension de la collection de normes du SC 45A de l'IEC correspond aux rapports techniques qui ne sont pas des documents normatifs.

Les normes de la collection produite par le SC 45A de l'IEC sont élaborées de façon à être en accord avec les principes de sûreté et de sécurité de haut niveau établis par les normes de sûreté de l'AIEA pertinentes pour les centrales nucléaires, ainsi qu'avec les documents pertinents de la collection de l'AIEA pour la sécurité nucléaire (NSS), en particulier avec le document d'exigences SSR-2/1 qui établit les exigences de sûreté relatives à la conception des centrales nucléaires, avec le guide de sûreté SSG-30 qui traite du classement de sûreté des structures, systèmes et composants des centrales nucléaires , avec le guide de sûreté SSG-39 qui traite de la conception de l'instrumentation et du contrôle commande des centrales nucléaires, avec le guide de sûreté SSG-34 qui traite de la conception des systèmes d'alimentation électrique des centrales nucléaires, et avec le guide de mise en œuvre NSS17 traitant de la sécurité informatique pour les installations nucléaires. La terminologie et les définitions utilisées pour la sûreté et la sécurité dans les normes produites par le SC 45A sont conformes à celles utilisées par l'AIEA.

Les normes IEC 61513 et IEC 63046 ont adopté une présentation similaire à celle de l'IEC 61508, avec un cycle de vie d'ensemble et un cycle de vie des systèmes. Au niveau sûreté nucléaire, les normes IEC 61513 et IEC 63046 sont l'interprétation des exigences générales de l'IEC 61508-1, de l'IEC 61508-2 et de l'IEC 61508-4 pour le secteur nucléaire. Dans ce domaine, l'IEC 60880, l'IEC 62138 et l'IEC 62566 correspondent à l'IEC 61508-3

pour le secteur nucléaire. Les normes IEC 61513 et IEC 63046 font référence aux normes ISO ainsi qu'aux documents AIEA GS-R partie 2 et AIEA GS-G-3.1 et AIEA GS-G-3.5 pour ce qui concerne l'assurance qualité. Au second niveau, la norme IEC 62645 est le document chapeau du SC 45A de l'IEC portant sur la sécurité nucléaire. Elle est élaborée à partir des principes pertinents de haut niveau des normes ISO/IEC 27001 et ISO/IEC 27002; elle les adapte et les complète pour qu'ils deviennent pertinents pour le secteur nucléaire; elle est coordonnée étroitement avec la norme IEC 62443. Au second niveau, la norme IEC 60964 est le document chapeau des normes du SC 45A de l'IEC portant sur les salles de commande et la norme IEC 62342 est le document chapeau des normes du SC 45A de l'IEC portant sur la gestion du vieillissement.

NOTE 1 Il est fait l'hypothèse que pour la conception des systèmes d'I&C qui sont supports de fonctions de sûreté conventionnelle (par exemple pour garantir la sécurité des travailleurs, la protection des biens, la prévention contre les risques chimiques, la prévention contre les risques liés au procédé énergétique) on applique des normes nationales ou internationales.

NOTE 2 Le domaine du SC 45A de l'IEC a été étendu en 2013 pour couvrir les systèmes électriques. En 2014 et en 2015 des discussions ont eu lieu au sein du SC 45A de l'IEC pour décider de la façon et de l'endroit pour établir les exigences générales portant sur la conception des systèmes électriques. Les experts du SC 45A de l'IEC ont recommandé que pour établir des exigences générales pour les systèmes électriques une norme indépendante soit développée au même niveau que l'IEC 61513. Le projet IEC 63046 est lancé pour atteindre cet objectif. Lorsque la norme IEC 63046 sera publiée la présente NOTE 2 de l'introduction sera supprimée.

CENTRALES NUCLÉAIRES DE PUISSANCE – SALLES DE COMMANDE – CONCEPTION

1 Domaine d'application

Le présent document établit des exigences en matière d'interface homme-machine pour la salle de commande principale des centrales nucléaires de puissance. Il établit aussi les exigences en matière de choix fonctionnels, de conception et d'organisation de l'interface homme-machine, ainsi que les procédures utilisées pour vérifier et valider systématiquement la conception fonctionnelle. Ces exigences reflètent les principes d'ergonomie tels qu'ils s'appliquent à une interface homme-machine pour les états opérationnels de la tranche et les conditions accidentelles (y compris les conditions de dimensionnement et les conditions hors dimensionnement), tels que définis par l'AIEA SSR-2/1 et l'AIEA NP-T-3.16. Ce document ne couvre pas les systèmes de commande spécifiques ou isolés tels que ceux prévus pour les opérations d'arrêt de l'extérieur de la salle de commande, pour les installations de situations de crise, pour les installations de traitement des effluents radioactifs. La conception détaillée des matériels ne fait pas partie du domaine d'application de ce document.

Le but premier du présent document est d'établir des exigences fonctionnelles pour la conception des salles de commande des centrales nucléaires de puissance afin de respecter les exigences de conduite et de sûreté. Ce document présente aussi les exigences d'interface fonctionnelles en rapport avec la structure de l'équipe de salle de commande, les procédures de conduite et le programme de formation qui sont en association avec l'interface homme-machine, les constituants du système de salle de commande.

Ce document s'applique aux salles de commande de conception nouvelle dont la conception débute après sa publication. Si on désire l'appliquer à des salles de commande existantes, une attention spéciale est à porter pour maintenir la cohérence de la base de conception.

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60671, *Centrales nucléaires de puissance – Systèmes d'instrumentation et de contrôle-commande importants pour la sûreté – Essais de surveillance*

IEC 60709, *Centrales nucléaires de puissance – Systèmes d'instrumentation, de contrôle-commande et électriques importants pour la sûreté – Séparation*

IEC/IEEE 60780-323, *Installations nucléaires– Equipements électriques importants pour la sûreté – Qualification*

IEC 60960, *Critères fonctionnels de conception pour un système de visualisation des paramètres de sûreté pour les centrales nucléaires*

IEC 60965, *Centrales nucléaires de puissance – Salles de commande – Salle de commande supplémentaire pour l'arrêt des réacteurs sans accès à la salle de commande principale*

IEC 60980, *Pratiques recommandées pour la qualification sismique du matériel électrique du système de sûreté dans les centrales électronucléaires*

IEC 61225, *Centrales nucléaires de puissance – Systèmes d'instrumentation et de contrôle-commande importants pour la sûreté – Exigences pour les alimentations électriques*

IEC 61226, *Centrales nucléaires de puissance – Systèmes d'instrumentation et de contrôle-commande importants pour la sûreté – Classement des fonctions d'instrumentation et de contrôle-commande*

IEC 61227, *Centrales nucléaires de puissance – Salles de commande – Commandes opérateurs*

IEC 61513, *Centrales nucléaires de puissance – Instrumentation et contrôle-commande importants pour la sûreté – Exigences générales pour les systèmes*

IEC 61771, *Centrales nucléaires de puissance – Salle de commande principale – Vérification et validation de la conception*

IEC 61772, *Centrales nucléaires de puissance – Salles de commande – Utilisation des unités de visualisation*

IEC 61839, *Centrales nucléaires de puissance – Conception des salles de commande – Analyse fonctionnelle et affectation des fonctions*

IEC 62003, *Centrales nucléaires de puissance – Instrumentation et contrôle-commande importants pour la sûreté – Exigences relatives aux essais de compatibilité électromagnétique*

IEC 62241, *Centrales nucléaires de puissance – Salle de commande principale – Fonctions et présentation des alarmes*

IEC 62645, *Centrales nucléaires de puissance – Systèmes d'instrumentation et de contrôle-commande – Exigences relatives aux programmes de sécurité applicable aux systèmes programmés*

IEC 62646, *Centrales nucléaires de puissance – Salles de commande – Procédures informatisées*

IEC 62859, *Centrales nucléaires de puissance – Systèmes d'instrumentation et de contrôle-commande – Exigences pour coordonner sûreté et cybersécurité*

ISO 11064 (toutes les parties), *Conception ergonomique des centres de commande*

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*

IAEA NP-T-3.16, *Accident Monitoring Systems for Nuclear Power Plants*