SVENSK STANDARD SS-EN IEC 62646

Fastställd	Utgåva	Sida	Ansvarig kommitté
2020-04-15	1	1 (1+47)	SEK TK 45

Kärnkraftanläggningar – Kontrollrum – Datorbaserade instruktioner

Nuclear power plants – Control rooms – Computer-based procedures

Som svensk standard gäller europastandarden EN IEC 62646:2019. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 62646:2019.

Nationellt förord

Europastandarden EN IEC 62646:2019

består av:

– **europastandardens ikraftsättningsdokument,** utarbetat inom CENELEC
– **IEC 62646, Second edition, 2016 - Nuclear power plants - Control rooms - Computer-based procedures**

utarbetad inom International Electrotechnical Commission, IEC.

Standarden ska användas tillsammans med SS-EN 60964, utgåva 1, 2012 och SS-EN 61839, utgåva 1, 2015.

ICS 27.120.20

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 62646

June 2019

ICS 27.120.20

English Version

Nuclear power plants - Control rooms - Computer-based procedures (IEC 62646:2016)

Centrales nucléaires de puissance - Salles de commande - Procédures informatisées (IEC 62646:2016)

Kernkraftwerke - Warten - Rechnerunterstützte Prozeduren (IEC 62646:2016)

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN IEC 62646:2019 E

SEK Svensk Elstandard SS-EN IEC 62646, utg 1:2020

European foreword

This document (EN IEC 62646:2019) consists of the text of IEC 62646:2016 prepared by IEC/SC 45A: "Instrumentation, control and electrical power systems of nuclear facilities", of IEC/TC 45: "Nuclear instrumentation".

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2020-06-17
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2022-06-17

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 and/or security measures in the subject-matter covered by this standard.

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

Endorsement notice

The text of the International Standard IEC 62646:2016 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 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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60880	-	Nuclear power plants - Instrumentation and control systems important to safety - Software aspects for computer-based systems performing category A functions	EN 60880	-
IEC 60964	2009	Nuclear power plants - Control rooms - Design	EN 60964	2010
IEC 60965	2016	Nuclear power plants - Control rooms - Supplementary control room for reactor shutdown without access to the main control room	EN 60965	2016
IEC 61513	-	Nuclear power plants - Instrumentation and control important to safety - General requirements for systems	EN 61513	-
IEC 61772	2009	Nuclear power plants - Control rooms - Application of visual display units (VDUs)	EN 61772	2013
IEC 61839	-	Nuclear power plants - Design of control rooms - Functional analysis and assignment	EN 61839	-
IEC 62138	-	Nuclear power plants - Instrumentation and control systems important to safety - Software aspects for computer-based systems performing category B or C functions	EN 62138	-
IEC 62241	2004	Nuclear power plants - Main control room - Alarm functions and presentation	EN 62241	2015
ISO 11064	series	Ergonomic design of control centres	EN ISO 11064	series
ISO 11064-1	-	Ergonomic design of control centres - Part 1: Principles for the design of control centres	EN ISO 11064-1	-
ISO 11064-3	-	Ergonomic design of control centres - Part 3: Control room layout	EN ISO 11064-3	-
ISO 11064-4	-	Ergonomic design of control centres - Part 4: Layout and dimensions of workstations	EN ISO 11064-4	-
ISO 11064-5	-	Ergonomic design of control centres - Part 5: Displays and controls	EN ISO 11064-5	-

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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NUCLEAR POWER PLANTS – CONTROL ROOMS – COMPUTER-BASED PROCEDURES

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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International Standard IEC 62646 has been prepared by subcommittee 45A: Instrumentation, control and electrical systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

This second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

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

a) clarification of the way in which the standard is to be used in conjunction with related standards (in 1.4);
b) replacement, when necessary, of HMI system by DPDS (abbreviation added in Clause 4);
c) new titles for 5.2.2 and 5.2.3 to more closely represent their content;
d) text improvement in 5.2.2, to present the CBP system as a part of the I&C architecture rather than a stand alone system;
e) text improvement in 5.2.3 and 7.2 to clarify links between safety and CBP;

f) new definition of CPB families in 5.3;
g) addition of generic recommendations for computerization in 5.4.2;
h) addition of generic recommendations for CBP guidance in 5.4.3;
i) improvements regarding use of CBP in 5.4.4;
j) addition of 5.6, named “Design extension conditions”;
k) addition of reference standards in 6.2.1;
l) addition of a criterion related to detail compatibility between CBP and operating formats in 6.2.2;
m) addition of references related to HMI in 6.2.3;
n) addition of 7.3 to deal with HMI aspects;
o) text improvement regarding integration of the CBP system into the DPDS in 7.3;
p) text improvement regarding implementation of the CBP into a system independent of the DPDS in 7.4;
q) text improvement regarding the CBP system failure in 7.6;
r) note added to detail the different types of feedbacks in 8.5.4;
s) text improvement to detail interactions between operators and procedure based automation in 8.6.2;
t) text improvement regarding design of CBP to control the plant in 8.6.3;
u) clarification of the content of the V&V programme for CBP in 9.5;
v) clarification regarding CBP programming in 9.4;
w) inversion of subclauses 9.4 and 9.5;
x) clarification of the content and requirements of the V&V in 9.6;
y) change of title of 9.7.

The text of this standard is based on the following documents:

FDIS	Report on voting
45A/1098/FDIS	45A/1110/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 62646 is to be read in conjunction with IEC 60964:2009 and IEC 61839:2000.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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 document using a colour printer.

INTRODUCTION

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

This IEC standard focuses on computerisation of procedures used by the operating staff. Procedures have always contributed to a large extent to nuclear power plant (NPP) safety and availability and, now, the use of computer technology to provide enhanced guidance to the plant operators is increasing and becoming current practice. This standard also provides guidance for the decision of the extent to which the procedures should be computerised.

It is intended that the standard be used by nuclear power plant designers, utilities operating staff, systems evaluators and by regulatory inspectors.

In June 2013 during the IEC SC 45A meeting held in Moscow, the decision was made to revise IEC 62646 with the lessons learned from the Tokyo Electric Power Company (TEPCO) Fukushima Daiichi accident and the late comments from the national committee of Canada. The resulting improvements are listed in the Foreword of the Standard.

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

IEC 62646 is the third level IEC SC 45A document tackling the generic issue of computerised procedures.

As indicated in the Foreword, IEC 62646 is to be read with IEC 60964 and IEC 61839. IEC 60964 – supported by IEC 61227, IEC 61771 and IEC 61772 – is the appropriate IEC SC 45A document providing guidance on operator controls, verification and validation of design, application of visual display units in the control room, whereas IEC 61839 establishes functional analysis and assignment guidance for allocating functions between operators and systems.

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

c) Recommendations and limitations regarding the application of the standard

It is important to note that this standard establishes no additional functional requirements for safety systems.

This standard deals with technical requirements and human factor engineering related to computer-based procedures (CBP). However it does not provide detailed guidance on ergonomic design of control centres as it is treated in the ISO 11064 series of standards, nor on task allocation between humans and systems dealt with in IEC 61839 and on cyber security, which is developed in IEC 62645. It also excludes the organisation for maintenance of procedures.

Aspects for which requirements and recommendations have been provided in this standard are:

- the establishment of a policy for computerisation of procedures, especially which types of procedure should be computerised and to what extent. The different families of CBP to be aimed at, with their associated features, are then defined. Finally, the safety aspects of CBP are considered,
- the use of CBP inside and outside of the MCR (main control room), in possible conjunction with paper-based procedures, as well as the assistance provided to operator activities, including user coordination,
- safety and non safety design requirements for the digital system processing CBP, and considerations about what to do in case of failure of this system,

- detailed requirements and recommendations related to the functional features of CBP, from the basic ones to the most sophisticated ones, i.e. information, navigation, guidance and plant control,
- the CBP life cycle, from the set-up of the project to the CBP maintenance and the operator training via design and implementation.

To ensure that the standard will continue to be relevant in 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 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 NPP. IEC 63046 provides general requirements for electrical power systems of NPP; 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 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 (NPP), the IAEA safety guide SSG-30 dealing with the safety classification of structures, systems and components in NPP, the IAEA safety guide SSG-39 dealing with the design of instrumentation and control systems for NPP, the IAEA safety guide SSG-34 dealing with the design of electrical power systems for NPP 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-3 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 27002; it adapts them and completes them to fit the nuclear context and coordinates with the IEC 62443 series. At level

2, regarding control rooms, IEC 60964 is the entry document for the IEC SC 45A control rooms standards and IEC 62342 is the entry document for the IEC SC 45A ageing management standards.

NOTE 1 It is assumed that for the design of I&C systems in NPP 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's 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 requirement 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 will be published this NOTE 2 of the introduction of IEC SC 45A standards will be suppressed.

NUCLEAR POWER PLANTS – CONTROL ROOMS – COMPUTER-BASED PROCEDURES

1 Scope

1.1 Object of this standard

This standard establishes requirements for the whole life cycle of operating procedures that the designer wishes to computerise. It also provides guidance for making decisions about which types of procedures should be computerised and to what extent. Once computerised, procedures are designated as "computer-based procedures" (CBP).

1.2 Context leading to development and use of CPB

Enhancing safety, easing operation and increasing NPP availability have always been greatly valued aims which, during NPP operation, rely to a large extent on the operating staff and on operating procedures. Digital technology contributes not only by providing efficient ways of automating key functions but also enhances instrumentation, control and the plant's HMI.

In addition, the use of computer technology to provide formats of operating procedures to the plant operators[1], on-line and in real time, is increasing and becoming current practice. This can be done both for normal operating situations and also as advisory formats for use in abnormal situations. When properly implemented and kept up-to-date, such operating procedures can provide enhanced support for greater safety and operator effectiveness compared to paper-based procedures. Their preparation demands great care and close interaction with operators and plant designers, and will also need close co-operation with I&C designers.

CBP have many common points with paper-based procedures. This standard focuses only on what is specific to CBP.

1.3 CBP overview

Procedures provide the operators with two types of high level elements:

- information, i.e. explanations or data displayed in order to enable the operator to control the process, assess the plant situation, understand operating strategies and make appropriate decisions,
- guidance, i.e. a set of ordered steps that prompt and help the operator to monitor and control the plant processes, systems and equipment.

Information and guidance are combined to minimise operator errors and to optimise the efficiency of plant operation.

Information and guidance can be of a varying level of detail depending on the procedure policy, which aims to benefit from operator experience and existing guidelines.

Computerisation of procedures can provide, according to the specified design policy:

– enhanced process and plant equipment information,

– enhanced operator guidance,

[1] Operators may be male or female, so that in this standard, "he" is a shortcut for "he / she" and "his" is a shortcut for "his / her".

– additional functions to initiate and control automation sequences.

This standard provides guidance on and an overview of policy, philosophy and conceptual requirements for CBP implementation, including design objectives, assumptions, approaches, inputs, scope, CBP family types, key CBP features, and output documentation.

1.4 Use of this standard with related standards

This standard intends to deal with aspects that are:

- specific to computer-based procedures, i.e. that are not common with paper-based procedures. For example, establishing functional scenarios to validate procedures is not specific to CBP,
- not already dealt with in existing standards, i.e. HFE, life cycle of safety classified systems, allocation of tasks to human or machines.

In order to design CBP efficiently and properly, some important considerations at the conceptual design stage of CBPs are addressed in the following related standards:

a) functional analysis and assignment

   IEC 61839 specifies functional analysis and assignment procedures and gives rules for developing criteria for the assignment of functions either to operators or to systems,

b) human factors design guidelines

   IEC 61772:2009, especially Clauses 4 and 5, provides guidance on physical implementation of VDUs (see 4.1), display formats (see 4.4), and implementation into the MCR (see Clause 5). The ISO 11064 series of standards provides guidance on human-centered design activities throughout the life cycle of a computer-based interactive system.

In addition, IEC 60964 and IEC 60965, which provide requirements and recommendations for the main control room and supplementary control room arrangements, and IEC 61772, providing requirements and recommendations for implementing VDUs in control rooms, apply to the implementation of CBP in new nuclear power plants. Complementary advice for implementing CBP in case of main control room retrofitting is given in 6.2.3.

This standard assumes the simultaneous consideration of the requirements for:

1) computer security, which is necessary to protect the whole life cycle of CBP, but is not restricted to computerisation of procedures. Nevertheless, this topic should be considered when computerising operating means (IEC 62645 deals with cyber-security),
2) requirements on the implementation for CBP functions of software and hardware of computer systems for CBP which should be implemented in line with their safety class in compliance with IEC 60880, IEC 61226, IEC 62138 and IEC 61513,
3) the design of plant scenarios (including anticipated operating occurrences such as plant transients, plant upset conditions and/or initiating events) for validating CBPs,
4) the organisation for functional maintenance of procedures.

1.5 Organisation of this standard

Clause 2 lists the reference documents.

Clause 3 gives definitions relevant to this standard.

Clause 4 lists the abbreviations used in this standard.

Clause 5 provides an overview of CBP. It presents recommendations for the development of a policy for computerisation of procedures, based on the type of procedure to be implemented. Three generic types (termed “families”) are described, for which general and specific

guidance is provided. Guidance related to the safety requirements of CBP systems is also provided.

Clause 6 gives requirements for use in different contexts, including main control room (MCR) upgrading, and different environments, inside and outside of the MCR and possibly in conjunction with paper-based procedures. It then considers assistance to and coordination of operator activities.

Clause 7 deals with the digital system which processes CBP. It first considers safety and non safety requirements, then gives requirements for handling failures of this system.

Clause 8 focuses on the detailed requirements and recommendations related to the functional features of CBP, from the basic ones to the most sophisticated ones, i.e. information, navigation, guidance and plant control. Miscellaneous options that could ease CBP use are also given.

Clause 9 considers the CBP life cycle, from the set-up of the project to the CBP maintenance and the operator training via design and implementation.

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.

NOTE The output documentation requested by these normative standards that is related to CBP is not addressed in this standard.

IEC 60880, *Nuclear power plants – Instrumentation and control systems important to safety – Software aspects for computer-based systems performing category A functions*

IEC 60964:2009, *Nuclear power plants – Control rooms – Design*

IEC 60965:2016, *Nuclear power plants – Control rooms – Supplementary control room for reactor shutdown without access to the main control room*

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

IEC 61772:2009, *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 62138, *Nuclear power plants – Instrumentation and control important for safety – Software aspects for computer-based systems performing category B or C functions*

IEC 62241:2004, *Nuclear power plants – Main control room – Alarm functions and presentation*

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

ISO 11064-1, *Ergonomic design of control centres – Part 1:Principles for the design of control centres*

ISO 11064-3, *Ergonomic design of control centres – Part 3: Control room layout*

ISO 11064-4, *Ergonomic design of control centres – Part 4: Layout and dimensions of workstations*

ISO 11064-5, *Ergonomic design of control centres – Part 5: Displays and controls*