

INTERNATIONAL STANDARD

REDLINE VERSION

**Nuclear power plants - Instrumentation, control and electrical power systems -
Requirements for static uninterruptible DC and AC power supply systems**

*iteh Standards
(<https://standards.iteh.ai>)
Document Preview*

IEC 61225:2025

<https://standards.iteh.ai/catalog/standards/iec/ffe1f9c6-cf6e-4119-ba07-eb8b52716f8c/iec-61225-2025>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2025 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search -

webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC 61225:2025

<https://standards.iteh.ai/catalog/standards/iec/ffe1f9c6-cf6e-4119-ba07-eb8b52716f8c/iec-61225-2025>

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	3
INTRODUCTION	1
1 Scope	8
2 Normative references	8
3 Terms and definitions	9
4 Abbreviated terms	11
5 System requirements	12
5.1 General	12
5.2 Function and description	12
5.2.1 Preamble	12
5.2.2 Designations	15
5.2.3 Direct current systems	15
5.2.4 Alternating current systems	15
5.3 System divisions	16
5.4 System boundaries	16
6 Functional requirements for static uninterruptible power supplies	17
6.1 Static uninterruptible power supplies for systems important to safety	17
6.2 Batteries and battery chargers	17
6.3 Inverters and bypass switches	19
6.4 UPS	20
6.5 Converters used for voltage stabilization	20
6.6 I&C power supply using DC/DC converters and AC/DC converters	20
7 Requirements for distribution systems	21
7.1 System aspects	21
7.2 Load allocation	21
7.3 Electrical aspects	23
7.4 Earthing	24
8 Effects of loads on supply quality	24
8.1 General	24
8.2 Electromagnetic interference	24
8.3 Transients	25
8.4 Load current	25
8.5 Power supplies to loads of lower safety classification	25
9 Monitoring and protection	26
9.1 General	26
9.2 Monitoring	26
9.3 Electrical protection	27
10 Qualification of equipment	27
11 Design to cope with ageing	27
12 Testing	28
13 Maintenance	28
Annex A (informative) Examples of voltage input variations	30
Annex B (informative) Examples of specifications	32
B.1 Example 1: Specification for a DC power supply for equipment requiring a non-interruptible supply	32

B.2	Example 2: Specification for AC power supply for equipment requiring a non-interruptible supply	33
B.3	Example 3: Specification for DC power supply with DC/DC converter for equipment	34
B.4	Human factor engineering programme	35
Annex C (normative) Uninterruptible power supplies and distribution systems for power plants with passive design and SMRs		36
C.1	General	36
C.2	Recommendations and requirements	37
C.3	Safety assessment	37
Bibliography		38
Figure 1 – Boundary of a SUPS		14
Figure 2 – Example of one division of a SUPS system		22
Figure 3 – Example of I&C uninterruptible AC power supply system		23
Figure A.1 – Example of voltage variations on the on-site AC power system during clearing of a transmission system fault		30
Figure A.2 – Example of on-site voltage profile after loss of load (transfer to house load operation)		30
Figure A.3 – Example of simulated safety bus voltages, double open phase condition in the 400 kV line to the unit transformer		31
Table B.1 – Example 1: Specification for a DC power supply for equipment requiring a non-interruptible supply		32
Table B.2 – Example 2: Specification for AC power supply for equipment requiring a non-interruptible supply		33
Table B.3 – Example 3: Specification for DC power supply with DC/DC converter for equipment		34
Table C.1 – Features of electrical power systems that support the different levels of defence in depth as stated in IAEA Safety Standard Series SSR-2/1 (Rev. 1)		36

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Nuclear power plants - instrumentation, control and electrical power systems - requirements for static uninterruptible dc and ac power supply systems

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61225:2019. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 61225 has been prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2019. This edition constitutes a technical revision.

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

- a) expansion and clarification of the requirements for static uninterruptible DC and AC power supply systems to ease the application in SMRs and passive designs.

This International Standard is to be used in conjunction with IEC 61513:2011, IEC 60709:2018, IEC 60880:2006, IEC 62138:2018, IEC 62855:2016 and IEC 63046:2020.

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

Draft	Report on voting
45A/1591/FDIS	45A/1610/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

The 1993 issue of IEC 61225 was developed for specifying the requirements relevant to the design of electrical supplies for I&C systems in nuclear power plants. Considering the experience gathered worldwide on this subject, in 2003 working group A2 recommended a revision to this document ~~so that~~ to allow a new revision, IEC 61225 Ed. 2 (2005), ~~could~~ to be consistently integrated into the SC 45A standard series. In 2015, working group A11 recommended a revision to this document following the publication of the revision of IAEA SSG-34 and that the scope of the standard should cover static uninterruptible power supplies for all types of connected equipment. In 2022, working group A11 recommended a revision to this document to ease the application to SMRs and passive designs.

International operating experience with electrical supply systems in nuclear power plants has highlighted a number of supply voltage variations and malfunctions, such as:

- voltage perturbations due to disturbances on the internal AC distribution system (with origin off-site or on-site).
- voltage overshoot on loss of grid.
- open phase conditions (one or two phases).
- asymmetrical faults.

These types of perturbations can degrade the performance of static uninterruptible power supplies and ultimately result in failure of connected equipment.

One of the objectives of the uninterruptible power supplies is to protect connected equipment from voltage variations on the on-site AC interruptible distribution system (the immunity concept). The power supplies ~~shall~~ also guarantee an output voltage with specified magnitude and waveform (in case of AC) to connected loads. The power supplies ~~shall~~ have the capacity to supply the relevant loads during a specified time regardless of any voltage variations on the on-site AC interruptible distribution system.

Examples of voltage and frequency variations in the incoming feeder to the supplies can be found in informative Annex A. Examples of specifications for static uninterruptible power supplies can be found in informative Annex B. Requirements for SMRs and passive designs are given in Annex C.

This document is applicable to the design of static uninterruptible electrical power supplies in new nuclear power plants (including SMRs and passive designs) when design work is initiated after the publication of this document and in general for nuclear facilities. It also serves as a reference for upgrading and modernizing existing nuclear power plants and facilities.

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

IEC 61225 is a second level document specifically addressing the particular topic of requirements for electrical supplies.

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

c) Recommendations and limitations regarding the application of this document

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

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.