
Jedrski objekti - Oprema, pomembna za varnost - Seizmična (potresna) kvalifikacija (IEC/IEEE 60980-344:2020)

Nuclear facilities - Equipment important to safety - Seismic qualification (IEC/IEEE 60980-344:2020)

Kerntechnische Anlagen - Gerät mit sicherheitstechnischer Bedeutung - Seismische Qualifizierung (IEC/IEEE 60980-344:2020)

Installations nucléaires - Equipements importants pour la sûreté - Qualification sismique (IEC/IEEE 60980-344:2020)

[SIST EN IEC/IEEE 60980-344:2021](https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9e1662ead6e8/sist-en-iec-ieee-60980-344-2021)

[https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-](https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9e1662ead6e8/sist-en-iec-ieee-60980-344-2021)

[927e-9e1662ead6e8/sist-en-iec-ieee-60980-344-2021](https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9e1662ead6e8/sist-en-iec-ieee-60980-344-2021)

Ta slovenski standard je istoveten z: EN IEC/IEEE 60980-344:2021

ICS:

27.120.20	Jedrské elektrarne. Varnost	Nuclear power plants. Safety
91.120.25	Zaščita pred potresi in vibracijami	Seismic and vibration protection

SIST EN IEC/IEEE 60980-344:2021 **en**

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN IEC/IEEE 60980-344:2021

<https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9c1662cad6e8/sist-en-iec-ieee-60980-344-2021>

EUROPEAN STANDARD

EN IEC/IEEE 60980-344

NORME EUROPÉENNE

EUROPÄISCHE NORM

April 2021

ICS 27.120.10; 27.120.20

English Version

Nuclear facilities - Equipment important to safety - Seismic qualification (IEC/IEEE 60980-344:2020)

Installations nucléaires - Equipements importants pour la sûreté - Qualification sismique
(IEC/IEEE 60980-344:2020)

Kerntechnische Anlagen - Gerät mit sicherheitstechnischer Bedeutung - Seismische Qualifizierung
(IEC/IEEE 60980-344:2020)

This European Standard was approved by CENELEC on 2021-04-19. 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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



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

EN IEC/IEEE 60980-344:2021 (E)**European foreword**

The text of document 45A/1323/FDIS, future edition 1 of IEC/IEEE 60980-344, prepared by SC 45A "Instrumentation, control and electrical power systems of nuclear facilities" of IEC/TC 45 "Nuclear instrumentation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC/IEEE 60980-344:2021.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2022-01-19 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2024-04-19 document have to be withdrawn

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.

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.

(Endorsement notice)

The text of the International Standard IEC/IEEE 60980-344:2021 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60068-3-3	NOTE	Harmonized as EN IEC 60068-3-3
IEC 60068-2-81	NOTE	Harmonized as EN 60068-2-81
IEC 60068-2-47	NOTE	Harmonized as EN 60068-2-47
IEC 60068-2-57	NOTE	Harmonized as EN 60068-2-57

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 Where 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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60068-2-6	-	Environmental testing - Part 2-6: Tests Test Fc: Vibration (sinusoidal)	-EN 60068-2-6	-
IEC/IEEE 60780-323	-	Nuclear facilities - Electrical equipment important to safety - Qualification	EN 60780-323	-

ITeH STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN IEC/IEEE 60980-344:2021](https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9c1662cad6e8/sist-en-iec-ieee-60980-344-2021)

<https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9c1662cad6e8/sist-en-iec-ieee-60980-344-2021>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN IEC/IEEE 60980-344:2021

<https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9c1662cad6e8/sist-en-iec-ieee-60980-344-2021>



IEEE

IEC/IEEE 60980-344

Edition 1.0 2020-10

INTERNATIONAL STANDARD

**Nuclear facilities – Equipment important to safety – Seismic qualification
(standards.iteh.ai)**

SIST EN IEC/IEEE 60980-344:2021

<https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9c1662cad6e8/sist-en-iec-ieee-60980-344-2021>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.120.10; 27.120.20

ISBN 978-2-8322-8482-7

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

CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	11
2 Normative references	11
3 Terms and definitions	11
4 Abbreviated terms	19
5 General discussion of earthquake environment and equipment response.....	20
5.1 General.....	20
5.2 Earthquake environment	20
5.3 Equipment on foundations.....	20
5.4 Equipment on structures	20
5.5 Interfaces and adverse interactions.....	21
5.6 Simulating vibration induced by an earthquake	21
5.6.1 General	21
5.6.2 Response spectrum	21
5.6.3 Time history.....	22
5.6.4 PSD function	22
5.7 Damping	22
5.7.1 General	22
5.7.2 Measurement of damping	23
5.8 Application of damping.....	23
5.8.1 General	23
5.8.2 Application of damping in testing	23
5.8.3 Application of damping in analysis	24
6 Seismic qualification requirements.....	24
6.1 General.....	24
6.2 Specification of equipment to be qualified	25
6.3 Specification of ageing condition.....	25
6.4 Specification of seismic requirements	25
6.5 Specification of acceptance criteria.....	25
7 Seismic qualification approach	26
7.1 Safety function.....	26
7.2 Seismic qualification methods	26
8 Ageing.....	27
8.1 General.....	27
8.2 Thermal ageing.....	28
8.3 Radiation ageing.....	28
8.4 Material degradation and corrosion	28
8.5 Mechanical or electrical cycle ageing	28
8.6 Vibration ageing.....	28
8.6.1 General	28
8.6.2 Ageing from non-seismic vibration conditions	29
8.6.3 Hydrodynamic loads	29
8.6.4 Seismic ageing (OBE/S1)	29
9 Testing	29
9.1 General.....	29

9.1.1	Test programme	29
9.1.2	Mounting	31
9.1.3	Monitoring	31
9.1.4	Loading	31
9.1.5	Refurbishment	32
9.1.6	Exploratory tests.....	32
9.1.7	Seismic ageing (OBE/S1)	34
9.2	Proof and generic testing	34
9.3	Fragility testing	35
9.4	Component testing.....	35
9.5	Assembly testing.....	35
9.5.1	General	35
9.6	Test methods	36
9.6.1	General	36
9.6.2	Single-frequency test.....	37
9.6.3	Multiple-frequency tests.....	40
9.6.4	Other tests.....	45
9.6.5	Test duration and low-cycle fatigue potential	45
9.6.6	Multi-axis tests	45
9.6.7	Line-mounted equipment	47
9.6.8	Additional tests.....	48
9.7	Test documentation	48
10	Qualification by similarity.....	48
10.1	General.....	48
10.2	Excitation.....	48
10.3	Physical systems.....	48
10.4	Safety function.....	49
11	Analysis.....	49
11.1	General.....	49
11.2	Seismic analysis methods	50
11.2.1	General	50
11.2.2	Static analysis	51
11.2.3	Static coefficient analysis	51
11.2.4	Dynamic analysis.....	51
11.3	Nonlinear equipment response.....	52
11.4	Other dynamic loads	52
11.5	Seismic analysis results	52
11.6	Documentation of analysis	53
12	Combined analysis and testing	53
12.1	General.....	53
12.2	Modal testing	53
12.2.1	General	53
12.2.2	Normal-mode method	53
12.2.3	Transfer-function method.....	54
12.2.4	Analytical methods utilizing test data	54
12.2.5	Qualification	54
12.3	Extrapolation for similar equipment	54
12.3.1	General	54
12.3.2	Test method	54

12.3.3	Analysis.....	55
12.4	Shock testing.....	55
12.5	Extrapolation for multi-cabinet assemblies.....	55
12.6	Other test/analysis.....	55
13	Documentation.....	56
13.1	General.....	56
13.2	Seismic qualification report.....	56
13.2.1	General.....	56
13.2.2	Analysis.....	56
13.2.3	Testing.....	56
13.2.4	Combined analysis and testing or similarity.....	57
Annex A (normative)	Experience-based seismic qualification.....	58
A.1	General.....	58
A.2	Earthquake experience data.....	58
A.2.1	General.....	58
A.2.2	Characterization of the earthquake experience motions.....	58
A.2.3	Earthquake experience spectrum (EES).....	59
A.2.4	Characterization of reference equipment class.....	59
A.2.5	Qualification of candidate equipment.....	61
A.3	Test experience data.....	62
A.3.1	General.....	62
A.3.2	Characterization of test experience input motions.....	62
A.3.3	Test experience spectra (TES).....	62
A.3.4	Characterization of reference equipment class.....	63
A.3.5	Qualification of candidate equipment.....	64
A.4	Special considerations.....	64
A.4.1	Inherently rugged equipment.....	64
A.4.2	Limitations.....	65
A.5	Experience-based documentation.....	65
A.5.1	General.....	65
A.5.2	Reference data.....	66
A.5.3	Candidate equipment qualification.....	66
Annex B (informative)	Measurement of zero period acceleration.....	67
Annex C (informative)	Frequency content and stationarity.....	68
Annex D (informative)	Fragility testing.....	69
D.1	General.....	69
D.2	Excitation motion.....	69
D.3	Application of results.....	70
D.4	Other considerations.....	70
Annex E (informative)	Test duration and number of cycles.....	72
Annex F (informative)	Statistically independent motions.....	76
Annex G (informative)	Seismic qualification illustrative flowcharts.....	77
G.1	General.....	77
G.2	Establishment of seismic conditions and acceptance criteria.....	77
G.3	Qualification by testing.....	77
G.4	Qualification by analysis.....	77
G.5	Qualification by combination of analysis and testing.....	77
Bibliography	82

Figure 1 – Sine beat	39
Figure 2 – Decaying sine	39
Figure 3 – Random spectrum with superimposed sine beats	43
Figure 4 – Resonant amplification versus cycles per beat	44
Figure E.1 – Fractional cycles to obtain one equipment maximum peak cycle	73
Figure E.2 – Equivalent peak-stress cycles induced by stationary random motion	74
Figure E.3 – Equivalent peak-stress cycles induced by stationary random motion to 20 Hz ...	74
Figure G.1 – Seismic qualification flowchart	78
Figure G.2 – Seismic qualification test flowchart	79
Figure G.3 – Seismic qualification analysis flowchart	80
Figure G.4 – Seismic qualification analysis and test flowchart	81
Table A.1 – EES reduction factor based on number of independent items	60

iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST EN IEC/IEEE 60980-344:2021](https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9c1662cad6e8/sist-en-iec-ieee-60980-344-2021)

<https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9c1662cad6e8/sist-en-iec-ieee-60980-344-2021>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**NUCLEAR FACILITIES –
EQUIPMENT IMPORTANT TO SAFETY –
SEISMIC QUALIFICATION****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.

IEEE Standards documents are developed within IEEE Societies and Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. IEEE develops its standards through a consensus development process, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of IEEE and serve without compensation. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards. Use of IEEE Standards documents is wholly voluntary. *IEEE documents are made available for use subject to important notices and legal disclaimers (see <http://standards.ieee.org/ipr/disclaimers.html> for more information).*

IEC collaborates closely with IEEE in accordance with conditions determined by agreement between the two organizations.

- 2) The formal decisions 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. The formal decisions of IEEE on technical matters, once consensus within IEEE Societies and Standards Coordinating Committees has been reached, is determined by a balanced ballot of materially interested parties who indicate interest in reviewing the proposed standard. Final approval of the IEEE standards document is given by the IEEE Standards Association (IEEE-SA) Standards Board.
- 3) IEC/IEEE Publications have the form of recommendations for international use and are accepted by IEC National Committees/IEEE Societies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC/IEEE Publications is accurate, IEC or IEEE 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 (including IEC/IEEE Publications) transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC/IEEE Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC and IEEE do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC and IEEE are 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 IEEE or their directors, employees, servants or agents including individual experts and members of technical committees and IEC National Committees, or volunteers of IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board, 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/IEEE Publication or any other IEC or IEEE 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) Attention is drawn to the possibility that implementation of this IEC/IEEE Publication may require use of material covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. IEC or IEEE shall not be held responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patent Claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

IEC/IEEE 60980-344:2020

– 7 –

© IEC/IEEE 2020

International Standard IEC/IEEE 60980-344 has been prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation, in cooperation with Nuclear Power Engineering Committee of the IEEE, under the IEC/IEEE Dual Logo Agreement.

It is published as an IEC/IEEE dual logo standard.

This new edition cancels and replaces the first edition of IEC 60980, published in 1989, and constitutes a technical revision. It also supersedes IEEE Std 344™-2013.

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

FDIS	Report on voting
45A/1323/FDIS	45A/1334/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.

International standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The IEC Technical Committee and IEEE Technical Committee have decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site 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.

[SIST EN IEC/IEEE 60980-344:2021](https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9c1662cad6e8/sist-en-iec-ieee-60980-344-2021)

<https://standards.iteh.ai/catalog/standards/sist/5082b296-387d-4d77-927e-9c1662cad6e8/sist-en-iec-ieee-60980-344-2021>

(standards.iteh.ai)

INTRODUCTION

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

This standard is applicable to electrical equipment important to safety and its interfaces that are necessary to perform a safety function, or whose failure could adversely affect the safety functions of other equipment.

Electrical equipment in nuclear facilities shall meet its safety function requirements throughout its installed life. This is accomplished by a thorough programme of quality assurance, design control, quality control, qualification, production, transportation, storage, installation, maintenance, periodic testing, and surveillance. This IEC/IEEE standard specifically focuses on seismic qualification. This standard shall be used in conjunction with IEC/IEEE 60780-323.

Other aspects, relating to quality assurance, reliability, selection and use of electronic devices, design and modification of digital systems including Verification and Validation (V&V) activities are not part of this standard.

Industry research in the area of equipment qualification and decades of its application have greatly benefited this standard. Future activities of the working group to update this standard will consider the following:

- Experience and knowledge gained by using condition monitoring techniques,
- Knowledge gained on ageing mechanisms and kinetics,
- Improvement in the use of methods (test and analysis) described throughout the standard,
- Improvement of computation tools and modalities of use.

It is intended that the Standard be used by operators of NPPs (utilities), systems evaluators, equipment manufacturers, test facilities, qualification laboratories and by licensors.

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

IEC 61513 and IEC 63046 are first level IEC SC 45A documents that give guidance applicable to Instrumentation and Control (I&C) system and electrical power systems (at system level). They are completed by guidance relative to functional classification (IEC 61226).

These documents are supplemented by second level IEC SC 45A documents. Second level IEC SC 45A documents give guidance on hardware design (IEC 60987), software (IEC 60880 and IEC 62138), selection and use of HDL programmed integrated circuits (IEC 62566), requirements in order to reduce the possibility and limit the impact of common cause failure of category A functions (IEC 62340), qualification (IEC/IEEE 60780-323, IEC/IEEE 60980-344 and IEC 62003), control room design (IEC 62342) and cybersecurity (IEC 62645).

IEC/IEEE 60980-344 is a second level IEC SC 45A document which focuses on seismic qualification of electrical equipment important to safety.

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 this standard

This dual logo standard applies to all electrical equipment important to safety in accordance with IAEA terminology. If using IEEE standards, this standard applies to systems, structures, and components classified as safety or safety-related. If using the IEC 61226 and IEC 61513 classification guidance, this standard applies to all Class 1, 2 and 3 equipment. This document shall only be applied in accordance with the single selected classification scheme, either IEC or IEEE.

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 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 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 (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 NSS 17 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.