



**IEEE**

**IEC/IEEE 60980-344**

Edition 1.0 2020-10

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Nuclear facilities – Equipment important to safety – Seismic qualification**

**Installations nucléaires – Équipements importants pour la sûreté – Qualification sismique**

[IEC/IEEE 60980-344:2020](https://standards.iteh.ai/catalog/standards/sist/2e11c6a1-04ff-4f61-973b-4c63d4d92927/iec-ieee-60980-344-2020)

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INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 27.120.10; 27.120.20

ISBN 978-2-8322-1016-8

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SEISMIC QUALIFICATION****FOREWORD**

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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.

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## 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.

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.

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# NUCLEAR FACILITIES – EQUIPMENT IMPORTANT TO SAFETY – SEISMIC QUALIFICATION

## 1 Scope

This International Standard describes methods for establishing seismic qualification procedures that will yield quantitative data to demonstrate that the equipment can meet its performance requirements. This document is applicable to electrical, mechanical, instrumentation and control equipment/components that are used in nuclear facilities. This document provides methods and documentation requirements for seismic qualification of equipment to verify the equipment's ability to perform its specified performance requirements during and/or after specified seismic demands. This document does not specify seismic demand or performance requirements. Other aspects, relating to quality assurance, selection of equipment, and design and modification of systems, are not part of this document. As seismic qualification is only a part of equipment qualification, this document is used in conjunction with IEC/IEEE 60780-323.

The seismic qualification demonstrates equipment's ability to perform its safety function(s) during and/or after the time it is subjected to the forces resulting from at least one safe shutdown earthquake (SSE/S2). This ability is demonstrated by taking into account, prior to the SSE/S2, the ageing of equipment and the postulated occurrences of a given number of lower intensity operating basis earthquake (OBE/S1). Ageing phenomena to be considered, if specified in the design specification, are those which could increase the vulnerability of equipment to vibrations caused by an SSE/S2.

## 2 Normative references

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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 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC/IEEE 60780-323, *Nuclear facilities – Electrical equipment important to safety – Qualification*<sup>1,2</sup>

IEEE Std 382™, *IEEE Standard for Qualification of Safety-Related Actuators for Nuclear Power Generating Stations*

## 3 Terms and definitions

The terminology and definitions used in this document are consistent with IAEA Safety Glossary<sup>3</sup>.

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<sup>3</sup> IAEA safety glossary is available at <https://www.iaea.org/publications/11098/iaea-safety-glossary-2018-edition>

For the purposes of this document, the following terms and definitions apply.

ISO, IEC, and IEEE maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEEE Standards Dictionary Online: available at <http://dictionary.ieee.org>

The *IEEE Standards Dictionary Online* should be consulted for terms not defined in these databases.<sup>4</sup>

### 3.1

#### **acceptance criteria**

specified bounds on the value of a functional indicator or condition indicator used to assess the ability of a structure, system or component to perform its design function

Note 1 to entry: Value(s) of performance parameters and other criteria to demonstrate that equipment can perform the safety function(s) shall be identified.

[SOURCE: IAEA Safety Glossary, 2018]

### 3.2

#### **assembly**

comprising all electrical, mechanical, and structural components of the equipment including a common mounting and supporting structure

### 3.3

#### **broadband response spectrum**

response spectrum that describes motion in which amplified response occurs over a wide (broad) range of frequencies

### 3.4

#### **Class 1E**

safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or otherwise are essential in preventing significant release of radioactive material to the environment

Note 1 to entry: Users of this standard are advised that “Class 1E” is a functional term. Equipment and systems are to be classified Class 1E only if they fulfill the functions listed in the definition. Identification of systems or equipment as Class 1E based on anything other than their function is an improper use of the term and should be avoided.

[SOURCE: IEEE Standards Dictionary Online]

### 3.5

#### **components**

one of the parts that make up an equipment. A component may be a hardware component (e.g., wires, transistors, integrated circuits, motors, relays, solenoids, pipes, fittings, pumps, tanks and valve or a software component). A component may be made up of other components

Note 1 to entry: Components are items from which equipment is assembled.

Note 2 to entry: The terms component and device are interchangeable.

[SOURCE: IAEA Safety Glossary, 2018]

<sup>4</sup> *IEEE Standards Dictionary Online subscription* is available at: <http://dictionary.ieee.org>

### 3.6

#### **coherence function**

comparative relationship between two time histories as a function of frequency

Note 1 to entry: It provides a statistical estimate of how much two motions are related, as a function of frequency.

Note 2 to entry: The numerical range is from zero for unrelated to +1,0 for related motions.

### 3.7

#### **correlation coefficient function**

comparative relationship between two time histories, as a function of time delay

Note 1 to entry: It provides a statistical estimate of how much two motions are related, as a function of time delay.

Note 2 to entry: The numerical range is from -1,0 for inversely related motions, zero for unrelated, to +1,0 for related motions.

### 3.8

#### **critical damping**

least amount of viscous damping that causes a single-degree-of-freedom (SDOF) system to return to its original position without oscillation after initial disturbance

[SOURCE: IEEE Standards Dictionary Online]

### 3.9

#### **critical seismic characteristics**

design, material, and performance characteristics of an equipment item that provide reasonable assurance that the item will perform its required function under seismic loads

### 3.10

#### **cutoff frequency**

frequency in the response spectrum where the zero period acceleration (ZPA) asymptote begins

Note 1 to entry: This is the frequency beyond which the single-degree-of-freedom (SDOF) oscillators exhibit no amplification of motion and indicates the upper limit of the frequency content of the waveform being analysed.

### 3.11

#### **damping**

energy dissipation mechanism that reduces the amplification and broadens the vibratory response in the region of resonance

Note 1 to entry: It is usually expressed as a percentage of critical damping.

### 3.12

#### **design basis events**

postulated events used in the design to establish the acceptable performance requirements for the structures, systems, and components

Note 1 to entry: The postulated design basis event (DBE) conditions including specified high-energy line break, loss-of-coolant accident, main steam line break, and/or seismic events to be taken into account for plant design, during or after which the equipment is required to perform its safety function(s), shall be specified.

Note 2 to entry: Equipment shall be qualified for the duration of its operational performance requirement for each applicable DBE condition, including any required post-DBE operation period.

[SOURCE: IEEE Standards Dictionary Online]

### 3.13

#### **earthquake experience spectrum**

response spectrum that defines the seismic capacity of a reference equipment class based on earthquake experience data