SLOVENSKI STANDARD
oSIST prEN IEC 60068-3-3:2018
01-oktober-2018

Okoljsko preskušanje - 3-3. del: Navodilo - Seizmične preskusne metode za opremo

Environmental testing - Part 3-3: Guidance - Seismic test methods for equipments

Essais d'environnement - Partie 3-3: Guide - Méthodes d'essais sismiques applicables aux matériels

Ta slovenski standard je istoveten z: prEN IEC 60068-3-3:2018

ICS:

19.040	Preskušanje v zvezi z okoljem	Environmental testing

oSIST prEN IEC 60068-3-3:2018 en

104/806/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: **IEC 60068-3-3 ED2**	
DATE OF CIRCULATION: **2018-08-10**	CLOSING DATE FOR VOTING: **2018-11-02**
SUPERSEDES DOCUMENTS: **104/787/CD,104/804/CC**	

IEC TC 104 : ENVIRONMENTAL CONDITIONS, CLASSIFICATION AND METHODS OF TEST	
SECRETARIAT: Sweden	SECRETARY: Mr Henrik Lagerström
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	
☒ SUBMITTED FOR CENELEC PARALLEL VOTING **Attention IEC-CENELEC parallel voting** The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

Environmental testing - Part 3-3: Guidance - Seismic test methods for equipments

PROPOSED STABILITY DATE: 2024

NOTE FROM TC/SC OFFICERS:

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

ENVIRONMENTAL TESTING –

Part 3-3: Guidance – Seismic test methods for equipments

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

International Standard IEC 60068-3-3 has been prepared by IEC technical committee TC 104.

This second edition cancels and replaces the first edition published in 1991-02-28 This edition constitutes a technical revision.

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

- The main aim of this revision is to connect the testing level to the seismic activity level of the zone where the equipment could be installed;
- A standard shape for the Required Response Spectrum is given also for the General Seismic Class for which the seismic environment is either not known or is imprecisely known;

- With reference to the old document clauses from 11 to 15 were moved in section one by renumbering them and by making some adjustments. This action is justified because the contents of those clauses are very general and the requirements can be applied both to the general seismic class and to the specific seismic class;

- The word “envelope” is changed into “dominance” and “to envelope” into “to dominate” for getting a more precise meaning from the mathematical point of view.

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

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

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

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

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

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

The National Committees are requested to note that for this document the stability date is 2024~~XX~~..

THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED AT THE PUBLICATION STAGE.

INTRODUCTION

Guidance is included in each of the two test methods referred to in this standard but it is specific to the test method. The guidance in this standard is directed towards choosing the appropriate test method and applying it to seismic testing.

This standard is to be used in conjunction with IEC 60068-1.

ENVIRONMENTAL TESTING –

Part 3-3: Guidance – Seismic test methods for equipments

I - SECTION ONE – GENERAL

1 Scope

This document applies primarily to electro-technical equipments but its application can be extended to other equipments and to components.

Also if some sort of analysis is always performed when making a seismic qualification, e.g. for the choice of the representative sample to be tested or for the extension of the seismic qualification from the tested specimen to similar specimens, the verification of the performance of an equipment by analysis or by a combination of testing and analysis may be acceptable but is outside the scope of this guide, which is restricted to verification based entirely upon data from dynamic testing.

This guide deals solely with the seismic testing of a full-size equipment which can be tested on a vibration table. The seismic testing of an equipment is intended to demonstrate its ability to perform its required function during and/or after the time it is subjected to the stresses and displacements resulting from an earthquake.

The object of this guide is to present a range of methods of testing which, when prescribed by the relevant specification, can be applied to demonstrate the performance of equipments for which seismic testing is required with the main aim of achieving qualification.

NOTE Qualification by so-called “fragility-testing” is not considered to be within the scope of this guide which has been prepared to give generally applicable guidance on seismic testing and specifically on the use of IEC 60068-2 test methods.

The choice of the method of testing can be made according to the criteria described in this guide. The methods themselves are closely based on published IEC test methods.

This guide is intended for use by manufacturers to substantiate, or by users to evaluate and verify, the performance of an equipment.

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 60068-1 Environmental testing – Part 1: General and guidance

IEC 60068-2-6 Test Fc and guidance: Vibration (sinusoidal)

IEC 60068-2-47 Mounting of components, equipment and other articles for dynamic tests including shock (Ea), bump (Eb), vibration (Fc and Fd) and steady-state acceleration (Ga) and guidance

IEC 60068-2-57 Environmental testing – Part 2: Tests – Test Ff: Vibration – Time-history and sine-beat method.

IEC 60068-2-64 Environmental testing – Part 2-64: Tests – Test Fh: Vibration, broadband random (digital control) and guidance

IEC 60068-2-81 2003 Environmental testing – Part 2-81: Tests – Test Ei: Shock – Shock response spectrum synthesis

IEC 60721-2-6: 1990 Classification of environmental conditions. Part 2: Environmental conditions appearing in nature. Earthquake vibration and shock

IEC TS 62271-210:2013 High-voltage switchgear and controlgear – Part 210: Seismic qualification for metal enclosed and solid-insulation enclosed switchgear and controlgear assemblies for rated voltages above 1 kV and up to and including 52 kV

ISO 2041 – Vibration and shock – Vocabulary

3 Terms and definitions

The terms used in this standard are generally defined in ISO 2041 or in IEC 60068-1, IEC 60068-2-6 and IEC 60068-2-57. Where, for the convenience of the reader, a definition from one of these sources is included here, the derivation is indicated and departures from the definitions in those sources are also indicated.

The additional terms and definitions that follow are also applicable for the purpose of this standard.

3.1
assembly
two or more devices sharing a common mounting or supporting structure

3.2
bandpass at –3 dB
frequency intervals defined by the points possessing an ordinate larger than or equal to $\sqrt{2}/2$ times the maximum value of the plot

Note 1 to entry: See figure 2.

3.3
basic response spectrum
unmodified response spectrum defined by the characteristics of the building, its floor level, damping ratio, etc. and obtained from a specific ground motion

Note 1 to entry: See figure 2.

Note 2 to entry The basic response spectrum is generally of the narrow band type at floor level. The basic response spectrum is calculated by the architect engineer of the plant and it is generally not known by the equipment manufacturer and by the test engineer.

3.4
broadband response spectrum
response spectrum that describes the motion indicating that a number of interacting frequencies exist which must be treated as a whole

Note 1 to entry: See figure 3c.

Note 2 to entry The bandwidth is normally greater than one octave.

3.5
critical frequency
frequencies at which:

– malfunctioning and/or deterioration of performance of the specimen which are dependent on vibration are exhibited, and/or

– mechanical resonances and/or other response effects occur, for example chatter

[SOURCE: IEC 60068-2-6, 3.9, modified – The text was editorially corrected]

3.6
crossover frequency
frequency at which the characteristic of a vibration changes from one relationship to another

Note 1 to entry For example, a crossover frequency may be that frequency at which the control of the test vibration amplitude changes from a constant displacement value versus frequency to a constant acceleration value versus frequency.

[SOURCE: ISO 2041, 2.118, modified – Example omitted and note added]

3.7
damping
generic term ascribed to the numerous energy dissipation mechanisms in a system. In practice, damping depends on many parameters, such as the structural system, mode of vibration, strain, applied forces, velocity, materials, joint slippage, etc.

Note 1 to entry This definition is not identical with ISO 2041 definition.

3.7.1
critical damping
minimum viscous damping that will allow a displaced system to return to its initial position without oscillation

3.7.2
damping ratio
ratio of actual damping to critical damping in a system with viscous damping

3.8
direction factor
factor taking account of the difference in magnitude at ground level that normally exists between the horizontal and vertical accelerations resulting from an earthquake

3.9
floor acceleration
acceleration of a particular building floor (or an equipment mounting) resulting from the ground motion of a given earthquake

Note 1 to entry In practice the floor acceleration may be resolved into its horizontal and vertical components.

3.10
geometric factor
factor required in single axis testing to take into account the interaction along the different axes of the equipment of simultaneous multi-directional input vibrations

3.11
"g_n"
standard acceleration due to the earth's gravity, which itself varies with altitude and geographical latitude

Note 1 to entry For the purposes of this standard, the value of g_n is rounded up to the nearest whole number, that is 10 m/s^2.

3.12
ground acceleration
acceleration of the ground resulting from the motion of a given earthquake

Note 1 to entry In practice the ground acceleration may be resolved into its horizontal and vertical components.

3.13
lateral frequencies
two frequencies determined according to the –3 dB response around the overall resonance frequency

Note 1 to entry: See figure2.

3.14
malfunction
loss of capability of the equipment to initiate or sustain a required function, or the initiation of undesired spurious action which may result in adverse consequences for safety

Note 1 to entry Malfunction will be defined by the relevant specification.

3.15
narrowband response spectrum
response spectrum in which single frequency excitation predominates

Note 1 to entry: See figure 3a.

Note 2 to entry The bandwidth is normally 1/3 octave or less.

Note 3 to entry When several widely spaced well-defined frequencies exist, if justified, each of their responses may be treated separately as a narrow-band response spectrum (see figure 3b).

3.16
damped natural frequency
frequency of free vibration of a damped linear system depending only on its own physical characteristics (mass, stiffness, and damping)

3.17
overall resonance
resonance frequency at which a complete structure amplifies the exciting motion

Note 1 to entry Within the frequency range between 1 Hz and 35 Hz, overall resonance generally corresponds to the first mode of vibration. It is important to take into account the overall resonance frequencies when they are enclosed in the strong part of the required response spectrum (see 3.27).

3.18
pause
interval between consecutive test waves (for example sine beats)

Note 1 to entry A pause should be such that it results in no significant superposition of the response motions of an equipment.

3.19
preferred testing axes
three orthogonal axes which correspond to the most vulnerable axes of the equipment

3.20
required response spectrum
response spectrum specified by the user

Note 1 to entry: See figure1, 2 and 3.

3.21
resonance frequency
frequency at which, in forced oscillation, a change in the frequency of excitation causes a decrease in the response of the system.

Note 1 to entry The value of resonance frequency depends upon the measured variable. For a damped linear system, the values of resonance frequency for displacement, velocity and acceleration (respectively dynamic compliance, mobility and accelerance; see ISO 2041) are in increasing order of frequency. The differences between these resonance frequency values are small for the usual damping ratios.

Note 2 to entry In seismic testing, it is often assumed that a resonance frequency is significant when the transmissibility of the response is greater than 2.

Note 3 to entry This definition is not identical with ISO 2041 definition.

3.22
response spectrum
plot of the maximum response to a defined input motion of a family of single-degree-of-freedom bodies at a specified damping ratio

Note 1 to entry: See figure1, 2 and 3.

Note 2 to entry This definition is not identical with ISO 2041 definition.

3.23
S1-earthquake
an earthquake which would be expected to occur during the operating life of the equipment and for which safety related equipments are to be designed to continue to operate without malfunction

Note 1 to entry An S1-earthquake corresponds in nuclear applications to the operating base earthquake (OBE).

3.24
S2-earthquake
an earthquake which produces the maximum vibratory ground motion for which certain structures, systems and components are designed to remain functional. These structures, systems and components are those essential to assure proper function, integrity and safety of the total system

Note 1 to entry An S2-earthquake corresponds in nuclear applications to the safe shutdown earthquake (SSE).

3.25
sine beat
continuous sinusoidal wave of one frequency which is modulated by a sinusoidal wave of a lower frequency. The duration of one sine beat is half the period of the modulating frequency

Note 1 to entry: See figure 5.

Note 2 to entry In this standard, the sine beat is considered as a single frequency wave.

3.26
strong part of time-history
part of time-history from the time when the plot first reaches 25 % of the maximum value to the time when it falls for the last time to the 25 % level.

Note 1 to entry: See figure 5.

3.27
strong part of the response spectrum
part of the spectrum for which the response acceleration is higher than for the –3 dB bandpass of the required response spectrum.

Note 1 to entry: See figure 2.

Note 2 to entry Generally, the strong part of the response spectrum is located in the first third of the frequency band.

3.28
superelevation factor
factor accounting for the change in the acceleration with respect to the earth due to the transmissibility of buildings and structures

3.29
synthesized time-history
artificially generated time-history such that its response spectrum dominates the required response spectrum

3.30
test level
largest peak value within a test wave

Note 1 to entry In seismic testing, acceleration is the parameter normally used.

3.31
test frequency
frequency at which the specimen is to be excited during a test

Note 1 to entry: A test frequency is one of two types as defined in 3.31.1 and 3.31.2.

3.31.1
predetermined test frequency
frequency prescribed by the relevant specification

3.31.2
investigated test frequency
frequency obtained by a vibration response investigation

3.32
test response spectrum
response spectrum derived from the real motion of the vibration table either analytically or by using spectrum analysis equipment

Note 1 to entry: See figures 1, 2c and 2d.

3.33
time-history
recording, as a function of time, of acceleration or velocity or displacement

Note 1 to entry This definition is not identical with ISO 2041 definition.

3.34
zero period acceleration
ZPA

high-frequency asymptotic value of acceleration of a response spectrum

Note 1 to entry: For an example see figure 2.

Note 2 to entry The zero period acceleration is of practical significance as it represents the largest peak value of acceleration, for example in a time-history. This should not be confused with the peak value of acceleration in the response spectrum.

4 General and qualification considerations

4.1 General and specific seismic class

Two seismic classes have been established: a general seismic class and a specific seismic class. Neither of these classes can be considered to be more demanding than the other. The difference between the two classes lies in the availability of and/or the accuracy in defining the characteristics of the seismic environment. When high reliability safety equipment for a specified environment is required, such as safety related equipment in nuclear power plants, the use of precise data is necessary and, therefore, the specific seismic class is applicable and not the general seismic class. Annex A contains a flow chart for the selection of the test class (general seismic class or specific seismic class) and three flow charts (A.1 to A.3) covering the possibilities discussed in this guide. To obtain the maximum advantage from this guide it is strongly recommended that the flow charts be studied very thoroughly.

Section Two describes the recommended seismic testing methods for equipment covered by the general seismic class for which the seismic environment is either not known or is imprecisely known.

This class covers equipments for which the relevant seismic motion does not result from a specific study taking into account the characteristics of the geographic location and of the supporting structure or building.

In this class, the seismic motion is generally characterized by one datum which is a peak acceleration at the ground level. This acceleration is derived from the seismic data relative to the area of interest.

When an equipment is not mounted at ground level, the transmissibility of the building and/or the supporting structure should be taken into account.

Section Three describes the recommended seismic testing methods for equipment covered by the specific seismic class for which the seismic environment is well known or the required response spectra and/or the time histories are prescribed in the relevant specification.

This class covers the equipment for which the relevant seismic motion results from a specific study taking into account the characteristics of the geographic location and of the supporting structure or building.

In this class, the seismic motion is defined by response spectra (evaluated for different damping ratios) or by a time-history.

The relevant specification should contain information relating to the subjects discussed in 4.2, 4.3 and 4.4.

4.2 Service conditions

Service conditions should be duplicated as closely as possible when an equipment is tested, particularly those conditions (electrical, mechanical, and thermal pressure, etc.) whose stresses combine with those of the seismic test to affect the operation or integrity of the equipment. When account is not taken of these service conditions in the test, the omission should be justified.