Technical Requirements for Electrical Equipment	Beteckning / Document TBE 102:2
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Contents

1 General

These Technical Requirements provide guidelines on how to specify and interpret seismic requirements for electrical equipment to be used in Swedish nuclear power plants.

1.1 Background

In a jointly project between SSM (Swedish Radiation Safety Authority) and the Swedish utilities in 1985-1989 a characterisation of earthquakes was defined, including ground response spectra with frequency content and duration applicable to Swedish conditions.

The frequencies 1E-5/year and 1E-7/year have been selected as requirements for the evaluation of the safe shut down and cooling of the reactor and the reactor containment integrity respectively.

1.2 Applicable standards and regulations

IEC 60980

Recommended practices for seismic qualification of electrical equipment of the safety system for nuclear generating stations.

IEEE Std 344

Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.

Other equivalent standards and regulations may be used after approval by the Purchaser.

2 Definitions

Frequency

In this document frequency has two completely different meanings:

1) Occurrence frequency is given the unit 1/year. The occurrence frequency is the inverse of the statistical mean time between earthquakes for a nuclear facility with maximum ground acceleration (PGA) exceeding a certain value.

2) The frequency content expressed in Hz for the actual earthquakes.

Seismic loads

In this document acceleration forces are expressed with the unit m/s^2 or g, where 1 g = 9,81 m/s^2.

Damping

Damping is the generic name used for energy dissipation, which reduce the forces and duration of the motions in mechanically oscillating systems. Damping occurs primarily due to friction in mechanical joints and permanent deformation of structural materials. Damping is expressed as percent of critical damping, which means that the next coming motion has x % less energy content than the previous motion. Common damping values are 2-10 %.

Node

Node means the location in a building for which a response spectrum is generated.

Response spectrum

A response spectrum is a diagram showing maximum response, e.g. in the form of displacement, velocity or acceleration acting on all single degree of freedom systems, caused by an applied motion (e.g. ground motions or building motions). Normally a response spectrum is expressed for a given damping. The damping applies to a certain affected oscillating system (installed equipment), when placed in the node for which the response spectrum is generated.

3 Environmental Conditions

This section gives basic information about the seismic loads that buildings and equipment are subjected to. Verification requirements for equipment with seismic requirements are specified in KBE EP-147.

3.1 General

An earthquake causes both horizontal and vertical ground motions. These motions are similar to random noise having the frequency content mainly below 50 Hz. The duration of a major Swedish earthquake is about 10 seconds.

3.2 Design seismic environment

For Swedish nuclear power plants the so called *S1 Earthquake* according to IEC 60980 or *OBE Operating Basic Earthquake* according to American regulations (with the frequency 1E-2/year) need not to be considered. This means an earthquake expected to occur during the operating life of the plants.

On the other hand *S2 Earthquake* according to IEC 60980 or *SSE Safe Shutdown Earthquake* according to American regulations has to be considered.

This means that for seismic loads which can occur with an average frequency greater than 1E-5/year and unit necessary safety functions shall be demonstrated to fulfil the intended functions.

3.3 Response spectra

Applicable horizontal and vertical response spectra are given in the Technical Specification.

In order to avoid that a large number of response spectra are called for during design or purchase of electrical equipment, a simplification may be made to allow for verification according to a seismic environmental class shown in this document. Hence the seismic environmental class becomes the requirement level that is verified by testing according to KBE EP-147.

3.4 Seismic environmental classes for other units

For equipment which can be expected to be used in a number of mounting positions or buildings, the response spectrum is to be selected so that the qualification becomes valid for all these positions and buildings. Primarily the response spectra are to be selected from the seismic environmental classes SL1–SL6.

The classes SL1–SL6 make no distinction between vertical and horizontal acceleration with respect to the test spectrum that is to be used.

If no broadened response spectrum according to class SL1–SL6 envelopes actual spectra for specific mounting positions, or if the broadened spectrum is considered too conservative, then the horizontal and vertical spectra for specific mounting positions could be used instead as required response spectra.

Seismic environmental class

Seismic Environ-mental Class	Equipment location	Comment
SL1	Equipment mounted directly to building structure or in cabinets	Response spectra based on calculated maxi-mum building response spectra. For equipment's mounted in cabinets the secondary spectre applies.
SL2	- " -	- " -
SL3	- " -	- " -
SL4	- " -	- " -
SL5	- " -	- " -
SL6	- " -	- " -

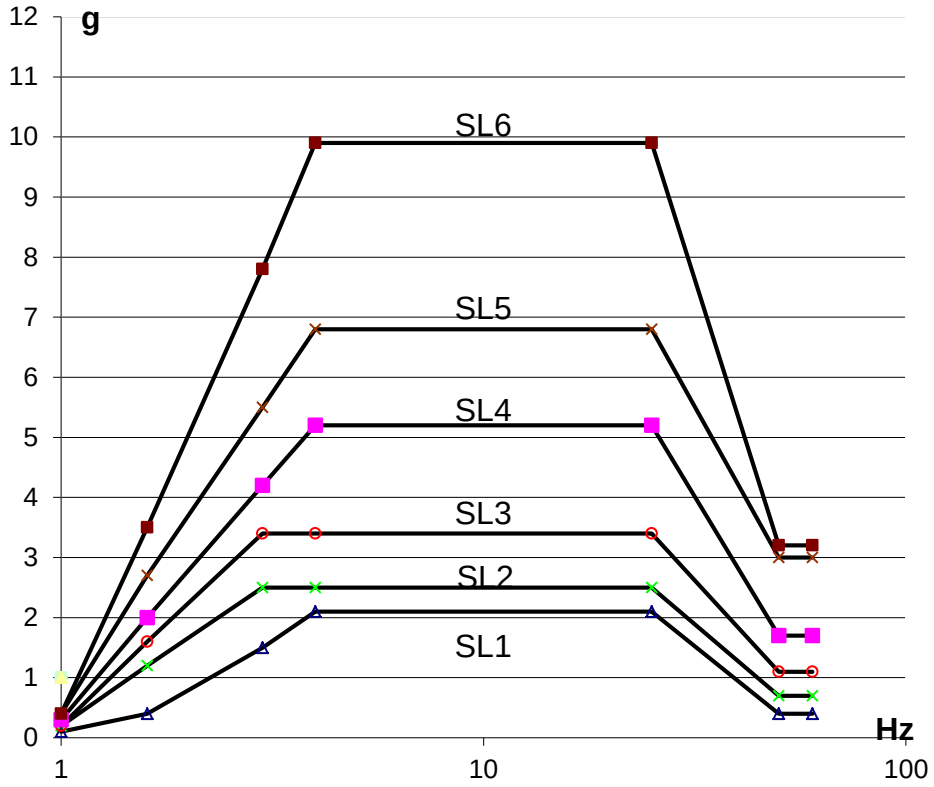
Table 2 Response spectra for seismic environmental classes shown above are given in section 3.6.

3.5 Damping

Damping values for verification by test or analysis are to be selected according to approved standard, e.g. those referred to in section 1.4, or according to documented recognised practice.

If damping values cannot be established 5 % shall be used, spectre in 3.6.

3.6 Seismic environmental classes - 5 % damping



Hz	SL1 g	SL2 g	SL3 g	SL4 g	SL5 g	SL6 g
1	0,1	0,2	0,2	0,3	0,4	0,4
1,6	0,4	1,2	1,6	2,0	2,7	3,5
3	1,5	2,5	3,4	4,2	5,5	7,8
4	2,1	2,5	3,4	5,2	6,8	9,9
25	2,1	2,5	3,4	5,2	6,8	9,9
50	0,4	0,7	1,1	1,7	3.0	3,2
60	0,4	0,7	1,1	1,7	3.0	3,2