ESKOM

GENERATION NUCLEAR GROUP

(KOEBERG NUCLEAR POWER STATION)

Specification Title:

SPECIFICATION FOR SEISMIC QUALIFICATION OF ELECTRICAL AND MECHANICAL EQUIPMENT

PREPARED BY:	[signature]	**J VENTER**
REVIEWED BY:	[signature]	**C STOLLE**
REVIEWED BY:	[signature]	**L UYS**
REVIEWED BY:	[signature]	**N BOONZAIER**
APPROVED BY:	[signature]	**R GOLDSTEIN**
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KOEBERG NUCLEAR POWER STATION

SDE

Technical Specification

for

SPECIFICATION FOR SEISMIC QUALIFICATION OF ELECTRICAL AND MECHANICAL EQUIPMENT

APPROVED: T SMYTHE DATE:1991-05-02

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RECORD OF REVISIONS

Rev	Date	Description of Revision	Prep.	Rev.	Appr.
0	1991-05-02	Original	LDR	PP	TS
1	2013-06-05	Rewrite and inclusion of mechanical items.	JV	CS	RG
2	2016-07-28	Added information to sections 2.2 and 4. Minor corrections	JV	CS	RG

TECHNICAL SPECIFICATION FOR SEISMIC QUALIFICATION OF ELECTRICAL AND MECHANICAL EQUIPMENT

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1.0 SCOPE OF SUPPLY

This specification establishes acceptable methods to seismically qualify equipment for service at Koeberg Nuclear Power Station. Fully detailed requirements are specified in References 3.1 and 3.23.

The requirements for the documentation compiled to perform and record the seismic qualification process and those for the compilers and reviewers of this documentation are specified.

EXCLUSIONS

- This specification does not detail the derivation of the floor response spectra.
- Concrete civil structures and buildings (see Reference 3.18).
- Free-standing equipment, excluding lead blankets and scaffolding, that is used for maintenance and testing near safety related equipment (see Reference 3.16)
- Temporary lead blanket radiation shielding on or near to safety related equipment in the plant (see Reference 3.15)
- Scaffolding used near safety related equipment (see Reference 3.17).
- Beyond design base seismic activity.
- Experience based seismic qualification requires approval from Eskom Nuclear Engineering after consideration of RG 1.100 endorsements.

2.0 GENERAL

Seismic qualification is necessary to ensure that safety related equipment is able to perform its safety function during and after a safe shutdown earthquake (SSE), or to ensure that safety related equipment is not damaged by nearby non safety related equipment during an earthquake. Seismic qualification may also be required to prove that equipment is not affected by five occurrences of either an Operational Basis Earthquake (see Reference 3.1 s/s 7.6) and one occurrence of a Safe Shutdown Earthquake.

Analysis alone, without testing, is acceptable as a basis for qualification only if the necessary functional operability of the equipment is assured by its structural integrity alone. When complete testing is impractical, a combination of tests and analyses may be acceptable.

The seismic classification of all Koeberg equipment is specified in Reference 3.14 and the DSE's. Seismic classifications of 1A, 1P, I, and ND require some form of seismic qualification, in terms of this specification.

Equipment that has been previously qualified by means of tests and analyses meeting the requirements of this specification may be acceptable subject to documentation of such tests and analyses being supplied to Eskom for review and approval.

2.1 Preferred Seismic Qualification Methods

Several methods or combinations of methods are available to seismically qualify equipment depending on the equipment characteristics and the mounting conditions of the equipment. Appropriate static and dynamic loads from normal, transient anticipated operational and accident conditions such as temperature, gravitational, flow induced, magnetic, and radiation shall be accounted for during the seismic qualification.

2.1.1 Shake Table Tests

The test involves vibrating the subject equipment in operational configuration to simulate the earthquake motion at its mountings. The test table motion therefore shall produce effects identical to or greater than those specified by the RRS. These tests are normally used to qualify complex/flexible parts or assemblies which cannot be accurately modelled for analysis by calculation.

Comprehensive documentation of the inputs, preparation, mounting, equipment, testing and test results is required.

2.1.2 Static Analysis of Rigid Items, (lowest natural frequency greater than 33 Hz)

Static forces resulting from the seismic motion are applied to the equipment at its centre of gravity. This is a simple and conservative method of seismic qualification but is only suitable for rigid components. The maximum seismic acceleration is the ZPA and simplified manual calculations determine the seismic stresses, which are compared to design code allowable stresses.

2.1.3 Equivalent Static Analysis (Calculations with coefficient)

Peak acceleration from the FRS at the appropriate damping is multiplied by a factor of 1,5 and applied to the equipment at its centre of gravity. This is normally a conservative method of seismic qualification but is only suitable for simple components. The seismic stresses are determined and compared to code allowable stresses.

2.1.4 Dynamic Analysis; Finite Element Modelling.

The equipment or structure is accurately modelled and analysed using appropriate software to prove that the equipment seismic displacements / stresses are acceptable. Two methods commonly used are;

- Response Spectrum Modal Superposition
- Time History Direct Integration

(These methods require greater skill but provide the best estimate of equipment response, stresses, and displacements.)

2.2 Required Response Spectra (RRS) at Koeberg

The location of the equipment and damping characteristics of the equipment determine the applicable floor response spectra (FRS) to which the equipment must be qualified. Contractors shall obtain confirmation from KNPS regarding which FRS is suitable for each qualification. FRS for most areas can be found in Reference 3.7.

Koeberg consists of several buildings which move relative to each other during seismic activity. Equipment which straddles two buildings requires that the RRS from each building is applied to the associated part of the equipment. The stresses due to the relative seismic displacement of anchor locations between the buildings shall also be analysed. See Reference 3.8 for detail of the relative movement between Koeberg buildings.

Note that the RRS could be significantly more severe than the FRS due to amplification of the FRS accelerations by intermediate (host) equipment flexibility. Amplification of the FRS accelerations through the host shall be accounted for in component qualification. Reference 3.2 section 5.1.2 provides an envelope spectrum for small devices which can be mounted inside or on panels/cabinets anywhere on the nuclear island. (This allows shake tests of the device on its own instead of multiple tests to qualify each location).

FRS for diesel buildings on the island are available in Reference 3.7. FRS for diesel buildings off the island are available in Reference 3.8. The SEC galleries FRS are also found in Reference 3.8.

FRS for buildings off the nuclear island are more severe than those on the island. SEC Pumphouse FRS are found in References 3.9. Envelope spectra for all 5 diesels are available in Reference 3.6.

Derivation (from existing Koeberg FRS) of intermediate spectra with more specific damping or acceleration values is possible, subject to approval by Eskom Nuclear Engineering.

2.3 Koeberg Envelope Spectra

Envelope spectra may be used for the seismic qualification of equipment to be installed in multiple locations at varying floor levels on the nuclear island. These spectra are representative of the severity levels determined for the Koeberg power plant and given for a damping value of 2 %. (See Attachment 8.2 and 8.3).

Koeberg nuclear island is built on a civil raft which rests on seismic bearings. The envelope spectra are not applicable to equipment installed off the nuclear island. Acceleration at the 40m and 50 m levels in containment also exceed those of the envelope spectrum.

Note 1: For equipment installed on the aseismic island the Koeberg horizontal floor response spectra have high accelerations at very low frequencies (≤ 1 Hz) that require very high test-table displacement capability. The general requirement for enveloping the RRS by the TRS can be modified in accordance with Reference 3.1.

Note 2: If the equipment has a damping value greater than 2%, a different RRS may be calculated for use with the same method (refer to Eskom Koeberg for information and approval in this regard).

2.4 Selection of Qualification Method.

Testing methods vary with different types of equipment. Knowledge of the natural frequencies of the equipment and/or seismic behaviour of the equipment to be qualified assists in the determination of a suitable test method. Equipment which has a lowest natural frequency greater than 33 Hz is considered to be a rigid component and would not be subjected to seismic accelerations greater than the ZPA of the relevant spectra. See section 4 for further detail.

Preferred Qualification Methods

Equipment	**Typical Seismic Qualification Method and Standard**
Electrical/instrumentation in a cabinet or frame that is flexible or has moving parts such as switches or relays.	Shake table test of the cabinet/frame with the cabinet and equipment mounted exactly as on the plant and functionally operable. See Ref 3.1
Electrical/instrumentation that is flexible or has moving parts such as switches or relays but mounted to a floor or wall.	Test of the functionally operable individual component on a shake table mounted exactly as on the plant. See Ref 3.1
Electric Motors, valve actuators	FEM, S.A.; Shake Table See Ref 3.1
Pumps, Valves, & other pipe mounted equipment	FEM, S.A.; Shake Table See Ref 3.1
Piping	FEM
Pressure Vessels, Heat exchangers	FEM
Cranes	FEM See Ref 3.1
Equipment supports, Structural steelwork	FEM, S.A.
Ducting	FEM, S.A.
Cable Trays	FEM, S.A.

2.5 Abbreviations

DSE: System Description Manuals
FEM: Finite Element Modelling
FRS: Floor Response Spectrum
KNPS: Koeberg Nuclear Power Station
SAR: Final Safety Analysis report
S.A.: Stress analysis
SDOF: Single Degree of Freedom
SSC: Systems, Structures and Components

See Section 5.0 Definitions for more abbreviations

3.0 REFERENCES

Note: Any deviation from the recommendations of US NRC Reg Guide 1.100 (current edition) requires Eskom Nuclear Engineering review and approval.

3.1 IEE 344-2004: Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations as endorsed by US NRC Reg Guide 1.100 (latest revision)

3.2 KBA 12 22 E02 008 Rev 1: Qualification of Safety-Related Electrical Equipment - General Seismic Test Specification

3.3 KBA 00 22 E06 950 Rev 2: Seismic Withstand Test Specification for Safety Related Electrical Equipment

3.4 KBA 12 22 E10 004 Rev 3: Equipment List for BNI Mechanical Equipment

3.5 KBA 12 22 E02 034 Rev 6: Seismic and DBA Qualification - Summary Document

3.6 KBA 00 22 E06 952 Rev 4: Seismic Qualification of the Equipment falling in CGEE/AA Scope of Supply - Summary Document

3.7 KBA 00 22 E01 020 Rev 2: Floor Response Spectra for the Design of Equipment and Piping Systems

3.8 KBA 09 A2 C00 033 Rev 4: Seismic Interface Civil/Mechanical Structures

3.9 KBA 09 11 F00 591 Rev 1: SEC Pumphouse Floor Response Design Spectra

3.10 KSS 6.3 Rev 0 Seismic Design of Plant Systems and Equipment.

3.11 KBA 12 22 E01 017 Rev 1: NSSS Auxiliary Equipment Resistance to Earthquakes

3.12 KBA 00 22 E06 005 Rev 1: BNI Summary of Equipment Seismic Data

3.13 KBA 12 22 E02 039 Rev 1: General Evaluation Report on Class 1E Electrical equipment Seismic Test Results

3.14 SAR II-1.8.2: PROTECTION OF THE EQUIPMENT AGAINST EARTHQUAKES

3.15 KGU-013: Guide for the Use of Lead Blankets for Temporary Radiation Shielding

3.16 KAA-561: The Control of Free-Standing Equipment that could affect Safety Related Equipment

3.17 KSM-031: Scaffolding Program

3.18 SAR 2-1.8.1 Protection of Buildings against earthquakes

3.19 IEEE Standard 1012-1998: Standard for Software Verification and Validation

3.20 10 CFR Part 50, Appendix S

3.21 KBA1215K00041: Checking Of The Loading Of The Cable Trays

3.22 ASME III Non Mandatory Appendix N: Dynamic analysis methods

3.23 ASME QME-1: Qualification of Active Mechanical equipment Used in Nuclear Power Plants as endorsed by US NRC Reg Guide 1.100 (latest revision).

3.24 Reg Guide 1.100: Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants

3.25 Reg Guide 1.92: Combining Modal and Spatial Components in Seismic Response Analysis

3.26 IEC 60068.2.6 Environmental Testing - Tests - Test Fc: Vibration (Sinusoidal)

3.27 ASME NQA-1: Quality Assurance Requirements for Nuclear Facility Applications

3.28 ISO-9001 2008. Quality Management Systems Requirements

3.29 Reg. Guide 1.61: Damping Values for Seismic Design of Nuclear Power Plant

3.30 RD-0034: Quality and Safety Management Requirements for Nuclear Installations

3.31 238-101: Nuclear Division Supplier Safety and Quality Management Requirements

4.0 SPECIFIC QUALIFICATION REQUIREMENTS

Combination of the 3 seismic directional forces shall be done in accordance with Reference 3.25.

4.1 Operational Conditions

Equipment being qualified shall be tested under normal operational conditions as far as it is technically possible. These conditions may be simulated providing that they are compatible with the actual operational ones. The test procedure shall state test conditions describing the loads (electrical and thermal / mechanical loads, etc ...) as well as the electrical and mechanical functions and conditions to be taken into account for qualification.

Instrumentation lines, pipes and electrical connections shall be taken into consideration.

4.2 Equipment mounting

Equipment mounting on the shake table or FEA model will reproduce the exact mounting and support structure as on site. Position of the equipment shall be identical as gravitational force shall be taken into consideration. Shake table qualification of equipment therefore requires that its mounting structure is included in the test installation.

4.3 Software

Software utilised for seismic qualification shall be NRC approved or authorised for use by means of a nuclear approved verification and validation (V&V) process which satisfies the requirements of Reference 3.19 (or a similar industry standard subject to approval by Eskom Koeberg).

4.4 Personnel

Contractor personnel performing and reviewing the qualification and or testing for Koeberg shall have at least 2 years' experience in seismic qualification of nuclear equipment.

4.5 Valves, pumps and motors

Simple items which require seismic qualification and have natural frequencies greater than 33 Hz may be analysed by the equivalent static analysis method in compliance with ASME Section III or IEEE 344. Equivalent static seismic loads are applied at the centre of gravity of the total assembly. Stresses at the connection points on the body and especially at the body-to-bonnet connection are compared to allowable stress limits. When these items are of sufficient complexity and/or functionality, either shake table testing or a full dynamic analysis in accordance with IEEE 344 requirements will be required.

For valves the equivalent static loads for OBE and SSE result from an acceleration value of 3.2 and 4 g respectively for each of the mutually perpendicular co-ordinates.

The loads imposed by the attachments such as piping or heavy cables shall also be taken into account. Weak points such as bearings and other high stress points shall be analysed.

Complex valve actuator assemblies may require shake table testing to demonstrate functionality.

In order to assure operability under combined loadings, the stresses resulting from the applied test loads should envelope the specified service stress limit for which the component's operability is intended. Stresses in mountings, bodies and casings should be limited to the particular material's elastic limit when the component is subject to the combination of normal operating loads, SSE, and other applicable dynamic loads

4.6 Electrical/instrumentation that has moving parts such as switches or relays, mounted in a cabinet or frame that is not rigid.

These assemblies are analysed by shake table testing with the RRS applied at the mounting points of the cabinet or frame.

Conservative enveloping spectra as defined in Figures 3 and 4 of Reference 3.2 may also alternatively be used to qualify these items individually. In this case demonstration shall be provided that the enveloping spectra account for any potential acceleration amplification of flexible equipment.

4.7 Axial Seismic Movement

The qualification shall show that adequate movement is successively applied to the 3 major perpendicular axes, defined as follows:
axis OX : Longitudinal horizontal axis (front-rear)
axis OY : Transversal horizontal axis (from left to right)
axis OZ : Vertical axis.

4.8 Search for Resonant Frequencies

Resonant frequency determination shall be carried out in accordance with Reference 3.1.

A frequency is considered as a resonance when the ratio between the acceleration level measured on the equipment (on peak value of the curve) and that applied to the vibration generator is higher or equal to 1,5.

4.9 Motion Control Measurement and Recording

Actual motion of the vibration generator table shall be controlled and recorded during the testing to ensure that the RRS is enveloped by the test motion.

4.10 Shake Table Instrumentation

Equipment motion shall also be measured and recorded.

A sufficient quantity of representative measurement points (accelerometers) shall be selected, and in particular:

a) Farthest point from the vibration generator table

b) Points located on ample masses expected to produce resonances within considered frequency range

c) Locations of the measurement points will be documented in the resulting test report.

Instrumentation shall be fitted to shake table qualified equipment to verify and record equipment functionality before, during and after qualification tests.

4.11 Tolerances

Tolerances on the vibration level and frequency shall be compatible with sub-clause 3.2.2. and 3.2.3. of IEC 60068.2.6 (Ref. 3.26).

5.0 DEFINITIONS

Cutoff Frequency:
The frequency in the response spectrum where the ZPA asymptote begins. This is the frequency beyond which the single-degree-of-freedom (SDOF) oscillators exhibit no amplification of motion and indicate the upper limit of the frequency content of the waveform being analyzed.

Damping:
An energy dissipation mechanism that reduces the amplification and broadens the vibratory response in the region of resonance. It is usually expressed as a percentage of critical damping. Critical damping is defined as the least amount of viscous damping that causes a SDOF system to return to its original position without oscillation after initial disturbance.

Flexible Equipment:
Equipment, structures, and components whose lowest resonant frequency is less than the cutoff frequency on the response spectrum.

Floor Acceleration:
The acceleration of a particular building floor (or equipment mounting) resulting from the motion of a given earthquake. The maximum floor acceleration is the ZPA of the floor response spectrum.

Ground Acceleration:
The acceleration of the ground resulting from the motion of a given earthquake. The maximum ground acceleration is the ZPA of the ground response spectrum.

Independent Items:
Components and equipment that (a) have different physical characteristics or (b) experienced different seismic motion characteristics, e.g., different earthquakes, different sites, different buildings, or different orientations/locations in the same building.

Natural Frequency:
The frequency(s) at which a body vibrates due to its own physical characteristics (mass and stiffness) when the body is distorted in a specific direction and then released.

Operating Basis Earthquake (OBE):
An earthquake that could reasonably be expected to occur at the plant site during the operating life of the plant considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is that earthquake that produces the vibratory ground motion for which those features of the nuclear power plant, necessary for continued operation without undue risk to the health and safety of the public, are designed to remain functional.

Required Response Spectrum (RRS):
The response spectrum issued by the user or the user's agent as part of the specifications for qualification or artificially created to cover future applications. The RRS constitutes a requirement to be met.

Resonant Frequency:
A frequency at which a response peak occurs in a system subjected to forced vibration. This frequency is accompanied by a phase shift of response relative to the excitation.

Response Spectrum:
A plot of the maximum response, as a function of oscillator frequency, of an array of SDOF damped oscillators subjected to the same base excitation.

Rigid Equipment:
Equipment, structures, and components whose lowest resonant frequency is greater than the cut-off frequency on the response spectrum.

Safe Shutdown Earthquake (SSE):
An earthquake that is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is that earthquake that 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 necessary to ensure the following:

a) Integrity of the reactor coolant pressure boundary
b) Capability to shut down the reactor and maintain it in a safe shutdown condition
c) Capability to prevent or mitigate the consequences of accidents that could result in potential off-site exposures comparable to the guideline exposures of 10 CFR—Chapter 1, Part 100

Seismic Ruggedness:
The ability to resist the damaging effects of an earthquake imparted by robust design and manufacture.

Seismic Vulnerability:
A physical and/or electrical characteristic that renders an equipment item susceptible to structural damage or malfunction from the effects of an earthquake.

Test Response Spectrum (TRS):
The response spectrum that is developed from the actual time history of the motion of the shake table.

Zero Period Acceleration (ZPA):
The acceleration level of the high-frequency, non-amplified portion of the response spectrum. This acceleration corresponds to the maximum peak acceleration of the time history used to derive the spectrum.

6.0 DOCUMENTATION REQUIREMENTS

The contractor responsible for the seismic qualification shall supply records detailing the seismic qualification of the equipment. Complete and auditable records shall be supplied in a single document. These records shall contain sufficient detail to document full compliance with this specification.

The documents shall include the following minimum information:

a) Identification of equipment, including vendor, model number, and location within each building.
b) Physical description, including dimensions, weight, and field mounting condition, and identification of whether the equipment is pipe-, floor-, or wall-supported.
c) A description of the equipment's function within the system.
d) Identification of all design (functional) specifications and qualification reports and their locations. Functional specifications for active valve assemblies should conform to Ref. 3.23.
e) Description of the required loads and their intensities for which the equipment must be qualified.
f) If qualification by test, identification of the test methods and procedures, important test parameters, and the test results.

g) If qualification by analysis, identification of the analysis methods and assumptions and comparisons between the calculated and allowable stresses and deflections for critical elements.
h) The natural frequency (or frequencies) of the equipment.
i) Identification of whether the equipment may be affected by vibration
j) Fatigue cycle effects and a description of the methods and criteria used to qualify the equipment for such loading conditions.
k) A compilation of the required response spectra (or time history) and corresponding damping for each seismic and dynamic load specified for the equipment together with all other loads considered in the qualification and the method of combining all loads.
l) Computer programs, systems, versions, etc. shall be specified.
j) Proof that the TRS envelopes the RRS.
k) Description and location of the testing installations.
l) Description of the testing procedure, including any limitations.
m) Calibration records of test instruments.
n) Test data including graphs and tables.
o) Compiler reviewer and approver details and signatures.
p) Date and signature for Eskom approval.

7.0 ENGINEERING QUALITY REQUIREMENTS

Seismic qualification shall be classified as a Q1 service. The contractor shall be qualified according to Eskom Koeberg Contractor Qualification Standards, compliant to ASME NQA-1(Ref. 3.27) requirements and certified to ISO-9001 2008 (Ref. 3.28). The contractor shall also meet the requirements of Ref. 3.30 and 3.31.

The contractor shall provide a Quality Control Plan to Eskom for review covering the various phases of the works, prior to commencement of the works. (The purpose is to allow for sufficient oversight from Eskom of the contractor's processes).

The seismic qualification shall be completed by suitably qualified and experienced personnel who have been evaluated and authorised by the Contractor. A list of key persons and a brief CV shall be provided to Eskom at tender phase.

8.0 APPENDICES

Appendix 8.1 Background Information

Appendix 8.2 Koeberg Seismic Island Horizontal Envelope Floor Response Spectrum

Appendix 8.3 Koeberg Seismic Island Vertical Envelope Floor Response Spectrum

Appendix 8.1: Background Information

Seismic Spectrum

Earthquake shock waves are transmitted to the floors supporting the equipment via the building structures. These waves have been determined by means of synthetic calculations.

The effects of these waves are defined by the reactions of single-degree-of-freedom oscillators connected to the floors. These reactions are displayed by the floor oscillator response spectra.

The spectra normally indicate the acceleration and associated frequency on a logarithmic graph.

Horizontal and vertical spectra exist for specific plant locations. There are also envelope spectra, which envelope several areas of the plant.

Each building floor may have several spectra with different magnitudes depending on the damping values and earthquake severity

The displacement of the floor during an earthquake can be divided into three perpendicula axes. The same horizontal spectrum is applied to both horizontal axes, and the associated vertical spectrum is applied to the vertical axes

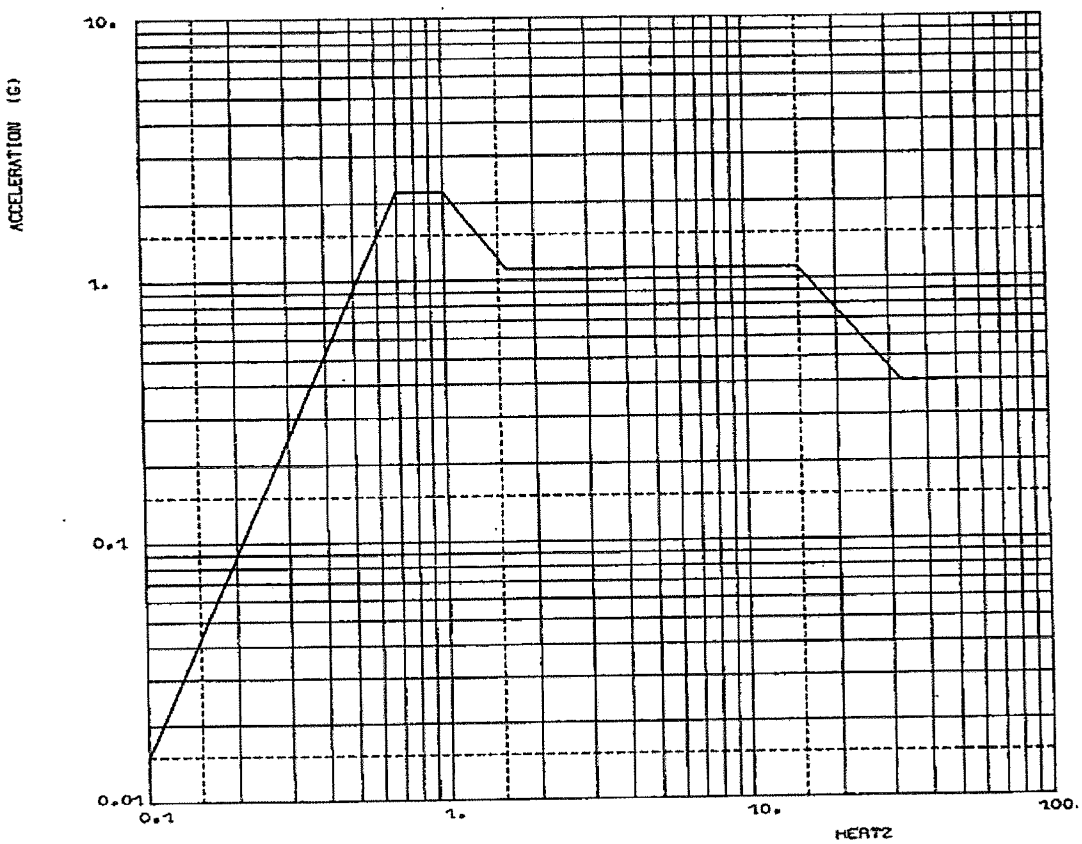
Damping

Damping is an energy dissipation mechanism that reduces the amplification and broadens the vibratory response in the region of resonance. Damping is usually expressed as a percentage of critical damping. Critical damping is the amount of damping which removes all vibration from the system. Vibrating SSCs have energy losses that depend on numerous factors, such as material characteristics, stress levels, and geometric configuration. This dissipation of energy, or damping effect, occurs because a part of the excitation input is transformed into heat, sound waves, and other energy forms.

The response of a system to dynamic loads is a function of the amount and type of damping existing in the system. Damping is also used to account for many nonlinear effects such as changes in boundary conditions, joint slippage, concrete cracking, gaps, and other effects that tend to alter response amplitude.

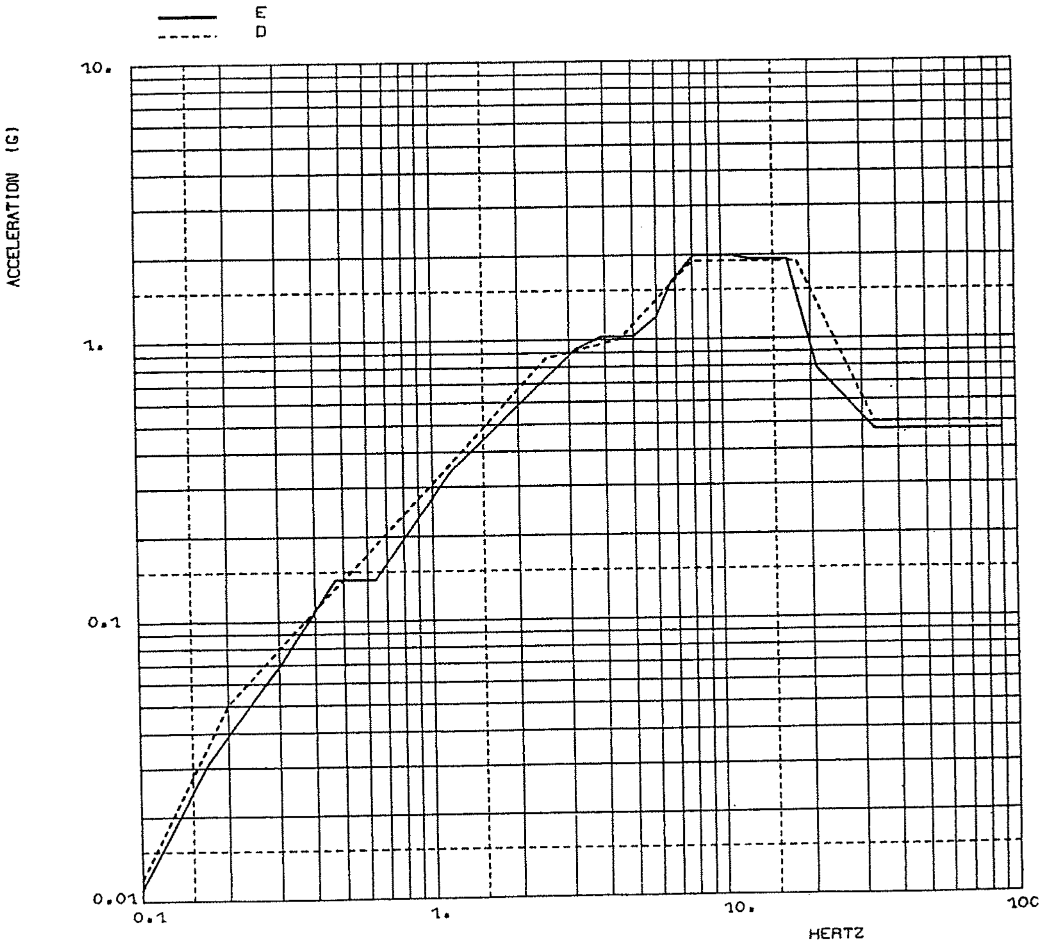
Koeberg Spectra are typically for damping of 2%, 4% for primary piping, and 5% damping for instrumentation and control assemblies. Higher damping values are used when justified by equipment behaviour and nuclear standards. The damping values given in Regulatory Guide (RG) 1.61 (Ref. 3.29) may be applied for seismic analysis of Koeberg SSCs subject to approval by Eskom Koeberg.

Appendix 8.2: Koeberg Seismic Island Horizontal Envelope Floor Response Spectrum (2% damping)



HERTZ	ACCELERATION (G)
0.10	0.015
0.70	2.20
1.00	2.20
1.61	1.10
15.0	1.10
33.0	0.40
80.0	0.40

Appendix 8.3: Koeberg Seismic Island Vertical Envelope Floor Response Spectrum (2% damping)



HERTZ	ACCELERATION (G)
0.10	0.011
0.17	0.031
0.31	0.072
0.47	0.14
0.64	0.14
1.16	0.34
3.14	0.92
3.87	1.02
5.00	1.02
6.00	1.20
6.71	1.58
8.06	1.99
10.9	1.99
12.3	1.93
16.7	1.93
21.0	0.78
33.0	0.47
90.0	0.47