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REGULATORY GUIDE

Technical Lead
Sarah Tabatabai
301-415-7000

REGULATORY GUIDE 1.60

DESIGN RESPONSE SPECTRA FOR SEISMIC DESIGN OF NUCLEAR POWER PLANTS

A. INTRODUCTION

Purpose

This regulatory guide describes an approach that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for defining response spectra for the seismic design of nuclear power plants to satisfy the requirements of Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," to Part 100, "Reactor Site Criteria," of Title 10 of the *Code of Federal Regulations* (10 CFR Part 100) (Ref. 1). Regulatory Guide (RG) 1.60 forms part of the licensing basis for a number of nuclear power plants constructed during the 1970s and 1980s. Specifically, the safe shutdown earthquake ground motion (SSE) for these nuclear power plants is defined by a RG 1.60 response spectrum.

The prominent role of probabilistic seismic hazard assessments (PSHA) led to the establishment in 1997 of new requirements for the siting regulation in 10 CFR 100.23, "Geologic and Seismic Siting Criteria," which specifies a different set of requirements to define the SSE. Regulatory Guide 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion" (Ref. 2) presents an NRC-acceptable approach to define the site-specific earthquake ground motion response spectrum (GMRS) that satisfies the requirements of 10 CFR 100.23and leads to the establishment of the SSE. The final SSE must also satisfy Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities" (Ref. 3).

Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," of the Commission's regulations (Ref. 4) provides a licensing framework for nuclear power plants. RG 1.60 has applicability within the 10 CFR Part 52 licensing framework. According to Section 5.3 of NRC Interim Staff Guidance (ISG) ISG-017, "Interim Staff Guidance on Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses," (Ref. 5) a RG 1.60 response spectrum, anchored at 0.1 g, is considered to be an appropriately shaped response spectrum to define the minimum seismic input requirement at the foundation as required by Appendix S to 10 CFR Part 50. In addition, the certified

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seismic design response spectra (CSDRS) for several new reactor design certification applications[1] are derived from RG 1.60 spectra with modified control points to broaden the spectra in the higher frequency range.

Applicable Regulations

- Title 10, Part 50, of the *Code of Federal Regulations* (10 CFR Part 50), “Domestic Licensing of Production and Utilization Facilities,” governs the licensing of domestic production and utilization facilities.

- Appendix A, to 10 CFR Part 50, provides general design criteria (GDC) for nuclear power plants. The following GDC are of importance to the seismic design of nuclear power plants:

    - GDC 1, “Quality Standards and Records,” requires, in part, that structures, systems, and components (SSCs) important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

    - GDC 2, “Design Bases for Protection Against Natural Phenomena,” requires that structures important to safety be designed to withstand the effects of expected natural phenomena when combined with the effects of normal accident conditions without loss of capability to perform their safety function

- Appendix S to 10 CFR Part 50, “Earthquake Engineering Criteria for Nuclear Power Plants,” provides the engineering criteria for nuclear power plants.

- 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” governs the issuance of early site permits, standard design certifications, combined licenses, standard design approvals, and manufacturing licenses for nuclear power facilities

- 10 CFR Part 100, “Reactor Site Criteria,” requires NRC to consider the physical characteristics of a site including seismology and geology in determining the site’s acceptability for a nuclear power reactor.

- 10 CFR 100.23, “Geologic and seismic siting criteria,” specifies the requirements to define the SSE.

- Appendix A to 10 CFR Part 100, “Seismic and Geologic Siting Criteria for Nuclear Power Plants,” provides the seismic and geologic siting criteria for nuclear power plants applicable to an operating license applicant or holder whose construction permit was issued prior to January 10, 1997.

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[1] The NRC staff’s final safety evaluation reports for the AP1000, Economic Simplified Boiling-Water Reactor (ESBWR), and Advances Boiling-Water Reactor (ABWR) design certification applications are available under the respective ADAMS Accession Numbers ML112061231, ML110040021, and ML080670509. At the time of this RG update, the US-APWR design certification application is still under NRC review.

Related Guidance

- Regulatory Guide (RG) 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," provides guidance on the development of the site-specific ground motion response spectrum (GMRS). The GMRS represents the first part of the development of the Safe Shutdown Earthquake ground motion (SSE) for a site as a characterization of the regional and local seismic hazard. The final SSE must satisfy both 10 CFR 100.23 and Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50.

- Interim Staff Guidance (ISG-017), "Interim Staff Guidance on Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses," supplements the guidance provided to the staff in Sections 2.5 and 3.7 of NUREG-0800 and ISG-01, "Interim Staff Guidance on Seismic Issues Associated with High Frequency Ground Motion in Design Certification and Combined License Applications" (Ref. 6).

- NUREG-0800, "Standard Review Plan (SRP) for the review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," (Ref. 7) Section 2.5.1 "Basic Geologic and Seismic Information, Section 2.5.2 "Vibratory Ground Motion," and Section 3.7.1 "Seismic Design Parameters," assures the quality and uniformity of staff safety reviews. It is also the intent of this plan to make information about regulatory matters widely available and to improve communication between the NRC, interested members of the public, and the nuclear power industry, thereby increasing understanding of the NRC's review process.

Purpose of Regulatory Guides

The NRC issues regulatory guides to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations and compliance with them is not required. Methods and solutions that differ from those set forth in regulatory guides will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

Paperwork Reduction Act

This regulatory guide contains information collection requirements covered by 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100 that the Office of Management and Budget (OMB) approved under OMB control numbers 3150-0011, 3150-0151 and 3150-0093, respectively. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number.

B. DISCUSSION

Reason for Change

The changes in this revision (Revision 2) reflect the applicability of RG 1.60 to the 10 CFR Part 52 licensing framework for new reactors. Other changes included updated reference materials, updated glossary, the text of the footnote on the first page, insertion of text in the Introduction explaining the purpose of regulatory guides, the Paperwork Reduction Act, update of the discussion in the Implementation section, and inclusion of the accession numbers for the NRC's Agencywide Documents Access and Management System (ADAMS) in the reference section.

Background

The NRC staff has used the 1973 version of RG 1.60 for numerous siting and licensing activities since its initial publication and it has also been used effectively by both domestic and international stakeholders. It forms part of the licensing basis for nuclear power plants constructed during the 1970s and 1980s. The new reactors, however, utilize other methods for determining the design response spectra through the calculation of the ground motion response spectra (GMRS) for early site permits (ESPs), or combined construction and operating licenses (COLs).

The prominent role of probabilistic seismic hazard assessments (PSHA) led to the establishment in 1997 of new requirements for the siting regulation in 10 CFR Part 100.23, "Geologic and Seismic Siting Criteria." The new siting regulation, which applies to new reactors as well as nuclear power plant construction permits or operating licenses on or after January 10, 1997, requires, in part, the explicit consideration of the uncertainties associated with geological and seismological characteristics through an appropriate analysis, such as PSHA. The role of PSHA also led to the development of RG 1.165 (Ref. 8), which was subsequently withdrawn and replaced by RG 1.208 in 2007. That guide provides general guidance on methods acceptable to the NRC staff for: (1) conducting geological, geophysical, seismological, and geotechnical investigations; (2) identifying and characterizing seismic sources; (3) conducting a probabilistic seismic hazard assessment (PSHA); (4) determining seismic wave transmission (soil amplification) characteristics of soil and rock sites; and (5) determining a site-specific, performance-based GMRS, satisfying the requirements of paragraphs (c), (d)(1), and (d)(2) of 10 CFR 100.23, and leading to the establishment of a Safe Shutdown Earthquake (SSE) to satisfy the design requirements of Appendix S to 10 CFR Part 50. According to Appendix S to 10 CFR Part 50, the foundation level ground motion must be represented by an appropriate response spectrum with a peak ground acceleration of at least 0.1 g. The steps necessary to develop the final SSE are described in Chapter 3, "Design of Structures, Components, Equipment and Systems," of NUREG-0800, and Regulatory Position 5.4 of RG 1.208 provides a detailed description of the development of the final SSE. ISG-017 supplements the guidance provided in NUREG-0800 and states that RG 1.60, anchored at 0.1 g, is an appropriately shaped response spectrum to define the minimum seismic input requirement at the foundation as required by Appendix S to 10 CFR Part 50.

Although RG 1.60 is no longer used to characterize the hazard for the seismic design of nuclear power plants, the CSDRS for several new reactor designs are derived from RG 1.60 spectra with modified control points to broaden the spectra in the higher frequency range. Specifically, RG 1.60 spectral values are based on deterministic values for western United States earthquakes, however, recent observations have shown that high frequency motions at central and eastern United States (CEUS) rock sites may be significantly greater than motions recorded at WUS rock sites.

Response Spectra Shapes

Appendix A to 10 CFR Part 100, which now applies only to an operating license applicant or holder whose construction permit was issued prior to January 10, 1997, specifies a number of required investigations for determining the SSE, that is, the potential maximum earthquake for which structures, systems, and components important to safety, are designed to sustain and remain functional.

The recorded ground accelerations and response spectra of past earthquakes provide a basis for the design of structures to resist earthquakes. Appendix A requires developing response spectra corresponding to the expected maximum ground acceleration for a site, but does not give a specific method for defining the response spectra. The response spectra developed for a site are known as the Design Response Spectra. The Design Response Spectra can be developed statistically from response spectra of past strong-motion earthquakes, as was done by Newmark, Blume and Kapur (Ref. 9, 10, 11 and 12). After reviewing these documents, the Atomic Energy Commission (AEC) (now NRC) staff determined that this procedure for defining the Design Response Spectra on sites underlain by either rock or soil deposits and covering all frequencies of interest was acceptable. However, for unusually soft sites, modification to this procedure will be required.

The horizontal and vertical component Design Response Spectra in Figures 1 and 2, respectively, of this guide correspond to a maximum horizontal ground acceleration of 1.0 g. For sites with different acceleration values specified for the design earthquake, the Design Response Spectra should be linearly scaled from Figures 1 and 2 in proportion to the specified maximum horizontal ground acceleration. For sites that (1) are relatively close to the epicenter of an expected earthquake or (2) have physical characteristics that could significantly affect the spectral pattern of input motion, such as being underlain by poor soil deposits, the procedure described above will not apply. In these cases, the Design Response Spectra should be developed individually according to the site characteristics.

1. **The Horizontal Component -** The numerical values of design displacements, velocities, and accelerations for the horizontal component Design Response Spectra are obtained by multiplying the corresponding values of the maximum ground displacement and acceleration by the factors given in Table 1 of this guide. In this procedure, the configurations of the horizontal component Design Response Spectra for each of the two mutually perpendicular horizontal axes are shown in Figure 1 of this guide. These shapes agree with those developed by Newmark, Blume, and Kapur and shown in Figure 15 of Ref. 9 as well as Figure 9 of Ref. 10. In Figure 1, the base diagram consists of three parts: the bottom line on the left part represents the maximum ground displacement, the bottom line on the right part represents the maximum acceleration, and the middle part depends on the maximum velocity. The horizontal component Design Response Spectra in Figure 1 of this guide correspond to a maximum horizontal ground acceleration of 1.0 g. The maximum ground displacement is taken proportional to the maximum ground acceleration, and is set at 36 inches for a ground acceleration of 1.0 g. The displacement region lines of the Design Response Spectra are parallel to the maximum ground displacement line and are shown on the left of Figure 1. The velocity region lines slope downward from a frequency of 0.25 cycles per second (cps) or Hertz (Hz) (control point D) to a frequency of 2.5 cps (control point C) and are shown at the top. The remaining two sets of lines between the frequencies of 2.5 cps and 33 cps (control point A), with a break at a frequency of 9 cps (control point B), constitute the acceleration region of the horizontal Design Response Spectra. For frequencies higher than 33 cps, the maximum ground acceleration line represents the Design Response Spectra.

Table 1. Horizontal Design Response Spectra

Relative Values of Spectrum Amplification Factors for Control Points

Percent of Critical Damping	Amplification Factors for Control Points			
	Acceleration[a,b]			Displacement[a,b]
	A (33 cps)	B (9 cps)	C (2.5 cps)	D (0.25 cps)
0.5	1.0	4.96	5.95	3.20
2.0	1.0	3.54	4.25	2.50
5.0	1.0	2.61	3.13	2.05
7.0	1.0	2.27	2.72	1.88
10.0	1.0	1.90	2.28	1.70

a. Maximum ground displacement is taken proportional to maximum ground acceleration, and is 36 in. for ground acceleration of 1.0 gravity.

b. Acceleration and displacement amplification factor are taken from recommendations given in Reference 9.

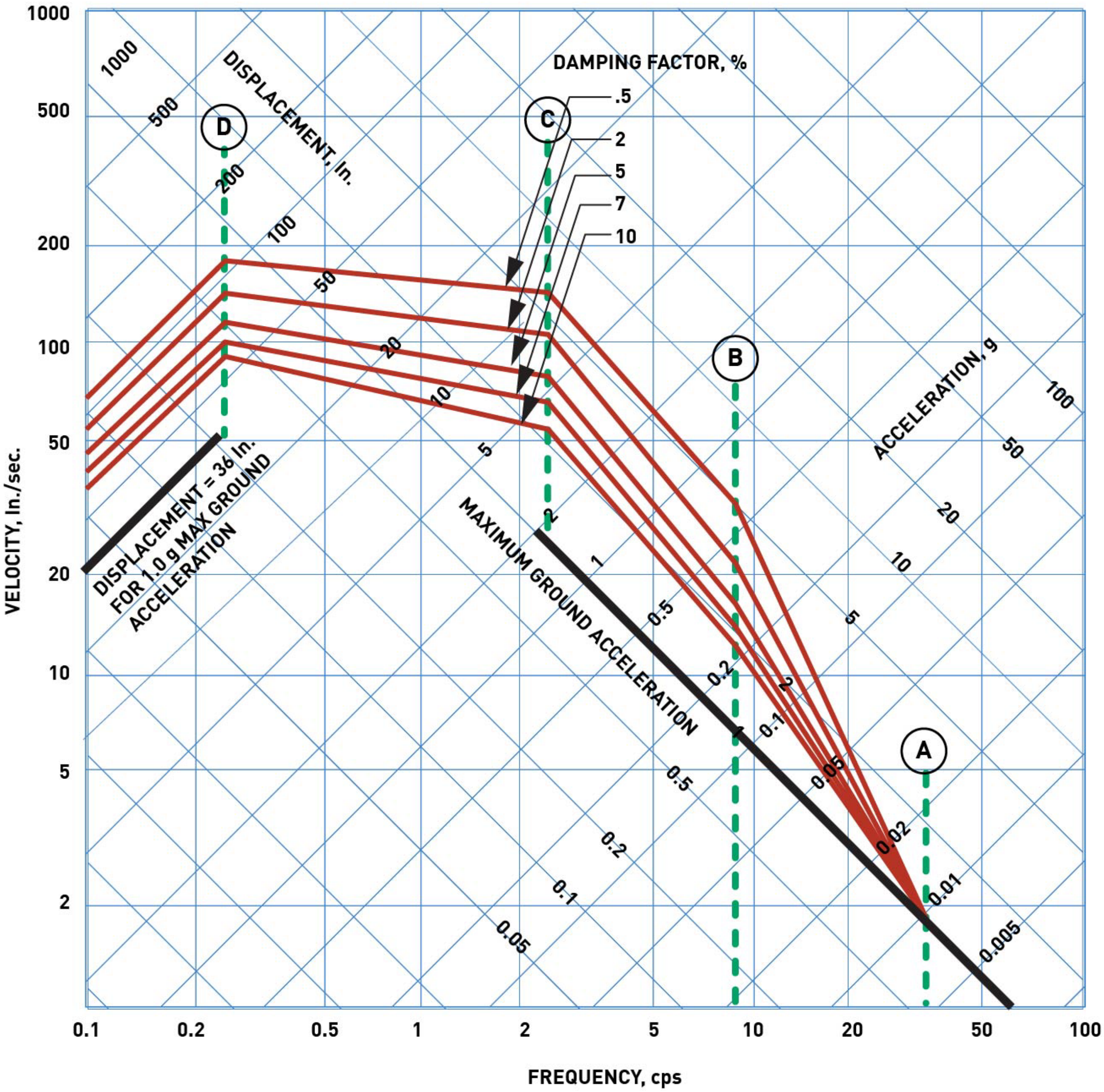

Figure 1. Horizontal Design Response Spectra Scaled to 1 g Horizontal Ground Acceleration

2. **The Vertical Component -** The numerical values of design displacements, velocities, and accelerations in these spectra are obtained by multiplying the corresponding values of the maximum horizontal ground motion (acceleration = 1.0 g and displacement = 36 in.) by the factors given in Table 2 of this guide. The vertical component Design Response Spectra corresponding to the maximum horizontal ground acceleration of 1.0 g are shown in Figure 2 of this guide. Construction of the spectral shapes in Figure 2 followed the instructions in references 7 and 8 for the construction of vertical component spectra, which are as described in the following. The displacement region lines of the Design Response Spectra are parallel to the maximum ground displacement line and are shown on the left of Figure 2. The velocity region lines slope downward from a frequency of 0.25 cps (control point D) to a frequency of 3.5 cps (control point C) and are shown at the top. The remaining two sets of lines between the frequencies of 3.5 cps and 33 cps (control point A), with a break at the frequency of 9 cps (control point B), constitute the acceleration region of the vertical Design Response Spectra. It should be noted that the vertical Design Response Spectra values are 2/3 those of the horizontal Design Response Spectra for frequencies less than 0.25; for frequencies higher than 3.5, they are the same, while the ratio varies between 2/3 and 1 for frequencies between 0.25 and 3.5. For frequencies higher than 33 cps, the Design Response Spectra follow the maximum ground acceleration line.

Table 2. Vertical Design Response Spectra

Relative Values of Spectrum Amplification Factors for Control Points

Percent of Critical Damping	Amplification Factors for Control Points			
	Acceleration[a,b]			Displacement[a,b]
	A (33 cps)	B (9 cps)	C (3.5 cps)	D (0.25 cps)
0.5	1.0	4.96	5.67[c]	2.13
2.0	1.0	3.54	4.05	1.67
5.0	1.0	2.61	2.98	1.37
7.0	1.0	2.27	2.59	1.25
10.0	1.0	1.90	2.17	1.13

a. Maximum ground displacement is taken proportional to maximum ground acceleration and is 36 in. for ground acceleration of 1.0 gravity.

b. Acceleration amplification factors for the vertical design response spectra are equal to those for horizontal design response spectra at a given frequency, whereas displacement amplification factors are 2/3 those for horizontal design response spectra. These ratios between the amplification factors for the two design response spectra are in agreement with those recommended in reference 9.

c. These values were changed to make this table consistent with the discussion of vertical components in Section B of this guide.

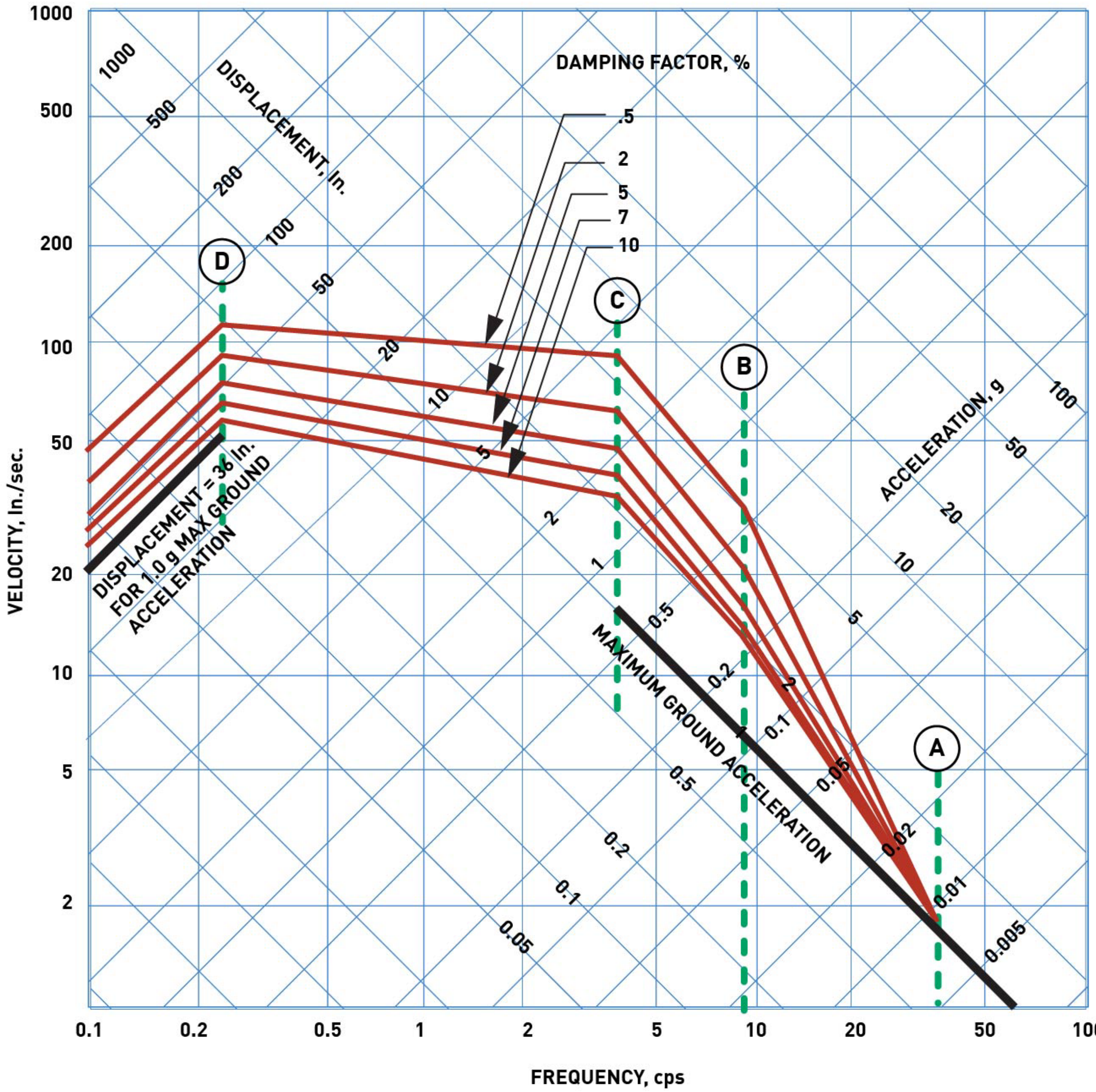

Figure 2. Vertical Design Response Spectra scaled to 1 g Horizontal Ground Acceleration

C. STAFF REGULATORY GUIDANCE

1. The horizontal component ground Design Response Spectra, without soil-structure interaction effects, of the SSE on sites underlain by rock or by soil should be linearly scaled from Figure 1[2] in proportion to the maximum horizontal ground acceleration specified for the earthquake chosen. (Figure 1 corresponds to a maximum horizontal ground acceleration of 1.0 g and accompanying displacement of 36 in.) The applicable multiplication factors and control points are given in Table 1. For damping ratios not included in Figure 1 or Table 1, a linear interpolation should be used.

2. The vertical component ground Design Response Spectra, without soil-structure interaction effects, of the SSE on sites underlain by rock or by soil should be linearly scaled from Figure 2 in proportion to the maximum horizontal ground acceleration specified for the earthquake chosen. (Figure 2 is based on a maximum horizontal ground acceleration of 1.0 g and accompanying displacement of 36 in.) The applicable multiplication factors and control points are given in Table 2. For damping ratios not included in Figure 2 or Table 2, a linear interpolation should be used.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees[3] may use this guide and information regarding the NRC's plans for using this regulatory guide. In addition, it describes how the NRC staff complies with 10 CFR 50.109, "Backfitting" and any applicable finality provisions in 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

Use by Applicants and Licensees

Applicants and licensees may voluntarily[4] use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described in this regulatory guide may be deemed acceptable if they provide sufficient basis and information for the NRC staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations. Current licensees may continue to use guidance the NRC found acceptable for complying with the identified regulations as long as their current licensing basis remains unchanged.
Licensees may use the information in this regulatory guide for actions which do not require NRC review and approval such as changes to a facility design under 10 CFR 50.59, "Changes, Tests, and Experiments." Licensees may use the information in this regulatory guide or applicable parts to resolve regulatory or inspection issues.

Use by NRC Staff

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this regulatory guide. The NRC staff does not expect any existing licensee to use or commit to using the guidance in this regulatory guide, unless the licensee makes a change to its licensing basis. The NRC

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2 This does not apply to sites which (1) are relatively close to the epicenter of an expected earthquake or (2) which have physical characteristics that could significantly affect the spectral combination of input motion. The Design Response Spectra for such sites should be developed on a case-by-case basis.

3 In this section, "licensees" refers to licensees of nuclear power plants under 10 CFR Parts 50 and 52; and the term "applicants" refers to applicants for licenses and permits for (or relating to) nuclear power plants under 10 CFR Parts 50 and 52, and applicants for standard design approvals and standard design certifications under 10 CFR Part 52.

4 In this section, "voluntary" and "voluntarily" mean that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

staff does not expect or plan to request licensees to voluntarily adopt this regulatory guide to resolve a generic regulatory issue. The NRC staff does not expect or plan to initiate NRC regulatory action which would require the use of this regulatory guide. Examples of such unplanned NRC regulatory actions include issuance of an order requiring the use of the regulatory guide, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to use of this regulatory guide, generic communication, or promulgation of a rule requiring the use of this regulatory guide without further backfit consideration.

During regulatory discussions on plant specific operational issues, the staff may discuss with licensees various actions consistent with staff positions in this regulatory guide, as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions would not ordinarily be considered backfitting even if prior versions of this regulatory guide are part of the licensing basis of the facility. However, unless this regulatory guide is part of the licensing basis for a facility, the staff may not represent to the licensee that the licensee's failure to comply with the positions in this regulatory guide constitutes a violation.

If an existing licensee voluntarily seeks a license amendment or change and (1) the NRC staff's consideration of the request involves a regulatory issue directly relevant to this new or revised regulatory guide and (2) the specific subject matter of this regulatory guide is an essential consideration in the staff's determination of the acceptability of the licensee's request, then the staff may request that the licensee either follow the guidance in this regulatory guide or provide an equivalent alternative process that demonstrates compliance with the underlying NRC regulatory requirements. This is not considered backfitting as defined in 10 CFR 50.109(a)(1) or a violation of any of the issue finality provisions in 10 CFR Part 52.

Additionally, an existing applicant may be required to comply with new rules, orders, or guidance if 10 CFR 50.109(a)(3) applies.

If a licensee believes that the NRC is either using this regulatory guide or requesting or requiring the licensee to implement the methods or processes in this regulatory guide in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in NUREG-1409, "Backfitting Guidelines," (Ref. 13) and the NRC Management Directive 8.4, "Management of Facility-Specific Backfitting and Information Collection" (Ref. 14).

GLOSSARY

Certified Seismic Design Response Spectra (CSDRS) are site-indpendent seismic design response spectra that have been approved under Subpart B of 10 CFR Part 52 as the seismic design response spectra for an approved certified standard design nuclear power plant. The input or control location for the CSDRS is specified in the certified standard design.

Design Response Spectrum is a relatively smooth relationship obtained by analyzing, evaluating, and statistically combining a number of individual response spectra derived from the records of significant past earthquakes.

Ground Motion Response Spectra (GMRS) are site-specific ground motion response spectra characterized by horizontal and vertical response spectra determined as free-field motions on the ground surface or as free-field outcrop motions on the uppermost in-situ competent material using performance-based procedures.

Maximum (peak) Ground Acceleration specified for a given site means that value of the acceleration, which corresponds to zero period in the design response spectra for that site. At zero period, the design response spectra acceleration is identical for all damping values and is equal to the maximum (peak) ground acceleration specified for that site.

Response Spectrum means a plot of the maximum response (acceleration, velocity, or displacement) of a family of idealized single-degree-of-freedom damped oscillators as a function of natural frequencies of the oscillators for a given damping value. The response spectrum is calculated for a specified vibratory motion input at the oscillators' supports.

Safe Shutdown Earthquake Ground Motion (SSE) is the vibratory ground motion for which certain structures, systems, and components are designed, pursuant to Appendix S to 10 CFR Part 50, to remain functional. The SSE for the site is characterized by both horizontal and vertical free-field ground motion response spectra at the free ground surface.

REFERENCES

1. *U.S. Code of Federal Regulations*, "Reactor Site Criteria," Part 100, Chapter I, Title 10, "Energy."

2. U.S. Nuclear Regulatory Commission (NRC), Regulatory Guide 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," Washington, DC.

3. *U.S. Code of Federal Regulations*, "Domestic Licensing of Production and Utilization Facilities Part 50, Chapter I, Title 10, "Energy

4. *U.S. Code of Federal Regulations*, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Part 52, Chapter I, Title 10, "Energy."

5. NRC Interim Staff Guidance (ISG) ISG-017, "Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses," March 24, 2010, Washington, DC (ADAMS Accession No. ML100570203).

6. NRC ISG-01, "Interim Staff Guidance on Seismic Issues Associated with High Frequency Ground Motion in Design Certification and Combined License Applications," May 19, 2008, Washington, DC (ADAMS Accession No. ML081400293)

7. NRC, "Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," NUREG–0800, Washington, DC.

8. NRC, Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion," Washington, DC.

9. Newmark, N. M., John A. Blume, and Kanwar K. Kapur, "Design Response Spectra for Nuclear Power Plants," American Society of Civil Engineers (ASCE) Structural Engineering Meeting, San Francisco, April 1973, (ADAMS Accession No. ML13207A044).

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13. NRC, "Backfitting Guidelines," NUREG-1409, July 1990, Washington, DC (ADAMS Accession No. ML032230247).

14. NRC, "Management of Facility-specific Backfitting and Information Collection," NRC Management Directive 8.4.