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For Signature of:

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Description:
The initial use of Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Earthhquake Ground Motion"

Assigned To:
DE

Contact:
BARRETT, RICHARD J

Special Instructions:

NUCLEAR ENERGY INSTITUTE

Adrian P Heymer
DIRECTOR, NEW PLANT
DEPLOYMENT
NUCLEAR GENERATION DIVISION

November 30, 2004

Mr. Richard J Barrett
Director, Division of Engineering
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Mr. Barrett:

The initial use of Regulatory Guide 1.165, *"Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion,"* has raised implementation issues that were not anticipated in the drafting of the guideline. The use of the guideline, which recommends a new, probabilistic seismic hazard assessment method for determining the site seismic ground motion, has resulted in unpredictable and unrealistically high ground motion estimates for some prospective ESP sites. This introduces a high potential at many Eastern U.S. locations for regulatory and technical instability. This uncertainty will become a barrier in the decision-making process for proceeding with a new nuclear plant order.

In the work by two applicants to support early site permit applications, the ground motion analyses using the regulatory guide methodology produces unexpected and very high ground motion estimates in the high frequency range. In addition, the regulatory guide requires licensees to update the seismic design bases ground motion at periodic intervals and at intervals based on changes to the reference probability of 29 sites. Thus, seismic activity in the vicinity of one site results in an update at another site located at a remote distance from the affected site. This will result in the expenditure of significant and unnecessary resources during the life of the license and will not provide for the degree of regulatory stability and finality envisioned for the new Part 52 licensing process.

In response to the identification of these issues, the industry is evaluating a modified approach to the Reg. Guide 1.165. It is a performance-based approach, which still incorporates a probabilistic seismic hazard assessment element. This modified approach is based on an approved national consensus standard, ASCE/SEI 43-05, *Seismic Design Criteria for Structures, Systems, and Components for Nuclear*

current technological approaches that have been developed during the past ten years, such as those described in NUREG/CR-6728. The ASCE standard has been approved and will be published in 2005.

In the regulatory interactions on two of the early site permit applications, questions have been raised on whether 10 CFR 100.23 provides sufficient flexibility to allow the use of performance-based approaches, such as the ASCE Standard. Attached is an industry White Paper, which shows that the ASCE performance-based methodology for defining the site seismic design spectra meets the requirements of Section 100.23.

To address high frequency range estimates for non-damaging accelerations derived from the Regulatory Guide 1.165 methodology, the industry is reviewing the EPRI report TR-102470, *Analysis of High-Frequency Seismic Effects*, to determine whether any revisions need to be made based on information that has become available subsequent to its publication. This review will be completed by the end of the year.

The industry would like to meet with the NRC staff early in 2005 to discuss the issues described in this letter and develop a plan for the generic resolution. Following the discussions, the industry will prepare a generic submittal on an alternative seismic ground motion evaluation methodology.

If you have any questions regarding this matter, please contact me (202-739-8094; aph@nei.org) or Cedric Jobe (202-739-8128; cij@nei.org).

Sincerely,

Adrian Heymer

Enclosure

c: Dr. Brian W Sheron, NRC
Dr. William D. Beckner, NRC
Mr. Eugene V. Imbro, NRC

Enclosure

Regulatory Basis for a Performance-Based Methodology for Establishing the Design SSE for ESP Sites

Purpose

The purpose of this white paper is to describe the regulatory basis for a *performance-based* approach for determining a risk-consistent seismic design basis for ESP sites and certified ALWR nuclear plants constructed on these sites. (This paper does not address the technical bases for this methodology).

Background

NRC Reg. Guide 1.165[1] provides guidance for estimating the seismic ground motion hazard and design Safe Shutdown Earthquake (SSE) for nuclear plant sites. Initial use of this guidance has resulted in unpredictable and unrealistically high ground motion estimates for some prospective ESP sites. There is also a potential concern that the Reg. Guide method may not provide the regulatory stability that was originally intended. For these reasons, the industry is evaluating an alternative to the Reg. Guide methodology for determining the appropriate design SSE spectra for potential ESP sites. It is clear from the initial attempts to follow the guidance in Reg. Guide 1.165 that such an alternative will be required for many ESP sites.

The alternative currently being considered is a *performance-based* method presented in the recently approved national consensus ASCE Standard ASCE/SEI 43-05, "Seismic Design Criteria for Structures, Systems and Components in Nuclear Facilities and Commentary"[2] which will be published in the near future. In this *performance-based* approach, the earthquake hazard is combined with the component seismic design criteria to determine risk of unacceptable behavior of plant systems, structures and components (SSCs) as measured by an integrated risk of unacceptable plant-level seismic performance. The final result is a site-specific, risk-consistent seismic design basis ground motion.

The Performance-Based Methodology

The performance-based method includes requirements for developing the design basis earthquake ground motion based on a probabilistic seismic hazard assessment and for developing design basis seismic input motion for building supported systems and components. By considering both the ground motion hazard and design criteria of SSCs, the methodology provides the annual probability of exceeding acceptable behavior limits—that is, it provides an integrated, risk-consistent method for assuring safe seismic performance of nuclear facilities. This is in contrast to the procedures described in Reg. Guide 1.165, which are intended to provide only earthquake hazard-consistent seismic ground motions between sites.

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[1] NRC Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion", March, 1997.

[2] This draft standard is essentially the same as Department of Energy Standard "Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities", DOE-STD-1020-94, U. S. Dept. of Energy, April 1994.

The performance-based method presented in draft ASCE Standard 43-05 was developed to implement the recommendations in NUREG/CR 6728 and 6769[3] to provide a fully risk-consistent basis for determining site-specific seismic design basis ground motion. The draft ASCE standard is an industry consensus document prepared by the Dynamic Analysis of Nuclear Structures Subcommittee of the Nuclear Standards Committee of the ASCE, a group of industry and NRC experts. It has been approved by the technical committees and has been through a required public comment period without comments; it is expected to be issued in the near future.

The Need for a Performance-Based Methodology

The performance-based methodology is an extension of the hazard-based methodology provided in Reg. Guide 1.165 by providing guidance for determining site-specific seismic design ground motions that are risk-consistent from site-to-site. While it provides guidance for determining risk-consistent SSE motions rather than hazard-consistent motions, it does not replace other elements of the guidance contained in Reg. Guide 1.165.

Initial results obtained using the untested guidance in Reg. Guide 1.165 have been unpredictable and unrealistically high for some central and eastern United States (CEUS) sites. In addition, the target hazard criterion provided in Reg. Guide 1.165 (a reference exceedance probability of 10E-5 based on the median of the computed seismic hazards of 29 existing nuclear plant sites) may not achieve the stability from site-to-site that was originally intended. This is because the Reg. Guide approach is a *relative* method based on the computed hazards of the 29 existing sites. As a result, new data and/or changes in methodology that change the hazards at one or more of these 29 sites in the future could also change the hazard for a single ESP site. Similarly, justification of a higher target exceedance probability (as permitted by Reg. Guide 1.165) would require an individual ESP applicant to re-compute the hazards for all 29 sites covered in the Reg. Guide, a task that is not practical or reasonable.

Based on the experiences with Reg. Guide 1.165, we do not believe the Reg. Guide provides seismic design basis results that are consistent with the Commission's over-arching risk-informed policy in that it leads to consistent seismic hazards between sites, but does not achieve uniform safety performance among units. Thus, there is an urgent need for an alternative methodology for specific ESP sites that is focused on overall seismic performance and is likely to achieve stable and risk-consistent design ground motions.

[3] NUREG/CR-6728 and -6769, "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Harzard- and Risk- Consistent Ground Motion Spectra Guidelines", October, 2001.

Regulatory Basis for the Performance-Based Methodology

The performance-based method for determining risk-consistent seismic design ground motion is fully consistent with the NRC's Risk-informed Regulatory Policy and with the applicable regulations for early site permitting, including 10CFR 100.23. This conclusion is based on the following:

The performance-based methodology is consistent with the requirements of 10 CFR 100.23. NRC Regulation, 10 CFR 100.23, describes the principal geologic and seismic considerations that must be evaluated to establish the adequacy of the site design basis ground motions. The intent of the regulation is clear -- that determination of the design basis ground motions must appropriately incorporate scientific and data uncertainties and together with the Commissions seismic design criteria and procedures, must provide adequate assurance that *a nuclear power plant can be constructed and operated at the proposed site without undue risk to the health and safety of the public.* There are no stated or unstated objectives to assure uniformity of the seismic hazard between sites or specific exceedance probabilities for site seismic hazards. Instead, the regulation defines the numerous geological, seismological, and engineering characteristics that must be investigated to permit evaluation of the site and *to support evaluations performed to arrive at estimates of the Safe Shutdown Earthquake Ground Motion.* It does not prescribe or restrict the type or method of evaluation employed to establish the Safe Shutdown Earthquake (SSE) Ground Motion.

It is clear that the regulation is focused on defining the site characteristics to be considered in evaluating the suitability of a site and in estimating the SSE ground motion to achieve a satisfactory level of overall risk. It contains no language that can be interpreted to preclude use of a performance-based approach. The objective of the performance-based method is consistent with that of 10 CFR 100.23.

10 CFR 100.23 and past licensing practice do not prohibit consideration of design criteria for SSCs in establishing the SSE ground motion for a nuclear plant and site.
The evolution of guidance for assessing the acceptability of a plant's design SSE ground motion has included consideration of seismic design criteria and procedures at every stage. From the beginning, seismic design criteria and the margin of safety achieved by the design criteria and procedures were integral to the development of guidance for evaluating the SSE. Assurance of safe seismic performance was the overriding objective that framed the guidance. For example:

- The Reg. Guide 1.60 Standard Design Spectrum, adopted for design of all modern plants, specifically considered the structural frequency response of plant SSCs and was conditioned to provide increasing response amplitude over the range of critical structural and component frequencies.
- Determination of site-specific PGAs for scaling the Standard Spectrum, taking into consideration a site's seismic environment and the need to achieve reasonable consistency among sites, was a major issue. It was well understood that typical controlling earthquakes for essentially all sites would produce site-specific ground motion spectra that would exceed the Standard Spectrum at structural frequencies above about 10 Hz for what were considered to be reasonable acceleration levels for

scaling the Standard Spectrum. The shape of the Standard Spectrum for frequencies greater than 10 Hz was nevertheless considered to provide acceptable seismic safety for plant components with response frequencies in this range. This reasoning led to the concept of assessing "effective PGAs" that when used to scale the Standard Spectrum at 33 Hz, would define a site's SSE such that in combination with the NRC's seismic design criteria and procedures, it would achieve the desired level of seismic safety.

- A recent NRC-initiated project reported in NUREG/CR 6728 and 6769 describes research on revisions to regulatory guidance to develop hazard-consistent and risk-consistent ground motion spectra guidelines. It recommends revisions to guidance to achieve uniform reliability spectra with the objective *to achieve approximate uniformity of seismic risk for structures, equipment, and components designed to those spectra, across a range of seismic environments, annual probabilities, and structural frequencies. By "seismic risk" we mean the annual frequency of failure of a plant system or of its components, as opposed to "seismic hazard" which is the annual frequency of exceedance of a level of ground motion.* The performance-based method described in the ASCE Standard implements the objective of these NUREGs in a consensus standard that is intended to achieve fully risk-consistent seismic design for nuclear power plants.

- There is no language in 10 CFR 100.23 that would prohibit consideration of design aspects in the assessment of a site's design seismic ground motion. The NRC's design criteria requirements for future plants, and in particular the certified ALWR plants, assure that their design aspects will be adequately conservative to meet the design assumptions of the ASCE Standard.

<u>The performance-based method is consistent with the NRC Policy Statement on Risk-Informed Regulation.</u>
The performance-based approach is intended to achieve acceptable performance-consistent SSCs in accordance with this overall policy. It is noted that the recent Skull Valley Hearing Board's approval of the design ground motion for that facility based on risk/performance arguments provides confirmation of the NRC's direction in implementing its risk-informed policy guidelines.

Clearly, the progression of NRC's policies, regulations, and guidance governing seismic design safety has been toward achieving an integrated performance-based design. To step back from this for future nuclear plants would undo 30 years of progress.