June 8, 2005

MEMORANDUM TO: Michele G. Evans, Branch Chief
Engineering Research Applications Branch
Office of Nuclear Regulatory Research

THRU: Anthony Hsia, Section Chief **/RA/**
Mechanical/Structural Engineering Section
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SUBJECT: SUMMARY OF MAY 25, 2005 PUBLIC MEETING WITH NUCLEAR ENERGY INSTITUTE (NEI) ON INDUSTRY'S APPROACH FOR RESOLVING HIGH FREQUENCY ISSUES RELATED TO FUTURE REACTOR SITING AND SUPPORT TO REVISIONS TO RG 1.165.

On May 25, 2005, Nuclear Regulatory Commission (NRC) staff met with representatives from the Nuclear Energy Institute (NEI) and the industry in a public meeting at NRC headquarters in Rockville, Maryland, to discuss industry initiatives to resolve seismic high frequency issues for Central and Eastern United States (CEUS) sites and also to support revisions to Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion." Also discussed was the interaction between NRC and industry to work together to resolve those issues. Attachment 1 is the list of meeting attendees. Attachment 2 is the meeting agenda.

After introductions, Dr. Robert P. Kassawara, of Electric Power Research Institute (EPRI), discussed a path toward resolving generic seismic issues in a timeframe that would support the administration's goal for nuclear power expressed in the NP2010 initiative and to update regulatory guidance, as necessary. Industry has raised some concerns on seismic issues with Regulatory Guide 1.165 and the high frequency issues related to CEUS sites. Industry believes that the RG 1.165 method is based on a relative reference probability, and not a performance-based approach. Industry believes that the current regulatory guide process is likely to deter many utilities from applying for early site permits (ESP) or combined operating license (COL). The group also noted that the Eastern U.S. ground motion spectra include a high frequency component that is non-damaging, but can exceed certified design spectra in the high frequency region. Industry proposed a resolution plan for resolving high frequency issues related to future reactor sites and support to revise RG 1.165. The industry plans to:

1. Evaluate alternate performance-based methods for determination of site spectra
2. Incorporate other technology advances in probabilistic seismic hazard assessment (PSHA)
3. Resolve the high frequency issue

4. Propose revisions to RG 1.165 and standard review plan (SRP) 2.5.2

Industry has organized a team of experts on seismic issues to handle the six different tasks that are associated with this new plant ESP project: geotechnical tasks G1.1, G1.2, G1.3; structural tasks S2.1, S2.2, and integrated task I1.1. For Task G1.1, performance-based methods, industry plans to:

A. Update EPRI hazard results at 28 sites (not 29 because they do not have data for Callaway) to reflect the latest codes, attenuation relationships, seismic sources, and ground motion model
B. Compute performance-based seismic spectra at 5 and 10 Hz for these sites using performance-based method described in ASCE/SEI 43-05
C. Calculate annual frequencies of plant damage for design response spectra at 5 and 10 Hz using simple fragility functions (β ranging from 0.3 to 0.6)
D. Define plant damage using the following:

    1. onset of significant inelastic deformation (OSID) is equal to the ratio of high confidence low probability of failure (HCLPF) and design response spectra (DRS) which equals 1 and that the core damage is equal to the ratio of HCLPH/DRS = 1.67
    2. form cumulative distributions of annual frequency of OSID and core damage
    3. demonstrate that annual frequency of OSID is consistent with the safety of the 25 nuclear plants for which probability risk assessments (PRAs) are available
    4. develop technical documentation and support implementation of performance-based method to update RG 1.165.

Task G1.1 is to be completed by July 2005.

For task G1.2, revise lower bound magnitude (LBM) for hazard integration, industry plans to incorporate advances in technologies made during the past 15 to 20 years that would permit more confident determination and characterization of the appropriate lower bound magnitude by improving probabilistic seismic hazard methodology. Industry also plans to study new observations of damage to industry facilities and nuclear power plant assessments to support a revised LBM, and also to study new data on Cumulative Absolute Velocity (CAV) to provide the basis for the LBM distribution. Industry believes that a realistic LBM distribution would reduce hazard consistent with realistic damage potential of small earthquakes.

The objective of task G1.3, truncation of lognormal distribution of variability on median ground motion, is to define rational, defendable bound on variability, a point where variability deviates from lognormal distribution. Industry believes that the current practice of modeling ground motion variability (epsilon) using an unbounded lognormal distribution is excessively conservative, but to date no consensus bound on the distribution exists. Carl Stepp, Consultant to EPRI, pointed out that assessment of hazard uncertainty at very low annual non-exceedance frequencies required for nuclear plant seismic design is critically important and that implementation of a bound on epsilon on rock will assure that site-specific ground motion based on PSHA is reasonable for the PSHA annual recurrence frequency.

Greg Hardy, ARES Corporation, discussed the new plant structural tasks: S2.1, effect of seismic wave incoherence on foundation and building response; and S2.2, effect of limited

inelastic behavior results from high frequency input motion. Industry's objective on task S2.1 is to develop a state-of-the-art representation of the coherency function based on the most

applicable data available; develop reduction factors for incoherent motion by developing an effective low-pass digital filter; and perform sensitivity analyses which compare applying reduction factors to the free-field motion, the base mat motion, or the floor response motion. For task S2.1, industry will define coherency function and incorporate that function into the Computer Linear Analysis for Soil-Structure Interaction (CLASSI) seismic response code; define
the parameters (site conditions, ground motion characteristics, foundation characteristics, structure characteristics) to be included in the seismic response analyses; conduct soil-structure
analyses; develop the reduction factors as a function of foundation side and frequency; and conduct sensitivity studies including upper bound on coherency function, 2000 m/s apparent wave velocity, and SASSI verification analyses.

The primary purpose of task S2.2 is to develop reduction knock down (KD) factors to apply to the high frequency portion of ground response spectra to conservatively account for the fact that typical power plant equipment and structures are not damaged by high frequency motions (i.e., due to extremely limited displacement demand). Industry plans to reassess key assumptions in TR-102470 report by developing examples to demonstrate the dynamics involved in high frequency response and capacity (simple sliding/rocking models, non linear inelastic response, etc.), justify floor spectra amplification, and justify bounding example fillet weld assumptions by reviewing 0.01 inch limit displacement, weld performance under cyclic loading, and weld failures during Loma Prieta earthquake. The group also plans to develop an improved procedure for knock down (KD) factor implementation by reevaluating simplified method within TR-102470 (conservatism relates to higher frequencies, ESP response potentially high in the greater 30 region) and simplifying the high frequency response reduction method by developing a low pass filter applied to Fourier amplitude spectra over the specified frequency ranges. Industry discussed recommendations for equipment such as relay chatter and breaker trip with functional failure modes. Industry noted that KD factors would not be appropriate for functional failure modes which are high frequency sensitive and that their goal would be to develop seismic qualification requirements that do not require calculation of floor spectra including large high frequency input. A draft report of this task should be available in November 2005.

Dr. Stepp proceeded with the discussion on industry program to support updating seismic regulatory guidance. The objective of this task is to develop state-of-practice technical documents and support NRC actions to update affected sections of seismic regulatory guidance, particularly, Regulatory Guide 1.165 and NUREG-0800. Industry proposed a plan to work with NRC staff and management to establish procedures and a schedule of interactions to implement revisions of seismic regulatory guidance, to prepare industry technical reports supporting the proposed update of RG 1.165 and NUREG-0800, and to work interactively with NRC staff in a series of meetings to implement specific updated technical revisions. Industry proposed February 2006 as the meeting date between NRC and industry to agree on specific technical revisions of RG 1.165 and NUREG-0800.

At the conclusion of the presentation, Richard Barrett along with Michael Mayfield from the NRC pointed out that the probability-based (PB) approach proposed by industry was different from what they anticipated and that the schedule to accomplish those tasks might be problematic. Mr. Mayfield suggested that the schedule for the tasks should be considered as part of the upcoming meeting between NEI and NRC in June 2005.

Action Item:

1. NRC to decide how and when to interact with industry on this issue and communicate that decision to the industry.

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May 25, 2005 at 09:00 – 16:00
NRC Office, T-8A1

Meeting Objectives: a) industry to describe initiatives for resolution of high frequency issues for CEUS sites
b) support revisions to RG 1.165 and NUREG-0800

Industry Participants:
Adrian Heymer – NEI
Cedric Jobe – NEI
Bob Kassawara et al – EPRI

Agenda:

09:00 am	1. Introductions and opening remarks – NEI and NRC
09:10 am	2. Industry Resolution Plan High Frequency Issue Improvements to Hazard Methodology Revision of Regulatory Guidance
10:15 am	**Break**
10:30 am	3. Industry Effort Related to Resolution of HF Issues (revisions to NUREG 0800 as required) Incoherence Effect of Limited Inelastic Behavior
12:00 noon	**Lunch**
12:45 pm	4. Industry Input to Improve Seismic Hazard Methodology (Revisions to Reg. Guide 1.165 as required) Update PSHAs Revision of Lower Bound Magnitude Truncation of Variability on Median Ground Motion
2:15 pm	**Break**
2:30 pm	5. Industry Program for Revision of Regulatory Guidance --RG 1.165 and NUREG 0800 as required
3:30 pm	6. Summary of meeting action items o High frequency issue and RG1.165/0800 revisions o NRC/Industry interactions and schedule
4:00 pm	7. Adjourn

Attachment 2