

October 24, 2008

MEMORANDUM TO: William D. Reckley, Chief
Rulemaking, Guidance and Advanced Reactors Branch
Division of New Reactor Licensing
Office of New Reactors

FROM: Ram Subbaratnam, Project Manager **/RA/**
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Office of New Reactors

SUBJECT: SUMMARY OF SEPTEMBER 25-26, 2008, PUBLIC MEETING/
WORKSHOP ON SEISMIC ISSUES CONSISTENT
SITE-RESPONSE-SOIL-STRUCTURE INTERACTION
CALCULATIONS

On September 25-26, 2008, the U.S. Nuclear Regulatory Commission (NRC) staff held a Category 2 public meeting/workshop at the Electric Power Research Institute in Palo Alto, CA. The objective of the meeting was to develop a common understanding of the NRC guidance provided in Interim Staff Guidance, Section 3, "Use of Various Ground Motions" (Agencywide Documents Access and Management System (ADAMS) accession no. ML082550165 (meeting notice)).

The industry vendors and subject experts presented materials that covered their understanding of the fundamentals for determining performance based ground motion and the associated issues, and the need for consistency in developing ground motions at different horizons (ADAMS Accession Number ML082810361). The NRC staff presented slides summarizing the NRC's safe-shutdown earthquake and siting process, current regulatory guidance on ground motion, and fundamental ground motion issues (ADAMS accession no. ML082680175). Handouts that were provided to the participants at the workshop are included in this meeting summary (ADAMS accession no. shown above (meeting notice)). The staff and industry comments that were discussed during meeting, as well as the action items that were identified during the workshop are provided in Enclosures 3 and 4.

Enclosures:

1. Attendees List
2. Definitions Agreed to at Workshop
3. Summary of Issues, Agreements and Action Items
4. Outline of Options 1 and 2 for Ground Motion Determination

cc w/encl: See next page

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ADAMS Accession Number: ML082950476

concur via email*

NRC-001

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CALCULATIONS

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RidsNroDnrINrga

RidsNroDser

RidsNroDserRgs2

RidsNroDe

RidsNroDeSeb1

RidsNroDeSeb2

**Public Meeting/ Workshop on Seismic Issues Consistent Site-Response-Soil-Structure
Interaction Calculations**

September 25-26, 2008

Attendance List*

Name	Organization
James J. Johnson	JJJ & Associates
Goutam Bagchi	US NRC
Mahmoud Jardaneh	US NRC
Cliff Munson	US NRC
Carl J. Constantino	CJCA
Nilesh Chokshi	US NRC
Sujit Samaddar	US NRC
P.K. Agrawal	Sargent & Lundy
Dan O'Connell	W. Lettis Associates
Nicholas Brown	Westinghouse L & S
Bhagwat Jain	US NRC
Farhang Ostadan	Bechtel
Brian E. Thomas	US NRC
Robert Kennedy	SMC

Definitions Suggested at the Workshop:

Geologic Outcrop ground motion is the free field ground motion with no soil above (no down coming waves) but the confining pressure of any soil above is considered for evaluating nonlinear effects included in computation of G/G_{max} and damping vs. strain. (Note the term Geologic Outcrop may be revised to better capture its meaning.)

Full Column Outcrop ground motion is an outcrop motion that includes the full effect of the soil above, e.g. outcrop ground motion from a 1D iterative dynamic soil column analysis program like SHAKE. The full column outcrop includes the effects of down coming waves from soils above the elevation of the outcrop. (Note the term Full Column Outcrop may be revised to better capture its meaning.)

Performance Based Surface Response Spectra (PBSRS) is the performance based ground surface response spectra derived at the free ground surface, i.e., plant grade.

Foundation Input Response Spectra (FIRS) is a performance based ground response spectra that is only used for the performance based site ground motion at the foundation horizon.

Ground Motion Response Spectra (GMRS) is a performance based probabilistic ground motion response spectra based on the Geologic Outcrop definition; i.e. no soil column above. The FIRS can be computed using either the Geologic Outcrop or the Full Column Outcrop definition.

Summary of Issues, Milestones and Proposed Action Items:

To ensure that both the GMRS and FIRS are consistent and performance based, the guidance in NUREG 0800 suggests that the site-specific GMRS be transferred to the foundation elevation and be termed as FIRS.

Key issue: The NRC NUREG 0800 states that FIRS is defined as a Geologic Outcrop ground motion, but the transfer of this Design Response Spectra (DRS) for site-specific soil-structure interaction (SSI) must consider the entire soil column. The industry proposes, depending on the combined license application (COLA) site conditions and the design control document (DCD) location of the certified seismic design response spectra (CSDRS) for the DCD SSI analyses, using the Full Column Outcrop FIRS in the site-specific SSI analyses, as outlined in Option 1.

There was agreement on the information provided on slide 2 under ADAMS accession no. ML082810361. The calculated ground motions at various foundation elevations must be performed using the performance based method using the same suite of site-specific soil profiles.

In addition, there was agreement that the FIRS be used as the basis for defining the input motion for a site-specific SSI analysis.

To insure that regulatory requirements are met, there are potentially up to three separate checks requiring response spectra at various elevations at a COLA site:

Check 1: FIRS greater or less than the CSDRS:

The development of the FIRS for comparison to a DCD's the design needs to be consistent with the DCD SSI modeling, i.e., if the CSDRS is input at foundation horizon with no soil above (no embedment) then the FIRS needs to be developed with no soil above the foundation. If the DCD SSI included embedment then the FIRS should include the soil above the foundation.

Check 2: The minimum foundation input ground motion for design shall be at least an appropriate broad band response spectrum with value 0.1g peak ground acceleration (PGA):

- The NRC's expectation is that the minimum required ground motion check per Title 10 of the *Code of Federal Regulations*, Part 50 (10 CFR Part 50), Appendix S will be Regulatory Guide (RG) 1.60, value 0.1g PGA unless otherwise justified. The NRC will further look at clarification of the term "appropriate response spectra."
- Depending on the SSI model of the structure for the site specific SSI analysis and consistent with the free-field SSI model, Full Column Outcrop FIRS which are calculated using the soil above or the Geologic Outcrop FIRS can be used to make this check.
- If the FIRS is less than RG 1.60, value 0.1g PGA, it was agreed that to satisfy this minimum ground motion design requirement, an applicant can design the safety related structure using two separate analyses; one using the site-specific FIRS and one using

- RG 1.60, value 0.1g PGA. Alternately, applicant may use the envelope of the two spectra.

Check 3: If Check 1 is not satisfied (CSDRS foundation input motion < FIRS) then a site-specific SSI analysis is required:

- For this check there needs to be a clear transition from the probabilistic performance based development of the FIRS to the deterministic linear SSI analysis. This typically is performed using a program such as system analysis of soil-structure interaction (SASSI) and three soil profiles (lower bound (LB), best estimate (BE), and upper bound (UB)).
- For surface founded structures or structures modeled as surface founded structures in the Certified Design (CD), it was agreed that for site-specific SSI analysis the Geologic Outcrop FIRS at the horizon corresponding to the horizon of the foundation should be used.
- NRC was not sure if using the Full Column Outcrop FIRS and convolving it up through the three soil profiles to the ground surface would bound the PBSRS, i.e., PBSRS. For the Vogtle early site permit/COLA the envelope of the convolved spectra at plant grade did bound the PBSRS. (See Attachment 2, page 26.)
- Different approaches for performing the deterministic site-specific SSI based on the performance based DRS and the randomization of the soil profile used in the performance based method were discussed. Two options were outlined. The details of these options will be provided as described below.
- Option 1 is the option that the industry representatives at the workshop preferred. The NRC outlined an alternate option, Option 2. It was agreed that the industry will provide in a Nuclear Energy Institute (NEI) White Paper the complete details, justification, and checks for Option 1. The NRC participants thought Option 1 would be acceptable if a check of the convolved Full Column Outcrop FIRS to the ground surface bounded the PBSRS. NRC stated they will provide details for Option 2.

Actions and Schedules:

- Don Moore to draft workshop meeting summary for the industry and send to the NEI technical subgroup for review and comment. Draft summary due no later than Tuesday, September 30th
- NEI will provide the final workshop meeting summary by the industry to the NRC for information. This is scheduled for early October.
- Farhang Ostadan will prepare a draft NEI White Paper that provides definitions of various ground motion terms, use of various ground motion spectra for the different checks required for a COLA, and a full description of Option 1 for a site-specific SSI analysis. A reference will be made to an alternate option, Option 2 that is to be provided by the NRC staff and their consultant.

- Farhang Ostadan will draft a short version of the NEI White Paper by close of business (COB) October 3rd and send out to the NEI technical subgroup for review and comment.
- The NEI technical subgroup will provide comments with changes to Farhang by COB Monday, October 6th.
- Farhang will revise and send the complete the short version of the White Paper to NEI by October 13th.
- NEI issues short version of White Paper to both the NEI SITF (a Commercial Seismic Analysis Computer System) and the NRC for parallel review.
- The Paper prepared by Carl Constantino and titled Consistent Site Response-SSI Calculations will be updated and issued to assist in interpretations and staff review.

Note 1: NRC requested a careful review of the White Paper by the CD nuclear steam supply system (NSSS) Vendors and the COLA applicants. The NRC wants to limit the number of requests for additional information related to these ground motion issues and does not want to impact current reviews. They stated these ground motion issues need to be resolved as quickly as possible so there is no impact on schedule and work being performed by the NRC, COLA applicants, and the CD NSSS vendors.

Outline of Options 1 and 2
(Options for Determining Ground Motion)

Outline of Option 1:

The industry presented a method to establish performance based FIRS and the development of ground motion at various elevations using a one step approach during the development of GMRS. This is referred to as Option 1 and is outlined below:

- Full Column Outcrop FIRS at the various foundation depths, e.g., FIRS from SHAKE (a Commercial Seismic Analysis Computer System) using the full soil column.
- Calculate the PBSRS. These spectra, by definition, would be at the ground surface, i.e., plant grade.
- Determine the LB, BE, and UB soil profiles based on the mean of the randomized soil profiles and the +/- one standard deviation; but if necessary applying the minimum requirement for variation of the soil shear modulus.
- Determine the in-column motion at foundation using the Full Column Outcrop FIRS for use in the site-specific SASSI SSI analysis. Alternately, the surface motion consistent with the in-column motion of the LB, BE, and UB soil profiles can be used in the SSI analysis.
- Convolve the Full Column Outcrop FIRS using the LB, BE, UB soil profiles to the ground surface (plant grade) and verify that the PBSRS is bounded.
- If the PBSRS is not bounded, the in-column motion or the companion surface motion for SSI needs to be modified. Alternately, additional soil columns in the range of the soil profiles used for the FIRS can be selected for SSI analysis as long as the extended group of soil profiles results in a set of surface motions that bound the PBSRS.

Outline of Option 2:

The NRC staff discussed a more rigorous approach for establishing GMRS and FIRS using a "Geologic Outcrop" as the condition for defining the FIRS motion. It was agreed that using the "geologic outcrop" was a more rigorous compliance with the regulatory definition of FIRS. This approach is referred to as Option 2 and is outlined below:

- Develop GMRS using the full soil column (up to the surface) using UHS at bed rock defined from the probabilistic seismic hazard analysis (PSHA).
- Develop FIRS using iterated soil properties from each of the soil columns analyzed in the above step for a soil column height up to the foundation level.
- Determine the LB, BE and UB soil profiles based on the mean of the randomized soil profiles and the +/- one standard deviation; but if necessary applying the minimum requirement for variation of the soil shear modulus. Use FIRS level in-column motion of the LB, BE and UB soil profiles as input to the corresponding SSI analysis.

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