From: Goutam Bagchi
To: Andrew Murphy; Anthony Hsia; Clifford Munson; Gene Imbro; John Segala; Kamal Manoly; Yong Li
Date: 5/18/05 9:40AM
Subject: Re: Thoughts on seismic action plan

To The addressees:
The Seismic Action Plan consists of two parts, one part is the text file of the plan, and the other part is the schedule. In order to make both parts consistent, I revised the text file to take out the dates. The schedule for the action plan resulted from Gene's detailed task table that was discussed and finalized at yesterday's meeting.

The schedule file was prepared by John Segala. With John's help Yong Li had updated the schedule file and forwarded it yesterday. I have included his file for completeness. Those of you who do not have MS Project program on your desktop will not be able to open the second file. I can give you hard copy upon request.

Thank you,
Goutam Bagchi
415-3305

>>> Andrew Murphy 05/18/05 08:52AM >>>
Gene & others,

I provided comment directly to Goutam on his text this morning. If additional input is required or would be helpful please let me know. Andy

>>> Gene Imbro 05/17/05 10:31AM >>>
John:

Thanks for settting up the MS Projects schedule based on our meeting yesterday. These are my ideas on what we need to accomplish. I suggest we meet again at 1 today as a group to finalize your schedule and make sure that my items are captured.

Thanks,

Gene

CC: Christopher Grimes; Laura Dudes; William Beckner

Mail Envelope Properties (428B45D3.8B6 : 24 : 10680)

Subject: Re: Thoughts on seismic action plan
Creation Date: 5/18/05 9:40AM
From: Goutam Bagchi

Created By: GXB1@nrc.gov

Recipients
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OWGWPO02.HQGWDO01
EXI (Gene Imbro)

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WDB CC (William Beckner)
YXL1 (Yong Li)

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Files	**Size**	**Date & Time**
MESSAGE	2327	05/18/05 09:40AM
SeismicPlan051805.wpd	31956	05/18/05 09:23AM
Seismic Action Plan.mpp	376832	05/17/05 04:16PM

Options

Expiration Date:	None
Priority:	Standard
Reply Requested:	No
Return Notification:	None
Concealed Subject:	No
Security:	Standard

Action Plan for Seismic Issues

Purpose: Several important seismic issues arose in the context of NRR review activities for Early Site Permit applications. This Action Plan is intended to layout activities and schedules for resolving the issues involving new site reviews and implications for operating reactors.

Ex Parte Rule: The Commissioners and the Commissioners' staffs are enveloped by the ex parte rules; therefore, the staff has to be very careful about the ex parte rule in developing the generic policy options.

Background:

The seismic design requirements for existing power reactor sites are incorporated in 10 CFR Part 100, Appendix A. These requirements were based on deterministic considerations of maximum historic earthquakes. Margins were included to account for the uncertainty in earthquake magnitude due to the limited data available. The safe shutdown earthquake (SSE) was described in terms of the magnitude of the earthquake and the peak ground acceleration (PGA). During the later phases of reactor licensing reviews, regulatory guidance was developed to describe the nature of the vibratory motion associated with the SSE by a standard spectrum shape that was scaled to the PGA value at each site. This guidance was the subject of Regulatory Guide 1.60.

With the introduction of risk assessment for power reactors, it became apparent that the uncertainty in seismic hazard (seismic hazard is defined as the probability of an earthquake that exceeds the SSE) is 2 to 3 orders of magnitude. At this level of uncertainty of seismic hazard, the range of seismically-induced ground motion could completely dominate any of the inherent design margins of structures, systems and components. Therefore, probabilistic seismic hazard analysis (PSHA), which incorporates full consideration of uncertainty, became important and was introduced in the new siting rule 10 CFR Part 100.23 that became effective for applications for new reactors after 1/10/97. This new regulation recommends the use of probabilistic seismic hazard analysis or suitable sensitivity analysis to address uncertainty. This new regulation specifies that the SSE Ground Motion for the site is characterized by both horizontal and vertical free-field ground motion response spectra at the free ground surface. Regulatory Guide 1.165, “Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion (ML003740084)” provides an acceptable way to implement the regulation. Regulatory Guide 1.165 guidance recognizes that in general, significant revisions to the data base are to be undertaken only periodically (every 10 years), or when there is an important new finding or occurrence. An overall revision of the data base would also require a reexamination of the acceptability of the reference probability discussed in Appendix B of the regulatory guide. The data base reevaluation consists of items such as current understanding of the seismic sources, new thinking of how frequently earthquakes of

certain magnitudes occur, and how the ground motion generated by an earthquake propagates. This evaluation is performed using a rigorous process, such as the Senior Seismic Hazard Advisory Committee (SSHAC) process (described further below). One of the concerns voiced by NEI is this periodic reevaluation of seismic hazard and its potential for redefinition of the SSE results in an unstable regulatory process.

The SSHAC developed a set of guidelines to elicit expert opinion on seismic hazard characterization for plants sited in the Central and Eastern United States, which were published as NUREG/CR 6372. Lawrence Livermore Laboratory conducted a study (NUREG/CR 6607 dated October 2002) to test and implement the SSHAC process at the Watts Bar and Vogtle sites. The results of this study indicated that the new response spectra exceeded the SSE response spectra for the Watts Bar site, but not for the Vogtle site. It also indicated the presence of higher spectral accelerations specified in Reg. Guide 1.60 at frequencies greater than 10 Hz. This exceedance led to a study of the generic implication of the increase in seismic hazard for the Eastern Tennessee Seismic Zone, which includes the Watts Bar site, in Generic Safety Issue (GSI) 194. During the GSI 194 resolution process, staff relied on the results of Individual Plant Examination for External Events (IPEEE). In the IPEEE process for sites in the Cental and Eastern United States, the staff required a plant vulnerability examination using a review level earthquake (RLE) of 0.3g PGA. The RLE was anywhere from 2.5 times to 1.2 times the licensed SSE. The results of IPEEE were used in the GSI-194 evaluation to come to the conclusion that plants sited in the Central and Eastern United States (CEUS) had an adequate level of protection with regard to the current perception of increased seismic hazard as shown in NUREG/CR-6607, “Guidance for Performing Probabilistic Seismic Hazard Analysis for a Nuclear Plant Site: Example Application to the Southern United States.”

Regulatory Guide 1.165 guidance, developed in the early 1990s, specifies a reference probability for exceedance of the SSE, i.e., seismic hazard, at a median annual value of 10^{-5}. This reference probability value is based on the annual probability of exceeding the SSEs for 29 CEUS nuclear power plant sites. Preliminary results from a recent (2002) United States Geological Survey (USGS) report indicates that the reference probability for the 29 CEUS sites is now about $6.7*10^{-5}$. This increase in the reference probability value is primarily due to recent developments in the modeling of earthquake ground motion in the CEUS.

Since no new plants have applied for a Construction Permit or Early Site Permit (ESP)since Part 100 was revised and Reg. Guide 1.165 was issued in 1997, the impact of the revised regulation and guidance on future plants was not realized until recently. Recent industry activities in connection with the applications for early site permits (ESP) related to site hazard analyses have surfaced some issues that are of concern to ESP applicants and have been the subject of inquires from NEI. The amplitude of the seismically-induced ground motion using the reference probability of 10^{-5} specified in Reg Guide 1.165 is high enough for some sites, that currently certified designs could not be used without modification or re-analysis. Five issues have arisen as a result of

NEI questions and staff review of the recent ESP applications: 1) what is the appropriate probability level for a site SSE ground motion, given that the Commission expects new reactors to be safer than the current fleet of plants; 2) recognition that the seismic hazard, i.e., probability of exceeding the SSE at operating facilities in the CEUS is higher than previously recognized by the staff; 3) the effects of high spectral accelerations at vibratory frequencies above approximately 10 Hz; 4) the Reg. Guide 1.165 guidance related to significant revisions to the data base periodically (every 10 years) is intended to ensure the use of most current and best technical information in the seismic hazard analysis, but the industry is concerned about the impact of increased hazard perception for sites with existing reactors; and 5) whether or not the use of performance-based approach described in ASCE Standard 43-05 generates a conflict between GDC 2 and 10 CFR Part 100.23.

With regard to the first issue, industry has proposed a performance-based approach to determine the SSE at any given site, including a specific target probability value associated with the approach. It provides for a uniform seismic risk across sites and for all structures, systems and components (SSCs). Seismic risk is defined as the probability that substantial inelastic behavior will occur in SSCs. The philosophy of the performance-based approach is that the seismic risk, as defined above, should be comparable to the probability of core damage (CDF). The performance-based approach specifies a seismic risk of 10^{-5}. The performance-based approach assumes that SSCs will be designed to the guidance in the Standard Review Plan and existing codes and standards. The performance-based approach uses a target mean annual failure probability of 10^{-5} and then it establishes a design seismic hazard spectrum with a mean annual probability of 10^{-4}. This is the level of SSE for those sites that would use the performance-based approach. The staff is currently reviewing the performance-based approach proposed by one of the ESP applicants. Depending on what can be justified, there may be, however, a potential policy issue connected to the performance-based approach, namely, specifying a seismic risk as being equivalent to the risk of core damage. While there is likely margin between the onset of substantial inelastic deformation and failure, this margin has not been quantified. In the past, the staff has concluded that the seismic demand for design is large (mean annual frequency of 10^{-5}) and that the failure of SSCs that could result in core damage due to an SSE is substantially less than the risk of core damage from other causes. In performing the ESP reviews, the staff has determined, based on the current information, that while seismic designs of operating plants in the CEUS still provide an adequate level of protection, the probability of exceeding the SSE at some of the currently operating sites in the CEUS is higher than previously recognized.

It is important that action be taken to apprise the Commission and as appropriate resolve these issues in a timely manner. The staff has developed a seismic action plan to resolve all five issues discussed above.

Regulatory Requirements:

The transition from deterministic seismic design requirements of 10 CFR Part 100, Appendix A to probabilistic criteria of 10 CFR Part 100.23, has brought several seismic issues to sharp focus at this point in time when the industry seems to be poised to pursue new plant construction. As the staff looks at the implications of the application of new criteria at locations with existing plants, it has become evident that the perception of seismic hazard has gone up. Appropriateness of the initiating frequency of the SSE and the conditional failure frequency of structures, systems and components must be examined. Past seismic design activity did not rely on probabilistic assessment of plant seismic risk. The Commission expects that the new reactor designs be safer. To that end, the staff may have to develop policy options for seismic design and risk and seek a Commission decision on which option should be pursued. In developing the seismic policy options, the staff has to be mindful that there is a fine balance between increasing seismic demand and the commensurate increase in structural capacity to match the increased demand.

NRC Activities:

The staff has initiated and management tasked a Seismic Issues Technical Advisory Group (SITAG) consisting of staff experts from RES, NRR and NMSS to perfom a broad review of the performance-based approach to seismic design. RES, with advice from the SITAG, has initiated a process for updating the Regulatory Guide 1.165 to consider a review of the American Society of Civil Engineers (ASCE) Standard 43 related to performance based seismic design and hazard considerations. The first draft of the revised RG 1.165 is expected to be available in mid-year 2006. The SITAG plans to interact with the industry through public meetings, therefore, it is expected that the first draft of the revised RG would be ready for review by the ACRS and the CRGR in two to three months after the draft is submitted to them. A month after the ACRS and CRGR review process is complete, the draft RG would be ready for public comments. From the preparation of the draft RG to the issuance for public comments the process takes about six months. The SITAG and appropriate NRC staff will continue to interact with the industry on this and the issue of seismically-induced ground motion in the high frequency range; i.e., greater than 10 Hz. The usual time lag between draft for public comment and final publication is 16 to 19 months depending on technical complexity of the impact of public comments.

Industry Activities:

NEI, with assistance from EPRI, is conducting studies to update the seismo-tectonic data base, seismic ground motion attenuation relationships and hazard calculation methods for the Central and Eastern United States (CEUS) sites. They have also conducted studies on the effects of high vibratory frequency of motion on seismic design. NEI has formally notified the RES Director of their desire to interact with the

NRC staff, to present and discuss the implications of new seismic hazard results and the effect of high frequency ground motion on design. It is expected that the results of industry studies would aid the NRC staff in developing a revision to RG 1.165 and other related guideline documents.

Planned Actions:

1. Prepare a letter to initiate the reopening of GSI -194 related to the perception of increased seismic hazard for the Central and Eastern United States.

2. Prepare a Commission Paper apprising the Commission of the recent seismic siting issues and implications with regard to operating and future plants including a discussion of the performance-based approach to seismic design and alerting the Commission to a potential policy issue regarding seismic CDF.

3. SITAG will interact with NEI on the effects of large high frequency ground motion on current and future reactors. Reevaluate Reg.Guide 1.165 for potential changes. Completion of this activity is contingent on NEI's support to prepare responses to staff questions and any need for confirmatory tests. SITAG will review publicly available information submitted for site suitability reviews.

    a. Initiate the process of revising RG 1.165 based on interactions with NEI and a detailed review of review of the performance based seismic design approach as incorporated in the American Society of Civil Engineers (ASCE) Standard 43-05. SITAG will review the NEI input and determine the suitability of 10^{-4} mean annual probability as a reference probability for the SSE.

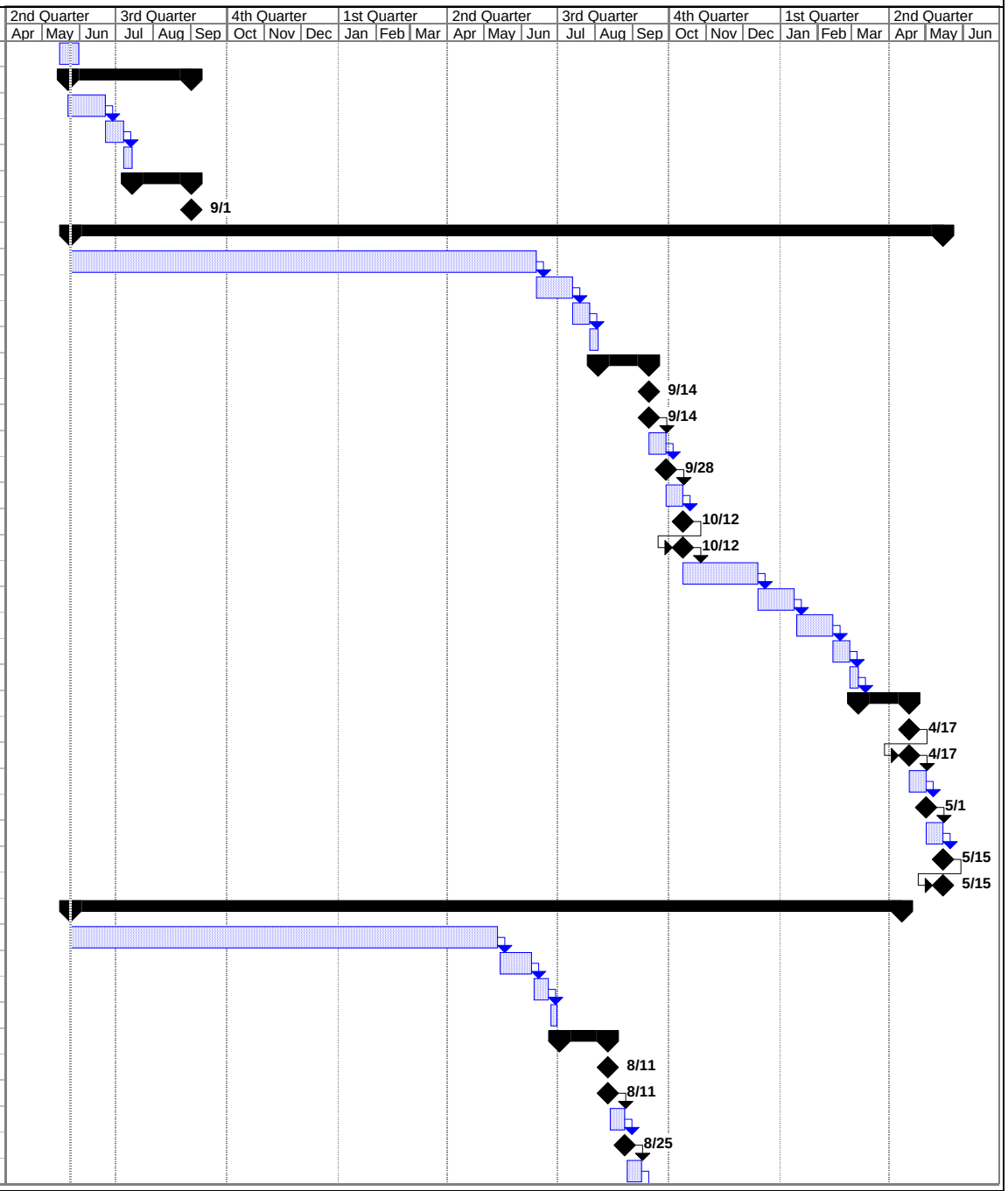
    b. USGS, under RES contract has performed PSHA for the 29 sites on which the original median annual reference probability of 10^{-5} was established. These results are preliminary and need scrutiny. SITAG will review the USGS results and also review any results that NEI may offer.

    c. Incorporate additional guidance on estimating site response found in NUREG/CR 6728. SITAG will make recommendation on the level of guidance to be incorporated in the revised Reg Guide 1.165 for site response consideration.

4. Interact with NEI on the effects of high frequency ground motion on engineering design and analysis, and plan for updating SRP section 3.7

Action Plan For Seismic Issues

ID	Task Name	Duration	Start
1	Initiate new GSI	11 days	Mon 5/16/05
2	**SECY Paper**	**72 days**	**Mon 5/23/05**
3	Write SECY Paper	22 days	Mon 5/23/05
4	SITAG Review	10 days	Thu 6/23/05
5	Address SITAG Comments	5 days	Fri 7/8/05
6	**Get Concurrences**	**35 days**	**Fri 7/15/05**
14	Issue SECY Paper	0 days	Thu 9/1/05
15	**RG 1.165 Update**	**507 days**	**Wed 5/25/05**
16	Interaction with NEI	267 days	Wed 5/25/05
17	Write RG	22 days	Wed 6/14/06
18	SITAG Review	10 days	Fri 7/14/06
19	Address SITAG Comments	5 days	Fri 7/28/06
20	**Get Concurrences**	**30 days**	**Fri 8/4/06**
27	RG Forwarded to ACRS	0 days	Thu 9/14/06
28	CRGR pkg forwarded to CRGR	0 days	Thu 9/14/06
29	CRGR Review	10 days	Fri 9/15/06
30	CRGR Presentation	0 days	Thu 9/28/06
31	Address CRGR Concerns	10 days	Fri 9/29/06
32	Receive CRGR Endorsement	0 days	Thu 10/12/06
33	Federal Register package forwarded to ADMIN	0 days	Thu 10/12/06
34	Public Comment Period (60 Days)	44 days	Fri 10/13/06
35	Documentation of Public Comments	22 days	Thu 12/14/06
36	Revise RG	22 days	Mon 1/15/07
37	SITAG Review	10 days	Wed 2/14/07
38	Address SITAG Comments	5 days	Wed 2/28/07
39	**Get Concurrences**	**30 days**	**Wed 3/7/07**
46	RG Forwarded to ACRS	0 days	Tue 4/17/07
47	Revised CRGR pkg forwarded to CRGR	0 days	Tue 4/17/07
48	CRGR Review	10 days	Wed 4/18/07
49	2nd CRGR Presentation	0 days	Tue 5/1/07
50	Address CRGR Concerns	10 days	Wed 5/2/07
51	Receive CRGR Endorsement	0 days	Tue 5/15/07
52	Issue RG	0 days	Tue 5/15/07
53	**SRP Update**	**483 days**	**Wed 5/25/05**
54	Interaction with NEI	245 days	Wed 5/25/05
55	Write SRP	20 days	Mon 5/15/06
56	SITAG Review	10 days	Mon 6/12/06
57	Address SITAG Comments	5 days	Mon 6/26/06
58	**Get Concurrences**	**30 days**	**Mon 7/3/06**
65	SRP Forwarded to ACRS	0 days	Fri 8/11/06
66	CRGR pkg forwarded to CRGR	0 days	Fri 8/11/06
67	CRGR Review	10 days	Mon 8/14/06
68	CRGR Presentation	0 days	Fri 8/25/06
69	Address CRGR Concerns	10 days	Mon 8/28/06



Action Plan For Seismic Issues

ID	Task Name	Duration	Start
70	Receive CRGR Endorsement	0 days	Fri 9/8/06
71	Federal Register package forwarded to ADMIN	0 days	Fri 9/8/06
72	Public Comment Period (60 Days)	44 days	Mon 9/11/06
73	Documentation of Public Comments	22 days	Fri 11/10/06
74	Revise SRP	22 days	Tue 12/12/06
75	SITAG Review	10 days	Thu 1/11/07
76	Address SITAG Comments	5 days	Thu 1/25/07
77	**Get Concurrences**	**30 days**	**Thu 2/1/07**
84	SRP Forwarded to ACRS	0 days	Wed 3/14/07
85	Revised CRGR pkg forwarded to CRGR	0 days	Wed 3/14/07
86	CRGR Review	10 days	Thu 3/15/07
87	2nd CRGR Presentation	0 days	Wed 3/28/07
88	Address CRGR Concerns	10 days	Thu 3/29/07
89	Receive CRGR Endorsement	0 days	Wed 4/11/07
90	Issue SRP	0 days	Wed 4/11/07