Communication Plan for Complete Seismic Hazard Re-evaluation Submittals in Response to NTTF Recommendation 2.1, Seismic

Goal

The goal of this plan is to guide U.S. Nuclear Regulatory Commission (NRC) staff communications with internal and external stakeholders related to licensee submittals of seismic hazard re-evaluation reports in response to the March 12, 2012, Request for Information Letter, Enclosure 1, *Recommendation 2.1: Seismic*.

Key Messages

Key messages to be communicated to stakeholders are:

- **Available information shows all U.S. reactors can continue operating safely while some sites do more detailed analysis.** The additional analysis will determine how the new seismic hazards specifically affects plant risk and what safety enhancements, if any, the plants should make.

- **Plants have provided multiple ways of increasing confidence they can continue operating safely.** Sites with a re-evaluated seismic hazard that exceeds their current design basis provided an additional evaluation that shows their plant is covered by either an existing evaluation or interim conclusion that earthquake risk remains acceptable.

- **The NRC is confident that these plants can operate safely.** The NRC reviewed these interim evaluations to assure those plants do not need immediate regulatory action while they conduct more detailed seismic risk evaluations and that they can safely shut down if an earthquake occurred at the higher seismic ground motion. In December 2014, NRC received from Central and Eastern US sites with a higher re-evaluated hazard an “expedited approach” to evaluate and reinforce certain core cooling systems and components, if necessary, to ensure plants can continue to operate safely. Similarly, the NRC expects, by January 2016, Western US sites will provide the “expedited approach” for sites with a higher re-evaluated hazard.

- **In 2012, NRC asked licensees to use updated methods and guidance in re-evaluating their plants’ seismic hazards**. These methods now consider the likelihoods of different earthquake magnitudes occurring, and the range of ground motions that might occur during these earthquakes. This new information will give a better understanding of possible earthquake hazards at the site.

- **Nuclear power plant designs already include a significant margin of safety from the effects of large earthquakes**. Beginning with the calculation of potential earthquake-generated

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motions, many steps in the nuclear reactor seismic design process add strength to safety systems. Nuclear power plant systems are also designed to withstand the force of many different internal and external events. These factors mean nuclear power plant systems can survive stronger ground motions than used in their seismic design.

- **Sites in the Central and Eastern United States (CEUS) submitted their re-evaluations on March 31, 2014. Three sites in the Western U.S. (WUS) submitted their re-evaluations by March 12, 2015.** CEUS sites had an earlier deadline because they could use well-reviewed source and ground motion models. Western plants have more time because they must develop site-specific models. The NRC inspected all U.S. plants immediately following the 2011 Fukushima accident. The plants and NRC inspectors did additional seismic walkdowns in 2012, and the NRC audited some of those walkdown results in 2013.

- The March 31, 2014 and the March 12, 2015 submittals show that for some CEUS and WUS sites the calculated seismic hazard is higher than previous estimates, using more recent research and information, and updated codes and models. The sites with higher hazards must now perform plant impact or capability analysis through a risk evaluation to determine if plant structures and equipment can withstand the shaking of the higher seismic ground motion. In the meantime, sites with a re-evaluated seismic hazard that exceeds their current design basis provided an additional evaluation that uses existing information to show plant equipment can likely withstand the higher seismic hazard. The NRC reviewed these interim evaluations to assure those plants do not need immediate regulatory action and can continue to operate safely while they conduct more detailed seismic risk evaluations. In December 2014, NRC received from Central and Eastern US sites with a higher re-evaluated hazard an “expedited approach” to evaluate and reinforce certain core cooling systems and components, if necessary, to ensure plants could safely shutdown if an earthquake occurred at the higher seismic ground motion. Similarly, the NRC expects that by January 2016 WUS sites will provide the “expedited approach” for sites with a higher re-evaluated hazard. NRC will use these in-depth analyses to determine if additional regulatory actions or additional plant modifications are necessary.

- The NRC staff has performed the screening reviews of the March 31, 2014 CEUS site submittals and has reached final screening and prioritization determinations. This NRC staff review evaluated which sites require the expedited approach and seismic risk evaluation. For those sites, the staff determined the adequacy of the interim evaluations, which also were submitted on March 31, 2014. The staff also created a priority list for the sites conducting detailed seismic risk evaluations. At present, based on the screening reviews 31 of the 58 operating CEUS sites are expected to perform Seismic Risk Evaluations. In addition, in December 2014 these sites submitted interim actions or the “expedited approach” also known as the Expedited Seismic Evaluation Process (ESEP).

- [The NRC staff has performed initial screening reviews of the March 12, 2015 WUS site submittals and has reached preliminary screening and prioritization determinations].

- The prioritization is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. Seismic risk analysis is a very specialized field and there are a limited number of experts available to perform the work at the necessary level of detail. Prioritization is appropriate to ensure the available resources are used most efficiently.

- About half of CEUS plant sites will need to conduct detailed risk evaluations for the higher seismic hazard. These sites will need to develop either a seismic probabilistic risk assessment or a seismic margin assessment. In addition, about a quarter of CEUS sites will conduct limited additional evaluations, such as verifying spent fuel pool seismic information, or examining equipment sensitive to high-frequency ground motions at the plant's higher seismic hazard. However, these limited-scope sites will not need to conduct the detailed risk evaluations.

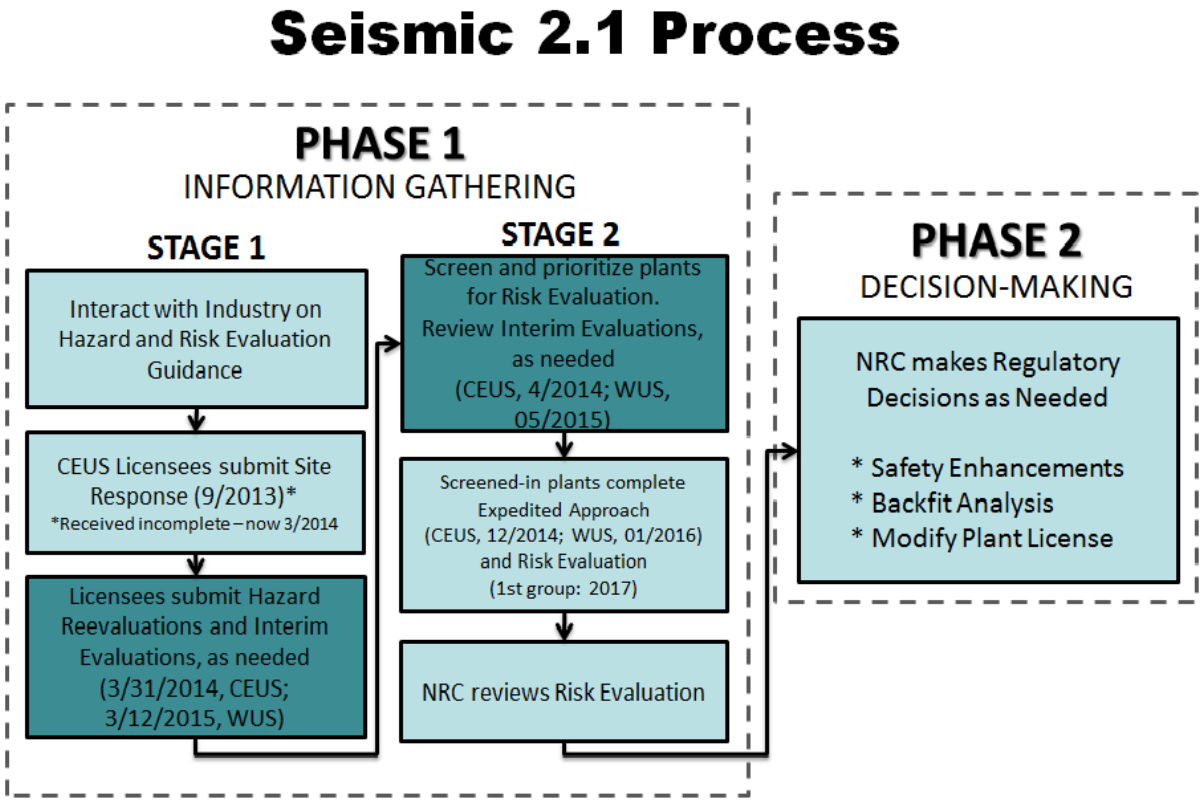
Background

On March 12, 2012, the Nuclear Regulatory Commission issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Part 50, Section 54(f). The purpose of that request was to gather sufficient information to enable the NRC staff to determine whether nuclear plant licenses should be modified, suspended, or revoked. Enclosure 1 to that letter directed the re-evaluation of seismic hazards at operating reactor sites.

In the 50.54(f) letter, NRC described the two-phase process it intends to use to make its regulatory decision (see figure below). The first phase of the NRC process focuses on information gathering and is divided into two stages. The first stage is for licensees to submit a re-evaluated seismic hazard calculated using current-day methods, along with an interim evaluation or an interim action to demonstrate that a plant can cope with the re-evaluated hazard if it is greater than the current design basis. For CEUS plants, the first stage culminated with submittals by the licensees on March 31, 2014. For WUS plants, the first stage culminated with submittals by the licensees on March 12, 2015. This communication plan focuses on key messages and likely questions that will stem from these submittals.

In the first step of Stage 2 of the process, within 30 days of the licensee submittals, the NRC staff identified (screened) which plants require further evaluations, including risk evaluations, and which plants should initiate the risk evaluations first. The NRC staff also conducted reviews of licensee interim evaluations and actions and determine that no immediate regulatory actions are needed to assure plant safety while further evaluations are ongoing. These further evaluations consist of two activities: (1) a near-term, expedited approach; and (2) a longer-term seismic risk evaluation. The expedited approach accelerates the review of certain accident scenarios (i.e., loss of all AC power and loss of ultimate heat sink) resulting from an earthquake. The purpose of the review is to assure key plant systems and components can withstand the higher ground motions associated with the reevaluated hazard. If it is determined that the plant

systems and components cannot adequately withstand the higher ground motion, then they will be modified.



For the CEUS plants, the expedited evaluations were submitted to the NRC staff by December 2014 and any modifications, if necessary, will be completed by December 2016. Similarly, the NRC expects that by January 2016 WUS sites will provide the “expedited approach” for sites with a higher re-evaluated hazard and any modifications, if necessary, will be completed by June 2018. The seismic risk evaluations, for both CEUS and WUS, will take longer and will be submitted to the staff beginning 2017. The staff will use all of this information in Phase 2 to make a determination whether further regulatory action is necessary. The staff will use its regulatory processes to make these decisions.

The two-phase approach provides for time needed to conduct adequate and thorough analyses for regulatory decisions, while assuring plant safety is maintained while these analyses are being conducted. Additional details of the two-phase are shown in Attachment 1.

Audience and Stakeholders

Internal

- Office of the Commission
- Office of the Executive Director for Operations
- Office of New Reactors (NRO)
- Office of Nuclear Reactor Regulation(NRR)
- Office of Nuclear Regulatory Research (RES)
- Region I
- Region II
- Region III
- Region IV
- Office of Public Affairs (OPA)
- Office of Congressional Affairs (OCA)
- Advisory Committee on Reactor Safeguards (ACRS)
- Office of Federal and State Materials and Environmental Management Programs (FSME)
- Office of Nuclear Material Safety and Safeguards (NMSS)

External

- licensees
- Electrical Power Research Institute (EPRI)
- Nuclear Energy Institute (NEI)
- Congressional members
- State and Tribal governments
- public interest groups/non-governmental organizations
- Other government agencies
- media
- public

Communication Timeline

Communication Plan for WUS Seismic Hazard Screening

Date	**Activity (responsible organization)**
Significant Historic Actions	
Completed	Issued letter to all licensees Re: Operability, Reportability, Interim

(2/20/14)	Evaluation and Actions (ML14030A046)
Completed (5/9/14)	Issued Central and Eastern US (CEUS) Seismic Screening Letter (ML14111A147)
WUS Seismic Hazard Screening Review	
Completed (3/12/15)	NRC Receipt of WUS Hazard Reports (JLD/licensees)
Completed (3/30/15)	NRC/NEI Seismic Public Meeting w/ Discussion of WUS Review Process
4/14/15)	Target for public meeting notice of April 28 Diablo Seismic Meeting (JLD-DiFrancesco)
4/28/15	Diablo Canyon Public Meeting on seismic hazard reevaluation and interim actions (NRR/JLD, NRO/DSEA, Licensee)
4/29/15	Complete WUS screening & prioritization technical review (NRO/DSEA)
05/04/2015	Distribute WUS screening & prioritization letter to R-IV, OPA, OCA, OEDO (NRR/JLD liaison team)
05/12/2015	Issue WUS screening & prioritization letter including review of interim evaluation and actions (NRR/JLD) Issue Press Release on prioritization review (OPA)
05/21/2015	NRC/NEI Seismic Public Meeting Discussion on overall Rec. 2.1 "Seismic" Review Process
06/04/2015	Palo Verde Public Meeting on seismic hazard reevaluation interim actions (NRR/JLD, NRO/DSEA, Licensee)
06/09/2015	Columbia Public Meeting on seismic hazard reevaluation and interim actions (NRR/JLD, NRO/DSEA, Licensee)
TBD	Columbia End of Cycle Meeting (R-IV)
June 2015	Diablo End of Cycle Meeting and Open House (R-IV)
Fall 2015	Seismic hazard agreement letter for WUS sites
Continuing	Staff assessment of the reevaluated seismic hazard (NRO/DSEA, NRR/JLD)

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Questions and Answers

Q&As: Basic Information for both CEUS and WUS Sites

1. What is the information being requested by the NRC and how will it be used?

The NRC's March 2012 letter asked CEUS and WUS sites to provide a re-evaluated seismic hazard calculated using current-day probabilistic seismic hazard analysis (PSHA) methods. The original 18-month schedule for completion was later increased by 6 months to March 31, 2014 for CEUS sites. WUS sites were asked to provide their re-evaluated hazards by March 12, 2015. The re-evaluated seismic hazard is represented by ground motion response spectra (GMRS). Attachment 2 explains both PSHA and the GMRS in more detail. The GMRS would then be compared to the plant's existing Safe Shutdown Earthquake (SSE). If the new hazard is higher than the design, licensees would need to perform a seismic risk evaluation for the plant. The seismic risk evaluation considers the likelihood of the possible ground motion levels at a plant and factors in the capability of the plant's systems, structures and components to withstand this ground motion to generate the likelihood of core damage due to seismic events.

Seismic risk evaluations are complex and will take several years to complete. Sites with a re-evaluated seismic hazard that exceeds their current design basis also must include an additional evaluation in the March 31, 2014 submittal for the CEUS sites and in the March 12, 2015 submittal for the WUS sites. . This interim evaluation either describes how the plant's existing capacities can withstand the higher hazard, or the plant's interim actions to enhance its ability to cope with the higher hazard. The NRC will review the interim evaluations to ensure those plants can continue to operate safely while they conduct more comprehensive seismic reviews. Sites with a higher re-evaluated hazard will also complete an "expedited approach" during the following 2 years to identify if any modifications need to be made to increase the ability of certain components to withstand the higher ground motion. This approach will provide additional assurance that the plants can shut down safely if the higher ground motion occurs. Sites with a higher hazard will also conduct more in-depth seismic risk evaluations of their response to design basis and beyond design basis ground motions. NRC will use these in-depth analyses to determine if additional regulatory actions or plant modifications are necessary.

2. What did the NRC do with the CEUS and WUS sites re-evaluated hazards submittals? How soon and how will they decide whether additional regulatory action is necessary?

The NRC took 30-60 days to review the submittals and determine:

(1) which sites require the expedited approach and seismic risk evaluation;
(2) which sites have priority in conducting the risk evaluation; and
(3) the adequacy of interim evaluations and actions.

NRC's review of the interim evaluations and actions determined there was no immediate safety concern that warranted immediate regulatory action for CEUS and WUS plants. The NRC's

longer-term review will examine in detail licensees' re-evaluated hazard submittals and related seismic risk assessments. NRC staff will document their evaluation of each plant. As part of the review, the NRC will consider whether additional regulatory action is appropriate. The implementation of additional regulatory action, if needed, will vary depending on the type of action. Attachment 1 provides a flowchart of the process.

3. What are interim actions or evaluations? Why are they needed? How was this information used?

If the re-evaluated hazard exceeded the plant's seismic design basis, the interim evaluations and actions answer the immediate question of whether a plant can continue operating safely. As the plants generally have significant margin beyond their design capacity to withstand earthquake motions, the interim evaluation uses the actual capacities and new hazard information to see if the preliminary understanding of seismic risk is still within acceptable limits while the plant does more detailed evaluations. If the preliminary risk is deemed beyond the acceptable limits, the interim actions enhance a plant's seismic capacity so that the seismic risk is brought back within acceptable limits. The staff reviewed this information and determined that the plants' preliminary seismic risk remained within acceptable limits for the re-evaluated seismic hazard. There was no need for NRC to take immediate licensing actions, and the plants should continue to move forward with longer-term seismic risk evaluations, as appropriate for the level of re-evaluated seismic hazard.

4. What is the expedited approach? Why is it needed? How will this information be used?

The longer-term seismic risk evaluations provide the most comprehensive information to make regulatory decisions, but they are complex and will take several years to complete. Once the interim actions and evaluations are completed, plants where the new hazard exceeds the design ground motion will conduct an additional evaluation. This evaluation is called the "expedited approach" and looks at the systems and components that can be used to safely shut down a plant under the conditions of a station blackout (i.e., no AC power is available to use other systems) and loss of ultimate heat sink. The expedited approach will either confirm that a plant has sufficient margin to continue with a longer-term evaluation without any modifications, or confirm the need to enhance the seismic capacity of these systems so the NRC has additional assurance that they can withstand the re-evaluated hazard. The staff will determine if the expedited evaluation submittals are adequate and have followed the NRC-endorsed industry guidance.

5. Why does the expedited approach only consider ground motions up to two times higher than the plant's design?

If a re-evaluated seismic hazard is greater than the plant's design basis, completion of the expedited approach provides additional confidence that a plant can cope with the higher hazard. This information builds on the interim evaluations that were submitted to NRC in March 2014 for the CEUS and March 2015 for the WUS sites, which showed that the plants were very unlikely to experience core-damage at the higher hazard levels. The expedited approach is designed to show that important equipment used to safely shut-down a plant will function as intended if a large earthquake occurs. However, to complete the expedited approach by December 2014 (CEUS) and January 2016 (WUS), need to use a simplified method to analyze how this equipment responds to the re-evaluated ground motions. This method scales the plant's original engineering analyses to a higher level of ground motion, up to two times the plant's design basis. By using this scaling method, licensees can promptly determine if important safe-shutdown equipment is safe or needs additional modification.

If a plant's re-evaluated hazard exceeds two times its design basis, the plant is categorized as either Priority Group 1 or Group 2 for completion of a seismic probabilistic risk assessment. For these risk assessments, licensees will use detailed engineering models that are based directly on the re-evaluated levels of ground motion for the plant. However, the first of these detailed risk assessments aren't expected until June, 2017. The NRC determined that the simplified method used in the expedited approach was appropriate, because it provided near-term information on the functionality of important safety equipment at a higher hazard level years before the longer-term risk assessments could be completed.

6. What is the 30 Day Prioritization? Which plants get reviewed first? Which plants will take additional actions first?

Since there are a limited number of seismic risk experts available, the NRC prioritized each site to ensure the sites of most interest are reviewed first. The prioritization is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. The NRC staff considered several factors in prioritizing (or screening) the risk assessments:

(1) the extent to which the re-evaluated hazard exceeds the current design basis;
(2) the site's overall seismic hazard, based on an examination of the re-evaluation; and
(3) previous estimates of plant capacity (e.g., IPEEE insights).

The NRC reviewed all CEUS sites and its currently reviewing the WUS sites with greater hazards to determine priority. Plants that are grouped in Priority 1 will complete their detailed risk assessments by June 30, 2017. Priority 2 plants will complete these assessments by December 31, 2019, with Priority 3 plants completed by December 31, 2020. The staff is conducting a more in-depth review of the seismic hazard evaluations for each site and will issue a staff assessment once these reviews are completed.

7. What is conditional screening?

If the NRC staff and a site reach different conclusions based on a March 31, 2014 submittal (CEUS) and on a March 12, 2015 submittal (WUS), the site will plan to conduct additional evaluations unless the differences are resolved. Some plants have unique or complex characteristics that require additional information to complete the review. Once the needed information is developed and reviewed, the staff will make a final determination if the plant screens in or out for conducting additional risk evaluations, and the priority for completing the evaluations.

8. How many plants need to do additional risk evaluations in response to the newly calculated seismic hazards?

Based on the results of the NRC staff's review of the March 31, 2014 submittals, 31 of 58 CEUS operating reactor sites need to perform some type of additional risk evaluation. These sites submitted interim actions or evaluations known as the Expedited Seismic Evaluation Process (ESEP) in December 2014. Of the remaining 27 sites, 22 sites are required to respond only to limited-scope evaluations (i.e., high-frequency evaluation, low-frequency evaluation, or spent fuel pool evaluation). Furthermore, 5 sites have screened-out of all further evaluations.

9. Why isn't the NRC requiring a licensee with higher seismic hazards to immediately modify its licensing basis?

A full seismic risk analysis is beneficial in determining how best to modify a plant's licensing basis. Since plants generally have significant margin beyond their existing seismic design basis, available information shows they can operate safely even with a higher hazard. The plants' interim evaluations and actions determined that the existing plant capacity can accommodate the re-evaluated hazard and that no immediate regulatory actions are necessary.

10. Why isn't the NRC immediately shutting down priority 1 plants/plants with higher seismic hazards?

The prioritization is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. The NRC continues to have confidence, based on our understanding of both reactor design and construction and the results of the plants' seismic "walkdowns," that plants can operate safely while more analyses are done. Nuclear power plant manufacturing and construction methods typically result in a plant having the capacity to withstand earthquakes larger than their design basis earthquake. This is because nuclear power plants are designed to withstand the force of different internal and external events. Many of these events create larger forces on a plant than an earthquake. Plants examined this capacity and demonstrated their safety systems can still perform properly after seismic hazards larger than those the plant was designed to withstand. The NRC is satisfied the systems will perform their safety functions at the higher seismic hazard levels, and that the plant can continue

operating. NRC staff's initial review of an industry screening analysis and the interim evaluations provided confidence that none of the plants showed a preliminary change in risk that would cause concern. Consequently, interim actions were not necessary to ensure the systems can function.

In addition to the design margins and interim actions, all plants recently underwent detailed seismic walkdowns. These walkdowns identified and addressed degraded, nonconforming, or unanalyzed conditions through the corrective action program, and verified the adequacy of the monitoring and maintenance procedures. NRC reviewed licensee actions to:

(1) verify the plant configuration with the current seismic licensing basis;
(2) address degraded, nonconforming, or unanalyzed seismic conditions; and
(3) verify the adequacy of monitoring and maintenance programs for protective features.

The results of these walkdowns provide additional confidence that plants can continue to operate safely while longer-term risk assessments progress.

11. How can the public be involved in the process?

The public has already participated in public meetings on the seismic re-evaluation process. The public may always send comments to JLD_Public.Resource@nrc.gov. The prioritization and screening letters resulting from staff's 30-day review for the CEUS is publically available. The prioritization and screening letter resulting from staff's 30-60 day review for the WUS is underway and will publically available in May 2015. The public always has the options of asking the NRC to take additional action through the 2.206 and rulemaking petition processes.

12. If you think there might be a significant problem, why aren't you doing anything right now?

The staff asked plants to perform the re-evaluation to ensure enough information is available to properly consider whether further action is warranted. It is important to remember that nuclear power plant safety systems are designed to withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, and all types of flooding and maintain their capability to perform their intended safety functions. The design bases for these systems consider the most severe of the natural phenomena that was historically reported for the site and surrounding area. The design bases also reflect margin to account for the limited accuracy, quantity, and period of time in which the historical data was accumulated. The plants were built with additional capacity to withstand even larger demands than required in their design bases. The NRC reviewed that capacity and determined that immediate plant modifications are not needed as a result of the newly re-evaluated seismic hazards. The NRC will continue to evaluate information from the licensee's Expedited Approach and additional seismic risk evaluations, and will determine if regulatory actions are needed to ensure continued safe operation of these plants.

13. Why is the NRC asking licensees to evaluate the integrity of spent fuel pools when the NRC recently concluded that these pools were safe from extreme earthquakes?

One of the questions emerging from the Fukushima accident was on the potential effects of seismic events on the integrity of spent fuel pools. Therefore, the NRC wanted to ensure U.S. nuclear power plants have considered the re-evaluated seismic hazard's implications for appropriate safety systems, including spent fuel pools. In developing guidance for the seismic re-evaluations, the nuclear industry proposed a limited set of spent fuel pool items to review for plants with increased hazards. After that guidance was finalized, an NRC study (SECY 13-0112, ML13256A342) confirmed that spent fuel pools are robust structures that are likely to withstand severe earthquakes without leaking. However, this study focused on the implications of transferring spent fuel from pools to dry storage systems. U.S. plants' previous Individual Plant Examination of External Events (IPEEE) analyses did not examine spent fuel pools. Consequently, the current seismic hazard re-evaluations present an opportunity for licensees to examine spent fuel pool seismic design, as well as any cost-effective enhancements to operations or safety systems.

14. When does an FSAR need to be updated with new seismic information?

As stated in the March 12, 2012 50.54(f) letter, the seismic hazard reevaluations conducted in Phase 1 do not revise the design basis of the plant. Based upon the results of Phase 1, the NRC staff will determine whether additional regulatory actions are necessary (e.g., update the design basis and SSCs important to safety) to provide additional protection against the updated hazards. If such actions are warranted, licensees would likely need to update the FSAR with new seismic information.

15. What is the NRC going to do with the SPRA results?

Once the SPRA analyses are completed, the NRC staff will use these results along with other available risk information to determine if additional regulatory actions are needed to provide additional protection against the updated seismic hazards. The NRC staff expects that the results of the SPRA analyses will provide a transparent basis to support backfit decisions for potential safety enhancements.

Q&As: Basic Information for WUS Sites

16. Why are plants in the western United States (WUS) on a different and longer schedule than plants in the central and eastern United States?

The Columbia, Diablo Canyon, and Palo Verde plants required additional time to develop an updated, site-specific probabilistic seismic hazard analysis due to the West Coast's complex seismic features. In developing probabilistic seismic hazard analyses, CEUS sites were able to use the same recently developed seismic source model and a common ground motion model (see Attachment 3). As a result, CEUS plants needed less time to complete their seismic hazard re-evaluations. West Coast site-specific seismic sources and ground motion models involve a Senior Seismic Hazard Analysis Committee (SSHAC) study, as described in NUREG/CR-6372, "Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and Use of Experts." The SSHAC is a group of independent seismic experts who were convened in the 1990's to develop guidance on the conduct of major seismic studies, and ensure that seismic activities are conducted properly and documented completely.

The SSHAC process is independent of the NRC's seismic experts. The NRC must approve any studies, models, methodologies, analyses etc. used by nuclear power plants if they form the basis for safety assessments and where the NRC needs to make regulatory decisions affecting their operating license. Further, although the NRC does carefully consider comments and recommendations from the SSHAC, as an independent regulatory body, NRC is not held to any decisions made by the SSHAC.

17. What information is NRC expecting in the March 12, 2015 WUS plant submittals?

NRC expects that the March 12, 2015 submittals will contain substantially more information than was submitted for CEUS plants in March 2014. This is because each of the WUS plants had to develop site-specific source models and ground-motion models, using the Senior Seismic Hazard Analysis Committee (SSHAC) approach. In contrast, the CEUS plants all used a common set of models (see Attachment 3). In addition to the information that was included for the CEUS plants, NRC expects that the important details of the site-specific SSHAC studies will be included in the March 12, 2015 submittals. NRC also expects that the complete SSHAC study report will be available for the NRC staff to review, as needed.

If the reevaluated hazard exceeded the plant's seismic design basis, NRC expects the WUS plants to follow the same approach as used for CEUS plants and also submit an interim evaluation of the plant's capacity to withstand the higher ground motions. Because nuclear power plants generally have significant margin beyond their design capacity to withstand earthquake motions, the interim evaluation uses the actual capacities and new hazard information to see if the preliminary understanding of seismic risk is still within acceptable limits while the plant does more detailed evaluations.

18. Will NRC conduct a screening and prioritization review for western United States (WUS) plant submittals?

Yes. NRC staff will conduct a screening and prioritization review for the WUS hazard reevaluations after the complete hazard reports are submitted. This review will likely take between 30-60 days to accomplish, because there is substantially more new information in these reports than was submitted for the CEUS plants in March 2014. If the reevaluated hazard is within the plant's design basis, the NRC staff will need to determine if sufficient information is available to support that conclusion. However, if the reevaluated seismic hazard exceeds the plant's design basis, NRC will need to determine:

(1) if the plant's interim evaluations and actions demonstrate the plant can continue to operate safely at the reevaluated hazard level, while longer-term risk assessments are ongoing.
(2) the priority for WUS plants to complete the additional risk evaluations
(3) the schedule for completion of the expedited approach and seismic risk evaluation.

NRC's review of the interim evaluations and actions will determined if there is an immediate safety concern that warrants immediate regulatory action for WUS plants. The NRC's longer-term review will examine in detail licensees' reevaluated hazard submittals and related seismic risk assessments.

19. Will NRC prioritize WUS plants for completion of seismic risk assessments?

Yes. As part of the initial review, WUS plants that have "screen in" for more detailed risk assessments will be prioritized to ensure the plants of most interest are reviewed first. This prioritization is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. Using the same approach as for the CEUS plants, the NRC staff will consider several factors in prioritizing (or screening) the WUS risk assessments:

(1) the extent to which the reevaluated hazard exceeds the current design basis;
(2) the site's overall seismic hazard, based on an examination of the reevaluation; and
(3) previous estimates of plant capacity (e.g., IPEEE insights).

Plants that are grouped in Priority 1 will complete their detailed risk assessments by June 30, 2017. Priority 2 plants will complete these assessments by December 31, 2019, with Priority 3 plants completed by December 31, 2020.

20. Does NRC expect to review the WUS submittals the same way as the CEUS submittals?

Compared to the CEUS submittals, NRC expects that the WUS submittals will be much longer and contain a lot more new information on site geology, earthquake sources, and ground motion modeling. As a result, NRC expects that the WUS submittals will be much more complex to review than the CEUS reevaluations. In addition to all the new information, each WUS plant also had to do a complex probabilistic seismic hazard assessment (PSHA), using a very detailed, multi-year process. In contrast, all the CEUS plants used essentially the same PSHA, which was extensively reviewed by NRC before the seismic hazard reevaluations were submitted.

After the screening and prioritization review is completed, NRC staff will conduct a thorough review of the WUS seismic hazard reevaluations. To review each of these site-specific hazard reevaluations, the NRC staff will need to examine important details of each plant-specific source characterization and ground motion model. The NRC staff expects to conduct confirmatory analyses of key parts of these models, to determine if the reevaluated seismic hazards are reasonable. In addition to examining the detailed technical information that supports the hazard reevaluation, the NRC staff also will review the lengthy documentation about the SSHAC process that licensees used to develop the source characterization and ground motion models. The staff will issue a staff assessment for each site once these reviews are completed.

21. Will NRC produce its own version of the WUS plant's reevaluated seismic hazard?

To support the initial review of CEUS plant submittals, the NRC developed a computer model that could calculate seismic hazards for each CEUS plant. These calculations were possible because all the CEUS plants used the same seismic hazard model, and the model was developed several years before the CEUS hazard reevaluations were submitted.

However, the WUS plants completed their site-specific hazard analyses less than a year before the final reports were submitted to NRC, and each plant used different types of seismic hazard models. The NRC staff determined that they could conduct an appropriate, risk-informed review of the WUS hazard reevaluations without expending considerable resources to develop three new, site-specific computer models. The NRC staff expects to do site-specific confirmatory analyses on key parts of the hazard analyses, including independent evaluations of the earthquake source models, ground motion models, and site response models.

22. Will WUS plants have to do additional risk assessments if their reevaluated hazard is larger than the plant's safe shutdown earthquake?

Yes, the same criteria used for CEUS plants applies to WUS plants for determining if additional risk assessments are needed. WUS plants that screen-in for the risk assessments will need to complete the expedited approach (see question #4) and either a seismic margins assessment or a probabilistic risk assessment. Plants that screen-out from the risk assessment might still meet the criteria for conducting limited-scope evaluations of low frequency exceedances, high frequency exceedances, or spent fuel pool performance. The need for conducting additional analyses will be determined during NRC's screening and prioritization review.

Q&As: Generic Seismic Questions

23. What is magnitude? What is the Richter scale? What is intensity?

Magnitude objectively measures an earthquake's strength based on seismographic observations. Magnitude is expressed in various ways based on seismographic records (e.g., Richter Local Magnitude, Surface Wave Magnitude, Body Wave Magnitude, and Moment Magnitude). Moment Magnitude is currently popular and is considered a direct measure of an earthquake's energy. Moment Magnitude is based on the strength of the rock that ruptured, the area of the fault that ruptured, and the average amount of slip. Each whole number increase in moment magnitude represents a tenfold increase in measured amplitude. Each whole number step in moment magnitude corresponds to the release of about 31 times more energy.

Charles F. Richter developed his magnitude scale in 1935 while at the California Institute of Technology. He based the scale on the behavior of a specific seismograph from that era. That instrument is no longer used and seismologists no longer use the Richter scale. Since the Richter scale remains a commonly used term, however, some seismologists answer questions about "Richter" magnitude by substituting moment magnitude without clarifying the difference.

Earthquake intensity is a subjective, location-specific assessment of the effects of strong ground motions. A quake's observed effects on humans, on human-built structures, and on the earth's surface locational factor into an intensity rating. The Modified Mercalli Intensity (MMI) scale is the most common U.S. measure, with values ranging from I to XII. An MMI of I is only felt by a very few, whereas an MMI of XII indicates every structure has been damaged, many completely. While an earthquake has only one magnitude, intensities will vary over a wide area.

24. What is PSHA?

A Probabilistic Seismic Hazards Analysis (PSHA) assesses a site's seismic hazard. This well-defined process examines earthquake sources near a site to determine how likely different levels of ground motions are at the site. A PSHA uses information from all seismic sources and

earthquake types that could affect a site. Earlier deterministic methods that were used to assess a site's seismic hazard identified a site's largest potentially damaging earthquake to determine the expected ground motions. The PSHA primer (Attachment 2) describes the process in more detail.

25. What is GMRS? What is the SSE?

The Ground Motion Response Spectra (GMRS) is one way of describing the site's seismic hazard, which defines the site-specific basis for design. The PSHA primer (Attachment 2) provides more details on calculating a GMRS and what it means. The GMRS is used to define the Safe Shutdown Earthquake (SSE), which represents the level of ground motion that important structures, systems, and components must be designed to remain functional if that ground motion occurs.

26. How do magnitude and ground motion relate to each other?

The ground motion experienced at a particular location depends on the magnitude of the earthquake, the distance from the epicenter to the site, and other factors such as the geologic formations through which the seismic energy passes. Because seismic energy travels through the Earth as waves, these ground motions have specific frequencies and amplitudes that create different levels of stress on different types of structures, systems and components.

27. How do these hazard re-evaluations relate to GI-199 and the IPEEE program?

GI-199 was a pre-Fukushima NRC effort to investigate updated earthquake-related data and models for the Central and Eastern United States. The NRC completed the risk assessment stage of GI-199 in September 2010 (ML100270582), concluding that higher seismic risks could exist and should be examined further. The regulatory resolution stage of GI-199 was overtaken by the NRC's post-Fukushima 50.54(f) actions. Completion of the 50.54(f) seismic re-evaluation will meet the regulatory resolution goal of GI-199.

The Individual Plant Examination of External Events (IPEEE) program was a 1990s-era look at how U.S. nuclear power plants would withstand severe weather or seismic events. Most plants reported no seismic risk vulnerabilities, but some reported other seismic concerns. Most plants voluntarily proposed safety system improvements as a result of their IPEEE analyses. During the post-Fukushima seismic walkdowns, NRC staff requested an update to the licensees' actions related to the IPEEE improvements. The staff's review of these actions will be reported in the staff assessments for the Walkdown Reports (scheduled for issuance from now through spring 2014).

28. What is Seismic Core Damage Frequency (SCDF) and how is NRC using SCDF to consider risk?

"Seismic core damage" refers to an accident that causes severe damage to the reactor core due to the loss of some safety function, which was caused by shaking from a large earthquake. The seismic core-damage frequency (SCDF) estimates the likelihood that an earthquake could occur and damage the core. Therefore, the SCDF is tied to the probabilistic seismic hazard assessment (PSHA), which estimates the frequency of occurrence for earthquake ground motions. NRC will use the SCDF in two ways:

(1) Initially, the NRC relied on SCDF calculated using a simplified and approximate process to determine the need for any immediate actions, and
(2) Once the detailed risk analyses are completed, the SCDF along with other information will be used to decide if additional regulatory actions are needed.

29. Why didn't the licensee's submit new SCDF numbers? How can the industry say that nobody is above 10^{-4}/year? What does 10^{-4}/year mean for plant safety?

Seismic core damage frequency (SCDF) is a numerical estimate of risk and provides a representative indication of plant safety. The March 12, 2012, 50.54(f) requested information stated that plant's where the re-evaluated hazard exceeds the design basis should submit and interim evaluation or actions. To support plant responses to the 50.54(f) request, industry independently assessed SCDF for all of the CEUS plants and provided the results to NRC in a March 12, 2014 letter. This assessment is similar to the NRC's preliminary seismic risk assessments for GI-199. The 10^{-4}/year value demonstrates that current understandings of seismic hazard do not represent an immediate concern to plant safety, and that plants should continue to operate while more rigorous risk evaluations are completed.

The licensees, as part of the March 31, 2014, submittals, confirmed that the industry conclusions for their facility are accurate. The NRC reviewed this information as part of the staff's assessment of licensee interim actions and evaluations, and agrees that the re-evaluated seismic hazards do not represent an immediate concern to plant safety.

30. How can U.S. plants be ranked for relative risk using the updated hazard information?

The NRC believes the industry's preliminary seismic core-damage frequency analysis provides a representative indicator of plant safety, which confirms that the re-evaluated seismic hazards do not represent an immediate concern for plant safety. The re-evaluated seismic hazard is one piece of information that is reviewed by the staff. However, the hazard alone is not sufficient to make a licensing decision. The seismic hazard is an input to determining how well a plant is able to withstand the hazard. During the 30-day prioritization, the NRC considered a range of information to determine which plants should be first to complete the risk evaluation. This

information included the March 31, 2014 and March 12, 2015 submittals for CEUS and WUS sites respectively along with previous estimates of plant capacity. The NRC's prioritization of plants for completing detailed risk assessments cannot be considered a risk ranking. The NRC believes that insufficient information is available to rank plants by relative risk. Plants with re-evaluated hazards that are higher than their design bases will complete detailed seismic risk evaluations. These detailed risk evaluations should provide the NRC with the most comprehensive information to make regulatory decisions.

31. How are the 2014 USGS seismic hazard maps different from the seismic hazard re-evaluations being requested by the NRC?

Nuclear power plants (NPPs) are designed to withstand very large and complex ground motions from earthquakes that are very unlikely to occur in the future. To meet NRC's safety requirements, the seismic hazard re-evaluations have to consider possible ground motions that might occur only once in ten thousand to one hundred thousand years. In contrast, the 2014 USGS seismic hazard maps calculate the odds of certain levels of peak ground motion occurring in the next 50 years. This time period is commonly used for building code and emergency planning requirements.

The 2014 USGS maps use much of the same information and models that are used in the NPP seismic hazard re-evaluations, but they expand this information to include the western United States. Compared to the NPP seismic hazard re-evaluations, the USGS includes some different models in their 2014 calculations and their database includes earthquakes that occurred in 2009-2012. More importantly, the NPP seismic hazard re-evaluations analyze how the specific geologic conditions of the site affect the characteristics of possible ground motions. These site-specific effects, which can give large increases in calculated ground motion, are not considered in the 2014 USGS hazard maps.

32. What is the Senior Seismic Hazard Analysis Committee (SSHAC)?

The SSHAC is a group of experts who formulated guidelines for various levels of PSHA studies to address uncertainties through the use of expert judgment. WUS plants have develop site-specific source models and ground-motion models using the SSHAC approach.

Q&As: US NPP Seismic Design

33. How many US reactors are located in active earthquake zones?

Although we often think of North America as having "active" and "non-active" earthquake zones, earthquakes can actually happen almost anywhere. The NRC requires that every nuclear plant be designed for earthquake ground motions appropriate for their locations. The NRC has

specified the minimum ground motion for nuclear plant designs is 0.1 g, or 10 percent of the acceleration from Earth's gravity.

34. What level of earthquake hazard are the US reactors designed for?

Each reactor is designed for site-specific ground motions. The existing nuclear plants were designed on a "deterministic" or "scenario earthquake" basis, accounting for the area's largest expected earthquakes, without considering how likely the earthquake actually is. A margin is further added to the predicted ground motions to provide added robustness. In contrast, new reactors are designed using probabilistic methods that characterize both the ground motion levels and uncertainty at the proposed site. These probabilistic methods account for the ground motions that may result from all potential seismic sources in the region around the site. Technically speaking, this is the ground motion with an annual frequency of exceedance of $1x10^{-4}$/year, but this can be thought of as the ground motion that occurs every 10,000 years on average. One important aspect is that probabilistic seismic hazard and risk-assessment techniques account for beyond-design basis events. The post-Fukushima effort uses the latest probabilistic methods to review the hazard for existing plants.

35. What magnitude earthquake are currently operating US nuclear plants designed to?

Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels. Ground motion depends on both an earthquake's magnitude and its distance from the site. The existing nuclear plants were designed on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant. A margin is further added to the predicted ground motions to provide added robustness.

Present-day NRC requirements and guidance with respect to characterizing seismic hazards use a "probabilistic" or "performance-based" approach in order to develop a ground motion response spectrum (GMRS) for the site. This approach is described in Regulatory Guide (RG) 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion." RG 1.208 recommends the use of the Senior Seismic Hazard Analysis Committee (SSHAC) approach for treatment of expert judgment and quantifying uncertainty in order to develop seismic source and ground motion models for a Probabilistic Seismic Hazard Analysis used to develop the GMRS for a site.

36. What is the likelihood of the design basis earthquake or "SSE" ground motions being exceeded over the life of a nuclear plant?

The ground motion response spectra forming the seismic design bases at U.S. nuclear plants are called the Safe Shutdown Earthquake (SSE). SSEs for operating nuclear power plants were established many years ago. Today's understanding of seismic hazard tells us there is some likelihood that a plant's SSE may be exceeded by an earthquake ground motion. However, each

plant was designed differently according to different licensing SSEs. Therefore, the likelihood of exceedance is plant specific. Meanwhile, systems, structures and components typically have margin, meaning that they often can withstand shaking levels that are above the plant's design basis.

37. Has there been an operating U.S. reactor site that has experienced exceedance of its seismic design basis during an earthquake?

The August 2011 earthquake at North Anna plant in Virginia was the first instance of an operating reactor in the United States where recorded ground motion exceeded its design basis in some frequency range. The plant shut down safely, and extensive inspections showed that there was no discernable damage to safety systems. After thorough review of the inspection information, NRC authorized the restart of North Anna in November 2011. In 1986, earthquake motions at the Perry plant in Ohio exceeded its SSE in limited frequencies during construction, but the plant was found acceptable for operation and its license was issued. In 1979, the V.C. Summer plant in South Carolina also exceeded its SSE while under construction, but was found acceptable for operation and its license was issued. In all of these cases, the exceedance of ground motion by itself was not an indicator of whether the plant's design limits were exceeded. Also, the plants had much higher capacity than the design basis. As expected, there was no damage to these plants from the earthquakes.

38. Why isn't the NRC requiring changes to a plant's design if higher seismic hazards are known, like what happened at Diablo Canyon?

At Diablo Canyon, a new fault was discovered near the site after a construction permit was issued in 1969. Studies showed this new fault had the potential to create large ground motions, which were then evaluated against the plant's existing design. Consequently, there was sufficient information to question if important safety systems would function. The NRC required the licensee to make significant modifications to the plant's design to ensure that the plant could shut-down safely if a large earthquake occurred on the new fault. Once those actions were completed, the NRC issued an operating license in 1984.

The current seismic hazard re-evaluations are different from the information used at Diablo Canyon. To ensure continued safe operations, the plants conducted an interim evaluation demonstrate the plant can safely cope with the potentially higher hazards. These interim actions addressed the plant's capacity to withstand ground motions that might exceed the original design basis. These plants will then conduct detailed seismic risk evaluations, which will provide the NRC with information to determine if important safety systems would function at the higher hazard levels. These evaluations should be comparable to the types of information used by the NRC to make decisions about Diablo Canyon. If licensees have not provided sufficient information to demonstrate continued safety at the higher ground motions, the NRC will take appropriate regulatory action to ensure protection of public health and safety and the environment.

39. Are there seismic monitors on site?

Yes. The NRC requires nuclear power plants to maintain operating seismic monitors on site.

40. How do the re-evaluated seismic hazards affect emergency planning?

With regard to a seismic hazard re-evaluation yielding a different result, the basis for emergency planning would not be impacted and remain valid. If the plant takes interim actions, or otherwise modifies the plant, then the NRC expects the plant's emergency planning group will evaluate the impact on emergency plan effectiveness. Additionally, if the plant's licensing or design basis is changed as a result of the re-evaluated seismic hazard, then the threshold(s) for emergency action levels may also need to be changed to align with the new seismic hazard.

Offsite emergency planning is the responsibility of State and local governments. Generally, offsite emergency planning is a decision-making process rather than a prescribed course of action. The NRC does not expect a differing seismic hazard to impact an offsite agency's decision-making process.

Q&As: Timeline and resources

41. Why does the agency believe that the staff will be more timely in its resolution of this issue than it has on other long-standing technical issues?

The 50.54(f) letter defines a staged process to ensure all seismic hazard re-evaluations and integrated assessments are completed in a timely manner. The NRC staff is tasked with ensuring public health and safety and security and protecting the environment using its existing regulations and processes. Part of the NRC's mission to avoid undue regulatory burdens on the safe civilian use of nuclear materials. While a systematic and methodical re-evaluation of nuclear power plant seismic hazards is a complex undertaking, the NRC staff is focused on ensuring the industry does a complete and accurate job the first time. The staff believes the current schedule can be carried out with available resources.

Q&A: Plant-specific Questions

42. Will plants that are facing permanent shutdown in the near term be considered for exemptions to the 50.54(f) seismic reviews if requested?

The 50.54(f) letter applies to all operating nuclear power plants and holders of construction permits as of March 2012, when the letter was issued. Since that time, three sites (Kewaunee, Crystal River, and San Onofre) have permanently ceased operation and have requested to be relieved from the obligation of responding to the letter. The NRC staff has granted that relief to those three sites. In addition, Vermont Yankee has announced its intention to shut down and to

ask for relief. Vermont Yankee has requested an extension to the time permitted to complete the re-evaluated seismic hazard.

43. Why did [plant] end up in priority category 1/2/3?

The prioritization is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. Seismic risk analysis is a very specialized field and there are limited numbers of experts available to perform the work at the necessary level of detail.

[Category 1 plant] has both a relatively large increase in seismic hazard and relatively large new ground motion estimate. Therefore [Category 1 plant] will benefit most from the results of detailed seismic risk analysis and has priority in using available seismic risk expertise.

[Category 2 plant]'s increase in seismic hazard and new ground motion estimate are smaller than Category 1 plants. Therefore, while [Category 2 plant] will benefit from the results of detailed seismic risk analysis, it can wait until resources are available after Category 1 evaluations are complete.

[Category 3 plant] has both a small increase in seismic hazard and small new ground motion estimate. Additional staff/plant discussions can also show a Category 3 plant does not need detailed analysis. Therefore [Category 3 plant]'s analysis can wait until Category 1 and 2 detailed seismic risk analyses are complete.

Q&As: Other facilities

44. Why are the seismic hazard re-evaluations limited to nuclear power plants only? Is anything being done for other nuclear facilities?

The NRC is considering whether or not the lessons-learned from Fukushima, such as seismic hazard re-evaluations, should be applied to other types of facilities that we regulate. The staff is currently preparing a paper for the Commission to address this issue.

45. What do the re-evaluated hazards for operating reactors mean for fuel cycle facilities? Are fuel cycle facilities required to re-evaluate their seismic hazards?

The re-evaluated hazards for operating reactors are not directly applicable to fuel cycle facilities. The regulatory requirements in Title 10 Code of Federal Regulations Part 40, 70 and 76 require fuel cycle licensees to evaluate the likelihood and consequences of accidents including those from seismic hazards. The NRC's Fukushima response included inspections at fuel cycle facilities to confirm that licensees were in compliance with regulatory requirements and license conditions; and to evaluate their readiness under natural phenomena events including seismic events. As a result of the inspection activities the NRC issued a confirmatory order to the

Honeywell Metropolis Work Facility. The order kept the plant shut down until Honeywell completed corrective actions to demonstrate that their systems and structures relied on for safety were adequate for natural phenomena events including seismic loads. In addition, as a result of the inspections, the staff identified unresolved items related to the current regulatory requirements and the licensing bases of fuel cycle facilities. Therefore, the NRC is issuing a generic letter to the fuel cycle facilities asking for information to verify that licensees are in compliance with regulatory requirements regarding the natural phenomenon events accident sequences including those from seismic hazards applicable to the facilities. The NRC will take further regulatory action based on the responses, if appropriate.

46. How are seismic hazards considered for research and test reactors? How do the revised seismic re-evaluations for operating reactors affect research and test reactors?

Research and test reactors must meet specific criteria to address seismic concerns. NRC-licensed research reactors must meet local building codes, whereas test reactors are required to meet 10 CFR, Part 100 as is the case for NRC-licensed power reactors. Due the low power level of the research and test reactors, this has been considered adequate for the protection of the public. After the accident at Fukushima Dai-ichi, the NRC determined that there was not an immediate safety concern for the research and test reactors. The NRC is currently evaluating whether the lessons-learned from the accident apply to other regulated facilities, such the research and test reactors. If appropriate, the NRC may ask for additional information from the research and test reactors.

47. Do the reevaluated seismic hazards affect our understanding of safety for spent nuclear fuel stored in casks at some of the operating plants?

U.S. Nuclear Regulatory Commission (NRC) regulations in Title 10 Code of Federal Regulations Part 72 and performance standards require licensees to analyze the environmental conditions and natural phenomena surrounding each Independent Spent Fuel Storage Installation (ISFSI) to determine severe design-basis events for each site. To be certified by the NRC, the storage casks must be evaluated and shown to withstand the forces and stresses from the most severe site specific design-basis loading conditions for each type of event.

In evaluating the adequacy of each licensee’s design basis events, the NRC uses historical seismic events, nearby seismic faults and site-specific ground characteristics for each ISFSI to determine the ground motions that could affect an ISFSI. The casks are designed to maintain stability, withstand the ground motions, and safely confine and shield the spent nuclear fuel under such events. In previous analyses, licensees have conservatively shown, and NRC has confirmed, freestanding dry storage cask components, such as the canister and overpack, will neither tip over nor fail during such events. Dry storage casks at North Anna remained upright during the August 2011 earthquake and continued to safely contain their spent fuel. The dry storage casks are also analyzed for other severe natural phenomena and accidents such as

cask drops and tipover, explosions, fires, floods, and tornado winds, and tornado missiles. The radiological consequences of a cask tipover accident are addressed in NRC safety evaluation reports and have been shown to be negligible.

The NRC does not anticipate that re-evaluated seismic hazards at the site would call into question the safety of the ISFSIs that are co-located at that site. However, the NRC is currently evaluating whether the lessons-learned from the Fukushima accident apply to other regulated facilities, such as ISFSIs or designs for spent fuel transportation and storage canisters.

48. Are any of the plants that have announced they are shutting down, or are decommissioned required to re-evaluate their seismic hazards? Is the fuel stored onsite still safe?

The NRC did not ask plants that were decommissioning to re-evaluate their seismic hazard as part of the initial request because the operating reactors were a higher priority. The NRC is considering whether seismic hazard re-evaluations would be appropriate for decommissioned plants as part of its broader effort to consider whether the lessons learned from Fukushima should be applied to the other facilities that we regulate. The staff is preparing a paper for the Commission.

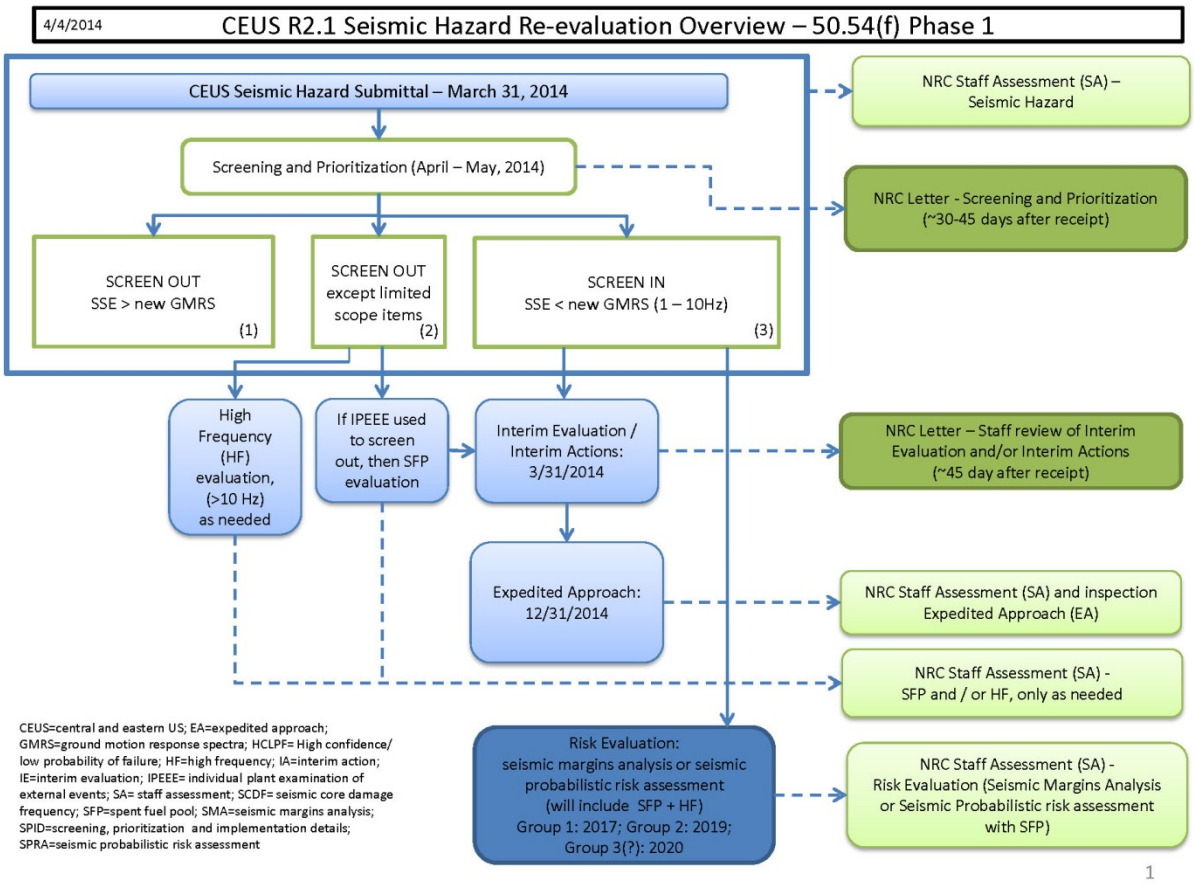
Since March 2012, when the request for information was sent, three additional sites have permanently ceased operation. Because they were included in the letter, they needed to apply to be relieved of the obligation of responding to the 50.54(f) letter. Kewaunee, Crystal River, and San Onofre have applied for this relief. The staff has granted relief to all three. Vermont Yankee is still operating. Vermont Yankee has requested an extension to the time permitted to complete the re-evaluated seismic hazard. The NRC is reviewing their extension request as part of the 30-day prioritization and screen.

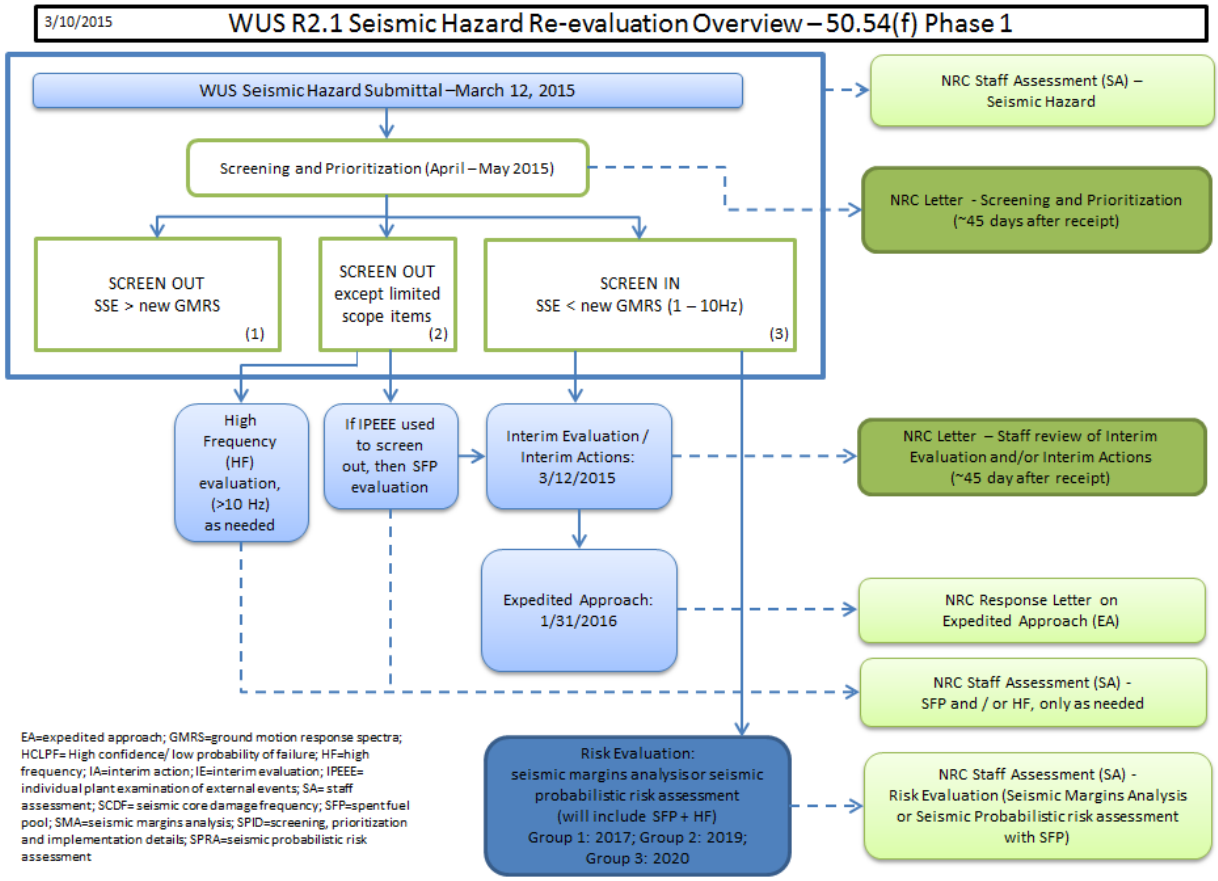
Regarding, the spent fuel safety for those plants, safety of fuel located in the spent fuel pool is assured for an extended period through maintenance of pool structural integrity, which preserves coolant inventory and maintains margin to prevent criticality. Previous evaluations of spent fuel pool structures have determined that seismic margins are very large and small changes in the re-evaluated seismic hazard would not threaten the structural integrity of a flooded pool. Furthermore, should beyond design basis external events challenging the safety of the spent fuel, recovery and mitigation actions could be completed over a long period of time due to the slow progression of any accident as a result of the very low decay heat levels present in the pool within a few months following 'permanent shutdown of the reactor.

However, as seismic studies continue for the remainder of the operating fleet, new information concerning the adequacy of design bases of spent fuel pools will be evaluated for applicability to decommissioned sites using existing NRC processes.

Attachment 1

Recommendation 2.1 Seismic Review Process





Attachment 2

Probabilistic Seismic Hazard Analysis: Background Information

Introduction

Nuclear power plants are designed and built to withstand strong earthquakes based on their location and nearby earthquake activity. This seismic design basis is established before a plant is built, using site-specific seismic hazard assessments. First, designers calculate the site's expected earthquake motions. Then, the design accounts for these ground motions so that it will safely withstand the earthquake and protect the public and the environment.

Our methods of assessing seismic hazards have evolved over time as our scientific understanding of earthquake hazards has improved. Each operating U.S. nuclear power plant determined its expected ground motions independently with site-specific information from historical earthquake catalogs and examination of local geology. Plant designers examined

earthquake sources near a site. They used the largest quake from that sample to determine the site's expected ground motion. This "deterministic" approach has been replaced with "probabilistic" analysis. This broader approach examines how all seismic sources and earthquake types can affect a site.

Probabilistic Seismic Hazard Analysis Methodology

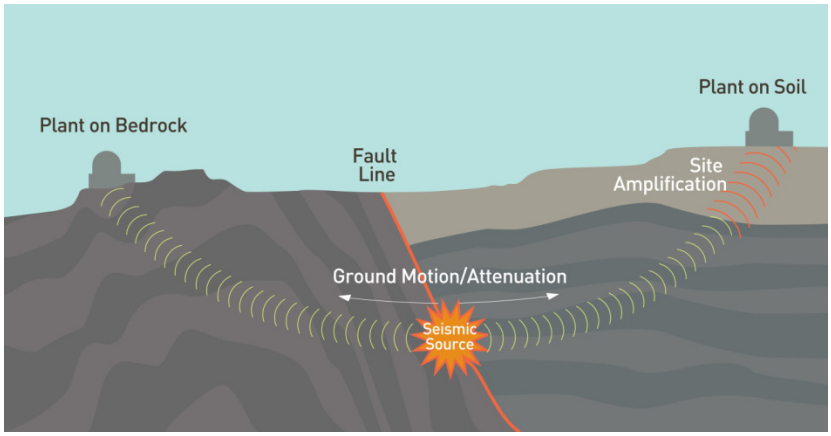
The NRC's regulations and guidance point U.S. nuclear power plants to Probabilistic Seismic Hazard Analysis (PSHA) as the favored assessment process. PSHA objectively assesses a site's seismic hazard. Seismic hazards are determined by combining knowledge of seismic sources surrounding a site, how often those sources generate earthquakes and how ground motions change based on a quake's magnitude and distance from the site. The PSHA method also meets NRC requirements to account for uncertainties in what we know.

A properly conducted PSHA study will produce an estimate of how likely a given ground motion level is for a certain time period (such as the operating life of a reactor). The studies describe ground motion in units of "g," the acceleration due to Earth's gravity. For example, a PSHA study might conclude a site has a 10 percent chance of exceeding ground motion of 0.3 g (a "strong" quake) within 50 years. The study could also estimate the maximum ground motion expected in the next 10,000 years at the site.

PSHA studies must account for uncertainty in their data. Current PSHA practices deal with uncertainty by incorporating alternative views into a calculation using "logic trees". For example, the three-dimensional relationship of a seismic source to a site in a PSHA study may be incompletely defined. In this situation, the PSHA would develop reasonable alternative site-source relationships. Each alternative model would become a branch in the logic tree. Each branch would be incorporated into the overall seismic hazard from that specific source. As with any sort of analysis, the final PSHA's quality depends on the quality and reliability of data that goes into the work. NRC guidance points to Senior Seismic Hazard Analyses Committee (SSHAC) guidelines for developing input models for seismic hazard studies at nuclear power plants. The SSHAC guidelines are described in NUREG 6372, available online at http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6372/ . This process relies on extensive input and guidance from the scientific community. This process leads to input models that represent the best knowledge and broad scientific perspectives, while also appropriately considering alternative ideas and views.

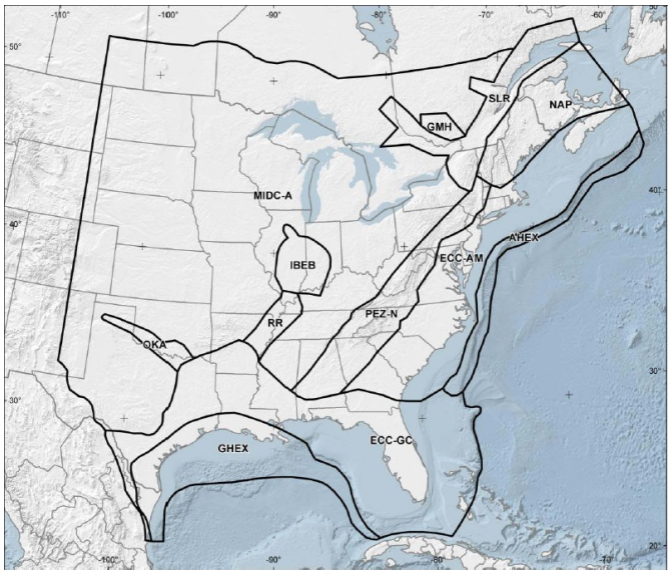
As shown in the figure below, a proper PSHA study needs information from three key areas:

- seismic sources and their relative locations to the site in question;
- how often each of those sources is expected to generate an earthquake of a given strength; and
- how earthquake energy is transmitted between the source and the site.



Here's a brief description of these three essential information sets.

Seismic Sources:



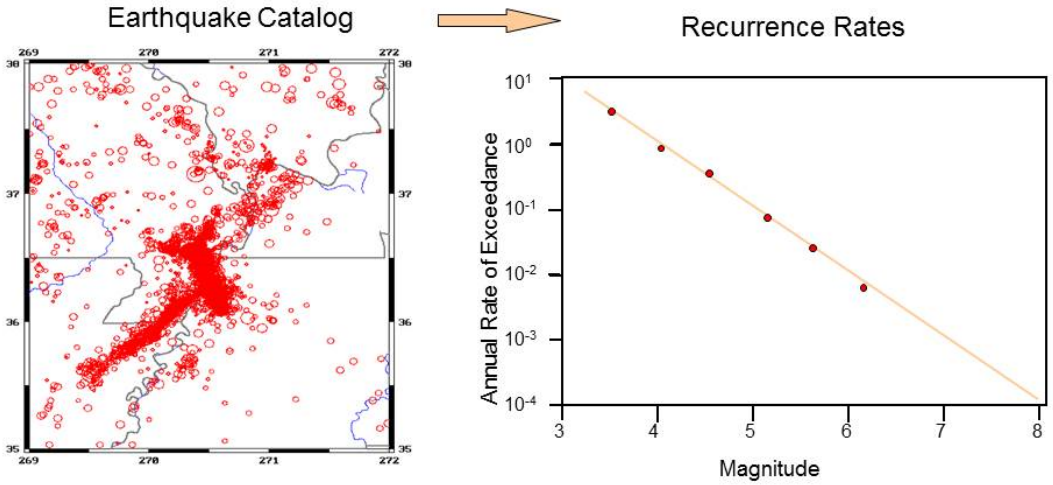
Geologically uniform areas that generate similar types of earthquakes are considered "seismic sources." A PSHA study identifies and characterizes seismic sources by conducting extensive geologic and geophysical investigations. The region's geologic history, previous earthquakes and their characteristics and geophysical properties of rocks are all studied using available information. The study identifies and maps boundaries of distinct seismic sources. Each identified seismic source's strongest expected earthquake is also assessed using past earthquake data and various geologic factors. NRC regulations call for PSHA studies to incorporate uncertainties regarding these seismic sources' geometries and their maximum earthquakes.

Almost all U.S. nuclear power plants lie east of the Rocky Mountains. While the West Coast is notorious for its earthquakes, the Central and Eastern United States (CEUS) has many seismic sources of its own. Together with the Dept. of Energy and the Electric Power Research Institute, the NRC in 2012 issued an approved CEUS seismic source model. This model used more than 400 years of historical earthquake reports, as well as detailed geologic information. The model, available online at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr2115/, supports

seismic hazard analysis for any potential or existing CEUS site. The figure above shows some of the model's seismic sources. The NRC requires PSHA studies to consider seismic sources within at least 200 miles of a site.

Earthquake Catalogs and Recurrence Rates:

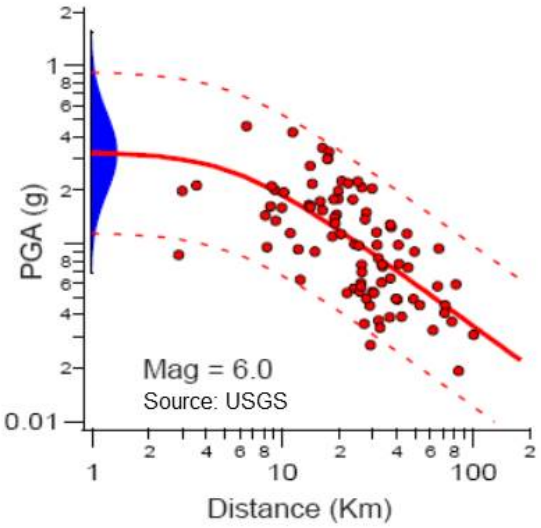
Another essential piece of PSHA information involves where and how often a seismic source will generate earthquakes of different strengths. PSHA studies obtain this information from earthquake catalogs compiled from a variety of sources such as the U.S. Geological Survey. Evidence of earthquakes in geologic formations often supplements the historical data in U.S. earthquake catalogs. Analyzing this information usually shows a simple relationship between an earthquake's strength and its rarity: the larger the quake, the rarer it is. PSHA studies assume the historical rate of earthquakes will accurately represent a region's seismic activity for at least as long as the analyzed nuclear power plant operates.



Ground Motion Prediction Models:

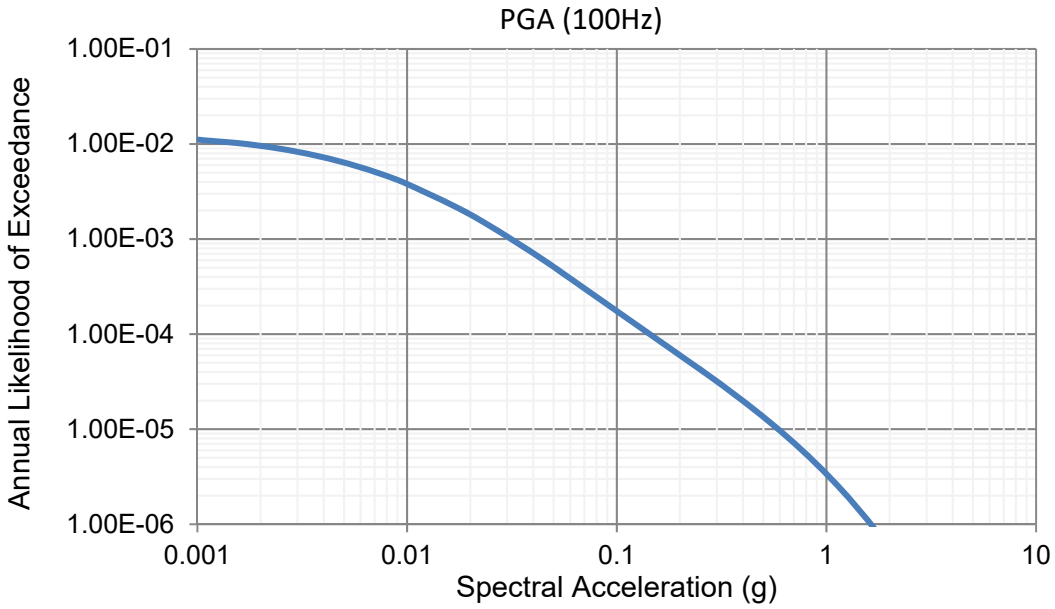
The third key area of a PSHA study involves understanding a site's expected ground motions based on a given earthquake's strength and distance. Earthquake energy spreads out from its origin through different geological layers, weakening the further it travels. Ground motions observed at any given point depend on the earthquake's distance to the site. Ground motion prediction models provide information about a site's expected ground motion levels, given an earthquake's distance and magnitude. These models are essential for a PSHA, which must analyze all of a seismic source's possible earthquakes. The red line in the figure below shows how the average ground motions for a magnitude 6 quake vary with distance. The red dots are individual ground motion measurements, plotted by their distance from the earthquake location. The blue curve represents the uncertainty (variability) in ground motion measurements. These models apply to specific regions and work best when based on an extensive set of observed

quakes. If a region only has a limited number of observations, those can be supplemented with simulated earthquake ground motions for a variety of situations.



Calculation of Seismic Hazard:

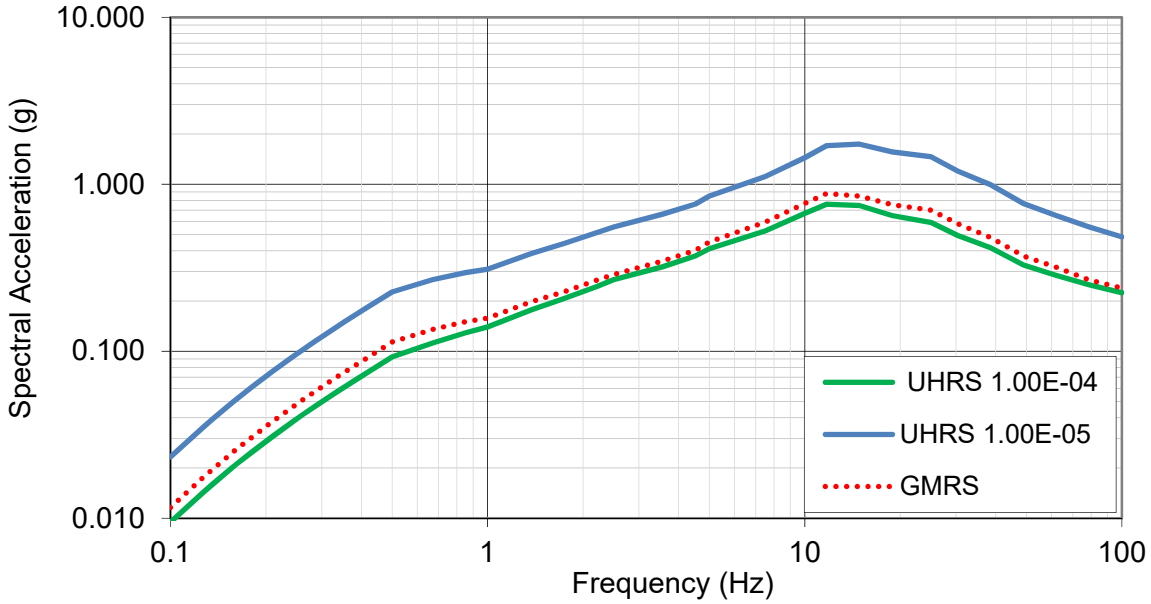
All of this information goes into calculating seismic hazard curves. This process determines how often a site can expect to have ground motions of a given strength. The chart below shows a seismic hazard curve for how strongly the ground would shake at 100 times per second (or hertz, abbreviated Hz). Earthquake researchers consider 100 Hz a good measure of a site's peak ground acceleration (PGA). The chart below shows a quake shaking the site at one-thousandth of a "g" is expected once in a hundred years. A quake shaking the site at 1 g is expected once every 300,000 years or so. PSHA studies calculate similar seismic hazard curves for different ground motion frequencies of interest, usually between 0.5 Hz and 100 Hz.



The next step in a PSHA creates what is called the uniform hazard response spectra to take into account all the seismic hazard curves for the site. The spectra represent the expected ground motions at a range of frequencies for a given period of time. For the seismic hazard at U.S. nuclear power plants we pay particular attention to the 10,000- and 100,000-year periods. In the figure below, the green line shows the spectra curve for quakes in the 10,000-year period. The blue line shows the spectra for quakes in the 100,000-year period.

Many plants calculate uniform hazard response spectra as if the reactor is located on hard rock. Some plants, however, sit on compacted soil or soft rock. These layers of softer materials can amplify ground motion at some frequencies. A “soft rock” plant determines this site amplification by modeling the physical characteristics of the soil and rock under the site, then calculating how the model responds to ground motions from hard rock. The plant then uses the site-amplification model to appropriately increase or decrease the uniform hazard response spectra.

The final step in seismic hazard calculations creates the ground motion response spectra (GMRS), which the nuclear power plant uses to properly design its safety systems. Plants calculate the GMRS based on the uniform hazard response spectra calculated for 10,000- and 100,000-year periods, using specific performance-based criteria. The dotted red curve below represents the GMRS a plant’s design would have to safely deal with for that site.


10.000
1.000
0.100
0.010
Spectral Acceleration (g)
0.1
1
10
100
Frequency (Hz)
UHRS 1.00E-04
UHRS 1.00E-05
GMRS

Attachment 3

Background on Development of Central and Eastern United States Seismic Source Characterization Model – NUREG 2115

The Central and Eastern United States Seismic Source Characterization for Nuclear Facilities (CEUS-SSC) Project developed a regional seismic source model for use in probabilistic seismic hazard analyses (PSHAs) for nuclear facilities. The CEUS-SSC Project was conducted from April 2008 to December 2011 and was sponsored by multiple stakeholders: the EPRI Advanced Nuclear Technology Program, the Office of Nuclear Energy and the Office of the Chief of Nuclear Safety of the U.S. Department of Energy (DOE), and the Nuclear Regulatory Commission (NRC). The study was conducted using the Senior Seismic Hazard Analysis Committee (SSHAC) Study Level 3 methodology, which provides high levels of confidence that the data, models, and methods of the larger technical community have been appropriately considered. As a result, the center, body, and range of technically defensible interpretations have been included in the study.

The regional seismic source characterization (SSC) model defined by this study can be used for site-specific PSHAs, if appropriate site-specific assessments are conducted for the nuclear facility of interest as required by current regulations and guidance. The SSHAC assessment process is an acceptable technical process in NRC's seismic regulatory guidance (Regulatory Guide 1.208), which ensures that uncertainties in data and scientific knowledge have been properly represented in seismic design ground motions consistent with the requirements of the seismic regulation 10 CFR Part 100.23 ("Geologic and Seismic Siting Criteria"). Therefore, the goal of the SSHAC assessment process is the accurate and complete representation of knowledge and uncertainties in the PSHA inputs.

The fundamental goal of a SSHAC process is to properly conduct and document completely the activities of evaluation and integration:

> Evaluation: The consideration of the complete set of data, models, and methods proposed by the larger technical community that are relevant to the hazard analysis.
>
> Integration: Representing the center, body, and range of technically defensible interpretations in light of the evaluation process (i.e., informed by the assessment of existing data, models, and methods).

Each of the methodology steps in the SSHAC guidelines were addressed appropriately during the CEUS-SSC Project. Furthermore, this project developed a number of enhancements to the process steps for conducting a SSHAC Study Level 3 project. For example, the SSHAC guidelines call for process steps that include developing a preliminary assessment model, calculating hazard using that model in order to identify the key issues, and finalizing the model

in light of the feedback provided from the hazard calculations and sensitivity analyses. Because of the regional scope of the project and the large number of assessments required, four rounds of model-building and three rounds of feedback were conducted as part of this project. These activities ensured that all significant issues and uncertainties were identified and that the appropriate effort was devoted to evaluating issues of most significance to the hazard results.

The catalog of past earthquakes that have occurred in a region is an important source of information for the quantification of future seismic hazards. This is particularly true in stable continental regions such as the CEUS where the source structures and causes of damaging earthquakes tend to be poorly understood. Also, the rates of crustal deformation in stable continental regions are low, so surface and near-surface indications of crustal stresses and the buildup and release of crustal strains (such as earthquakes) are difficult to quantify. Because the earthquake catalog is used in the characterization of the occurrence of future earthquakes in the CEUS, developing an updated earthquake catalog for the study region was an important focus of the CEUS-SSC Project.

The project team and sponsors determined the approach for quality assurance on the CEUS-SSC Project in 2008, taking into account the SSHAC assessment process and national standards. The approach was documented in the CEUS-SSC Project Plan, dated June 2008, and discussed in more detail in the CEUS-SSC Report. Beyond the assurance of quality arising from the external scientific review process, it is the collective, informed judgment of the team (via the process of evaluation and integration) and the concurrence of the participatory peer review panel that ultimately lead to the assurance of quality in the process followed and in the products that resulted from the SSHAC hazard assessment framework.

Attachment 4

Screening and Prioritization Results by Region

REGION 1

Seismic Hazard Reevaluation Screening and Prioritization Results

Breakdown of the Plants

- **Priority 1 –** Detailed risk analysis due by June 30, 2017: Indian Point, Pilgrim, Peach Bottom
- **Priority 2 –** Detailed risk analysis due by Dec. 31, 2019: Beaver Valley
- **Priority 3 –** If necessary, detailed risk analysis due by Dec. 31, 2020: Calvert Cliffs, Limerick, Seabrook, Three Mile Island, Vermont Yankee*, Oyster Creek
- **Plants that require less-detailed analysis –** Hope Creek, Millstone 2 & 3, Nine Mile Point, Ginna, Susquehanna, Salem, FitzPatrick

**Deferred.*

Explanation of Priority Groups

The priority grouping is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. Seismic risk analysis is a very specialized field and there are limited numbers of experts available to perform the work at the necessary level of detail.

Priority Group 1: Plants have both a relatively large increase in seismic hazard and a relatively large new ground motion estimate. Therefore Group 1 plants will benefit most from the results of detailed seismic risk analysis and have priority in using available seismic risk expertise. The risk evaluations are due in 2017.

Priority Group 2: The plants' increase in seismic hazard and new ground motion estimate are smaller than Priority 1 plants. Therefore, while Group 2 plants will benefit from the results of detailed seismic risk analysis, they can wait until resources are available after Group 1 evaluations are complete. The risk evaluations are due in 2019.

Priority Group 3: The plants have both a small increase in seismic hazard and a small new ground motion estimate. Additional staff/plant discussions could also show the NRC has enough information to make regulatory decisions and a Group 3 plant does not need to do detailed risk analysis. Therefore Group 3 plants' analyses can wait until Group 1 and 2 detailed seismic risk analyses are complete. The risk evaluations are due in 2020.

Plants of Interest

1. **Why did [plant] end up in priority group 1/2/3?**

   The prioritization is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. Seismic risk analysis is a very specialized field and there are limited numbers of experts available to perform the work at the necessary level of detail.

   [Group 1 plant] has both a relatively large increase in seismic hazard and relatively large new ground motion estimate. Therefore [Group 1 plant] will benefit most from the results of detailed seismic risk analysis and has priority in using available seismic risk expertise.

   [Group 2 plant]'s increase in seismic hazard and new ground motion estimate are smaller than Group 1 plants. Therefore, while [Group 2 plant] will benefit from the results of detailed seismic risk analysis, it can wait until resources are available after Group 1 evaluations are complete.

   [Group 3 plant] has both a small increase in seismic hazard and small new ground motion estimate. Additional staff/plant discussions could also show the NRC has enough information to make regulatory decisions and a Group 3 plant does not need to do detailed risk analysis. Therefore [Group 3 plant]'s analysis can wait until Group 1 and 2 detailed seismic risk analyses are complete.

2. **Is [Pilgrim, etc.] safe to operate while it completes its re-evaluation?**

   The priority group is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. The NRC continues to have confidence, based on our understanding of both reactor design and construction and the results of the plants' seismic "walkdowns," that plants can operate safely while more analyses are done. Nuclear power plant manufacturing and construction methods typically result in a

plant having the capacity to withstand earthquakes larger than their design basis earthquake. This is because nuclear power plants are designed to withstand the force of different internal and external events. Many of these events create larger forces on a plant than an earthquake. Plants examined this capacity and demonstrated their safety systems can still perform properly if earthquakes occur that are larger than those the plant was designed to withstand. The NRC is satisfied the systems will perform their safety functions at the higher seismic hazard levels, and that the plant can continue operating. NRC staff's initial review of an industry screening analysis and the interim evaluations provided confidence that none of the plants showed a preliminary change in risk that would cause concern. Consequently, interim actions were not necessary to ensure the systems can function.

In addition to the design margins and interim actions, all plants recently underwent detailed seismic walkdowns. These walkdowns identified and addressed degraded, nonconforming, or unanalyzed conditions through the corrective action program, and verified the adequacy of the monitoring and maintenance procedures. NRC reviewed licensee actions to:

(4) verify the plant configuration with the current seismic licensing basis;
(5) address degraded, nonconforming, or unanalyzed seismic conditions; and
(6) verify the adequacy of monitoring and maintenance programs for protective features.

The results of these walkdowns provide additional confidence that plants can continue to operate safely while longer-term risk assessments progress.

3. Why has Vermont Yankee been screened in if they are shutting down?

Until Vermont Yankee certifies that they have permanently ceased operation, they are considered an operating reactor and the 50.54(f) letter requesting the seismic re-evaluation applies to them. However, they did not actually submit a seismic hazard re-evaluation in March 2014. Given that we did not receive the re-evaluation, we conditionally screened them in as a Group 3 plant.

On March 12, 2014, the NRC staff received a letter from Entergy, the licensee for Vermont Yankee, notifying the staff of revised regulatory commitments by the licensee with respect to responding to outstanding information requests from the NRC's 50.54(f) letter of March 12, 2012. The revised regulatory commitments defer any further responses until June 30, 2015. The licensee plans to permanently shut down their

facility in December 2014, with removal of reactor fuel from their vessel by February 2015, and subsequent certification to the NRC in accordance with 10 CFR 50.82(a)(1). The licensee's letter notes that upon their docketing of certifications pursuant to 10 CFR 50.82(a)(1), Vermont Yankee will no longer be an operating facility, and the requests and commitments associated with March 12, 2012, 50.54(f) letter will no longer be applicable. The NRC has not yet responded to the licensee's letter.

4. I have heard that Oyster Creek is shutting down. Why has it screened in?

Oyster Creek has not formally informed the NRC of whether it intends to shut down. Until Oyster Creek certifies that they have permanently ceased operation, they are considered an operating reactor and the 50.54(f) letter requesting the seismic re-evaluation applies to them.

5. Why is the NRC's seismic hazard curve higher than the licensee calculated for [Oyster Creek, etc.]?

Given the short time period to make the screening and prioritization decisions, the NRC staff independently calculated its own GMRS for CEUS sites. The staff used the same CEUS seismic source-characterization models (NUREG-2115) and ground-motion models (EPRI, 2013) as the licensees. However, the staff collected available geological data and applied their professional judgment on what data and assumptions to use in these models, which might be different than used by the licensees. For most sites, the NRC and licensee developed GMRS curves are similar but, as expected, differences exist. In the cases where different input and modeling assumptions and data led to significant differences in the calculated GMRS, the staff will engage the licensees to discuss the differences. Plants for which the difference in the GMRS curve will make a difference in a follow-on evaluation will have priority for meeting with the staff. The staff will be setting up public meetings for the month of June 2014 to conduct these discussions. For the conditionally screened-in plants, once sufficient information is understood, the staff will make a final determination on screening and provide the determination in a letter to the licensee.

REGION 2

Seismic Hazard Reevaluation Screening and Prioritization Results

Breakdown of the Plants

- **Priority 1 –** Detailed risk analysis due by June 30, 2017: North Anna, Oconee, Robinson, Vogtle, Watts Bar
- **Priority 2 –** Detailed risk analysis due by Dec. 31, 2019: Browns Ferry, Catawba, Hatch, Sequoia, Summer

  Priority 3 – If necessary, detailed risk analysis due by Dec. 31, 2020: Bellefonte, McGuire
- **Plants that require less-detailed analysis –** Farley, Harris, Brunswick, Surry
- **Plants that do not require any additional analysis –** St. Lucie, Turkey Point
- **Plants that are expected to provide supplements to their seismic hazards reports –** Oconee, Robinson and Summer

Explanation of Priority Groups

The priority grouping is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. Seismic risk analysis is a very specialized field and there are limited numbers of experts available to perform the work at the necessary level of detail.

Priority Group 1: Plants have both a relatively large increase in seismic hazard and a relatively large new ground motion estimate. Therefore Group 1 plants will benefit most from the results of detailed seismic risk analysis and have priority in using available seismic risk expertise. The risk evaluations are due in 2017.

Priority Group 2: The plants' increase in seismic hazard and new ground motion estimate are smaller than Priority 1 plants. Therefore, while Group 2 plants will benefit from the results of detailed seismic risk analysis, they can wait until resources are available after Group 1 evaluations are complete. The risk evaluations are due in 2019.

Priority Group 3: The plants have both a small increase in seismic hazard and a small new ground motion estimate. Additional staff/plant discussions could also show the NRC has enough information to make regulatory decisions and a Group 3 plant does not need to do detailed risk analysis. Therefore Group 3 plants' analyses can wait until Group 1 and 2 detailed seismic risk analyses are complete. The risk evaluations are due in 2020.

Plants of Interest

1. **Why did [plant] end up in priority group 1/2/3?**

   The prioritization is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. Seismic risk analysis is a very specialized field and there are limited numbers of experts available to perform the work at the necessary level of detail.

   [Group 1 plant] has both a relatively large increase in seismic hazard and relatively large new ground motion estimate. Therefore [Group 1 plant] will benefit most from the results of detailed seismic risk analysis and has priority in using available seismic risk expertise.

   [Group 2 plant]'s increase in seismic hazard and new ground motion estimate are smaller than Group 1 plants. Therefore, while [Group 2 plant] will benefit from the results of detailed seismic risk analysis, it can wait until resources are available after Group 1 evaluations are complete.

   [Group 3 plant] has both a small increase in seismic hazard and small new ground motion estimate. Additional staff/plant discussions could also show the NRC has enough information to make regulatory decisions and a Group 3 plant does not need to do detailed risk analysis. Therefore [Group 3 plant]'s analysis can wait until Group 1 and 2 detailed seismic risk analyses are complete.

2. **Is [North Anna, etc.] safe to operate while it completes its reevaluation?**

The priority group is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. The NRC continues to have confidence, based on our understanding of both reactor design and construction and the results of the plants' seismic "walkdowns," that plants can operate safely while more analyses are done. Nuclear power plant manufacturing and construction methods typically result in a plant having the capacity to withstand earthquakes larger than their design basis earthquake. This is because nuclear power plants are designed to withstand the force of different internal and external events. Many of these events create larger forces on a plant than an earthquake. Plants examined this capacity and demonstrated their safety systems can still perform properly if earthquakes occur that are larger than those the plant was designed to withstand. The NRC is satisfied the systems will perform their safety functions at the higher seismic hazard levels, and that the plant can continue operating. NRC staff's initial review of an industry screening analysis and the interim evaluations provided confidence that none of the plants showed a preliminary change in risk that would cause concern. Consequently, interim actions were not necessary to ensure the systems can function.

In addition to the design margins and interim actions, all plants recently underwent detailed seismic walkdowns. These walkdowns identified and addressed degraded, nonconforming, or unanalyzed conditions through the corrective action program, and verified the adequacy of the monitoring and maintenance procedures. NRC reviewed licensee actions to:

(1) verify the plant configuration with the current seismic licensing basis;
(2) address degraded, nonconforming, or unanalyzed seismic conditions; and
(3) verify the adequacy of monitoring and maintenance programs for protective features.

The results of these walkdowns provide additional confidence that plants can continue to operate safely while longer-term risk assessments progress.

3. Will Watts Bar Unit 2 be in compliance with the updated seismic hazard re-evaluation if the operating licensee is issued?

If the NRC grants the operating license for Watts Bar Unit 2, the unit will be on the step of the process that is consistent with other operating reactors and the schedule that was established in the screening and prioritization letter. As a priority 1 site, Unit 1 and potential Unit 2 of Watts Bar would need to complete the Expedited Evaluation by December 31, 2014, and the seismic risk evaluation by June 30, 2017. The NRC is not

requiring the applicant to complete the full seismic risk re-evaluation as a condition of the Unit 2 operating license being granted.

4. **Has Watts Bar Unit 2 taken any corrective actions to address the relatively large increase in seismic hazard and relatively large new ground motion estimate?**

   TVA updated their Individual Plant Examination of External Events (IPEEE) evaluation using higher ground motion values. Based on the results of the IPEEE evaluation and other geological studies, TVA identified equipment modifications that would enhance the plant's seismic capacities. Using this information, TVA modified bolting for 480 volt shutdown transformers. This information was obtained during discussions with TVA and the staff has not had the opportunity to independently verify the information.

5. **Why is the NRC's seismic hazard curve higher than the licensee calculated for [Oconee, etc.]?**

   Given the short time period to make the screening and prioritization decisions, the NRC staff independently calculated its own GMRS for CEUS sites. The staff used the same CEUS seismic source-characterization models (NUREG-2115) and ground-motion models (EPRI, 2013) as the licensees. However, the staff collected available geological data and applied their professional judgment on what data and assumptions to use in these models, which might be different than used by the licensees. For most sites, the NRC and licensee developed GMRS curves are similar but, as expected, differences exist. In the cases where different input and modeling assumptions and data led to significant differences in the calculated GMRS, the staff will engage the licensees to discuss the differences. Plants for which the difference in the GMRS curve will make a difference in a follow-on evaluation will have priority for meeting with the staff. The staff will be setting up public meetings for the month of June 2014 to conduct these discussions. For the conditionally screened-in plants, once sufficient information is understood, the staff will make a final determination on screening and provide the determination in a letter to the licensee.

6. **Why is [Catawba, etc.] a Priority Group 2 plant while a nearby plant like [McGuire, etc.] is a lower priority?**

In the screening and prioritization review, the staff considered several sources of information for each plant to determine if further risk analysis is warranted and the priority for conducting these analyses, including:

- Licensee's re-evaluated ground motion response spectrum (GMRS) and description in the March 2014 submittal
- NRC staff's independently calculated preliminary GMRS
- Area of exceedance between the licensee's safe shutdown earthquake (SSE) and the NRC-calculated GMRS in the 1–10 Hz range
- Ratio in amplitude between the licensee's SSE and the NRC-calculated GMRS in the 1–10 Hz range
- Overall (or maximum) hazard level for the site

Although one plant might be located relatively close to another, the above information can change significantly when plant-specific conditions are considered. Consequently, it is reasonable to expect that nearby plants might have different screening and prioritization determinations.

7. Why will Vogtle Units 3/4 and Summer Units 2/3 be in compliance with the updated seismic hazard re-evaluation once they are allowed to operate?

The seismic hazard reevaluation 50.54(f) letter does not apply to plants that are applying for or have been granted Combined Operating Licenses (COL), which includes Vogtle Units 3 & 4 and V.C. Summer Units 2 & 3. This is because there are separate, but similar, requirements for those plants that evaluated seismic safety as part of the recent license application process.

For the currently operating units that are co-located at the Vogtle and V.C. Summer sites, the licensees' re-evaluated GMRS exceeds the SSE at both sites. However, the AP1000 reactors that are under construction at these sites have a different SSE than these operating units. This SSE is defined by the certified seismic design response spectra for the AP1000 reactor design. The NRC staff has determined that the re-evaluated GMRS also exceeds the SSE for the AP1000 units under construction.

As part of the AP1000 licensing process, the licensees conducted detailed seismic margins assessments, which are more rigorous than the evaluations performed for the IPEEE in the 1990s. Based on the seismic margin inherent in AP1000 reactor design, the certified design has sufficient margin to withstand the re-evaluated GMRS as a beyond-design-basis event. Once construction is complete, both licensees are required to perform an upgraded, plant-specific probabilistic risk assessment (PRA) prior to the

scheduled date of loading fuel. This includes a seismic PRA, for which licensees will use the re-evaluated seismic hazard information.

REGION 3

Seismic Hazard Reevaluation Screening and Prioritization Results

Breakdown of the Plants

- **Priority 1 –** Detailed risk analysis due by June 30, 2017: Cook
- **Priority 2 –** Detailed risk analysis due by Dec. 31, 2019: Dresden, Fermi, LaSalle, Palisades
- **Priority 3 –** If necessary, detailed risk analysis due by Dec. 31, 2020: Davis-Besse, Monticello, Perry, Point Beach
- **Plants that require less-detailed analysis –** Braidwood, Byron, Prairie Island, Clinton, Duane Arnold, Quad Cities

Explanation of Priority Groups

The priority grouping is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. Seismic risk analysis is a very specialized field and there are limited numbers of experts available to perform the work at the necessary level of detail.

Priority Group 1: Plants have both a relatively large increase in seismic hazard and a relatively large new ground motion estimate. Therefore Group 1 plants will benefit most from the results of detailed seismic risk analysis and have priority in using available seismic risk expertise. The risk evaluations are due in 2017.

Priority Group 2: The plants' increase in seismic hazard and new ground motion estimate are smaller than Priority 1 plants. Therefore, while Group 2 plants will benefit from the results of detailed seismic risk analysis, they can wait until resources are available after Group 1 evaluations are complete. The risk evaluations are due in 2019.

Priority Group 3: The plants have both a small increase in seismic hazard and a small new ground motion estimate. Additional staff/plant discussions could also show the NRC has enough information to make regulatory decisions and a Group 3 plant does not need to do detailed risk analysis. Therefore Group 3 plants' analyses can wait until Group 1 and 2 detailed seismic risk analyses are complete. The risk evaluations are due in 2020.

Plants of Interest

1. **Why did [plant] end up in priority group 1/2/3?**

   The prioritization is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. Seismic risk analysis is a very specialized field and there are limited numbers of experts available to perform the work at the necessary level of detail.

   [Group 1 plant] has both a relatively large increase in seismic hazard and relatively large new ground motion estimate. Therefore [Group 1 plant] will benefit most from the results of detailed seismic risk analysis and has priority in using available seismic risk expertise.

   [Group 2 plant]'s increase in seismic hazard and new ground motion estimate are smaller than Group 1 plants. Therefore, while [Group 2 plant] will benefit from the results of detailed seismic risk analysis, it can wait until resources are available after Group 1 evaluations are complete.

   [Group 3 plant] has both a small increase in seismic hazard and small new ground motion estimate. Additional staff/plant discussions could also show the NRC has enough information to make regulatory decisions and a Group 3 plant does not need to do detailed risk analysis. Therefore [Group 3 plant]'s analysis can wait until Group 1 and 2 detailed seismic risk analyses are complete.

2. **Is [Davis-Besse, etc.] safe to operate while it completes its reevaluation?**

   The priority group is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. The NRC continues to have confidence, based on our understanding of both reactor design and construction and the results of the plants' seismic "walkdowns," that plants can operate safely while more analyses are done. Nuclear power plant manufacturing and construction methods typically result in a

plant having the capacity to withstand earthquakes larger than their design basis earthquake. This is because nuclear power plants are designed to withstand the force of different internal and external events. Many of these events create larger forces on a plant than an earthquake. Plants examined this capacity and demonstrated their safety systems can still perform properly if earthquakes occur that are larger than those the plant was designed to withstand. The NRC is satisfied the systems will perform their safety functions at the higher seismic hazard levels, and that the plant can continue operating. NRC staff's initial review of an industry screening analysis and the interim evaluations provided confidence that none of the plants showed a preliminary change in risk that would cause concern. Consequently, interim actions were not necessary to ensure the systems can function.

In addition to the design margins and interim actions, all plants recently underwent detailed seismic walkdowns. These walkdowns identified and addressed degraded, nonconforming, or unanalyzed conditions through the corrective action program, and verified the adequacy of the monitoring and maintenance procedures. NRC reviewed licensee actions to:

(1) verify the plant configuration with the current seismic licensing basis;
(2) address degraded, nonconforming, or unanalyzed seismic conditions; and
(3) verify the adequacy of monitoring and maintenance programs for protective features.

The results of these walkdowns provide additional confidence that plants can continue to operate safely while longer-term risk assessments progress.

3. Why is the NRC's seismic hazard curve higher than the licensee calculated for [D.C. Cook, etc.]?

Given the short time period to make the screening and prioritization decisions, the NRC staff independently calculated its own GMRS for CEUS sites. The staff used the same CEUS seismic source-characterization models (NUREG-2115) and ground-motion models (EPRI, 2013) as the licensees. However, the staff collected available geological data and applied their professional judgment on what data and assumptions to use in these models, which might be different than used by the licensees. For most sites, the NRC and licensee developed GMRS curves are similar but, as expected, differences exist. In the cases where different input and modeling assumptions and data led to significant differences in the calculated GMRS, the staff will engage the licensees to discuss the differences. Plants for which the difference in the GMRS curve will make a

difference in a follow-on evaluation will have priority for meeting with the staff. The staff will be setting up public meetings for the month of June 2014 to conduct these discussions. For the conditionally screened-in plants, once sufficient information is understood, the staff will make a final determination on screening and provide the determination in a letter to the licensee.

4. Why is [D.C. Cook, etc.] screened in while a nearby plant like [Palisades, etc.] is screened out?

In the screening and prioritization review, the staff considered several sources of information for each plant to determine if further risk analysis is warranted and the priority for conducting these analyses, including:

- Licensee's re-evaluated ground motion response spectrum (GMRS) and description in the March 2014 submittal
- NRC staff's independently calculated preliminary GMRS
- Area of exceedance between the licensee's safe shutdown earthquake (SSE) and the NRC-calculated GMRS in the 1–10 Hz range
- Ratio in amplitude between the licensee's SSE and the NRC-calculated GMRS in the 1–10 Hz range
- Overall (or maximum) hazard level for the site

Although one plant might be located relatively close to another, the above information can change significantly when plant-specific conditions are considered. Consequently, it is reasonable to expect that nearby plants might have different screening and prioritization determinations.

REGION 4

Seismic Hazard Reevaluation Screening and Prioritization Results

Breakdown of the Plants

- **Priority 1 –** Detailed risk analysis due by June 30, 2017: Callaway, [Diablo Canyon], [Columbia]
- **Priority 2 –** Detailed risk analysis due by Dec. 31, 2019: (none in Region 4)
- **Priority 3 –** If necessary, detailed risk analysis due by Dec. 31, 2020: Cooper*, Wolf Creek
- **Conditionally screen-in** – [Palo Verde]

*By letter dated February 11, 2015 the licensee submitted a revised Seismic Hazard Evaluation and Screening Report for Cooper . NRC will review the submittal to determine if changes are necessary to screening decision.

- **Plants that require less-detailed analysis –** River Bend, Waterford, Arkansas Nuclear One, Fort Calhoun
- **Plants that do not require any additional analysis –** Comanche Peak, Grand Gulf, South Texas Project

Explanation of Priority Groups

The priority grouping is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. Seismic risk analysis is a very specialized field and there are limited numbers of experts available to perform the work at the necessary level of detail.

Priority Group 1: Plants have both a relatively large increase in seismic hazard and a relatively large new ground motion estimate. Therefore Group 1 plants will benefit most from the results of detailed seismic risk analysis and have priority in using available seismic risk expertise. The risk evaluations are due in 2017.

Priority Group 2: The plants' increase in seismic hazard and new ground motion estimate are smaller than Priority 1 plants. Therefore, while Group 2 plants will benefit from the results of detailed seismic risk analysis, they can wait until resources are available after Group 1 evaluations are complete. The risk evaluations are due in 2019.

Priority Group 3: The plants have both a small increase in seismic hazard and a small new ground motion estimate. Additional staff/plant discussions could also show the NRC has enough information to make regulatory decisions and a Group 3 plant does not need to do detailed risk analysis. Therefore Group 3 plants' analyses can wait until Group 1 and 2 detailed seismic risk analyses are complete. The risk evaluations are due in 2020.

Plants of Interest

1. **Why did [plant] end up in priority group 1/2/3?**

   The prioritization is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. Seismic risk analysis is a very specialized field and there are limited numbers of experts available to perform the work at the necessary level of detail.

   [Group 1 plant] has both a relatively large increase in seismic hazard and relatively large new ground motion estimate. Therefore [Group 1 plant] will benefit most from the results of detailed seismic risk analysis and has priority in using available seismic risk expertise.

   [Group 2 plant]'s increase in seismic hazard and new ground motion estimate are smaller than Group 1 plants. Therefore, while [Group 2 plant] will benefit from the results of detailed seismic risk analysis, it can wait until resources are available after Group 1 evaluations are complete.

   [Group 3 plant] has both a small increase in seismic hazard and small new ground motion estimate. Additional staff/plant discussions could also show the NRC has enough information to make regulatory decisions and a Group 3 plant does not need to do

detailed risk analysis. Therefore [Group 3 plant]'s analysis can wait until Group 1 and 2 detailed seismic risk analyses are complete.

2. Is [Callaway, etc.] safe to operate while it completes its reevaluation?

The priority group is not a risk ranking – more analysis is needed to determine actual changes in a plant's seismic accident risk. The NRC continues to have confidence, based on our understanding of both reactor design and construction and the results of the plants' seismic "walkdowns," that plants can operate safely while more analyses are done. Nuclear power plant manufacturing and construction methods typically result in a plant having the capacity to withstand earthquakes larger than their design basis earthquake. This is because nuclear power plants are designed to withstand the force of different internal and external events. Many of these events create larger forces on a plant than an earthquake. Plants examined this capacity and demonstrated their safety systems can still perform properly if earthquakes occur that are larger than those the plant was designed to withstand. The NRC is satisfied the systems will perform their safety functions at the higher seismic hazard levels, and that the plant can continue operating. NRC staff's initial review of an industry screening analysis and the interim evaluations provided confidence that none of the plants showed a preliminary change in risk that would cause concern. Consequently, interim actions were not necessary to ensure the systems can function.

In addition to the design margins and interim actions, all plants recently underwent detailed seismic walkdowns. These walkdowns identified and addressed degraded, nonconforming, or unanalyzed conditions through the corrective action program, and verified the adequacy of the monitoring and maintenance procedures. NRC reviewed licensee actions to:

(1) verify the plant configuration with the current seismic licensing basis;
(2) address degraded, nonconforming, or unanalyzed seismic conditions; and
(3) verify the adequacy of monitoring and maintenance programs for protective features.

The results of these walkdowns provide additional confidence that plants can continue to operate safely while longer-term risk assessments progress.

4. Why is the NRC's seismic hazard curve higher than the licensee calculated for [Callaway, etc.]?

Given the short time period to make the screening and prioritization decisions, the NRC staff independently calculated its own GMRS for CEUS sites. The staff used the same CEUS seismic source-characterization models (NUREG-2115) and ground-motion models (EPRI, 2013) as the licensees. However, the staff collected available geological data and applied their professional judgment on what data and assumptions to use in these models, which might be different than used by the licensees. For most sites, the NRC and licensee developed GMRS curves are similar but, as expected, differences exist. In the cases where different data, and input and modeling assumptions led to significant differences in the calculated GMRS, the staff will engage the licensees to discuss the differences. Plants for which the difference in the GMRS curve will make a difference in a follow-on evaluation will have priority for meeting with the staff. The staff will be setting up public meetings for the month of June 2014 to conduct these discussions. For the conditionally screened-in plants, once sufficient information is understood, the staff will make a final determination on screening and provide the determination in a letter to the licensee.

5. Why is Diablo Canyon safe to operate today?

In support of the requested interim evaluation for Diablo Canyon, PG&E provided a comparison of the reevaluated GMRS to ground motions based on the 1988 Long Term Seismic Program (LTSP). As part of the LTSP, PG&E determined that structures, systems and components at Diablo Canyon can safely withstand ground motions that are at least 1.35 times larger than the LTSP median ground motion. The NRC staff had previously reviewed the LTSP analyses and determined they were acceptable. Although the reevaluated GMRS exceeds Diablo Canyon's SSE, these ground motions do not exceed the minimum 1.35 "factor of safety" in Diablo Canyon's design. After reviewing this information, NRC staff determined that the DCPP remains safe to operate while additional seismic risk evaluations are being conducted. Diablo Canyon has been screened-in as a priority Group 1 plant and a detailed risk evaluation is expected to be submitted to the NRC by June 30, 2017.

6. Why is Columbia Generating Station (GCS) safe to operate today?

In support of the requested interim evaluations for CGS, Energy Northwest provided a summary their Individual Plant Examination of External Events (IPEEE) seismic risk evaluation and discussed the calculated seismic design margins for SSCs. Energy

Northwest also updated the seismic core damage frequency (SCDF) and corresponding plant-level HCLPF capacity values as part of license renewal activities. These updates showed that SCDF for CGS is several orders of magnitude smaller than the 10 per year maximum seismic risk threshold identified in the Commission's Safety Goal Policy Statement. Using the same approach as the Central and Eastern US licensees, Energy Northwest used the reevaluated GMRS to update their SCDF estimate. The updated SCDF for CGS is even smaller than calculated in previous analyses. After reviewing this information, NRC staff determined that that the CGS remains safe to operate while additional seismic risk evaluations are conducted.

7. Why is Palo Verde safe to operate today?

The Palo Verde plant was designed using ground motions that were 25% higher than the SSE ground motions. The NRC staff reviewed and accepted these seismic ground motions during initial licensing of the Palo Verde plant. Although the reevaluated GMRS has some accelerations that are slightly larger than the SSE, all GMRS ground motions are bounded by the ground motions used in Palo Verde's seismic design. After reviewing this information, NRC staff determined that Palo Verde remains safe to operate while the final screening decision is being made.

8. Why does Palo Verde conditionally screen – in?

The March 12, 2012 50.54(f) letter requests that licensees compare the reevaluated GMRS to the plant's SSE. In their March 10, 2015 submittal, Arizona Public Service Company (APS) compared the GMRS to the plant's "design spectral response curve," which has ground motions that are 25% higher than the SSE. The NRC staff determined that the reevaluated GMRS would slightly exceed the plant's SSE at frequencies around 1.5 Hertz and greater than 30 Hertz. Consistent with industry-sponsored guidance, these SSE exceedances indicate that the Palo Verde plant would screen-in for additional risk analyses, including the expedited approach. The NRC staff recognizes that APS is providing supplemental information to clarify the licensing basis for Palo Verde's SSE, which might affect the staff's screening decision. The staff expects to reach a final screening decision once the supplemental information has been reviewed.

9. Why it's acceptable for PG&E not to perform the Expedited Seismic Evaluation Process (ESEP) for Diablo Canyon?

In their March 11, 2015 submittal, PG&E indicated that their interim evaluation adequately demonstrates DCPP is safe to operate while additional risk analyses are ongoing and that no additional safety insights would result while conducting the ESEP analyses. The staff reviewed PG&E's interim evaluation, which includes detailed information on previous evaluations that demonstrate DCPP seismic capacities. The NRC staff has reviewed and accepted these previous seismic evaluations in previous licensing reviews (NUREG 0675, ADAMS ML14279A130). After reviewing this information, the NRC staff determined that the planned ESEP would only duplicate the safety insights already provided by PG&E in their March 2015 submittal.

Revision History / Summary of Updates

1. Key Messages and Background section were updated to better differentiate between CEUS and WUS seismic related activities.
2. Figure in Page # 4 was updated to include WUS related dates
3. The Communication Timeline for the WUS screening review in page 5 has been updated.
4. Several Q/As were added to the Basic Information section applicable to both, WUS and CEUS sites.
5. The (Q/As) related to Basic Information was modified to better differentiate between those Q/As applicable to both, CEUS and WUS sites and those that just were applicable to the WUS sites.
6. Figure in Page #32 was added to present an overview of the WUS site review.
7. Attachment 4 "Screening and Priortization results by Region" was updated to show final screening results for all CEUS Plants and preliminary screening results for the WUS sites
8. Attachment 4 "Screening and Priortization results by Region" for Region 4 was updated to include several Q/As applicable for specific WUS sites.