

Compiled Seismic Questions for NRC Response to the March 11, 2011 Japanese Earthquake and Tsunami

This is current as of 3-28-11 at 10 pm.

The keeper of this file is Annie Kammerer. Please provide comments, additions and updates to Annie with CC to Clifford Munson, Jon Ake and Michelle Bensi.

A SharePoint site has been set up so that anyone can download the latest Q&As. The site is found at NRC>NRR>NRR TA or at <http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

A list of topics is shown in the Table of Contents at the front of this document.

A list of all questions is provided at the end of the document.

A list of terms and definitions is provided at the end of the document.

A list of acronyms is provided at the end of the document

We greatly appreciate the assistance of the many people who have contributed to this document. Please do not distribute beyond the NRC.

TT/39

CONTENTS

Natural Hazards and Ground Shaking Design Levels 1

Design Against Natural Hazards & Plant Safety in the US..... 8

Seismically Induced Fire 13

Seismically Induced Internal Flooding..... 15

About Japanese Hazard, Design and Earthquake Impact..... 17

Impact at US Nuclear Power Plants During the March 11, 2011 Earthquake and Tsunami? ... 20

NRC Response and Future Licensing Actions..... 22

Reassessment of US Plants and Generic Issue 199 (GI-199)..... 24

Seismic Probabilistic Risk Assessment (SPRA) 32

State-of-the-art Reactor Consequence Analysis (SOARCA)..... 33

Defense-in-Depth and Severe Accident Management..... 35

Spent Fuel Pools and Independent Spent Fuel Storage Installations 37

Station Blackout 40

Emergency Preparedness (Emphasis on B.5.b)..... 42

Other External Hazards..... 44

Plant-Specific Questions 45

 San Onofre Nuclear Generating Station (SONGS) Questions 45

 Diablo Canyon Nuclear Power Plant (DCNPP) Questions 49

 Indian Point Questions..... 56

Questions posed by utilities 57

Pending and Unanswered Questions from Members of Congress and industry 58

Additional Information: Useful Tables 62

 Table of Design Basis Ground Motions for US Plants 62

 Table of SSE, OBE and Tsunami Water Levels..... 64

 Table of Plants Near Known Active Faults or in High or Moderate Seismicity Zones..... 69

 Table From GI-199 Program Containing SSE, SSE Exceedance Frequencies, Review Level
 Earthquakes (RLE), and Seismic Core Damage Frequencies 70

 Table: Design Basis Ground Motions and New Review Level Ground Motions Used for Review of
 Japanese Plants..... 75

 Table: Status of Review of Japanese NPPs to New Earthquake Levels Based on 2006 Guidance 76

Additional Information: Useful Plots 77

 Plot of Mapped Active Quaternary Faults and Nuclear Plants in the US..... 77

~~Official Use Only~~

Nuclear Plants in the US Compared to the USGS National Seismic Hazard Maps..... 78

USGS US National Seismic Hazard Maps..... 78

Plot of Nuclear Plants in the US Compared to Recent Earthquakes..... 79

UCERF Map of California Earthquake Probabilities for Northern versus Southern California 79

Plot of ground motion acceleration (PGA) from Japanese earthquake..... 80

Plot of Tsunami Wave Heights at 5 Meter Bathymetry Offshore at the Japanese Plants (NOAA)..... 83

Plot of Tsunami Wave Heights in the Pacific (NOAA) 84

Plant Status (6pm, Japan time, on 3-25-11) 85

Fact Sheets 88

Fact Sheet: Summarization of the NRC’s Regulatory Framework for Seismic Safety (High level overview) 88

Fact Sheet: Summarization of the NRC’s Regulatory Framework for Seismic Safety (The policy work version) 89

Fact Sheet: Summarization of the NRC’s Regulatory Framework for Seismic Safety (The cliff notes) ... 91

Fact Sheet: Summarization of the NRC’s Regulatory Framework for Tsunami 92

Fact Sheet: Tsunami Assessment Method for Nuclear Power Plants in Japan..... 93

Fact Sheet: Summarization of the NRC’s Regulatory Framework for Flooding 94

Fact Sheet: Summarization of Seismological Information from Regional Instrumentation 96

Fact Sheet: Seismic considerations of Western U.S. NPP sites 97

Fact Sheet: Regulatory Framework for Protection of Nuclear Power Plants against Tsunami Flooding 100

Fact Sheet: Seismic Zones and US Plants 103

Fact Sheet: Seismicity of the Central and Eastern US (In-depth technical information) 107

Fact Sheet: US Portable Array Information..... 109

Fact Sheet: The B.5.b Rule (10 CFR 50.54hh/B.5.b) 111

Fact Sheet: Generic Issue GI-199, “Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants” 113

Fact Sheet: Station Blackout Rule 115

Other useful resources: 116

Acronyms 117

Terms and Definitions 120

List of Questions..... 132

Natural Hazards and Ground Shaking Design Levels

1) Does the NRC consider earthquakes of magnitude 9?

Public response: This earthquake was caused by a “subduction zone” event, which is the type of earthquake that can produce the largest magnitudes. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of northern California, Oregon and Washington. As a result, magnitude 9 events would only be considered for this particular seismic source. The NRC requires all credible earthquakes that may impact a site to be considered.

Additional, technical, non-public information: None.

2) Did the Japanese underestimate the size of the maximum credible earthquake that could affect the plants?

Public response: The magnitude of the earthquake was somewhat greater than was expected for that part of the subduction zone. However, the Japanese nuclear plants were recently reassessed using ground motion levels similar to those that are believed to have occurred at the sites. The ground motions against which the Japanese nuclear plants were reviewed were expected to result from earthquakes that were smaller, but were much closer to the sites. The NRC does not currently have information on the maximum tsunami height that was expected at the sites.

Additional, technical, non-public information: Jon Ake is doing some review of the data to determine the likely return period of this motion.

3) Can an earthquake and tsunami as large as happened in Japan also happen here?

Public response: See below.

4) What if an earthquake like the Sendai earthquake occurred near a US plant?

Public response: This earthquake occurred on a “subduction zone”, which is the type of tectonic region that produces earthquakes of the largest magnitude. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. The only nuclear plant near the Cascadia subduction zone is the Columbia Generating Station. This plant is located a large distance from the coast (approximately 225 miles) and the subduction zone (approximately 300 miles), so the ground motions estimated at the plant are far lower than those seen at the Fukushima plants. This distance also precludes the possibility of a tsunami affecting the plant. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8. Magnitude is measured on a log scale and so a magnitude 9 earthquake produces about ten times stronger shaking and releases about 31 times more energy than a magnitude 8 earthquake.

Additional, technical, non-public information: None.

5) What magnitude earthquake are US nuclear plants designed to?

Public Answer: Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site. Nuclear plants, and in fact all engineered structures, are actually designed

based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based 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.

Additional, technical non-public information: In the past, “deterministic” or “scenario based” or “maximum credible earthquake” analyses were used to determine ground shaking (seismic hazard) levels. Seismic hazard for the new plants is determined using a probabilistic seismic hazard assessment approach that explicitly addresses uncertainty and the potential for beyond-design-basis earthquakes, as described in Regulatory Guide 1.208. Probabilistic methods account for possible earthquakes of various magnitudes that come from potential sources (including background seismicity) and the likelihood that each particular hypothetical earthquake occurs. The ground motions that are used as seismic design bases at US nuclear power plants are called the Safe Shutdown Earthquake ground motion (SSE) and are described mathematically through use of a response spectrum. On the west coast of the US, the two nuclear power plants are designed to specific ground motions that are determined from earthquakes of about magnitude 7 (SONGS) and 7.5 (Diablo) on faults located just offshore of the plants. Because the faults are well characterized, the magnitude and distances are known. However the design and licensing bases are still the ground motions...not the earthquakes. The earthquakes on these faults are mainly strike-slip (horizontal motion) type earthquakes, not subduction zone earthquakes. Therefore, the likelihood of a tsunami from these faults is remote.

The NRC also requires that adequate margin beyond the design basis ground shaking levels is assured. The NRC further enhances seismic safety for beyond-design-basis events through the use of a defense-in-depth approach. In addition, the NRC reviews the seismic risk at operating reactors as needed when information may have changed. Over the last few years the NRC has undertaken a program called Generic Issue 199, which is focused on assessing hazard for plants in the central and eastern US using the latest techniques and data and determining the possible risk implications of any increase in the anticipated ground shaking levels. This program will help us assure that the plants are safe under exceptionally rare and extreme ground motions that represent beyond-design-basis events.

6) How many US reactors are located in active earthquake zones?

Public Answer: Although we often think of the US as having “active” and “non-active” earthquake zones, earthquakes can actually happen almost anywhere. Seismologists typically separate the US into low, moderate, and high seismicity zones. The NRC requires that every nuclear plant be designed for site-specific ground motions that are appropriate for their locations. In addition, the NRC has specified a minimum ground motion level to which nuclear plants must be designed.

Additional, technical non-public information: The preliminary consensus opinion by NRC staff is that there are approximately 9 plants in the moderate seismicity zones in the CEUS: 4 or 5 in the Charleston SZ (depending on whose interpretation you use, it varies widely), 1 in the Wabash valley SZ, 2 in the East Tennessee SZ, 1 in the Central Virginia SZ. But some of these are open to interpretation and debate. This does not have a simple answer and NRC seismic staff are developing a fact sheet to respond to this question. There are also two plants that are in highly seismicity areas of California. Unfortunately, the extent of the moderate seismicity zones in the US are open to interpretation and are a matter of scientific debate.

Please note that although the earthquakes in the CEUS are rare, they can be big. The most widely felt earthquakes within the continental US were the 1811-12 New Madrid sequence and the 1886 Charleston, SC, which were estimated to be between about magnitude 7.0 to 7.75.

7) **Has this changed our perception of earthquake risk to the plants in the US?**

Public Answer: The NRC continues to determine that US nuclear plants are safe. This does not change the NRC's perception of earthquake hazard (i.e., ground motion levels) at US nuclear plants. It is too early to tell what the lessons from this earthquake are. The NRC will look closely at all aspects of response of the plants to the earthquake and tsunami to determine if any actions need to be taken in US nuclear plants and if any changes are necessary to NRC regulations.

Additional, technical, non-public information: We expect that there would be lessons learned and we may need to seriously relook at common cause failures, including dam failure and tsunami.

8) **Why do we have confidence that US nuclear power plants are adequately designed for earthquakes and tsunamis?**

Public Answer: [use the first paragraph of the response below]

Additional, technical, non-public information: None.

9) **Can significant damage to a nuclear plant like we see in Japan happen in the US due to an earthquake? Are the Japanese nuclear plants similar to US nuclear plants?**

Public Answer: All US nuclear plants are built to withstand environmental hazards, including earthquakes and tsunamis. Even those nuclear plants that are located within areas with low and moderate seismic activity are designed for safety in the event of such a natural disaster. The NRC requires that safety-significant structures, systems, and components be designed to take into account even rare and extreme seismic and tsunami events. In addition to the design of the plants, significant effort goes into emergency response planning and accident management. This approach is called defense-in-depth.

The Japanese facilities are similar in design to some US facilities. However, the NRC has required modifications to the plants since they were built, including design changes to control hydrogen and pressure in the containment. The NRC has also required plants to have additional equipment and measures to mitigate damage stemming from large fires and explosions from a beyond-design-basis event. The measures include providing core and spent fuel pool cooling and an additional means to power other equipment on site.

Additional technical, non-public information: See notes under question "What magnitude earthquake are US nuclear plants designed to?"

10) **If the earthquake in Japan was a larger magnitude than considered by plant design, why can't the same thing happen in the US?**

Public response: *Discuss in terms of, IPEEE, Seismic PRA to be provided by Nileshe*

Additional, technical, non-public information: ADD

11) **What level of earthquake hazard are the US reactors designed for?**

Public Answer: Each reactor is designed for a different ground motion that is determined on a site-specific basis. The existing nuclear plants were designed on a "deterministic" or "scenario earthquake" basis that accounts for the largest earthquakes expected in the area around the plant, without consideration of the likelihood of the earthquakes considered, and with an additional factor applied for conservatism. New reactors are designed using probabilistic techniques that characterize both the ground motion levels and uncertainty at the proposed site. These probabilistic techniques 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 occurrence of 1×10^{-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 hazard and risk-assessment techniques account for beyond-design basis events. NRC's Generic Issue 199 (GI-199) project is using the latest probabilistic techniques used for new nuclear plants to review the safety of the existing plants. [see questions in the section about GI-199 for more information]

Additional technical, non-public information: Note to OPA: This may perhaps seem like an oddly worded general question because the word "hazard" has several meanings, but in fact it is a specific technical question. If you see "earthquake hazard levels" or similar language, check with the seismic staff.

12) How was the seismic design basis for existing nuclear plants established?

Public Answer: The seismic ground motions used for the design basis of existing nuclear plants were determined from the evaluation of the maximum historic earthquake within 200 miles of the site, without explicitly considering the time spans between such earthquakes; safety margin was then added beyond this maximum historic earthquake to form a hypothetical *design basis earthquake*. The relevant regulation for currently operating plants is 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants" (<http://www.nrc.gov/reading-rm/doc-collections/cfr/part100/part100-appa.html>).

Additional, technical, non-public information: None.

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

Public response: The ground motions that are used as seismic design bases at US nuclear plants are called the Safe Shutdown Earthquake ground motion (SSE). In the mid to late 1990s, the NRC staff reviewed the potential for ground motions beyond the design basis as part of the Individual Plant Examination of External Events (IPEEE). From this review, the staff determined that seismic designs of operating nuclear plants in the US have adequate safety margins for withstanding earthquakes. Currently, the NRC is in the process of conducting GI-199 to again assess the resistance of US nuclear plants to earthquakes. Based on NRC's preliminary analyses to date, the mean probability of ground motions exceeding the SSE over the life of the plant for the plants in the Central and Eastern United States is less than about 1%.

It is important to remember that structures, systems and components are required to have "adequate margin," meaning that they must continue be able withstand shaking levels that are above the plant's design basis.

Additional technical, non-public information: There is a section of this document focused on questions related to GI-199.

14) What is magnitude anyway? What is the Richter Scale? What is intensity?

Public Answer: An earthquake's magnitude is a measure of the strength of the earthquake as determined from seismographic observations. Magnitude is essentially an objective, quantitative measure of the size of an earthquake. The magnitude can be expressed in various ways based on seismographic records (e.g., Richter Local Magnitude, Surface Wave Magnitude, Body Wave Magnitude, and Moment Magnitude). Currently, the most commonly used magnitude measurement is the Moment Magnitude, M_w , which is based on the strength of the rock that ruptured, the area of the fault that ruptured, and the average amount of slip. Moment magnitude is, therefore, a direct measure of the energy released during an earthquake. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy,

each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology and was based on the behavior of a specific seismograph that was manufactured at that time. The instruments are no longer in use and the magnitude scale is, therefore, no longer used in the technical community. However, the Richter Scale is a term that is so commonly used by the public that scientists generally just answer questions about "Richter" magnitude by substituting moment magnitude without correcting the misunderstanding.

The intensity of an earthquake is a qualitative assessment of effects of the earthquake at a particular location. The intensity assigned is based on observed effects on humans, on human-built structures, and on the earth's surface at a particular location. The most commonly used scale in the US is the Modified Mercalli Intensity (MMI) scale, which has values ranging from I to XII in the order of severity. MMI of I indicates an earthquake that was not felt except by a very few, whereas MMI of XII indicates total damage of all works of construction, either partially or completely. While an earthquake has only one magnitude, intensity depends on the effects at each particular location.

Additional, technical non-public information: None.

15) How do magnitude and ground motion relate to each other?

Public Answer: The ground motion experienced at a particular location is a function of the magnitude of the earthquake, the distance from the fault to the location of interest, and other elements such as the geologic materials through which the waves pass.

Additional, technical non-public information: None.

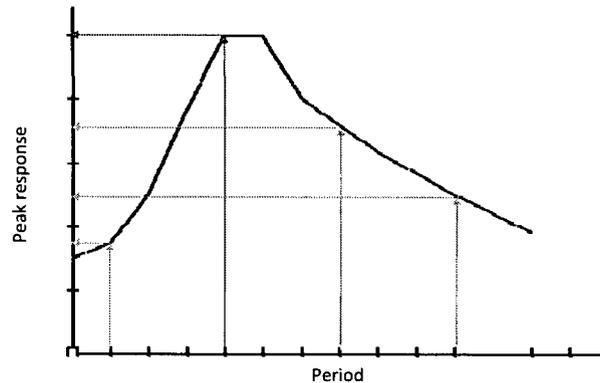
16) What is a seismic response spectrum?

Public Answer: not yet available

Draft of a simple "non-technical answer" (needs revision): For a given earthquake, different types of structures will respond to the earthquake ground motion differently depending on the characteristics of the structure and earthquake ground motion. For example, a rigid short building will "feel" an earthquake very differently than a tall flexible building. In fact, if the rigid short building and the flexible tall building are subjected to the exact same ground motion, one building may be damaged while the other is relatively unharmed. One important difference between these two buildings is a characteristic known as the natural period of vibration of the building. While defining the period of a building is a complicated engineering problem, as a general rule, a short rigid building will tend to have a short period while the tall flexible building will tend to have a long period of vibration.

If the natural period of the response of a building is "in tune" with the vibrations of the earthquake, it will experience resonance and the building may be badly damaged. (Many people have experienced resonance when using a playground swing. Pushing a swing in time with the interval of the swing causes the swing to go higher while pushing the swing at a faster or slower tempo will cause the swing to slow down.) In the example above, the short rigid building will tend to resonate and be damaged by seismic waves with short wavelengths (periods), while the tall flexible building will tend to resonate and be damaged by seismic waves with long wavelengths.

A response spectrum is a plot of the peak response of different oscillators (e.g. simple buildings) with varying natural periods that are subjected to the same base ground motion. An example of a response spectrum used for design is shown below:



Seismic response spectra are used by earthquake engineers to analyze the performance of structures and components subjected to the ground motion caused by earthquakes. The design response spectrum tells the engineer how strong the earthquake forces on the structure will be depending on its natural period of vibration.

17) Which reactors are along coastal areas that could be affected by a tsunami?

Public Answer: Many nuclear plants are located in coastal areas that could potentially be affected by a tsunami. Two nuclear plants, Diablo Canyon and San Onofre, are on the Pacific Coast, which is known to have a tsunami hazard. Two nuclear plants on the Gulf Coast, South Texas and Crystal River, could also be affected by tsunami. There are many nuclear plants on the Atlantic Coast or on rivers that may be affected by a tidal bore resulting from a tsunami. These include St. Lucie, Turkey Point, Brunswick, Oyster Creek, Millstone, Pilgrim, Seabrook, Calvert Cliffs, Salem/Hope Creek, and Surry. Tsunami on the Gulf and Atlantic Coasts occur, but are very rare. Generally the flooding anticipated from hurricane storm surge exceeds the flooding expected from a tsunami for nuclear plants on the Atlantic and Gulf Coast. Regardless, all nuclear plants are designed to withstand a tsunami.

Additional, technical non-public information: A table with information on tsunami design levels is provided in the "Additional Information" section of this document.

18) How are combined seismic and tsunami events treated in risk space? Are they considered together?

The PRA Standard (ASME/ANS-Ra-Sa2009) does address the technical requirements for both seismic events and tsunamis (tsunami hazard under the technical requirements for external flooding analysis). But together? The standard does note that uncertainties associated with probabilistic analysis of tsunami hazard frequency are large and that an engineering analysis can usually be used to screen out tsunamis.

19) How are aftershocks treated in terms of risk assessment?

Seismic PRAs do not consider the affect of aftershocks since there are not methods to predict equipment fragility after the first main shock.

20) Could a "mega-tsunami" strike the U.S. East Coast as indicated in a recent Washington Post Weather Gang article?

Public Answer: Please verify information before public release.

Additional, technical, non-public information: The Washington Post Weather Gang article is based on a scenario involving a mega-tsunami caused by a massive landslide in the Canary Islands. This scenario has

~~Official Use Only~~

been debunked by the scientific community (including the NRC's tsunami research program). Volcanic flank failures on the Canary Islands will produce a mega-tsunami in the very near area, but won't be noticeable in the United States. Refer to the 2008 USGS report on tsunamis for additional information: [insert citation].

Design Against Natural Hazards & Plant Safety in the US

21) Are US nuclear plants designed for tsunamis? If so, what level of tsunami are they designed for?

Public Answer: Yes. Plants are built to withstand a variety of environmental hazards and those plants that might face a threat from tsunami are required to withstand large waves and the maximum wave height at the intake structure (which varies by plant.) Like seismic hazard, the level of tsunami that each plant is designed for is site-specific and is appropriate for what may occur at each location. [See table with tsunami design heights in Tables section of document]

Additional, technical, non-public information: Tsunami are considered in the design of US nuclear plants. Nuclear plants are designed to withstand flooding from not only tsunami, but also hurricane and storm surge; therefore there is often significant margin against tsunami flooding. However, it should be noted that Japanese experience (prior to the March 2011 earthquake) has shown that drawdown can be a significant problem.

Currently the US NRC has a tsunami research program that is focused on developing modern hazard assessment techniques and additional guidance through cooperation with the National Oceanic and Atmospheric Administration and the United States Geological Survey. This has already lead to several technical reports and an update to NUREG 0-800. The NOAA and USGS contractors are also assisting with NRO reviews of tsunami hazard. A new regulatory guide on tsunami hazard assessment is currently planned in the office of research, although it is not expected to be available in draft form until 2012.

22) Is there a minimum earthquake shaking that nuclear plants are designed for?

Public Answer: Yes. According to Appendix S to 10 CFR Part 50, the foundation level ground motion must be represented by an appropriate response spectrum with a peak ground acceleration of at least 0.1g.

Additional, technical, non-public information: NOTE TO OPA: this comes straight from RG1.208 and it, therefore, approved for public release. If you get this question, we can help make it more user friendly.

23) Which plants are close to known active faults? What are the faults and how far away are they from the plants?

Public Answer: Jon to develop answer with Dogan's help. I created a placeholder table for your use "Table of Plants Near Known Active Faults" to be populated in the additional information section. The plots that Dogan made are in the additional information section under "Plot of Mapped Active Quaternary Faults and Nuclear Plants in the US".

Additional, technical, non-public information: ADD

24) Is there margin above the design basis?

Public Answer: Yes, there is margin beyond the design basis. In the mid to late 1990s, NRC staff reviewed the plants' assessments of potential consequences of severe earthquakes (earthquakes beyond the safety margin included in each plant's design basis), which licensees performed as part of the Individual Plant Examination of External Events (or IPEEE) program. From this review, the staff determined that seismic designs of operating plants in the United States have adequate safety margins, for withstanding earthquakes, built into the designs.

General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," in Appendix A requires that the design bases include sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

Additional, technical, non-public information: None.

25) Are US plants safe? Would a plant in the U.S. be able to withstand a large earthquake?

Public Answer: US plants are designed for appropriate earthquake shaking levels that are based on historical data for the site plus additional margin to account for uncertainties. Currently, the NRC is conducting a program called Generic Issue 199, which is reviewing the adequacy of the earthquake design of US NPPs in central and eastern North America based on the latest data and analysis techniques. The NRC will look closely at all aspects of the response of the plants in Japan to the earthquake and tsunami to determine if any actions need to be taken in US plants and if any changes are necessary to NRC regulations.

Additional, technical, non-public information: None.

26) Could an accident sequence like the one at Japan's Fukushima Daiichi nuclear plants happen in the US?

Public response: It is difficult to answer this question until we have a better understanding of the precise problems and conditions that faced the operators at Fukushima Daiichi. We do know, however, that Fukushima Daiichi Units 1-3 lost all offsite power and emergency diesel generators. This situation is called "station blackout." US nuclear power plants are designed to cope with a station blackout event that involves a loss of offsite power and onsite emergency power. The Nuclear Regulatory Commission's detailed regulations address this scenario. US nuclear plants are required to conduct a "coping" assessment and develop a strategy to demonstrate to the NRC that they could maintain the plant in a safe condition during a station blackout scenario. These assessments, proposed modifications to the plant, and operating procedures were reviewed and approved by the NRC. Several plants added additional AC power sources to comply with this regulation.

In addition, US nuclear plant designs and operating practices since the terrorist events of September 11, 2001, are designed to mitigate severe accident scenarios such as aircraft impact, which include the complete loss of offsite power and all on-site emergency power sources.

US nuclear plant designs include consideration of seismic events and tsunamis'. It is important not to extrapolate earthquake and tsunami data from one location of the world to another when evaluating these natural hazards. These catastrophic natural events are very region- and location-specific, based on tectonic and geological fault line locations.

Additional technical, non-public information: None

27) Should US nuclear facilities be required to withstand earthquakes and tsunamis of the kind just experienced in Japan? If not, why not?

Public response: US nuclear reactors are designed to withstand an earthquake equal to the most significant historical event or the maximum projected seismic event and associated tsunami without any breach of safety systems.

The lessons learned from this experience must be reviewed carefully to see whether they apply to US nuclear power plants. It is important not to extrapolate earthquake and tsunami data from one location of the world to another when evaluating these natural hazards, however. These catastrophic natural events are very region- and location-specific, based on tectonic and geological fault line locations.

The United States Geological Survey (USGS) conducts continuous research of earthquake history and geology, and publishes updated seismic hazard curves for various regions in the continental US. These curves are updated approximately every six years. NRC identified a generic issue (GI-199) that is currently undergoing an evaluation to assess implications of this new information to nuclear plant sites

located in the central and eastern United States. The industry is working with the NRC to address this issue.

Additional technical, non-public information: None

28) Do any plants have special design considerations associated with seismic design?

Public response: Many plants have unique features. However, the most notable design element is the automatic reactor trip systems in Diablo Canyon and San Onofre.

Additional, technical, non-public information: None

29) How do we know equipment will work if the magnitude is bigger than expected, like in Japan?

Public response: [see below]

30) How do we know that the equipment in plants is safe in earthquakes?

Public response: All equipment important to safety (required to safely shutdown a nuclear power plant) has significant seismic margin and is qualified to withstand earthquakes in accordance with plants' licensing basis and NRC regulations.

Additional, technical, non-public information: 10 CFR 50, Appendix A, General Design Criterion 2 and 4, 10 Part 100, and Appendix S. Guidance: Regulatory Guides 1.100, IEEE 344 and ASME QME-1. See also part 100 Reactor Site Criteria

31) Are US plants susceptible to the same kind of loss of power as happened in Japan?

Public response: NRC previously recognized that there is the possibility of a total loss of AC power at a site, called a 'Station Blackout', or SBO. Existing Regulations require the sites to be prepared for the possibility of an SBO. In addition to battery powered back-up system to immediately provide power for emergency systems, NRC regulations require the sites to have a detailed plan of action to address the loss of AC power while maintaining control of the reactor.

There has also been an understanding that sites can lose offsite power as well. Of course, this can be caused by earthquake. However, hurricane- or tornado-related high winds may potentially damage the transmission network in the vicinity of a nuclear plant as well. Flood waters can also affect transformers used to power station auxiliary system. These types of weather related events have the potential to degrade the offsite power source to a plant.

The onsite Emergency Diesel Generators need fuel oil stored in tanks that are normally buried underground. These tanks and associated pumps and piping require protection from the elements. Above ground tanks have tornado and missile protection.

In case both offsite and onsite power supplies fail, NRC has required all licensee to evaluate for a loss of all AC power (station blackout) scenario and implement coping measures to safely shutdown the plant law 10 CFR 50.63.

Additional, technical, non-public information: Additional SBO information is found in a fact sheet on the subject at the back of the document. Some plants have safeguards equipment below sea level and rely on watertight doors or Bilge pumps to remove water from equipment required to support safe shutdown. Overflowing rivers can result in insurmountable volume of water flooding the vulnerable areas. SBO definition in 10CFR50.2, SBO plan requirements in 10CFR50.63.

32) How do we know that the emergency diesel generators will not fail to operate like in Japan?

Public response: Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure and are seismic Category I equipment. Even if these EDGs did fail, plants can safely shutdown using station blackout power source law 10 CFR 50.63. In 1988 the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

Additional, technical, non-public information: None.

33) Is there a risk of loss of water during tsunami drawdown? Is it considered in design?

Public response: Yes. Section 2.4.6 (Tsunami Hazards) of NUREG 0800 Standard Review Plan specifically addresses tsunami drawdown in the safety review of new reactor applications.

Additional, technical, non-public information: None.

34) Are aftershocks considered in the design of equipment at the plants? Are aftershocks considered in design of the structure?

Public response: ADD

Additional, technical, non-public information: ADD

35) Are there any special issues associated with seismic design at the plants? For example, Diablo Canyon has special requirements. Are there any others?

Public response: Both SONGS and Diablo canyon are licensed with an automatic trip for seismic events.

Additional, technical, non-public information: ADD

36) Is the NRC planning to require seismic isolators for the next generation of nuclear power plants? How does that differ from current requirements and/or precautions at existing US nuclear power plants?

Public response: The NRC would not require isolators for the next generation of plants. However, it is recognized that a properly designed isolation system can be very effective in mitigating the effect of earthquake. Currently the NRC is preparing guidance for plant designers considering the use of seismic isolation devices.

Additional, technical, non-public information: A NUREG is in the works in the office of research. It is expected to be available for comment in 2011.

37) Are there any US nuclear power plants that incorporate seismic isolators? What precautions are taken in earthquake-prone areas?

Public response: No currently constructed nuclear power plants in the US use seismic isolators. However seismic isolation is being considered for a number of reactor designs under development. Currently seismic design of plants is focused on assuring that design of structures, systems, and components are designed and qualified to assure that there is sufficient margin beyond the design basis ground motion.

Additional, technical, non-public information: None.

- 38) Do you think that the recent Japan disaster will cause any rethinking of the planned seismic isolation guidelines, particularly as it regards earthquakes and secondary effects such as tsunamis?

Public response: Whenever an event like this happens, the NRC thoroughly reviews the experience and tries to identify any lessons learned. The NRC further considers the need to change guidance or regulations. In this case, the event will be studied and any necessary changes will be made to the guidance under development. However, it should be noted that Japan does not have seismically isolated nuclear plants.

Additional, technical, non-public information: None.

Seismically Induced Fire

39) How does the NRC address seismic-induced fire?

Public Response: The below is from the internal Q&As for the 3/21 briefing. This needs to be cleared before it can be used.

Additional, technical, non-public information: The NRC's rules for fire protection are independent of the event that caused the fire. The power plant operators are required to evaluate all the fire hazards in the plant and make sure a fire will not prevent a safe plant shutdown. The NRC's guidance says that power plant operators should assume that a fire can happen at any time. The rules do not require specific consideration of a fire that starts as a result of an earthquake. In addition, we do not require analysis of more than one fire at a time at one reactor.

40) Does the NRC require the fire protection water supply system be designed to withstand an earthquake?

Public Response: The below is from the internal Q&As for the 3/21 briefing. This needs to be cleared before it can be used.

Additional, technical, non-public information: The NRC recommends the licensee follow the applicable National Fire Protection Association (NFPA) codes and standards for the fire protection systems or provide an acceptable alternative. This would include local building code earthquake requirements. Since 1976, the NRC has recommended that, "At a minimum, the fire suppression system should be capable of delivering water to manual hose stations located within hose reach of areas containing equipment required for safe plant shutdown following the safe shutdown earthquake (SSE)." For plants located, "in areas of high seismic activity, the staff will consider on a case-by-case basis the need to design the fire detection and suppression system to be functional following the SSE." This is the guidance provided to plants that were licensed to operate, or had construction permits prior to July 1, 1976. For plants with applications docketed but construction permit not received as of July 1, 1976, they were required, "in the event of the most severe earthquake, i.e., the SSE, the fire suppression system should be capable of delivering water to manual hose stations located within hose reach of areas containing equipment required for safe plant shutdown."

The NRC's guidance since 1976 also recommends that fire detection, alarm, and suppression systems function as designed after less severe earthquakes that are expected to occur once every 10 years. The guidance further recommends plant operators in areas of high seismic activity consider the need to design those fire protection systems to function after a severe earthquake.

41) How are safe shutdown equipment protected from an oil spill which can cause potential fire?

Public Response: The below is from the internal Q&As for the 3/21 briefing. This needs to be cleared before it can be used.

Additional, technical, non-public information: In general, the NRC recommends that curbing and dikes be located around all equipment that presents an oil fire hazard. In one special case, the Reactor Cooling Pumps (RCPs) located inside the containment of Pressurized Water Reactors (PWRs) the NRC requires that plants have a seismically qualified oil collection system. The purpose of this requirement is that in the event of a severe earthquake the lubrication oil is not spread out inside containment.

42) How are safe shutdown equipment protected from a hydrogen fire?

Public Response: The below is from an internal document. This needs to be cleared before it can be used.

Additional, technical, non-public information: Hydrogen can be normally found in a couple areas of the plant. For example, most all large electric generating stations (Nuclear, Coal, Oil, Gas and Hydro) use hydrogen as a blanket in the electric generator. This hydrogen storage is typically well separated from safe shutdown equipment. Hydrogen may also be generated in Battery Rooms during charging and discharging of the stations emergency batteries. The battery rooms are typically equipped with hydrogen detectors set to alarm at about 2% (Hydrogen's lower flammable limit is 4.1%). The ventilation system is typically run to prevent any hydrogen build up. In PWR's hydrogen is used as a cover gas in the Volume Control Tank (VCT). This gas is kept at a normally lower pressure (15-20 psig) to allow oxygen scavenging in the tank. Systems like this typically have devices such as excess flow check valves that automatically isolate the system if excess flow occurs. The NRC recommends that pipes that contain hydrogen are designed to withstand a severe earthquake. This design includes a separate pipe wrapped around the hydrogen pipe that vents any leaked hydrogen to the outside.

[Also please note that this is general information. Mark Salley noted that if the question relates to H2 generated as a part of fuel failure there is a whole other conversation that needs to happen. Please contact him with questions.]

Seismically Induced Internal Flooding

43) How does the NRC consider seismically induced equipment failures leading to internal flooding?

Public Response: The below is from the internal Q&As for the 3/21 briefing. This needs to be cleared before it can be used.

Additional, technical, non-public information: 10 CFR Part 50 Appendix A General Design Criterion (GDC) 2 requires, in part, that structures, systems, and components (SSCs) important to safety be designed to withstand the effects of earthquakes without loss of capability to perform their safety functions. 10 CFR Part 50 Appendix A, GDC 4 requires the SSCs important to safety being designed to accommodate the effects of the flooding associated with seismic events. NUREG-0800, Standard Review Plan, Section 3.4.1, "Internal Flood Protection for Onsite Equipment Failures," provide guidance for the NRC staff to consider seismically induced equipment failures (pipe breaks, tank failures) that could affect safety-related SSCs to perform their safety functions.

The specific areas of review include the following :

- Identify all safety-related SSCs that must be protected against flooding;
- The location of the safety-related SSCs relative to the **internal flood level** (from internal flood analysis) in various buildings, rooms, and enclosures that house safety-related SSCs;
- Possible flow paths from interconnected non-safety-related areas to rooms that house safety-related SSCs;
- The adequacy of the isolation, if applicable, from sources causing the flood (e.g., tank of water)
- Provisions for protection against possible in-leakage sources (from outside to inside of the structures)
- All SSCs that could be a potential source of internal flooding (e.g. pipe breaks and cracks, tank and vessel failures, backflow through drains), **which includes seismically induced equipment failures**, are included for the internal flood analysis – see Q&A (2);
- Design features that will be used to mitigate the effects of internal flooding (e.g., adequate drainage, sump pumps, etc.);
- Safety-related structures that are protected from below-grade groundwater seepage by means of a permanent dewatering system.

44) How is the potential source of internal flooding from the seismically induced equipment failures postulated in the internal flood analysis?

Public Response: The below is from the internal Q&As for the 3/21 briefing. This needs to be cleared before it can be used.

Additional, technical, non-public information: All of the non-safety-related systems in the room are assumed to fail. However, the analysis systematically considers the flooding condition/level caused by only one system at a time. By considering the pipe size, volume of the source tank, and the isolation valves, the limiting case, which is the one that releases the largest volume of water, is used to determine the internal flood level. All of the safety-related SSCs are designed to be located above the calculated flood level caused by the limiting case.

45) Are the non-safety-related equipment failures assumed to occur at the same time?

Public Response: The below is from the internal Q&As for the 3/21 briefing. This needs to be cleared before it can be used.

~~Official Use Only~~

Additional, technical, non-public information: No. As stated earlier, for design basis flood analysis, it is assumed that a system (containing water source) fails one at a time. Then, the most limiting case, a system breach that causes highest level of flooding, is applied in the design of the location of the safety-related systems.

About Japanese Hazard, Design and Earthquake Impact

46) Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?

Public response: Because this event happened in Japan, it is hard for NRC staff to make the assessment necessary to understand exactly what happened at this time. In the nuclear plants there may have been some damage from the shaking, and the earthquake caused the loss of offsite power. However, the tsunami appears to have played a key role in the loss of other power sources at the site producing station blackout, which is a critical factor in the ongoing problems.

Additional, technical, non-public information: None

47) What was the disposition of the plant during the time after the earthquake struck and before the tsunami arrived? Was there indication of damage to the plant solely from the earthquake (if so, what systems) and did emergency procedures function during this time.

Public response: Given that the Fukushima plant is not in the US, the NRC does not yet have enough information to answer this question.

Additional, technical, non-public information: Typically there would be the opportunity to get this data, but given the situation it is not clear.

48) What magnitude earthquake was the plant designed to withstand? For example, what magnitude earthquake was the plant expected to sustain with damage but continued operation? And with an expected shutdown but no release of radioactive material?

Public response: There are two shaking levels relevant to the Fukushima plant, the original design level ground motion and a newer review level ground motion. As a result of a significant change in seismic regulations in 2006, NISA, the Japanese regulator initiated a program to reassess seismic hazard and seismic risk for all nuclear plants in Japan. This resulted in new assessments of higher ground shaking levels (i.e. seismic hazard) and a review of seismic safety for all Japanese plants. The program is still ongoing, but has already resulted in retrofit in some plants. Therefore, it is useful to discuss both the design level and a review level ground motion for the plants. A relevant table is found a few questions down, and also in the "Additional Information: Useful Tables" section.

Plant sites	Contributing earthquakes used for determination of hazard	New DBGM S ₂	Original DBGM S ₁
Fukushima	Magnitude 7.1 Earthquake near the site	600 gal (0.62g)	370 gal (0.37g)

Additional, technical, non-public information: Add

49) Did this reactor sustain damage in the July 16, 2007 earthquake, as the Kashiwazaki power plant did? What damage and how serious was it?

Public response: Neither Fukushima power plant was affected by the 2007 earthquake.

Additional, technical, non-public information: None.

50) Was the Fukushima power plant designed to withstand a tsunami of any size? What specific design criteria were applied?

Public response: Japanese plants are designed to withstand both earthquake and tsunami. An English explanation of how Tsunami hazard assessments are undertaken for Japanese plants is found in Annex II to IAEA Guidance on Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations Assessment of Tsunami Hazard: Current Practice in Some States in Japan. The design ground motions are as shown above. We do not have information on the design basis tsunami.

Additional, technical, non-public information: Annie has a copy of the draft annex and will put them into ADAMS

51) What is the design level of the Japanese plants? Was it exceeded?

Public response: As a result of a significant change in seismic regulations in 2006, the Japanese regulator initiated a program to reassess seismic hazard and seismic risk for all nuclear plants in Japan. This resulted in new assessments of higher ground shaking levels (i.e. seismic hazard) and a review of seismic safety for all Japanese plants. The program is still on-going, but has already resulted in retrofit in some plants. Therefore, it is useful to discuss both the design level and a review level ground motion for the plants, as shown below.

Currently we do not have official information. However, it appears that the ground motions (in terms of peak ground acceleration) are similar to the S_2 shaking levels, although the causative earthquakes are different. Thus the design basis was exceeded, but the review level may not have been.

Table: Original Design Basis Ground Motions (S_2) and New Review Level Ground Motions (S_1) Used for Review of Japanese Plants

Plant sites	Contributing earthquakes used for determination of hazard	New DBGMS ₂	Original DBGMS ₁
Onagawa	Soutei Miyagiken-oki (M8.2)	580 gal (0.59g)	375 gal (0.38g)
Fukushima	Earthquake near the site (M7.1)	600 gal (0.62g)	370 gal (0.37g)
Tokai	Earthquakes specifically undefined	600 gal (0.62g)	380 gal (0.39g)
Hamaoka	Assumed Tokai (M8.0), etc.	800 gal (0.82g)	600 gal (0.62g)

Additional, technical, non-public information: A PDF file provided by John Anderson (prepared by Japanese colleagues) indicates that the majority of the recorded ground motions during the main shock were below the attenuation curve by Si & Midorikawa (1999). Most of the recorded motions fit well to median minus 1 sigma of their GMPE. There are also about a dozen stations with the recorded ground motions above 1g. The highest recorded PGA (~3g) is at the K-Net station MYG004. We can use this information to try to estimate motions at the plants as soon as someone catches a breath.

52) What are the Japanese S_1 and S_2 ground motions and how are they determined?

Public response: Japanese nuclear power plants are designed to withstand specified earthquake ground motions, previously specified as S_1 and S_2 , but now simply S_2 . The design basis earthquake ground motion S_1 was defined as the largest earthquake that can reasonably be expected to occur at the site of a nuclear power plant, based on the known seismicity of the area and local faults that have shown activity during the past 10,000 years. A power reactor could continue to operate safely during an S_1

level earthquake, though in practice they are set to trip at lower levels. The S_2 level ground motion was based on a larger earthquake from faults that have shown activity during the past 50,000 years and assumed to be closer to the site. The revised seismic regulations in May 2007 replaced S_1 and S_2 with S_5 . The S_5 design basis earthquake is based on evaluating potential earthquakes from faults that have shown activity during the past 130,000 years. The ground motion from these potential earthquakes are simulated for each of the sites and used to determine the revised S_5 design basis ground motion level. Along with the change in definition, came a requirement to consider "residual risk", which is a consideration of the beyond-design-basis event.

Additional, technical, non-public information: None

53) Did this earthquake affect the Kashiwazaki-Kariwa nuclear power plant?

Public response: No, this earthquake did not affect Kashiwazaki-Kariwa nuclear power plant and all reactors remained in the state of operation prior to the March 11, 2011, Japan earthquake. It also did not trip during an earthquake of magnitude ~~XX~~ that occurred on the western side subsequent to the 8.9 earthquake. This is very important for the stability of Japan's energy supply due to the loss of production at TEPCO's Fukushima nuclear power plants.

Additional, technical, non-public information: None

54) How high was the tsunami at the Fukushima nuclear power plants?

Public response: The tsunami modeling team at the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Lab have estimated the wave height offshore (at the 5 meter bathymetric line) to be approximately 8 meters in height at Fukushima Daiichi and approximately 7 meters in Fukushima Daini. This is based on recordings from NOAA's Deep-ocean Assessment and Reporting of Tsunamis (DART) buoys and a high resolution numerical model developed for the tsunami warning system. NEI subsequently reported that TEPCO believes that TEPCO believes the tsunami that inundated the Fukushima Daiichi site was 14 meters high at the plant location. This is not inconsistent as wave heights increase as they come ashore. NEI also noted that design basis tsunami for the site was 5.7 meters, and the reactors and backup power sources were located 10 to 13 meters above sea level, according to TEPCO.

Additional, technical, non-public information: NOAA's PMEL center has provided us their best numbers for all the plants on the NW coast of Japan. These can be found in the Additional Information section in the back of this document.

55) Wikileaks has a story that quotes US embassy correspondence and some un-named IAEA expert stating that the Japanese were warned about this ... Does the NRC want to comment?

<http://www.dailymail.co.uk/news/article-1366721/Japan-tsunami-Government-warned-nuclear-plants-withstand-earthquake.html>

Public response: TBD Annie to explain the history of their recent retrofit program.

Additional, technical, non-public information: The article talks about that the plants and that they were checked for a magnitude 7, but the earthquake was a 9. The reality is that they assumed the magnitude 7 close in had similar ground motions to a 9 farther away. They did check (and retrofit) the plant to the ground motions that they probably saw (or nearly). The problem was the tsunami. We probably need a small write up so that staff understands, even if we keep it internal.

Impact at US Nuclear Power Plants During the March 11, 2011 Earthquake and Tsunami?

56) Was there any damage to US reactors from either the earthquake or the resulting tsunami?

Public Answer: No

Additional, technical non-public information: Two US plants on the Pacific Ocean (Diablo Canyon and San Onofre) experienced higher than normal sea level due to tsunami. However, the wave heights were consistent with previously predicted levels and this had no negative impact to the plants. In response, Diablo Canyon Units 1 and 2 declared an "unusual event" based on tsunami warning following the Japanese earthquake. They have since exited the "unusual event" declaration, based on a downgrade to a tsunami advisory.

57) Have any lessons for US plants been identified?

Public Answer: The NRC is in the process of following and reviewing the event in real time. This will undoubtedly lead to the identification of issues that warrant further study. However, a complete understanding of lessons learned will require more information than is currently available to NRC staff.

Additional, technical non-public information: We need to take a closer look at common cause failures, such as earthquake and tsunami, and earthquake and dam failure.

58) It appears that the estimates of the tsunami are changing frequently. The NOAA and TEPCO estimates are different. Why?

The following is based on an email and added here for record-keeping (it needs to be revised into a formal Q&A):

NOAA best prediction of 8m offshore (at the 5 meter bathymetric line) and TEPCO's most recent estimate of 14m runup onshore are consistent. A tsunami has two phases of response. In the open ocean it is very well behaved and calculations are highly accurate. As it gets close to shore and the shoaling effect begins, the behavior starts to go non-linear and very high resolution bathymetric (an topographic) information is required for a very precise prediction of runup (onto land) at any particular point on the coastline. However, it is well understood that as a tsunami wave comes onshore it grows in size significantly. Therefore, NOAA's calculation of 8 meters offshore and TEPCO's (most recently) announcement of 14 meters onshore are consistent.

This is the third estimate that TEPCO has published, and we do not have information about why their estimates are changing.

59) How well can we predict a tsunami wave height? What have we learned about our prediction abilities based on the events in Japan?

The following is based on an email and added here for record-keeping (it needs to be revised into a formal Q&A):

First, it's very important to understand that the method used by the Japanese nuclear industry is very different from how assessments are made in the US. The under-prediction of the possible tsunami in Japan does not indicate a problem in the US. The Japanese approach is heavily focused on using their extensive database of past events and doing modeling based on segmented faults.

NOAA's tsunami warning system models (NOAA, not the USGS) have been extremely well validated over time (with hundreds of real tsunami), and that continues to be the case. But, that is up to water depth where they have the necessary resolution of bathymetric data (and where the non-linear response begins in earnest). As a result of this fact, there is an effort currently to collect very high resolution data for the entire US pacific coast and to implement it into the NOAA database (currently the resolution of US data is not uniform). This will make US Pacific coast onshore runup predictions highly accurate.

NRC Response and Future Licensing Actions

60) What is the NRC doing about the emergencies at the nuclear power plants in Japan? Are you sending staff over there?

Public Answer: We are closely following events in Japan, working with other agencies of the federal government and with our counterparts in that country. In addition, we currently have a team of experts in boiling water reactors working in Japan.

Additional technical, non-public information: NOTE TO OPA: please check the current staffing in Japan to provide more accurate information. This is changing on an ongoing basis. We are taking the knowledge that the staff has about the design of the US nuclear plants and we are applying this knowledge to the Japan situation. For example, this includes calculations of severe accident mitigation that have been performed.

61) With NRC moving to design certification, at what point is seismic capability tested – during design or modified to be site-specific? If in design, what strength seismic event must these be built to withstand?

Public Answer: During design certification, vendors propose a seismic design in terms of a ground motion spectrum for their nuclear facility. This spectrum is called a standard design response spectrum and is developed so that the proposed nuclear facility can be sited at most locations in the central and eastern United States. The vendors show that this design ground motion is suitable for a variety of different subsurface conditions such as hard rock, deep soil, or shallow soil over rock. Combined License and Early Site Permits applicants are required to develop a site specific ground motion response spectrum that takes into account all of the earthquakes in the region surrounding their site as well as the local site geologic conditions. Applicants estimate the ground motion from these postulated earthquakes to develop seismic hazard curves. These seismic hazard curves are then used to determine a site specific ground motion response spectrum that has a maximum annual likelihood of 1×10^{-4} of being exceeded. This can be thought of as a ground motion with a 10,000 year return period. This site specific ground motion response spectrum is then compared to the standard design response spectrum for the proposed design. If the standard design ground motion spectrum envelopes the site specific ground motion spectrum then the site is considered to be suitable for the proposed design. If the standard design spectrum does not completely envelope the site specific ground motion spectrum, then the COL applicant must do further detailed structural analysis to show that the design capacity is adequate. Margin beyond the standard design and site specific ground motions must also be demonstrated before fuel loading can begin.

Additional technical, non-public information: None.

62) What are the near term actions that U.S. plants are taking in consideration of the events in Japan?

Public Answer: The U.S. nuclear energy industry has already started an assessment of the events in Japan and is taking steps to ensure that U.S. reactors could respond to events that may challenge safe operation of the facilities. These actions include:

- Verify each plant's capability to manage major challenges, such as aircraft impacts and losses of large areas of the plant due to natural events, fires or explosions.
Verify each plant's capability to manage a total loss of off-site power.

Official Use Only

- Verify the capability to mitigate flooding and the impact of floods on systems inside and outside the plant.
- Perform walk-downs and inspection of important equipment needed to respond successfully to extreme events like fires and floods.

Additional technical, non-public information: Note to OPA: This was a Q&A from the 3/21 briefing. please check that this is OK to provide to the public before doing so.

63) What are the immediate steps NRC is taking?

Public Answer: To date (march 20, 2011) the NRC has taken the following steps:

- The Nuclear Regulatory Commission has issued an Information Notice to all currently operating U.S. nuclear power plants, describing the effects of the March 11 earthquake and tsunami on Japanese nuclear power plants.
- The notice provides a brief overview of how the earthquake and tsunami are understood to have disabled several key cooling systems at the Fukushima Daiichi nuclear power station, and also hampered efforts to return those systems to service. The notice is based on the NRC's current understanding of the damage to the reactors and associated spent fuel pools as of Friday, March 18.
- The notice reflects the current belief that the combined effects of the March 11 earthquake and tsunami exceeded the Fukushima Daiichi plant's design limits. The notice also recounts the NRC's efforts, post-9/11, to enhance U.S. plants' abilities to cope with severe events, such as the loss of large areas of a site, including safety systems and power supplies.

The NRC expects U.S. nuclear power plants will review the entire notice to determine how it applies to their facilities and consider actions, as appropriate.

Additional technical, non-public information: Note to OPA: This was a Q&A from the 3/21 briefing. please check that this is OK to provide to the public before doing so.

64) Should U.S. residents be using Potassium iodide?

Public Response: It is the responsibility of the individual States to decide on the use of KI. It is EPAs responsibility to inform states of projected doses. Due to the extremely low levels of radioactivity expected on the U.S. West coast and Pacific States/territories, the NRC staff does not recommend use of KI.

Additional technical, non-public information: None.

Reassessment of US Plants and Generic Issue 199 (GI-199)

65) What is Generic Issue 199 about?

Public Answer: Generic Issue 199 investigates the safety and risk implications of updated earthquake-related data and models. These data and models suggest that the probability for earthquake ground motion above the seismic design basis for some nuclear plants in the Central and Eastern United States, although is still low, is larger than previous estimates.

Additional, technical, non-public information: See additional summary/discussion of GI-199 and terms below.

66) Does the NRC have a position on the MSNBC article that ranked the safety of US plants?

Public Response: [see below]

67) A recent Can we get the rankings of the plants in terms of safety? (Actually this answer should be considered any time GI-199 data is used to "rank" plants)

Public Response: The NRC does not rank nuclear plants by seismic risk. The objective of the GI-199 Safety/Risk Assessment was to perform a conservative, screening-level assessment to evaluate if further investigations of seismic safety for operating reactors in the central and eastern US (CEUS) are warranted, consistent with NRC directives. The results of the GI-199 safety risk assessment should not be interpreted as definitive estimates of plant-specific seismic risk because some analyses were very conservative making the calculated risk higher than in reality. The nature of the information used (both seismic hazard data and plant-level fragility information) make these estimates useful only as a screening tool.

Additional, technical, non-public information: NOTE TO OPA: Add the answer to "What are the current findings of GI-199", to create a longer answer if it is appropriate.

68) What are the current findings of GI-199?

Currently operating nuclear plants in the US remain safe, with no need for immediate action. This determination is based on NRC staff reviews of updated seismic hazard information and the conclusions of the first stage of GI-199. Existing nuclear plants were designed with considerable margin to be able to withstand the ground motions from the "deterministic" or "scenario earthquake" that accounted for the largest earthquakes expected in the area around the plant. The results of the GI-199 assessment demonstrate that the probability of exceeding the design basis ground motion may have increased at some sites, but only by a relatively small amount. In addition, the probabilities of seismic core damage are lower than the guidelines for taking immediate action. Although there is not an immediate safety concern, the NRC is focused on assuring safety during even very rare and extreme events. Therefore, the NRC has determined that assessment of updated seismic hazards and plant performance should continue.

Additional, technical, non-public information: None.

69) If the plants are designed to withstand the ground shaking why is there so much risk from the design level earthquake

Much of the risk in the total risk levels provided in the report comes from earthquakes stronger than the safe shutdown ground motion. The anything indicated in the geologic record used to determine the design requirements at these sites. The numbers are based on an evaluation of all of the potential

seismic sources in the CEUS and are used to produce seismic hazard estimates (curves) for each site. The GI-199 effort to date has performed a screening assessment to determine if further, more detailed studies are warranted. This study has utilized information from plant-specific evaluation of external hazards, including earthquakes. That information was gathered to identify potential seismic vulnerabilities, not to produce robust risk estimates. Therefore, the GI-199 results should be viewed as preliminary and not definitive.

70) Overall, how would the NRC characterize the CDF numbers? A quirk of numbers? A serious concern?

Public Response: The objective of the GI-199 Safety/Risk Assessment was to perform a conservative, screening-level assessment to evaluate if further investigations of seismic safety for operating reactors in the central and eastern US (CEUS) are warranted consistent with NRC directives. The results of the GI-199 SRA should not be interpreted as definitive estimates of plant-specific seismic risk. The nature of the information used (both seismic hazard data and plant-level fragility information) make these estimates useful only as a screening tool. The use of the absolute value of the seismic hazard-related risk, as done in the MSNBC article, is not the intended use, and the NRC considers it an inappropriate use of the results.

The study is still underway and it is too early to predict the final outcome. However, staff has determined that there is no immediate safety concern and that overall seismic risk estimates remain small. If at any time the NRC determines that an immediate safety concern exists, action to address the issue will be taken. However, the NRC is focused on assuring safety during even very rare and extreme events. Therefore, the NRC has determined that assessment of updated seismic hazards and plant performance should continue.

Additional, technical, non-public information: None.

71) Describe the study and what it factored in – plant design, soils, previous quakes, etc.

Public Response: The study considers the factors that impact estimates of both the seismic hazard (i.e. ground shaking levels) at the site and the plants resistance to earthquakes (mathematically represented by the plant level fragility curve). Previous quakes, the tectonic environment, and the soils that underlie the site are all used in the development of the ground shaking estimates used in the analyses. Plant design and the seismic resistance of the important structures, systems, and components are all used in the development of plant level fragility curves.

Additional, technical, non-public information: None.

72) Explain “seismic curve” and “plant level fragility curve”.

Public Response: A seismic curve is a graphical representation of seismic hazard. Seismic hazard in this context is the highest level of ground motion expected to occur (on average) at a site over different periods of time. Plant level fragility is the probability of damage to plant structures, systems and components as a function of ground shaking levels.

Additional, technical, non-public information: None.

73) Explain the “weakest link model”.

Public Response: The weakest link model is a method for evaluating the importance of different frequencies of ground vibration to the overall plant performance. The model and its details are not integral to understanding the fundamental conclusions of the study.

Additional, technical, non-public information: None.

74) What would constitute fragility at a plant?

Public Response: Fragility is a term that relates the probability of failure of an individual structure, system or component to the level of seismic shaking it experiences. Plant level fragility is the probability of damage to sets of plant structures, systems and components as a function of ground shaking levels.

Additional, technical, non-public information: None.

75) Can someone put that risk factor into perspective, using something other than MSNRC's chances of winning the lottery?

Public Response: As noted above, the risk factors determined in GI-199 were conservative estimates of risk intended for use as a screening tool. Use of these factors beyond this intended purpose is inappropriate.

Additional, technical, non-public information: None.

76) What, if anything, can be done at a site experiencing such a risk? (Or at Limerick in particular.)

Public Response: The probabilistic seismic risk analyses (SPRA) that are performed to determine the core damage frequency (CDF) numbers also provides a significant amount of information on what the plant vulnerabilities are. This allows the analyst to determine what can be done to the plant to address the risk.

Additional, technical, non-public information: None.

77) Has anyone determined that anything SHOULD be done at Limerick or any of the other PA plants?

Public Response: The fundamental conclusion of the report is that "work to date supports a decision to continue ...; the methodology, input assumptions, and data are not sufficiently developed to support other regulatory actions or decisions." The NRC is planning to issue a Generic Communication to operating reactor licensees in the CEUS requesting additional information. This includes the plants in PA.

Additional, technical, non-public information: None.

78) Page 20 of the report: This result confirms NRR's conclusion that currently operating plants are adequately protected against the change in seismic hazard estimates because the guidelines in NRR Office Instruction LIC-504 "Integrated Risk-Informed Decision Making Process for Emergent Issues" are not exceeded. Can someone please explain?

Public response: Can someone help with this?

Additional, technical, non-public information: None.

79) Is the earthquake safety of US plants reviewed once the plants are constructed?

Public response: Yes, earthquake safety is reviewed during focused design inspections, under the Generic Issues Program (GI-199) and as part of the Individual Plant Evaluation of External Events program (IPEEE) that was conducted in response to Generic Letter 88-20 Supplement 4.

Additional, technical, non-public information: None.

80) Does the NRC ever review tsunami risk for existing plants?

Public Answer: The NRC has not conducted a generic issue program on tsunami risk to date. However, some plants have been reviewed as a result of the application for a license for a new reactor. In the ASME/ANS 2009 seismic probabilistic risk assessment standard, all external hazards are included.

Additional, technical, non-public information: None.

81) Does GI-199 consider tsunami?

Public response: GI-199 stems from the increased in perceived seismic hazard focused on understanding the impact of increased ground motion on the risk at a plant. GI-199 does not consider tsunami

Additional, technical, non-public information: In the past there has been discussion about a GI program on tsunami, but the NRC's research and guidance was not yet at the point it would be effective. We are just getting to this stage and the topic should be revisited.

82) Where can I get current information about Generic Issue 199?

Public Answer: The public NRC Generic Issues Program (GIP) website (<http://www.nrc.gov/about-nrc/regulatory/gen-issues.html>) contains program information and documents, background and historical information, generic issue status information, and links to related programs. The latest Generic Issue Management Control System quarterly report, which has regularly updated GI-199 information, is publicly available at <http://www.nrc.gov/reading-rm/doc-collections/generic-issues/quarterly/index.html>. Additionally, the US Geological Survey provides data and results that are publicly available at <http://earthquake.usgs.gov/hazards/products/conterminous/2008/>.

Additional, technical, non-public information: The GI-199 section of the NRC internal GIP website (<http://www.internal.nrc.gov/RES/projects/GIP/Individual%20GIs/GI-0199.html>) contains additional information about Generic Issue 199 (GI-199) and is available to NRC staff.

83) Are all US plants being evaluated as a part of Generic Issue 199?

Public Answer: Currently the scope of the Generic Issue 199 (GI-199) Safety/Risk Assessment is limited to all plants in the Central and Eastern United States. Although plants at the Columbia, Diablo Canyon, Palo Verde, and San Onofre sites are not included in the GI-199 Safety/Risk Assessment, the Information Notice on GI-199 is addressed to all operating power plants in the US (as well as all independent spent fuel storage installation licensees). The staff will also consider inclusion of operating reactors in the Western US in its future generic communication information requests.

Additional, technical, non-public information: The staff is currently developing specific information needs to be included in a Generic Letter to licensees in the CEUS.

84) Are the plants safe? If you are not sure they are safe, why are they not being shut down? If you are sure they are safe, why are you continuing evaluations related to this generic issue?

Public Answer: Yes, currently operating nuclear plants in the United States remain safe, with no need for immediate action. This determination is based on NRC staff reviews associated with Early Site Permits (ESP) and updated seismic hazard information, the conclusions of the Generic Issue 199 Screening Panel (comprised of technical experts), and the conclusions of the Safety/Risk Assessment Panel (also comprised of technical experts).

No immediate action is needed because: (1) existing plants were designed to withstand anticipated earthquakes with substantial design margins, as confirmed by the results of the Individual Plant Examination of External Events program; (2) the probability of exceeding the *safe shutdown earthquake* ground motion may have increased at some sites, but only by a relatively small amount; and (3) the Safety/Risk Assessment Stage results indicate that the probabilities of seismic core damage are lower than the guidelines for taking immediate action.

Even though the staff has determined that existing plants remain safe, the Generic Issues Program criteria (Management Directive 6.4) direct staff to continue their analysis to determine whether any cost-justified plant improvements can be identified to make plants enhance plant safety.

Additional, technical, non-public information : The Safety/Risk Assessment results confirm that plants are safe. The relevant risk criterion for GI-199 is total *core damage frequency* (CDF). The threshold for taking immediate regulatory action (found in NRR Office Instruction LIC-504, see below) is a total CDF greater than or on the order of 10^{-3} (0.001) per year. For GI-199, the staff calculated seismic CDFs of 10^{-4} (0.0001) per year and below for nuclear power plants operating in the Central and Eastern US (CEUS) (based on the new US Geological Survey seismic hazard curves). The CDF from internal events (estimated using the staff-developed Standardized Plant Analysis of Risk models) and fires (as reported by licensees during the IPEEE process and documented in NUREG-1742), when added to the seismic CDF estimates results in the total risk for each plant to be, at most, 4×10^{-4} (0.0004) per year or below. This is well below the threshold (a CDF of 10^{-3} [0.001] per year) for taking immediate action. Based on the determination that there is no need for immediate action, and that this issue has not changed the licensing basis for any operating plant, the CEUS operating nuclear power plants are considered safe. In addition, as detailed in the GI-199 Safety/Risk Assessment there are additional, qualitative considerations that provide further support to the conclusion that plants are safe.

Note: The NRC has an integrated, risk-informed decision-making process for emergent reactor issues (NRR Office Instruction LIC-504, ADAMS Accession No. ML100541776 [not publically available]). In addition to deterministic criteria, LIC-504 contains risk criteria for determining when an emergent issue requires regulatory action to place or maintain a plant in a safe condition.

85) What do you mean by “increased estimates of seismic hazards” at nuclear power plant sites?

Public Answer: *Seismic hazard* (earthquake hazard) represents the chance (or probability) that a specific level of ground motion could be observed or exceeded at a given location. Our estimates of seismic hazard at some Central and Eastern United States locations have changed based on results from recent research, indicating that earthquakes occurred more often in some locations than previously estimated. Our estimates of seismic hazard have also changed because the models used to predict the level of ground motion, as caused by a specific magnitude earthquake at a certain distance from a site, changed. The increased estimates of seismic hazard at some locations in the Central and Eastern United States were discussed in a memorandum to the Commission, dated July 26, 2006. (The memorandum is available in the NRC Agencywide Documents Access and Management System [ADAMS] under Accession No. ML052360044).

Additional, technical, non-public information: See additional discussion of terms at the end of the document.

86) Does the SCDF represent a measurement of the risk of radiation RELEASE or only the risk of core damage (not accounting for secondary containment, etc.)?

Public Response: Seismic core damage frequency is the probability of damage to the core resulting from a seismic initiating event. It does not imply either a meltdown or the loss of containment, which would be required for radiological release to occur. The likelihood of radiation release is far lower.

87) Did an NRC spokesperson tell MSNBC's Bill Dedman that the weighted risk average was invalid and useless? He contends to us that this is the case.

Public Response: No. See Answers below.

88) 3. If it was "invalid" as he claims, why would the USGS include that metric?

Public Response: The weighted average is not invalid (see Answer 5 below). All of the values in Appendix D were developed by NRC staff. Table D-1 in Appendix D uses the (2008) US Geological Survey (USGS) seismic source model, but the Seismic Core Damage Frequency results were developed by US NRC staff. The USGS seismic source model is the same one used to develop the USGS National Seismic Hazard Maps.

89) Can you explain the weighted average and how it compares to the weakest link average?

Public Response: Tables D-1 through D-3 in Appendix D of the US NRC study show the "simple" average of the four spectral frequencies (1, Hz, 5 Hz, 10 Hz, peak ground acceleration (PGA)), the "IPEEE weighted" average and the "weakest link" model. These different averaging approaches are explained in Appendix A.3 (simple average and IPEEE weighted average) and Appendix A.4 (weakest link model). The weighted average uses a combination of the three spectral frequencies (1, 5, and 10 Hz) at which most important structures, systems, and components of nuclear power plants will resonate. The weakest link is the largest SCDF value from among the four spectral frequencies noted above.

90) Ultimately would you suggest using one of the models (average, weighted, weakest link) or to combine the information from all three?

Public Response: Most nuclear power plant structures, systems, and components resonate at frequencies between 1 and 10 Hz, so there are different approaches to averaging the Seismic Core Damage Frequency (SCDF) values. By using multiple approaches, the NRC staff gains a better understanding of the uncertainties involved in the assessments.

91) Were there any other factual inaccuracies or flaws in Mr. Dedman's piece you would like clarify/point out.

Public Response: The US Nuclear Regulatory Commission study, released in September, 2010, was prepared as a screening assessment to evaluate if further investigations of seismic safety for operating reactors in the central and eastern US (CEUS) are warranted, consistent with NRC directives. The report clearly states that "work to date supports a decision to continue ...; the methodology, input assumptions, and data are not sufficiently developed to support other regulatory actions or decisions." Accordingly, the results were not used to rank or compare plants. The study produced plant-specific results of the estimated change in risk from seismic hazards. The study did not rely on the absolute value of the seismic risk except to assure that all operating plants are safe. The plant-specific results were used in aggregate to determine the need for continued evaluation and were included in the report for openness and transparency. The use of the absolute value of the seismic hazard-related risk, as done in the MSNBC article, is not the intended use, and the NRC considers it an inappropriate use of the results.

92) Mr. Dedman infers that the plant quake risk has grown (between the 1989 and 2008 estimates) to the threshold of danger and may cross it in the next study. Is this the NRC's position?

Public Response: The US NRC evaluation is still underway and it is too early to predict the final outcome. However, staff has determined that there is no immediate safety concern and that overall seismic risk estimates remain small. If at any time the NRC determines that an immediate safety concern exists, action to address the issue will be taken. However, the NRC is focused on assuring safety during even very rare and extreme events. Therefore, the NRC has determined that assessment of updated seismic hazards and plant performance should continue

93) What document has the latest seismic hazard estimates (probabilistic or not) for existing nuclear power plants in the western US?

Public Response: At this time the staff has not formally developed updated probabilistic seismic hazard estimates for the existing nuclear power plants in the Western US. However, NRC staff during the mid- to late-1990's reviewed the plants' assessments of potential consequences of severe ground motion from earthquakes beyond the plant design basis as part of the Individual Plant Examination of External Events (IPEEE) program. From this review, the NRC staff determined that the seismic designs of operating plants in the US have adequate safety margin. NRC staff has continued to stay abreast of the latest research on seismic hazards in the Western US and interface with colleagues at the US Geological Survey. The focus of Generic Issue 199 has been on the CEUS. However, the Information Notice that summarized the results of the Safety/Risk Assessment was sent to all existing power reactor licensees. The documents that summarize existing hazard estimates are contained in the Final Safety Analysis Reports (FSARS) and in the IPEEE submittals. It must be noted that following 9/11 the IPEEE documents are no longer publicly available.

Additional, technical, non-public information: None

94) The GI-199 documents refer to newer data on the way. Have NRC, USGS et al. released those? I'm referring to this: "New consensus seismic-hazard estimates will become available in late 2010 or early 2011 (these are a product of a joint NRC, US Department of Energy, US Geological Survey (USGS) and Electric Power Research Institute (EPRI) project). These consensus seismic hazard estimates will supersede the existing EPRI, Lawrence Livermore National Laboratory, and USGS hazard estimates used in the GI-199 Safety/Risk Assessment."

Public Response: The new consensus hazard curves are being developed in a cooperative project that has NRC, US Department of Energy, US Geological Survey (USGS) and Electric Power Research Institute (EPRI) participation. The title is: The Central and Eastern US Seismic Source Characterization (CEUS-SSC) project. The project is being conducted following comprehensive standards to ensure quality and regulatory defensibility. It is in its final phase and is expected to be publicly released in the fall of 2011. The project manager is Larry Salamone (Lawrence.salamone@srs.gov, 803-645-9195) and the technical lead on the project is Dr. Kevin Coppersmith (925-974-3335, kcoppersmith@earthlink.net). Additional information on this project can be found at: <http://mydocs.epri.com/docs/ANT/2008-04.pdf>, and http://my.epri.com/portal/server.pt?open=512&objID=319&&PageID=218833&mode=2&in_hi_us_erid=2&cached=true.

Additional, technical, non-public information: None

95) What is the timetable now for consideration of any regulatory changes from the GI-199 research?

Public Response: The NRC is working on developing a Generic Letter (GL) to request information from affected licensees. The GL will likely be issued in a draft form within the next 2 months to stimulate discussions with industry in a public meeting. After that it has to be approved by the Committee to Review Generic Requirements, presented to the Advisory Committee on Reactor Safeguards and issued as a draft for formal public comments (60 days). After evaluation of the public comments it can then be finalized for issuance. We expect to issue the GL by the end of this calendar year, as the new consensus seismic hazard estimates become available. The information from licensees will likely require 3 to 6 months to complete. Staff's review will commence after receiving licensees' responses. Based on staff's review, a determination can be made regarding cost beneficial backfits where it can be justified.

Additional, technical, non-public information: None

1. Please explain in plain language how the NRC determined plants are safe with regard to the results of our GI199 assessment report..
2. The GI199 Safety/Risk Assessment states 24 plants "lie in the continue zone" (pg 23) These plants "need more assessment." What are these 24 plants? Why are these plants that require further evaluation safe? (pg 23 and Figure 8)
3. Why is the list of plants identified by the NRC for further evaluation under GI199 different than those identified by MSNBC as the "top 10" likely to fail due to seismic event?
4. Why are plants safe when MSNBC calculations indicate several hundred percent increases in the risk of a seismic event that damages the core?
5. Why do Indian Point 2 and Indian Point 3 plants have different probabilities of failing due to a seismic event when the plants are located next to each other? Is IP3 calculated to be the most likely to fail due to a seismic event? Why? Why is IP2 different? Aren't these plant at the same location and very similar design?
6. Why is Pilgrim not in the NRC "continue to evaluate zone" but second on the MSNBC list as moist likely to fail due to a seismic event?

Seismic Probabilistic Risk Assessment (SPRA)

96) The NRC increasingly uses risk-information in regulatory decisions. Are risk-informed PRAs useful in assessing an event such as this?

Public response: Nilesch Chokshi to provide Q&As on SPRA

Additional, technical, non-public information: None

State-of-the-art Reactor Consequence Analysis (SOARCA)

97) What severe accident research is the U.S. Nuclear Regulatory Commission (NRC) doing?

Public Answer: The below is from the internal Q&As for the 3/21 briefing. This needs to be cleared before it can be used.

Additional, technical, non-public information: The NRC and its contractor presently are completing a research project entitled "State-of-the-Art Reactor Consequence Analysis" (SOARCA). This research project develops best estimates of the potential public health effects from a nuclear power plant accident where low-likelihood scenarios could release radioactive material into the environment and potentially cause offsite consequences. The project also evaluates and improves, as appropriate, methods and models for evaluating outcomes of such severe accidents. In addition, research is being conducted to develop advanced risk assessment modeling techniques (e.g., dynamic probabilistic risk assessment (PRA) using simulation based methods) to improve the state-of-the practice in PRA severe accident modeling. Key goals of this research include increased analysis realism, reduced reliance on modeling simplification, and improved the treatment of human interactions with the reactor plant system.

98) Why is the NRC performing the SOARCA study?

Public Answer: The below is from the internal Q&As for the 3/21 briefing. This needs to be cleared before it can be used.

Additional, technical, non-public information: NRC is doing this study to develop the most realistic evaluations for the potential consequences of severe nuclear accidents. Over the years, NRC, industry, and international nuclear safety organizations have completed substantial research on plant response to hypothetical accidents that could damage the core and containment. The results have significantly improved NRC's ability to analyze and predict how nuclear plant systems and operators would respond to severe accidents. Also, plant owners have improved the plant design, emergency procedures, maintenance programs, and operator training, all of which have improved plant safety. Emergency preparedness measures also have been refined and improved to further protect the public in the highly unlikely event of a severe accident. Combining all of this new information and analysis will improve the realism of accident consequence evaluations.

99) Does the NRC intend to revisit previous risk studies?

Public Answer: The below is from the internal Q&As for the 3/21 briefing. This needs to be cleared before it can be used.

Additional, technical, non-public information: The last NRC-sponsored Level 3 probabilistic risk assessment (PRA) studies to estimate the integrated risk to the public from severe nuclear reactor accidents were conducted in the late 1980s with the results published in a collection of reports and a corresponding summary document, NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants." Based on advances in both nuclear power plant safety and PRA technology since NUREG-1150 was published, the NRC staff is considering conducting new Level 3 PRA studies to update its understanding of the integrated risk to the public from accidents involving nuclear power plant sites. The NRC staff is currently conducting a scoping study to develop various options for proceeding with Level 3 PRA activities, and plans to provide the Commission with these potential options and a specific recommendation for proceeding by July 2011.

100) How will the SOARCA study be different from earlier studies?

Public Answer: The below is from the internal Q&As for the 3/21 briefing. This needs to be cleared before it can be used.

Additional, technical, non-public information: The SOARCA project will:

- Use an improved understanding of source terms and severe accident phenomenology.
- Credit the use of severe accident mitigation strategies and procedures.
- Use updated emergency preparedness modeling.
- Account for plant improvements.
- Use modern computer resources and advanced software to yield more accurate results.

In addition, the SOARCA project is designed to be a more realistic estimate. Some of the earlier studies also were designed to be best estimates; however, because they were limited by the available knowledge of accident phenomenology, these older studies were conservative (particularly the very improbable severe accidents) in their estimates of off-site releases and early fatalities. The SOARCA project will provide the latest basis from which the public and decision makers can assess the consequences of severe reactor accidents.

Defense-in-Depth and Severe Accident Management

This is not exactly related to seismic questions. I read these with great interest. I believe there are many staff who would like to be more informed about this topic. So, I have included it.

102) Although there undoubtedly will be many lessons learned about severe accidents from the tragic events at Fukushima, have you identified any early lessons?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: There will undoubtedly be many lessons learned in the months and years to come as we learn more about the tragic events at the Fukushima Daiichi plant in Japan. However, one of the early lessons is this: You can't anticipate — either in the deterministic design basis of the plant or through probabilistic risk assessment models — everything that could happen. That is why the NRC's defense-in-depth philosophy is fundamental to ensuring that safety is achieved, even under extreme circumstances, such as those experienced at the Fukushima Daiichi plant. This NRC focus on defense-in-depth has led to a number of improvements in the design and operation of U.S. Nuclear Power Plants:

- Studies of severe accident prevention and mitigation in the 1980s led to a number of improvements at plants, such as installation of hardened vents at BWRs with Mark I containments. (See "fact sheet" for more detail.)
- Also, in the 1980s (specifically in 1988) the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted. (See "fact sheet" on station black-out.)
- Operator procedures that are symptom-based and ensure that operators primary focus is maintaining the critical safety functions such as ensuring the core is cooled and covered.
- Addition procedures for operators to use in the event of a severe accident (Severe Accident Mitigation Guidelines (SAMG)).
- Provisions in 10 CFR 50.54hh that require licensees to develop and implement guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities in situations involving loss of large areas of the plant due to explosions or fire.

103) What procedures do U.S. plants have for responding to an unexpected event like the events in Japan.

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: One of the most significant lessons learned from the Three Mile Island Accident in 1979 was that operating procedures need to be symptom based and less prescriptive. Procedures that previously directed operators to take a series of actions based on a preestablished accident were replaced with procedures that directed operators to maintain the critical safety functions, such as keeping the core covered and cooled. Operators routinely practice these

procedures on a plant specific simulator to ensure that they can be implemented for a wide range of accident scenarios, including a station blackout scenario, or other events caused by an earthquake or a flood.

104) What are Severe Accident Management Guidelines

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: SAMGs are the set of guidelines employed to manage the in-plant response following a severe accident (i.e., Beyond design basis events that are expected to have resulted in significant core damage).

The *ultimate objective* of SAMGs is to protect the health and safety of the public from the hazards associated with the uncontrolled release of radioactive materials

The *operational objective* of SAMGs is to protect or restore, if possible, the integrity of the three physical barriers (fuel, reactor coolant system, and containment) to contain fission products.

Some important aspects of the guidelines are as follows:

- SAMGs go beyond the Emergency Operating Procedures (EOPs)
- SAMGs identify all possible means of achieving the operational objective, including the use of non-safety-related equipment and capabilities on site (including capabilities from other units)
- plant-specific SAMGs identify the various safety functions and list the capabilities to achieve that function, with some high-level procedure-like guidance.

Spent Fuel Pools and Independent Spent Fuel Storage Installations

105) Are Independent Spent Fuel Storage Installations (ISFSIs) required to withstand the same ground shaking as the reactor?

Public Response: Nuclear plant licensees use the same Safe Shutdown Earthquake (SSE) ground motion developed for the nuclear plant site for the design basis ground motion for the spent fuel dry cask storage facilities (also known as independent spent fuel storage installations, or ISFSIs) located at that site. Some reactor licensees have ISFSIs under a site-specific 10 CFR Part 72 license, and these licensees are required to use the same Part 50 reactor SSE for their design basis earthquake, in accordance with 10 CFR 72.102(f)(1). Other reactor licensees have onsite ISFSIs under the general license provisions of 10 CFR 72.210; they are similarly required to apply the same seismic design bases for the Part 50 license to the ISFSI design, in accordance with 10 CFR 72.212(b)(3).

Additional, technical, non-public information: none.

106) What do we know about the potential for and consequences of a zirconium fire in the spent fuel pool?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Spent fuel pools contain large amounts of water to keep the fuel cooled, and no fire can result as long as the water covers the fuel. Should the pool not be cooled for a substantial amount of time (on the order of days), the water in the pool may boil off. Should that continue and the fuel be exposed, the fuel could overheat. In the worst case, the zirconium cladding could oxidize and burn. The result of such a fire would be significant damage to the fuel, also the fire has the potential to propagate to the other assemblies, as well as release of hydrogen gas and volatile radioactive materials.

107) Can a zirconium fuel fire be prevented by wide spacing of spent fuel assemblies in the spent fuel pool?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Wider spacing would help in preventing a fire. Preventing a fire requires coolability in absence of water submersion. This depends on the heat and the assembly arrangement in the pool. A checkerboard arrangement (no two assemblies in adjacent locations) is coolable in about one third the time needed for a fully loaded (no open locations) pool. Other arrangements can also mitigate the potential of the onset of zirconium fires.

108) Are the implications of new seismic hazard estimates being considered for the storage of spent fuel?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Yes, while the GI-199 Safety/Risk Assessment focused solely on operating power reactors in the Central and Eastern U.S., spent fuel storage has been considered by NRC.

The NRC Office of Nuclear Materials Safety and Safeguards (NMSS) was informed of GI-199 and a preliminary screening review was performed in November, 2008 by the NMSS Division of Spent Fuel Storage and Transportation. There is a total of 40 operating independent spent fuel storage installations

(ISFSIs) in the Central and Eastern U.S. (CEUS). Except for a wet storage facility at G. E. Morris located in Illinois, the ISFSIs are co-located at the operating and permanently shutdown reactor sites. A review of design earthquakes (DE) used at the existing ISFSI locations in CEUS indicated that the safety margin (defined for ISFSIs as the ratio of DE/SSE, where SSE is the safe shutdown earthquake discussed in answer A8) for the cask designs were in the range of 1.20 ~ 3.90.

Therefore, NMSS considers that there is significant margin built into the existing designs and has confidence that the ISFSIs can continue to operate safely while the licensees' investigate this issue using their site specific information. Even so, holders of operating license for ISFSIs are included among addressees in the Information Notice on GI-199. Spent fuel pools (SFPs) were not specifically evaluated as part of GI-199. However, based on their design attributes (as follows), SFPs remain safe. SFPs are constructed of reinforced concrete, several feet thick, with a stainless steel liner to prevent leakage and maintain water quality. Due to their configuration, SFPs are inherently structurally-rugged and are designed to the same seismic requirements and ground motion intensity as the nuclear plant. However, the spent fuel cooling systems are not always seismic category 1.

Note: Typically, SFPs are about 40 feet deep and vary in width and length. The fuel is stored in stainless steel racks and submerged with approximately 23 feet of water above the top of the stored fuel. Each plant has a preferred SFP make-up water source (the refueling water storage tank for pressurized water reactors and the condensate storage tank for boiling water reactors). SFPs have alternate means of make-up such as service water systems and the fire water system. SFPs are also typically designed (e.g. with anti-siphon check valves) and instrumented such that leakage is minimized and promptly detected.

109) What are the design acceptance criteria for cooling systems for the spent fuel pools?

Public Response: The Standard Review Plan (NUREG0-800) acceptance Criteria for SP Cooling includes the following aspects:

General Design Criterion (GDC) 2 contained in Appendix A to 10 CFR Part 50, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, and hurricanes. Acceptance for meeting this criterion is based on conformance to positions C.1, C.2, C.6, and C.8 of RG 1.13 and position C.1 of RG 1.29 for safety-related and position C.2 of RG 1.29 for nonsafety-related portions of the system.

This criterion does not apply to the cleanup portion of the system and need not apply to the cooling system if the fuel pool makeup water system and its source meet this criterion, the fuel pool building and its ventilation and filtration system meet this criterion, and the ventilation and filtration system meets the guidelines of RG 1.52.

The cooling and makeup system should be designed to Quality Group C requirements in accordance with RG 1.26. However, when the cooling system is not designated Category I it need not meet the requirements of ASME Section XI for in-service inspection of nuclear plant components.

110) How does B.5.b apply to spent fuel pools?

Public Response: The answer below is a compilation of two questions contained in the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Section B.5.b of the ICM Order required licensees to "Develop specific guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities using existing or readily available resources (equipment and personnel) that can be effectively implemented under the circumstances associated with loss of large areas of the plant due to explosions or fire." Phase 1 was part of a larger NRC effort to enhance the safety and security of the nation's nuclear power plants. In Phase 2, the NRC independently looked at additional

~~Official Use Only~~

ways to protect the spent fuel pools at nuclear power plants. The NRC's plant-specific assessments identified both "readily available" and other resources that could be used to mitigate damage to spent fuel pools and the surrounding areas. The assessments considered damage that could have been caused by land, water, or air attacks.

Station Blackout

This is not exactly related to seismic questions. But, similar to the above topics, I read these with great interest. I believe there are many staff who would like to be more informed about this topic and this is an excellent summary. So, I have included it here.

A Factsheet related to station blackout has been added (see pg ~~XX~~).

111) What is the definition of station blackout?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Station blackout (SBO) means the complete loss of alternating current (ac) electric power to the essential and nonessential switchgear buses in a nuclear power plant (i.e., loss of offsite electric power system concurrent with turbine trip and unavailability of the onsite emergency ac power system). Station blackout does not include the loss of available ac power to buses fed by station batteries through inverters or by alternate ac sources as defined in this section, nor does it assume a concurrent single failure or design basis accident. At single unit sites, any emergency ac power source(s) in excess of the number required to meet minimum redundancy requirements (i.e., single failure) for safe shutdown (non-DBA) is assumed to be available and may be designated as an alternate power source(s) provided the applicable requirements are met. At multi-unit sites, where the combination of emergency ac power sources exceeds the minimum redundancy requirements for safe shutdown (non-DBA) of all units, the remaining emergency ac power sources may be used as alternate ac power sources provided they meet the applicable requirements. If these criteria are not met, station blackout must be assumed on all the units.

112) What is the existing regulatory requirement regarding SBO?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Each light-water-cooled nuclear power plant licensed to operate must be able to withstand for a specified duration and recover from a station blackout as defined in Sec. 50.2.

113) How many plants have an alternate ac (AAC) source with the existing EDGs

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: 60 plants

114) How many plants cope with existing class 1E batteries?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: 44 plants

115) What are the coping duration determined for the plants based on the SBO Rule ?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: 4-16 hours (4 hours only with batteries; 4-16 with AAC)

116) How is coping duration determined?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: The specified station blackout duration shall be based on the following factors:

- (i) The redundancy of the onsite emergency ac power sources;
- (ii) The reliability of the onsite emergency ac power sources;
- (iii) The expected frequency of loss of offsite power; and
- (iv) The probable time needed to restore offsite power.

117) When does the SBO event start?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: The onset of a loss of offsite power and onsite power as verified by the control room indications

118) When does the SBO event end?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Either onsite or offsite power is recovered.

119) Did the NRC review the licensee's actions to meet the SBO rule?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Yes. The NRC staff reviewed the responses from each licensee and issued a SER accepting the proposed coping methods. All plants have (1) established SBO coping and recovery procedures; (2) completed training for these procedures; (3) implemented modifications as necessary to cope with an SBO; and (4) ensured a 4-16 hour coping capability. In addition, the staff performed pilot inspections at 8 sites to verify the implementation of the SBO rule implementation. No issues were identified during initial implementation.

120) Are all plants designed to mitigate a station blackout event?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Yes. All plants have the capability to withstand and recover from a SBO event. In 1988, the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems—a station blackout condition—would not adversely affect public health and safety. Studies conducted by the NRC have shown that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense in depth.

Emergency Preparedness (Emphasis on B.5.b)

Although this is not strictly seismic, it is often the case that design for mitigation actions taken for one issue have impact on others. It seems apparent that the actions taken for B.5.b are going to have an impact on the assessment of seismic risk at the plants.

121) Is the emergency preparedness planning basis for nuclear power plants is valid?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Yes- NRC continues to conduct studies to determine the vulnerability of nuclear power plants and the adequacy of licensee programs to protect public health and safety. Whether the initiating event is a severe earthquake, a terrorist based event, or a nuclear accident, the EP planning basis provides reasonable assurance that the public health and safety will be protected. EP plans have always been based on a range of postulated events that would result in a radiological release, including the most severe.

122) What is B.5.b?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: After the terrorist attacks of 9/11, the NRC issued an Interim Compensatory Measures (ICM) Order on February 25, 2002, requiring power reactor licensees to take certain actions to prevent or mitigate terrorist attacks. Section B.5.b of the ICM Order required licensees to "Develop specific guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities using existing or readily available resources (equipment and personnel) that can be effectively implemented under the circumstances associated with loss of large areas of the plant due to explosions or fire."

123) What were Phases 1, 2, and 3 of the B.5.b?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information:

Phase 1: Phase 1 was part of a larger NRC effort to enhance the safety and security of the nation's nuclear power plants. The Phase 1 effort was initiated as part of the February 2002 ICM Order. The Order, among other things, required licensees to look at what might happen if a nuclear power plant lost large areas due to explosions or fire. The licensees then were required to identify – and later implement – strategies that would maintain or restore cooling for the reactor core, containment building, and spent fuel pool. The requirements listed in Section B.5.b of the ICM Order directed licensees to identify "mitigative strategies" (meaning the measures licensees could take to reduce the potential consequences of a large fire or explosion) that could be implemented with resources already existing or "readily available."

Phase 2: In Phase 2, the NRC independently looked at additional ways to protect the spent fuel pools at nuclear power plants. The NRC's plant-specific assessments identified both "readily available" and other resources that could be used to mitigate damage to spent fuel pools and the surrounding areas. The assessments considered damage that could have been caused by land, water, or air attacks.

Phase 3: In Phase 3, each nuclear power plant licensee identified ways to improve its ability to protect the reactor core and containment from a terrorist attack. This was done by identifying both "readily available" and other resources that could be used to mitigate loss of large areas of the plant due to fires

and explosions. In addition, the NRC independently assessed the plant and audited the licensee's effort to identify additional mitigation strategies.

124) Has the NRC inspected full implementation of the mitigating strategies?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: All phases of the B.5.b mitigating strategies were complete and inspected by December 2008.

125) What additional action has been taken?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: On March 27, 2009, the NRC amended 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," which added 10 CFR 50.54(hh)(2) in order to impose the same mitigating strategies requirements on new reactor applicants and licensees as those imposed by the ICM Order and associated license conditions. The Statement of Considerations for this rulemaking specifically noted that the requirements described in Section 50.54(hh) are for addressing certain events that are the cause of large fires and explosions and in addition, the rule contemplates that the initiating event for such large fires and explosions could be any number of beyond-design basis events, including natural phenomena such as earthquakes, tornadoes, floods, and tsunamis.

126) Is more information available about the mitigating strategies and inspections and reviews conducted?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: In general, the B.5.b mitigating strategies are plans, procedures, and pre-staged equipment whose intent is to minimize the effects of adverse events or accidents due to terrorist attacks. The NRC does not publicly release information that could assist terrorists to make nuclear power plants less safe. Since the NRC cannot share the details of the mitigating strategies with the public, we have given briefings to elected officials such as state governors and members of Congress to share sensitive unclassified or classified information, as appropriate. In addition, the NRC

Other External Hazards

127) How many plants are in hurricane zones?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: The plants near Gulf of Mexico and East coast as far north as Pilgrim have experienced Hurricane force winds in the past. Approximately 30 plants fall in this category.

128) How many plants are susceptible to flooding?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Most nuclear plants are close to large bodies of water and are situated on flat lands. Approximately 80% of the plants fall in this category. There are a few plants that may NOT be vulnerable to flooding such as Palo Verde.

129) How many plants are susceptible to blizzard?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: The plants in California, Arizona, South Texas, Louisiana and Florida are not expected to fall in this category. Approximately 80% of the plants are likely to experience blizzard conditions or adverse wintry weather conditions.

130) How many plants are susceptible to tornadoes?

Public Response: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional, technical, non-public information: Majority of the plants in the Midwest and the South have had tornado activity in the area. Approximately 50% of the operating plants

Plant-Specific Questions

San Onofre Nuclear Generating Station (SONGS) Questions

131) Could an earthquake and tsunami the size of the one in Japan happen at San Onofre?

No. This earthquake occurred on a "subduction zone", which is the type of tectonic region that produces the largest magnitudes earthquake. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of far northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25; and that would only occur on the largest fault lines, such as the San Andreas fault, which is 50 miles away onshore.

132) What magnitude earthquake are currently operating US nuclear plants such as SONGS designed to?

Each reactor is designed for a different ground motion that is determined on a site-specific basis. Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site; and it is ground motion that causes damage. So, Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant. The scenario earthquake at SONGS is a magnitude 7 approximately 5 miles from the main plant. This earthquake results in a ground motion that has a peak ground acceleration of 0.67g, that is 67% of the acceleration of gravity.

133) Could San Onofre withstand an earthquake of the magnitude of the Japanese earthquake?

It could withstand the ground shaking experienced by the Japanese nuclear plants. As discussed above, it is actually ground motions that structures, systems, and components "feel". We do not have direct recordings of ground motion at the Japanese reactors. However, we do have estimates of shaking that come from a ShakeMap produced by the K-NET system. The ground motion at the Japanese nuclear reactors is believed to be somewhat on the order of the 0.67g, or possibly slightly higher, that San Onofre peak ground acceleration has been analyzed to. However, US nuclear plants have additional seismic margin, as demonstrated by the result of the Individual Plant Examination of External Events program carried out by the NRC in the mid-90s.

It should be noted that, the Fukushima plant also withstood the earthquake. In the hour or so after the earthquake the Fukushima plant's safety systems, including the diesel generators, performed as expected and effectively shut down the reactor. The cause of the problems at the plant stemmed from the loss of emergency power that appears to be the direct result of the subsequent tsunami, which far exceeded the design basis tsunami for the Fukushima plant.

134) Is possible to have a tsunami at San Onofre that is capable of damaging the plant?

Public Information: The San Onofre Units 2 and 3 plant grade is elevation +30.0 feet MLLW. San Onofre has reinforced concrete cantilevered retaining seawall and screen well perimeter wall designed to withstand the design basis earthquake, followed by the maximum predicted tsunami with coincident storm wave action. The controlling tsunami for San Onofre occurring during simultaneous high tide and

storm surge produces a maximum runup to elevation +15.6 feet MLLW at the Unit 2 and 3 seawall. When storm waves are superimposed, the predicted maximum runup is to elevation +27 MLLW. Tsunami protection for the SONGS site is provided by a reinforced concrete seawall constructed to elevation +30.0 MLLW. A tsunami larger than this is extremely unlikely.

Additional, technical, non-public information: None

135) Has the earthquake hazard at San Onofre been reviewed like Diablo Canyon nuclear power plant is doing? Are they planning on doing an update before relicensing?

Relicensing does not evaluate seismic hazard or other siting issues. Seismic safety is part of NRC's ongoing licensing activities. If an immediate safety concern is identified, the issue would be addressed as part of NRC's response, regardless of relicensing status.

The closest active fault is approximately five miles offshore from San Onofre, a system of folds and faults exist called the offshore zone of deformation (OZD). The OZD includes the Newport-Inglewood-Rose Canyon fault system. The Cristianitos fault is ½ mile southeast, but is an inactive fault. Other faults such as the San Andreas and San Jacinto, which can generate a larger magnitude earthquake, are far enough away that they would produce ground motions much less severe than earthquakes in the OZD for San Onofre.

Notwithstanding the above, the NRC is considering extending the Generic Issue 199 program to all operating reactors. This would require a reassessment of hazard for San Onofre using the latest probabilistic seismic hazard assessment approaches. Based on a preliminary assessment using the source model developed by the USGS for the national seismic hazard maps, the annual probability of occurrence of a 0.67g ground motion at the San Onofre site is only slightly higher than is than the annual probability of occurrence that is recommended for new nuclear plants.

Additional, technical, non-public information: Past history relative to nearby major quakes have been of no consequences to San Onofre. In fact, three major earthquakes from 1992 to 1994 (Big Bear, Landers and Northridge), ranging in distance from 70-90 miles away and registering approximately 6.5 to 7.3 magnitude, did not disrupt power production at San Onofre. The plant is expected to safely shutdown if a major earthquake occurs nearby. Safety related structures, systems and components have been designed and qualified to remain functional and not fail during and after an earthquake.

136) How do we know that the emergency diesel generators in San Onofre will not fail to operate like in Japan?

Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure and are seismic Category I equipment. Even if these EDGs did fail, plants can safely shutdown using station blackout power source law 10 CFR 50.63. In 1988 the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

137) Was there any damage to San Onofre from either the earthquake or the resulting tsunami?

There was no damage at the San Onofre nuclear plant from either the earthquake or tsunami.

138) What about emergency planning for San Onofre. Does it consider tsunami?

Public Response: FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at San Onofre. The next such exercise is planned for April 12, 2011.

The San Onofre emergency plan initiates the emergency response organization and results in declaration of emergency conditions via their Emergency Action Levels. The facility would then make protective action recommendations to the Governor, who would then decide on what protective actions would be ordered for the residents around San Onofre. The consideration of tsunami would be contained in the State and local (City, County) emergency plans, which are reviewed by FEMA.

Additional, technical, non-public information: None

139) SONGS received a white finding in 2008 for 125VDC battery issue related to the EDGs that went undetected for 4 years. NRC issued the white finding as there was increased risk that one EDG may not have started due to a low voltage condition on the battery on one Unit (Unit 2). Aren't all plants susceptible to the unknown? Is there any assurance the emergency cooling systems will function as desired in a Japan-like emergency?

Public response: The low voltage condition was caused by a failure to properly tighten bolts on a electrical breaker that connected the battery to the electrical bus that would be relied on to start the EDG in case of a loss of off-site power. This was corrected immediately on identification and actions taken to prevent its reoccurrence. The 3 other EDGs at SONGS were not affected.

Additional, technical, non-public information: None

140) What is the height of water that SONGS is designed to withstand?

Public Response: 30 feet (9.1 meters). Information for all plants can be found in the "Additional Information" section of this document.

Additional, technical, non-public information: None

141) What about drawdown and debris?

Public Response: *Good question...can HQ answer? Goutam, Henry, or Rich...can you help with this one?*

Additional, technical, non-public information: None

142) Will this be reviewed in light of the Japan earthquake.

Public Response: The NRC will do a thorough assessment of the lessons learned from this event and will review all potential issues at US nuclear plants as a result.

Additional, technical, non-public information: None

143) Could all onsite and offsite power be disrupted from SONGS in the event of a tsunami, and if that happened, could the plant be safely cooled down if power wasn't restored for days after?

Public Response: Seismic Category I equipment is equipment that is essential to the safe shutdown and isolation of the reactor or whose failure or damage could result in significant release of radioactive

material. All Seismic Category I equipment at SONGS is designed to function following a DBE with ground acceleration of 0.67g.

The operating basis earthquake (1/2 of the DBE) is characterized by maximum ground shaking of 0.33g. Historically, even this level of ground shaking has not been observed at the site. Based on expert analysis, the average recurrence interval for 0.33g ground shaking at the San Onofre site would be in excess of 1000 years and, thus, the probability of occurrence in the 40-year design life of the plant would be less than 1 in 25. The frequency of the DBE would be much more infrequent, and very unlikely to occur during the life of the plant. Even if an earthquake resulted in greater than the DBE movement/acceleration at SONGS, the containment structure would ultimately protect the public from harmful radiation release, in the event significant damage occurred to Seismic category 1 equipment.

Additional, technical, non-public information: None

144) Are there any faults nearby SONGS that could generate a significant tsunami?

Public Response: Current expert evaluations estimate a magnitude 7 earthquake about 4 miles (6.4 km) from SONGS. This is significantly less than the Japan earthquake, and SONGS has been designed to withstand this size earthquake without incident. Should discuss the different tectonic nature (not a subduction zone like Japan)?

Additional, technical, non-public information: None

145) What magnitude or shaking level is SONGS designed to withstand? How likely is an earthquake of that magnitude for the SONGS site?

Public Response: The design basis earthquake (DBE) is defined as that earthquake producing the maximum vibratory ground motion that the nuclear power generating station is designed to withstand without functional impairment of those features necessary to shut down the reactor, maintain the station in a safe condition, and prevent undue risk to the health and safety of the public. The DBE for SONGS was assessed during the construction permit phase of the project. The DBE is postulated to occur near the site (5 miles (8km)), and the ground accelerations are postulated to be quite high (0.67g), when compared to other nuclear plant sites in the U.S (0.25g or less is typical for plants in the eastern US). Based on the unique seismic characteristics of the SONGS site, the site tends to amplify long-period motions, and to attenuate short-period motions. These site-specific characteristics were accounted for in the SONGS site-specific seismic analyses.

Additional, technical, non-public information: None

146) Could SONGS withstand an earthquake of the magnitude of the Japanese earthquake?

Public Response: We do not have current information on the ground motion at the Japanese reactors. SONGS was designed for approximately a 7.0 magnitude earthquake 4 miles (6.4 km) away. The Japanese earthquake was much larger (8.9), but was also almost 9 miles (14.5 km) away. The local ground motion at a particular plant is significantly affected by the local soil and bedrock conditions. SONGS was designed (0.67g) to withstand more than 2 times the design motion at average US plants.

Additional, technical, non-public information: None

147) What about the evacuation routes at SONGS? How do we know they are reasonable?

Public Response: FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public

health and safety in the event of an emergency at SONGS. The next such exercise is planned for April 12, 2011.

Additional, technical, non-public information: None

148) Regarding tsunami at DCNPP and SONGS, is the tsunami considered separately from flooding in licensing? And from the design perspective, is the flood still the controlling event for those plants rather than the tsunami?

Public response: See below

149) What is the design level flooding for San Onofre? Can a tsunami be larger?

Public response: San Onofre is located above the flood level associated with tsunami. San Onofre has reinforced concrete cantilevered retaining seawall and screen well perimeter wall designed to withstand the design basis earthquake, followed by the maximum predicted tsunami with coincident storm wave action

Additional, technical, non-public information: None

Additional songs questions

Diablo Canyon Nuclear Power Plant (DCNPP) Questions

150) Could an earthquake and tsunami the size of the one in Japan happen at Diablo Canyon?

No. This earthquake occurred on a "subduction zone", which is the type of tectonic region that produces the largest magnitudes earthquake. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of far northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25; and that would only occur on the largest fault lines, such as the San Andreas fault, which is 50 miles away onshore.

151) What magnitude earthquake are currently operating US nuclear plants such as Diablo Canyon designed to?

Each reactor is designed for a different ground motion that is determined on a site-specific basis. Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site; and it is ground motion that causes damage. So, Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant. The scenario earthquake at Diablo is a magnitude 7.5 on the Hosgri Fault 3 miles from the main plant. This earthquake results in a ground motion that has a peak ground acceleration of 0.75g, that is 75% of the acceleration of gravity.

152) Could the newly discovered Shoreline Fault produce a larger "Scenario Earthquake"?

The NRC's preliminary analyses indicate that the ground motions from the largest earthquakes expected on the smaller Shoreline Fault do not exceed the ground motions from the Hosgri Fault, for which the plant has already been analyzed and been found to be safe. NRC is currently reviewing the Final Report

on the Shoreline Fault that was submitted to the NRC earlier this year. The NRC is performing an independent analysis of potential ground motions based the data contained in the report and other information. Much of the data on the Shoreline Fault comes from the USGS in Menlo Park.

153) Could Diablo Canyon withstand an earthquake of the magnitude of the Japanese earthquake?

It could withstand the ground shaking experienced by the Japanese nuclear plants. As discussed above, it is actually ground motions that structures, systems, and components "feel". We do not have direct recordings of ground motion at the Japanese reactors. However, we do have estimates of shaking that come from a ShakeMap produced by the the K-NET system. The ground motion at the Japanese nuclear reactors is believed to be somewhat smaller than the 0.75g peak ground acceleration that Diablo Canyon has been analyzed to. Do, Diablo Canyon could withstand the ground shaking experienced by the Fukushima plant.

In fact, the Fukushima plant also withstood the earthquake. In the hour or so after the earthquake the Fukushima plant's safety systems, including the diesel generators, performed as expected and effectively shut down the reactor. The cause of the problems at the plant stemmed from the loss of emergency power that appears to be the direct result of the subsequent tsunami, which far exceeded the design basis tsunami for the Fukushima plant.

154) Is Diablo Canyon's equipment vulnerable to tsunami?

Nuclear plants are designed to withstand protection against natural phenomena such as tsunami, earthquakes. Diablo Canyon's main plant is located above the flood level associated with tsunami. The intake structures and Auxiliary Sea Water System at Diablo canyon are designed for combination of tsunami and storm wave activity.

155) How do we know that the emergency diesel generators in Diablo Canyon will not fail to operate like in Japan?

FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at DCNPP.

156) Was there any damage to Diablo Canyon from either the earthquake or the resulting tsunami?

A small tsunami did hit the region around Diablo Canyon. There was no damage at the nuclear plant.

157) How do we know the evacuation routes in the region around Diablo Canyon are realistic?

FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at DCNPP.

158) Now after the Japan tragedy, will the NRC finally hear us (A4NR) and postpone DC license renewal until seismic studies are complete? How can you be sure that what happened there is not going to happen at Diablo with a worse cast earthquake and tsunami?

Public response: ADD

Additional, technical, non-public information: ADD

159) The evacuation routes at DCNPP see are not realistic. Highway 101 is small...and can you imagine what it will be like with 40K people on it? Has the evacuation plan been updated w/ all the population growth?

Public Response: FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at DCNPP.

Additional, technical, non-public information: None

160) Are there local offshore fault sources capable of producing a tsunami with very short warning times?

Public Response: ADD- question forwarded to region

Additional, technical, non-public information: ADD

161) Are there other seismically induced failure modes (other than tsunami) that would yield LTSBO? Flooding due to dam failure or widespread liquefaction are examples.

Public Response: ADD question forwarded to region

Additional, technical, non-public information: ADD

162) Ramifications of beyond design basis events (seismic and tsunami) and potential LTSBO on spent fuel storage facilities?

Public Response: ADD question forwarded to region

Additional, technical, non-public information: ADD

163) Why did the Emergency Warning go out for a 'tsunami' that was only 6 ft (1.8 m) high? Do these guys really know what they're doing? Would they know it if a big one was really coming? Crying wolf all the time doesn't instill a lot of confidence.

Public Response: The warning system performed well. The 6 foot (1.8 meters) wave was predicted many hours before and arrived at the time it was predicted. Federal officials to accurately predicted the tsunami arrival time and size; allowing local official to take appropriate measures as they saw necessary to warn and protect the public. It should be understood that even a 6 foot tsunami is very dangerous. Tsunamis have far more energy and power than wind-driven waves.

Additional, technical, non-public information: ADD

The Japanese were supposed to have one of the best tsunami warning systems around. What went wrong last week?

Public Response: ADD can HQ answer?

Additional, technical, non-public information: ADD

NOTE: need to add to SONGS and DCNPP... Canyon and San Onofre IPEEEs - based on the Technical Evaluation Reports, Diablo did consider a locally induced tsunami in a limited way (the aux service water pumps were assumed to become flooded following a seismic event) while SONGS did not consider a coupled seismic/tsunami event.

164) Shouldn't the NRC make licensees consider a Tsunami coincident with a seismic event that triggers the Tsunami?

ADD

165) Given that SSCs get fatigued over time, shouldn't the NRC consider after-shocks in seismic hazard analyses?

ADD

166) Did the Japanese also consider an 8.9 magnitude earthquake and resulting tsunami "way too low a probability for consideration"?

ADD

167) GI-199 shows that the scientific community doesn't know everything about the seismicity of CEUS. And isn't there a prediction that the West coast is likely to get hit with some huge earthquake in the next 30 years or so? Why does the NRC continue to license plants on the west coast?

Work the following into Q&As as time permits.

After an earthquake, in order to restart, in practice a licensee needs to determine from engineering analysis that the stresses on the plant did not exceed their licensed limits. That would be a very tall order for a plant that experienced a beyond design basis earthquake, and probably is why it had taken Japan so long to restore the KK plants following the earlier earthquake.

168) Has anyone done work to look at the effect of many cycles of low amplitude acceleration following a larger event. How do we know a plant would be fit to start back up after an event? We cannot possibly do NDE on everything to determine if flaws have propagated to the point where they need to be replaced.

169) Aren't the California plants right on the San Andreas fault?

No. Both plants are approximately 50 miles from the San Andreas Fault. However, both are closer to other active fault zones. Diablo Canyon is closer to the Hosgri fault zone and has been retrofit to be safe in ground motions from a magnitude 7.5 earthquake on the Hosgri, which is 3 miles away. Recently there was a new fault, called the Shoreline fault discovered, about a 1/2 mile from the plant. But it is smaller and only capable of about a 6.5 earthquake at the most. The ground motions from the Hosgri's 7.5 earthquake would be larger than an 6.5 on the Shoreline fault. San Onofre is closes to the Newport-Inglewood fault which is about 5 miles away and capable of a magnitude 7. San Onofre was built to withstand the ground motions from that earthquake.

The following questions are from a series of questions asked by a reporter:

170) I heard that, at the urging of PG&E, effective acceleration was calculated at an average value, rather than peak. Is this true?

NRC response:

To be clear, the term "average" value in this case refers to the average of the two horizontal components of motion (accelerations) as recorded by seismographs. The maximum motion is the largest motion in any horizontal direction. It is most common to calculate the peak ground acceleration as an average horizontal value, rather than the maximum in any single direction, because that is what ground motion prediction equations are developed for and that is what is used in design. This is done because the weakest direction of a structure is rarely exactly aligned with the direction that has the single largest acceleration pulse.

Ground motion prediction equations are statistical relationships that provide the range of ground motion values for a particular magnitude and distance pair. The peak ground acceleration is typically determined as the maximum single value of the average of the horizontal accelerations. It should be noted also that the peak acceleration ground motions predicted are a distribution, rather than a single value (consider that not every time you record a magnitude 7 earthquake from 10 kilometers away are you going to get the same exact values; there is natural variability.) So, the ground motions they used are not the "average" value from that distribution, but rather the +1standard deviation motions (i.e. the ground motions that have an 84% chance of being greater than the actual ground motions recorded for a particular magnitude-distance pair.) So, what 0.75g actually represents is the 84th percentile peak ground acceleration motions (where the motions are the average of the horizontal directions). This is the standard approach for a deterministic assessment.

171) (Continued from previous question) A so-called "tau factor" was used, which reduced it again to .67g. Can you please explain this?

NRC Response:

During the operating license review for the evaluation of the Diablo Canyon plant for the Hosgri earthquake (HE), the licensee used NRC-outlined procedures and parameters that were considered appropriate for the evaluation of the seismic response of plant structures, including an adjustment of the response spectra to account for the filtering effect of the large building foundations (Tau filtering procedure) (Reference Supplement 5 of NRC Safety Evaluation Report). It should be noted that the Tau factors were used for the evaluation of the seismic response of the Diablo Canyon plant structures only for the HE, and not for the design earthquake (DE) and the original Double Design earthquake (DDE or Safe Shutdown Earthquake (SSE)). It is further noted that the Tau effect in the HE evaluation is generally analogous to the combined effects of soil structure interaction (SSI) between plant structures and underlying foundation rock, foundation embedment, and ground motion incoherence effects associated with the horizontal spatial variation of the free-field ground-shaking on the seismic response of plant structures.

The NRC does not readily have a count of nuclear plants that have used the Tau factor approach for evaluation of seismic response of plant structures. Such information may be typically found in the updated Final Safety Analysis Report (FSAR) of the plant, which is a public document. Detailed state-of-the-art SSI analyses including the effects of incoherence and embedment are being used by applicants for new reactors.

172) (Continued from previous question) To assess the strength of concrete, actual values were used, rather than code allowable minimums. Can you please explain this?

NRC Response:

The NRC does not readily have a count of nuclear plants that have made such changes to design concrete compressive strength of concrete structures. Such information may be typically found in the updated FSAR of the plant, which is a public document. Diablo Canyon did use an increased concrete compressive strength only for design evaluation of its containment structures for accident load combination that includes the HE seismic design spectrum based on a postulated magnitude 7.5 earthquake on the Hosgri Fault 3 miles from the Diablo Canyon site with a peak ground acceleration of 0.75g. The specified minimum compressive strength of concrete was used for all other load combinations including those with the original operating-basis design earthquake and the original Double Design earthquake (or SSE).

Indian Point Questions

173) Why is Indian Point safe if there is a fault line so close to it?

Public Response: The Ramapo fault system, located near the Indian Point Nuclear Power Plant, is an example of an old fault system that, based on geologic field evidence, has not been active in the last 65.5 million years. The Ramapo fault system extends primarily from southeastern New York to northern New Jersey and is made up of a series of northeast-oriented faults. Even though there is minor earthquake activity in the vicinity of the Ramapo faults, this earthquake activity cannot be directly correlated with any individual fault within the Ramapo fault system.

US nuclear power plants are designed and built to withstand the largest expected earthquake in the site region, based on observed historical seismicity and field evidence for prehistoric earthquakes, and are also designed to incorporate seismic safety margins. A potential earthquake in and around the vicinity of the Ramapo fault system was taken into account during the NRC licensing process for the Indian Point plants, and the plant design incorporated the largest expected earthquake in the site region. In summary, the Ramapo fault system exhibits no definitive evidence for recent fault displacement (i.e., no evidence for fault activity in the last 65.5 million years) and the Indian Point nuclear power plant was designed and built to safely shutdown in the event of an earthquake having the highest magnitude observed in the site region. Therefore, the NRC concluded that the risk of significant damage to the Indian Point reactors due to a potential earthquake is acceptable.

Additional, technical, non-public information: The information above and following is consistent with the literature and the UFSAR for IP related to the Ramapo fault. The Ramapo fault system, which passes through the Indian Point area, is a group of Mesozoic age faults, extending from southeastern New York to northern New Jersey, as well as further southwest. The fault system is composed of a series of southeast-dipping, northeast-striking faults. Various faults of the system contain evidence of repeated slip in various directions since Proterozoic time, including Mesozoic extensional reactivation. However, the USGS staff, who reviewed 31 geologic features in the Appalachian Mountains and Coastal Plain and compiled a National Database on Quaternary Faulting (Crone and Wheeler, 2000), listed the Ramapo fault system as low risk because the fault system lacks evidence for Quaternary slip. They further pointed out that the Ramapo fault system, and 17 other geologic features, "have little or no published geologic evidence of Quaternary tectonic faulting that could indicate the likely occurrence of earthquakes larger than those observed historically" (Wheeler and Crone, 2004). Among these faults, the Ramapo fault system is one of the three that underwent a paleoseismological study. In two trenches excavated across the Ramapo fault, no evidence of Quaternary tectonic faulting was found (Wheeler and Crone, 2000). Because the Ramapo fault system is relatively inactive, and because the plants are designed to safely shutdown in the event of an earthquake of the highest intensity ever recorded in that area, the NRC has concluded that the risk of significant damage to the reactors due to a probable earthquake in the area is extremely small.

The letter that was sent to the NRC from Rep Lowey refers to the Ramapo seismic zone (RSZ) and the Dobbs Ferry fault. The letter incorrectly states that the Dobbs Ferry fault is located within the Ramapo seismic zone. Based on the literature, it is not. It is close, but it is considered to be in the Manhattan Prong more to the east (more like 10-15 miles away) while the Ramapo fault system is considered to be in the Reading Prong (a couple of miles away from IP). Also for clarification, the seismicity is considered to be within the Precambrian/Paleozoic basement at depths greater than the Mesozoic Newark Basin where the RSZ is situated.

Questions posed by utilities

The following questions were received from NextEra Energy. Responses are the most recent as of 6pm on 3-25-11.

- 174) We are trying to understand why our plants in low-seismic areas (see below) would appear on the list of 27 plants that the NRC intends to review for seismic issues. While the story below notes that these plants have been identified based on "largest increase in seismic risk from a 1980s-era USGS study," the USGS maps show a low probability for seismic activity. I'm not aware of any major changes that would have increased seismic risk... can you help explain?**

Answer: First, it should be clarified that the list of 27 plants is only provided to show that there is sufficient reason to move the project to the next phase of the generic issue program. These are not the only plants that will be reassessed. Due to the significant uncertainty in the data available, all plants in the central and eastern US were expected to receive the generic letter and will be reassessed. Further, in light of the events in Japan, it has been decided that all 104 operating reactors will be reassessed.

The GI-199 study considers both overall risk and also changes in risk. Both the approach to assessing seismic hazard and the data available to seismologists have improved significantly since the 1980. As a result, estimates of seismic hazard, although still low, have increased since that time. This is the result of a steady improvement in the understanding of seismic hazard over time. It is important to note that it is not the seismic activity, or the seismic hazard itself, that has increased; but rather it is the understanding of it that has changed. (Information on how the USGS seismic hazard maps are developed is available at the USGS website). The larger change in the risk (in terms of core damage frequency) associated with some sites in the study directly reflects the change in assessed hazard.

- 175) My basic understanding - especially in the case of St. Lucie and Duane Arnold - is that highly conservative values were input into your screening process for plants with low-seismic probability, therefore moving plants like those previously mentioned up in the listing. Can you help me to understand this?**

Answer: The screening process that was undertaken used data currently available to the NRC, principally from the IPEEE study conducted in the mid-90s. Licensees of nuclear plants in moderate to high seismicity areas tended to provide more detailed information regarding the seismic resistance of the structures, systems, and components than plants in low seismicity areas. Therefore when considering loads beyond the seismic design, NRC staff tended to have more detailed information to rely on for plants in moderate to high seismicity zones; and had to make conservative assumptions for plants in low seismicity regions.

Pending and Unanswered Questions from Members of Congress and Industry

The below questions are gleaned from the congressional letters coming into the NRC. Because they generally cover different topics, they are being kept together as sets to assist the office assigned with response. Once a formal response is developed and sent, the questions will be moved to the appropriate sections.

176) Received 3/16/11 from Congresswoman Lowey

The key elements of the congresswoman's letter are as follows:

The Ramapo Seismic Zone is a particular threat because the zone passes within two miles of Indian Point. The Ramapo Seismic zone includes the Dobbs Ferry fault in Westchester, which generated a 4.1 magnitude earthquake in 1955. The Columbia University study suggests that this pattern of subtle but active faults increases the risk to the New York City area and that an earthquake with a magnitude of 7.0 on the Richter scale is within reach. Disturbingly, Entergy measures the risk of an earthquake near Indian Point to be between 1.0 and 3.0 on the Richter scale, despite evidence to the contrary.

The NRC should study Indian Point's risk of, and ability to sustain a disaster, including the impact of earthquakes and hurricanes, as well as collateral impacts such as loss of power, inability to cool reactors and emergency evacuation routes. The NRC should evaluate how a similar incident in the New York metropolitan area could be further complicated due to a dramatically higher population and the effectiveness of the proposed evacuation routes.

Public Response: Please see response in the Indian Point section.

Additional, technical, non-public information: None.

177) From 3/16/11 Press Release from Senators Boxer and Feinstein

Plant Design and Operations

1. What changes to the design or operation of the Diablo Canyon and SONGS facilities have improved safety at the plants since they began operating in the mid-1980s?

Public Response: NRR/DORL developing response

Additional, technical, non-public information: ADD

2. What emergency notification systems have been installed at California nuclear power plants? Has there ever been a lapse of these systems during previous earthquakes or emergencies?

Public Response: NRR/DORL developing response

Additional, technical, non-public information: ADD

3. What safety measures are in place to ensure continued power to California reactors in the event of an extended power failure?

Public Response: NRR/DORL developing response

Additional, technical, non-public information: ADD

Type of Reactor

4. What are the differences and similarities between the reactors being used in California (pressurized water reactors) and those in Japan (boiling water reactors), as well as the

facilities used to house the reactors, including the standards to which they were built and their ability to withstand natural and manmade disasters?

Public Response: NRR/DORL developing response

Additional, technical, non-public information: ADD

Earthquakes and Tsunamis

5. We have been told that both Diablo Canyon and San Onofre Nuclear Generating Station are designed to withstand the maximum credible threat at both plants, which we understand to be much less than the 9.0 earthquake that hit Japan. What assumptions have you made about the ability of both plants to withstand an earthquake or tsunami? Given the disaster in Japan, what are our options to provide these plants with a greater margin for safety?

Public Response: Annie and Kamal developing response

Additional, technical, non-public information: ADD

6. Have new faults been discovered near Diablo Canyon or San Onofre Nuclear Generating Station since those plants began operations? If so, how have the plants been modified to account for the increased risk of an earthquake? How will the NRC consider information on ways to address risks posed by faults near these plants that is produced pursuant to state law or recommendations by state agencies during the NRC relicensing process?

Public Response: Annie and Kamal developing response

Additional, technical, non-public information: ADD

7. What are the evacuation plans for both plants in the event of an emergency? We understand that Highway 1 is the main route out of San Luis Obispo, what is the plan for evacuation of the nearby population if an earthquake takes out portions of the highway and a nuclear emergency occurs simultaneously?

Public Response: NRR/DORL developing response

Additional, technical, non-public information: ADD

8. What is the NRC's role in monitoring radiation in the event of a nuclear accident both here and abroad? What is the role of EPA and other federal agencies?

Public Response: NRR/DORL developing response

Additional, technical, non-public information: ADD

9. What monitoring systems currently are in place to track potential impacts on the US, including California, associated with the events in Japan?

Public Response: NRR/DORL developing response

Additional, technical, non-public information: ADD

10. 6. Which federal agency is leading the monitoring effort and which agencies have responsibility for assessing human health impacts? What impacts have occurred to date on the health or environment of the US or are currently projected or modeled in connection with the events in Japan?

Public Response: NRR/DORL developing response

Additional, technical, non-public information: ADD

11. What contingency plans are in place to ensure that the American public is notified in the event that hazardous materials associated with the events in Japan pose an imminent threat to the US?

Public Response: NRR/DORL developing response

Additional, technical, non-public information: ADD

178) From 3/15/11 Press Release from Congresspeople Markey and Capps

Note that these are only the seismic questions. There are other questions that are structural

1. Provide the Richter or moment magnitude scale rating for each operating nuclear reactor in the United States. If no such information exists, on what basis can such an assertion be made regarding the design of any single nuclear power plant?

Public Response: US nuclear power plants are designed for different ground motions determined on a site-specific basis, which are called the Safe Shutdown Earthquake ground motions (SSE). Each nuclear power plant is designed to a ground motion level that is appropriate for the geology and tectonics in the region surrounding the plant location. Ground motion, or shaking, is a function of both earthquake magnitude and distance from the fault to the site. The magnitude alone cannot be used to predict ground motions. Currently operating nuclear power plants developed their SSEs based on a "deterministic" or "scenario earthquake" basis that account for the largest earthquake expected in the area around the plant.

Please see the available table of Design Basis Ground Motions for US Plants in the Additional Information: Useful Tables.

Additional, technical, non-public information: ADD

2. The San Onofre reactor is reportedly designed to withstand a 7.0 earthquake, and the Diablo Canyon reactor is designed to withstand a 7.5 magnitude. According to the Southern California Earthquake Center (SCEC), there is an 82% probability of an earthquake 7.0 magnitude in the next 30 years, and a 37 percent probability that an earthquake of 7.5 magnitude will occur. Shouldn't these reactors be retrofitted to ensure that they can withstand a stronger earthquake than a 7.5? If not, why not?

Public Response: ~~This needs to be edited and enhanced.~~ The question arises from an un-cited reference to the Uniform California Earthquake Rupture Forecast (UCERF). The UCERF was developed by a multidisciplinary group of scientists and engineers called the Working Group on California Earthquake Probabilities (WGCEP). The goal of the UCERF model is to determine earthquake rupture probabilities of various magnitudes for different regions of California. The probability values cited in the Congressional Inquiry are from the UCERF for the entire Southern California region, not specifically for the region near either SONGS or DCNPP. The faults located near DCNPP and SONGS contribute nothing to the cited probability values, in the sense that their contributions are mathematically insignificant. The cited probabilities are totally dominated by the San Andreas, San Jacinto, Imperial and other highly active faults along the plate boundary in Southern California. These faults are all located at great distances from DCNPP and SONGS. As noted in the answer to Question #1, NPPs are not designed for earthquake magnitudes but for anticipated ground shaking. The ground shaking hazard posed by earthquakes located at distances equal to the faults important to the UCERF model is very low, much less than the hazard estimated for the nearby faults used to develop the design ground motions for the subject plants. In summary, the specific probability values cited in the letter do not apply to either DCNPP and SONGS; the actual probabilities at the NPP sites are far less.

Additional, technical, non-public information: The colors in UCERF Figure 2 represent the probabilities of having a nearby earthquake rupture (within 3 or 4 miles) of magnitude 6.7 or larger in the next 30 years. Therefore, reading the colors off of Figure 2, the San Onofre and Diablo Canyon NPPs have a $\leq 10\%$ probability of having a $\geq M6.7$ earthquake rupture within 3 to 4 miles in the next 30 years. Therefore, retrofitting these reactors to withstand earthquakes of M7.5 or stronger based on the UCERF study would put an unnecessary burden on the licensees.

3. Provide specific information regarding the differences in safety-significant structures between a nuclear power plant that is located in a seismically active area and one that is not. Provide, for each

operating nuclear reactor in a seismically active area, a full list and description of the safety-significant design features that are included that are not included in similar models that are not located in seismically active areas.

Public Response: This is a rough draft. We need to get some reviews of this. Assumed NRR will have ultimate responsibility for the response.

There are no differences in safety requirements for nuclear power plants located in seismically active areas and ones that are not. Regardless of site seismicity, Appendix S to 10 CFR Part 50 requires for site-specific SSE ground motions, structures, systems, and components will remain functional and within applicable stress, strain, and deformation limits. The required safety functions of SSCs must be assured during and after the vibratory ground motion through design, testing, or qualification methods. The evaluation must take into account soil-structure interaction effects and the expected duration of the vibratory motions. Appendix S also requires that the horizontal component of the SSE ground motion in the free field at the foundation elevation of structures must be an appropriate response spectrum with peak ground acceleration (PGA) of at least 0.10g. Design basis loads for nuclear power plant structures, important to safety, include combined loads for seismic, wind, tornado, normal operating conditions (pressure and thermal), and accident conditions. Codes and standards, such as the American Institute of Concrete (ACI-349) and the American Institute of Steel Construction (AISC N690), are used in the design of nuclear power plant structures to ensure a conservative, safe design under design basis loads. In addition to the nominal seismic design, all new generation reactors have to demonstrate a seismic margin of 1.67 relative to the site-specific seismic demands.

For the current operating fleet of nuclear power reactors, site-to-site differences in structural design can result from differences in external site hazards such as seismic, wind, tornado, and tsunami. For a low-seismicity region, wind or tornado loads may control the design. Conversely, for a high-seismicity region, seismic loads will likely control. Structures in high-seismicity regions have robust designs with typically higher capacity shear walls, as an example. Systems and components will also be more robust and are designed and tested to higher levels of acceleration.

Additional, technical, non-public information: ADD

4. In your opinion, can any operating nuclear reactors in the United States withstand an earthquake of the magnitude experience in Japan?

Public Response: The March 11, 2011, magnitude 9 earthquake that recently affected Japan is different than earthquakes that could affect US nuclear plants. Each US nuclear plant is designed to a ground-shaking level that is appropriate for its location, given the possible earthquake sources that may affect the site and its tectonic environment. The Japan earthquake was caused by a "subduction zone" event, which is the type of mechanism that produces the largest possible magnitude earthquakes. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of northern California, Oregon and Washington, so an earthquake this large could only happen in that region. The only plant in that area is Columbia Generating Station, which is approximately 225 miles (363 km) from the coast and the subduction zone. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximate 8, which has 31 times less energy than a magnitude 9.

Additional, technical, non-public information: ADD

179) Questions suggested by ANS for inclusion in a public FAQ document:

1. How badly were the SFP structures damaged by the earthquake?
2. Was the SFP water drained due to the earthquake? If yes, over what period of time?
3. Are the SFPs structurally sound enough to be refilled with water, a slurry, or sand?

4. What are the SFP loadings (# F/As, weight, heat load, radioactivity)?
5. How much has the cladding in the SFPs been oxidized (perhaps as inferred from the hydrogen released)?
6. What is the degree of fuel melting in the SFPs?
7. Is the fuel in the SFPs in a coolable geometry?
8. What effect has the spraying with water cannons and concrete pumping truck had (fuel cooling, fuel degradation, water accumulation)?
9. What are the options to refill the SFPs with water, i.e., plant systems, external systems, water supplies, heat sink?
10. Will refilling the SFPs with water cause the fuel within to "slump" as occurred at TMI?
11. Will refilling the SFPs with water produce massive amounts of hydrogen? If yes, is it likely to explode before it is vented from the building?
12. Will refilling the SFPs with water produce a potential nuclear criticality?
13. What special precautions and being taken, e.g., shielding being installed around cooling system components to accommodate high levels of contamination in and radiation from the water to be circulated from the SFPs (and reactor assemblies), to ensure worker protection prior to activating installed cooling systems?
14. Is filling the SFPs with a slurry or sand being aggressively evaluated?

Additional Information: Useful Tables

Table of Design Basis Ground Motions for US Plants

Design Basis Earthquake Information					
Nuclear Plant By State/Location	Maximum Observed Or Inferred Intensity (MMI Scale)	Relative Distance Of Seismic Source	Design SSE Peak Acceleration, <i>g</i>	OBE Peak Acceleration, <i>g</i>	Soil Condition
New York					
Fitzpatrick	VI	Near	0.15	0.08	Soil
Ginna 1	VIII/IX	>60 miles	0.2	0.08	Rock
Indian Point 2, 3	VII	Near	0.15	0.1	Rock
Nine Mile Point 1	IX-X	>60 miles	0.11	0.06	Rock
Nine Mile Point 2	VI	Near	0.15	0.075	Rock
New Jersey					
Salem 1,2	VII-VIII	Near	0.2	0.1	Deep Soil
Connecticut					
Millstone 1, 2, 3	VII	Near	0.17	0.07	Rock
Vermont					
Vermont Yankee	VI	Near	0.14	0.07	Rock
Ohio					

~~Official Use Only~~

Davis Besse 1	VII	Near	0.15	0.08	Rock
Perry 1	VII	Near	0.15	0.08	Rock
Georgia					
Hatch 1, 2	VII	Near	0.15	0.08	Deep Soil
Vogtle 1, 2	VII-VIII	Near	0.2	0.12	Deep Soil
Tennessee					
Sequoyah 1, 2	VIII	Near	0.18	0.09	Rock
Watts Bar 1	VIII	Near	0.18	0.09	Rock
California					
San Onofre 2, 3	IX-X	Near	0.67	0.34	Soil
Diablo Canyon 1, 2	X-XI	Near	0.75	0.20	Rock
Florida					
Crystal River 3	V	Near	0.10	0.05	Rock
St. Lucie 1, 2	VI	Near	0.10	0.05	Soil
Turkey Point 3, 4	VII	Near	0.15	0.05	Rock

NOTES:

MMI=Modified Mercalli Intensity, a measure of observed/reported damage and severity of shaking.
Relative distance measure used in FSAR to develop SSE acceleration, "Near" indicates distance less than 10 miles.
SSE=Safe Shutdown Earthquake ground motion, for horizontal acceleration, in units of earth's gravity, *g*.
OBE=Operating Basis Earthquake ground motion, level of horizontal acceleration, which if exceeded requires plant shutdown.

Table of SSE, OBE and Tsunami Water Levels

Nuclear Plant Name By State/ Location	Safe Shutdown Earthquake (SSE) Peak Acceleration (g)	Operating Basis Earthquake (OBE) Peak Acceleration, (g)	Probable Maximum Tsunami OR Maximum Tsunami Water Level
Alabama			
Browns Ferry	0.200	0.100	N/A (Non-Coastal)
Farley	0.100	0.050	N/A (Non-Coastal)
Arkansas			
Arkansas Nuclear	0.200		N/A (Non-Coastal)
Arizona			
Palo Verde	0.200	0.100	N/A (Non-Coastal)
California			
Diablo Canyon	0.400	0.200	The design basis maximum combined wave runup is the greater of that determined for near-shore or distantly-generated tsunamis, and results from near-shore tsunamis. For distantly-generated tsunamis, the combined runup is 30 feet. For near-shore tsunamis, the combined wave runup is 34.6 feet, as determined by hydraulic model testing. The safety-related equipment is installed in watertight compartments to protect it from adverse sea wave events to elevation +48 feet above mean lower low water line (MLLWL).
San Onofre	0.670	0.340	The controlling tsunami occurs during simultaneous high tide and storm surge produces a maximum runup to elevation +15.6 feet mean lower low water line (MLLWL) at the Unit 2 and 3 seawall. When storm waves are superimposed, the predicted maximum runup is to elevation +27 MLLWL. Tsunami protection for the SONGS site is provided by a reinforced concrete seawall constructed to elevation +30.0 MLLWL.
Connecticut			
Millstone	0.170	0.090	18 ft SWL
Florida			
Crystal River	0.050	0.025	N/A (Non-Coastal)
St. Lucie	0.100	0.050	No maximum tsunami level, bounded by PMH surge of +18 MLW wave runup, with plant openings at +19.5 MLW

~~Official Use Only~~

Nuclear Plant Name By State/ Location	Safe Shutdown Earthquake (SSE) Peak Acceleration (g)	Operating Basis Earthquake (OBE) Peak Acceleration, (g)	Probable Maximum Tsunami OR Maximum Tsunami Water Level
Turkey Point	0.150	0.050	No maximum tsunami level, bounded by PMH surge of +18.3 MLW water level, site protected to +20 MLW with vital equipment protected to +22 MLW
Georgia			
Hatch	0.150	0.080	N/A (Non-Coastal)
Vogtle	0.200	0.120	N/A (Non-Coastal)
Illinois			
Braidwood	0.200	0.090	N/A (Non-Coastal)
Byron	0.200	0.090	N/A (Non-Coastal)
Clinton	0.250	0.100	N/A (Non-Coastal)
Dresden	0.200	0.100	N/A (Non-Coastal)
LaSalle	0.200	0.100	N/A (Non-Coastal)
Quad Cities	0.240	0.120	N/A (Non-Coastal)
Iowa			
Duane Arnold	0.120	0.060	N/A (Non-Coastal)
Kansas			
Wolf Creek	0.120	0.060	N/A (Non-Coastal)
Louisiana			
River Bend	0.100	0.050	
Waterford	0.100		Floods – 30 feet MSL
Maryland			
Calvert Cliffs	0.150	0.080	14 ft design wave
Massachusetts			
Pilgrim	0.150	0.080	*Storm flooding design basis - 18.3ft
Michigan			
D.C. Cook	0.200	0.100	N/A
Fermi	0.150	0.080	N/A
Palisades	0.200	0.100	N/A
Missouri			
Callaway	0.200		N/A (Non-Coastal)

~~Official Use Only~~

Nuclear Plant Name By State/ Location	Safe Shutdown Earthquake (SSE) Peak Acceleration (g)	Operating Basis Earthquake (OBE) Peak Acceleration, (g)	Probable Maximum Tsunami OR Maximum Tsunami Water Level
Mississippi			
Grand Gulf	0.150	0.075	N/A
Minnesota			
Monticello	0.120	0.060	N/A (Non-Coastal)
Prarie Island	0.120	0.060	N/A (Non-Coastal)
Nebraska			
Cooper	0.200	0.100	N/A (Non-Coastal)
Fort Calhoun	0.170	0.080	N/A (Non-Coastal)
New York			
Fitzpatrick	0.150	0.080	N/A (Non-Coastal)
Ginna	0.200	0.080	N/A
Indian Point	0.150	0.100	15 ft msl
Nine Mile Point, Unit 1	0.110	0.060	N/A
Nine Mile Point, Unit 2	0.150	0.075	N/A
New Hampshire			
Seabrook	0.250	0.125	(+) 15.6' MSL Still Water Level (Tsunami Flooding -Such activity is extremely rare on the US Atlantic coast and would result in only minor wave action inside the harbor.)
New Jersey			
Hope Creek	0.200	0.100	35.4 MSL The maximum probable tsunami produces relatively minor water level changes at the site. The maximum runoff height reaches an elevation of 18.1 feet MSL with coincident 10 percent exceedance high tide)
Oyster Creek	0.184	0.092	(+) 23.5' MSL Still Water Level (Probable Maximum Tsunami - Tsunami events are not typical of the eastern coast of the United States and have not, therefore, been addressed.)
Salem	0.200	0.100	21.9 MSL (There is no evidence of surface rupture in East Coast earthquakes and no history of significant tsunami activity in the region)
North Carolina			
Brunswick	0.160	0.030	N/A

~~Official Use Only~~

Nuclear Plant Name By State/ Location	Safe Shutdown Earthquake (SSE) Peak Acceleration (g)	Operating Basis Earthquake (OBE) Peak Acceleration, (g)	Probable Maximum Tsunami OR Maximum Tsunami Water Level
McGuire	0.150	0.080	N/A (Non-Coastal)
Shearon Harris	0.150		N/A (Non-Coastal)
Ohio			
Davis-Besse	0.150	0.080	N/A
Perry	0.150	0.080	N/A
Pennsylvania			
Beaver Valley	0.130	0.060	N/A (Non-Coastal)
Limerick	0.150	0.075	N/A (Non-Coastal)
Peach Bottom	0.120	0.050	N/A (Non-Coastal)
Three Mile Island	0.120	0.060	N/A (Non-Coastal)
Susquehanna	0.150	0.080	N/A (Non-Coastal)
South Carolina			
Catawba	0.150	0.080	N/A (Non-Coastal)
Oconee	0.150	0.050	N/A (Non-Coastal)
Robinson	0.200	0.100	N/A (Non-Coastal)
V.C. Summer	0.250	0.150	N/A (Non-Coastal)
Tennessee			
Sequoyah	0.180	0.090	N/A (Non-Coastal)
Watts Bar, Unit 1	0.180	0.090	N/A (Non-Coastal)
Texas			
Comanche Peak	0.120	0.060	N/A
South Texas Project	0.100	0.050	N/A
Vermont			
Vermont Yankee	0.140	0.070	N/A
Virginia			
North Anna	0.180		N/A
Surry	0.150	0.080	N/A
Washington			
Columbia	0.250		N/A (Non-Coastal)

~~Official Use Only~~

Nuclear Plant Name By State/ Location	Safe Shutdown Earthquake (SSE) Peak Acceleration (g)	Operating Basis Earthquake (OBE) Peak Acceleration, (g)	Probable Maximum Tsunami OR Maximum Tsunami Water Level
Wisconsin			
Kewaunee	0.120	0.060	N/A
Point Beach	0.120		N/A
Definition of Safe Shutdown Earthquake	The safe-shutdown earthquake (SSE) for the site is the ground motion response spectra (GMRS), which also satisfies the minimum requirement of paragraph IV(a)(1)(i) of Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," of the Code of Federal Regulations (10 CFR Part 50).		
Definition of Operating Basis Earthquake:	<p>To satisfy the requirements of paragraph IV(a)(2)(A) of Appendix S to 10 CFR Part 50, the operating-basis earthquake (OBE) ground motion is defined as follows:</p> <ul style="list-style-type: none"> (i) For the certified design portion of the plant, the OBE ground motion is one-third of the CSDRS. (ii) For the safety-related noncertified design portion of the plant, the OBE ground motion is one-third of the design motion response spectra, as stipulated in the design certification conditions specified in design control document (DCD). (iii) The spectrum ordinate criterion to be used in conjunction with Regulatory Guide 1.166, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-earthquake Actions," issued March 1997, is the lowest of (i) and (ii). 		

Table of Plants Near Known Active Faults or in High or Moderate Seismicity Zones

It should be noted that in much of the Central and Eastern US, the seismicity comes from “background” seismicity. Background seismicity is earthquake activity, where the earthquakes cannot be tied to known faults.

Plant (state)	Nearest Active Fault or Seismic Zone	Distance to Fault or Range of Distances to Zones	Type of Faulting Mechanism	Range of Maximum Magnitude (M _w)	OBE (g)	SSE (g)
Diablo Canyon (CA)	Hosgri Fault	5 miles	Predominantly Strike Slip	7.5		
	Shoreline Fault	0.5 miles	Strike Slip	6.25 to 6.75 best estimate by NRC staff in RIL 09-001. Final report on the fault in review by NRC staff		
San Onofre (CA)						
Comanche Peak						

Table From GI-199 Program Containing SSE, SSE Exceedance Frequencies, Review Level Earthquakes (RLE), and Seismic Core Damage Frequencies							
Plant	Docket	SSE (g's)	Frequency of Exceeding the SSE (per year)	RLE (HCLPF) (g's)	Seismic Core Damage Frequency (per year)	IPEEE Method	Source
Arkansas 1	05000313	0.2	2.8E-04	0.3	4.1E-06	0.3g full-scope EPRI SMA	GI-199
Arkansas 2	05000368	0.2	9.7E-05	0.3	4.1E-06	0.3g focused-scope EPRI SMA	GI-199
Beaver Valley 1	05000334	0.12	3.3E-04	n/a	4.8E-05	seismic PRA	GI-199
Beaver Valley 2	05000412	0.12	2.7E-04	n/a	2.2E-05	seismic PRA	GI-199
Braidwood 1	05000456	0.2	6.7E-05	0.3	7.3E-06	0.3g focused-scope EPRI SMA	GI-199
Braidwood 2	05000457	0.2	6.7E-05	0.3	7.3E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 1	05000259	0.2	2.5E-04	0.3	3.7E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 2	05000260	0.2	2.5E-04	0.26	5.4E-06	0.3g focused-scope EPRI SMA	GI-199
Browns Ferry 3	05000296	0.2	2.5E-04	0.26	5.4E-06	0.3g focused-scope EPRI SMA	GI-199
Brunswick 1	05000325	0.16	7.3E-04	0.3	1.5E-05	0.3g focused-scope EPRI SMA	GI-199
Brunswick 2	05000324	0.16	7.3E-04	0.3	1.5E-05	0.3g focused-scope EPRI SMA	GI-199
Byron 1	05000454	0.2	5.2E-05	0.3	5.8E-06	0.3g focused-scope EPRI SMA	GI-199
Byron 2	05000455	0.2	5.2E-05	0.3	5.8E-06	0.3g focused-scope EPRI SMA	GI-199
Callaway	05000483	0.2	3.8E-05	0.3	2.0E-06	0.3g focused-scope EPRI SMA	GI-199
Calvert Cliffs 1	05000317	0.15	1.9E-04	n/a	1.0E-05	seismic PRA	GI-199
Calvert Cliffs 2	05000318	0.15	1.9E-04	n/a	1.2E-05	seismic PRA	GI-199
Catawba 1	05000413	0.15	1.4E-04	n/a	3.7E-05	seismic PRA	GI-199
Catawba 2	05000414	0.15	1.4E-04	n/a	3.7E-05	seismic PRA	GI-199
Clinton	05000461	0.25	5.8E-05	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Columbia	05000397	0.25	1.7E-04	n/a	2.1E-05	seismic PRA	IPEEE
Comanche Peak 1	05000445	0.12	1.6E-05	0.12	4.0E-06	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Comanche Peak 2	05000446	0.12	1.6E-05	0.12	4.0E-06	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Cooper	05000298	0.2	1.5E-04	0.3	7.0E-06	0.3g focused-scope EPRI SMA	GI-199
Crystal River 3	05000302	0.1	8.9E-05	0.1	2.2E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
D.C. Cook 1	05000315	0.2	2.1E-04	n/a	2.2E-05	seismic PRA	GI-199
D.C. Cook 2	05000316	0.2	2.1E-04	n/a	2.2E-05	seismic PRA	GI-199

Official Use Only

Table From GI-199 Program Containing SSE, SSE Exceedance Frequencies, Review Level Earthquakes (RLE), and Seismic Core Damage Frequencies							
Plant	Docket	SSE (g's)	Frequency of Exceeding the SSE (per year)	RLE (HCLPF) (g's)	Seismic Core Damage Frequency (per year)	IPEEE Method	Source
Davis Besse	05000346	0.15	6.3E-05	0.26	6.7E-06	reduced-scope EPRI SMA	GI-199
Diablo Canyon 1	05000275	0.75	2.0E-04	n/a	4.1E-05	seismic PRA	IPEEE
Diablo Canyon 2	05000323	0.75	2.0E-04	n/a	4.1E-05	seismic PRA	IPEEE
Dresden 2	05000237	0.2	9.7E-05	0.26	1.9E-05	0.3g focused-scope EPRI SMA	GI-199
Dresden 3	05000249	0.2	9.7E-05	0.26	1.9E-05	0.3g focused-scope EPRI SMA	GI-199
Duane Arnold	05000331	0.12	2.3E-04	0.12	3.2E-05	reduced-scope EPRI SMA; SSE = 0.12g	GI-199
Farley 1	05000348	0.1	1.0E-04	0.1	2.8E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Farley 2	05000364	0.1	1.0E-04	0.1	2.8E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Fermi 2	05000341	0.15	1.0E-04	0.3	4.2E-06	0.3g focused-scope EPRI SMA	GI-199
Fitzpatrick	05000333	0.15	3.2E-04	0.22	6.1E-06	0.3g focused-scope NRC SMA	GI-199
Fort Calhoun 1	05000285	0.17	3.7E-04	0.25	5.4E-06	0.3g focused-scope NRC SMA	GI-199
Ginna	05000244	0.2	1.0E-04	0.2	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Grand Gulf	05000416	0.15	1.0E-04	0.15	1.2E-05	reduced-scope EPRI SMA; SSE = 0.15g	GI-199
Hatch 1	05000400	0.148	3.9E-04	0.29	2.3E-06	0.3g focused-scope EPRI SMA	GI-199
Hatch 2	05000321	0.15	2.7E-04	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Hope Creek	05000366	0.2	9.7E-05	0.3	2.5E-06	0.3g focused-scope EPRI SMA	GI-199
Indian Point 2	05000354	0.15	4.9E-04	n/a	2.8E-06	seismic PRA	GI-199
Indian Point 3	05000247	0.15	4.9E-04	n/a	3.3E-05	seismic PRA	GI-199
Kewaunee	05000286	0.12	2.8E-04	n/a	1.0E-04	seismic PRA	GI-199
LaSalle 1	05000305	0.2	1.7E-04	n/a	5.1E-06	seismic PRA	GI-199
LaSalle 2	05000373	0.2	1.7E-04	n/a	2.8E-06	seismic PRA	GI-199
Limerick 1	05000374	0.15	1.8E-04	n/a	2.8E-06	seismic PRA	GI-199
Limerick 2	05000352	0.15	1.8E-04	0.15	5.3E-05	reduced-scope EPRI SMA	GI-199
McGuire 1	05000353	0.15	9.5E-05	0.15	5.3E-05	reduced-scope EPRI SMA	GI-199
McGuire 2	05000369	0.15	9.5E-05	n/a	3.1E-05	seismic PRA	GI-199

Table From GI-199 Program Containing SSE, SSE Exceedance Frequencies, Review Level Earthquakes (RLE), and Seismic Core Damage Frequencies							
Plant	Docket	SSE (g's)	Frequency of Exceeding the SSE (per year)	RLE (HCLPF) (g's)	Seismic Core Damage Frequency (per year)	IPEEE Method	Source
Millstone 1	05000370	0.254	9.3E-05	n/a	3.1E-05	seismic PRA	GI-199
Millstone 2	05000336	0.17	8.3E-05	0.25	1.1E-05	0.3g focused-scope EPRI SMA	GI-199
Millstone 3	05000423	0.17	8.3E-05	n/a	1.5E-05	seismic PRA	GI-199
Monticello	05000263	0.12	9.3E-05	0.12	1.9E-05	modified focused/expended reduced-scope EPRI SMA	GI-199
Nine Mile Point 1	05000220	0.11	1.5E-04	0.27	4.2E-06	0.3g focused-scope EPRI SMA	GI-199
Nine Mile Point 2	05000410	0.15	4.8E-05	0.23	5.6E-06	SPRA and focused-scope EPRI SMA	GI-199
North Anna 1	05000338	0.12	2.1E-04	0.16	4.4E-05	0.3g focused-scope EPRI SMA	GI-199
North Anna 2	05000339	0.12	2.1E-04	0.16	4.4E-05	0.3g focused-scope EPRI SMA	GI-199
Oconee 1	05000269	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oconee 2	05000270	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oconee 3	05000287	0.1	9.7E-04	n/a	4.3E-05	seismic PRA	GI-199
Oyster Creek	05000219	0.17	1.5E-04	n/a	1.4E-05	seismic PRA	GI-199
Palisades	05000255	0.2	1.4E-04	n/a	6.4E-06	seismic PRA	GI-199
Palo Verde 1	05000528	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Palo Verde 2	05000529	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Palo Verde 3	05000530	0.258	3.5E-05	0.3	3.8E-05	0.3g full-scope EPRI SMA	IPEEE
Peach Bottom 2	05000277	0.12	2.0E-04	0.2	2.4E-05	modified focused-scope EPRI SMA	GI-199
Peach Bottom 3	05000278	0.12	2.0E-04	0.2	2.4E-05	modified focused-scope EPRI SMA	GI-199
Perry	05000440	0.15	2.2E-04	0.3	2.1E-05	0.3g focused-scope EPRI SMA	GI-199
Pilgrim 1	05000293	0.15	8.1E-04	n/a	6.9E-05	seismic PRA	GI-199
Point Beach 1	05000266	0.12	2.0E-04	n/a	1.1E-05	seismic PRA	GI-199
Point Beach 2	05000301	0.12	2.0E-04	n/a	1.1E-05	seismic PRA	GI-199
Prairie Island 1	05000282	0.12	2.0E-04	0.28	3.0E-06	0.3g focused-scope EPRI SMA	GI-199
Prairie Island 2	05000306	0.12	2.0E-04	0.28	3.0E-06	0.3g focused-scope EPRI SMA	GI-199
Quad Cities 1	05000254	0.24	8.2E-04	0.09	2.7E-05	0.3g focused-scope EPRI SMA	GI-199
Quad Cities 2	05000265	0.24	8.2E-04	0.09	2.7E-05	0.3g focused-scope EPRI SMA	GI-199
River Bend	05000458	0.1	2.4E-04	0.1	2.5E-05	reduced-scope EPRI SMA; SSE =	GI-199

Table From GI-199 Program Containing SSE, SSE Exceedance Frequencies, Review Level Earthquakes (RLE), and Seismic Core Damage Frequencies							
Plant	Docket	SSE (g's)	Frequency of Exceeding the SSE (per year)	RLE (HCLPF) (g's)	Seismic Core Damage Frequency (per year)	IPEEE Method	Source
						0.1g	
Robinson (HR)	05000261	0.2	1.1E-03	0.28	1.5E-05	0.3g full-scope EPRI SMA	GI-199
Saint Lucie	05000335	0.1	1.4E-04	0.1	4.6E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Salem 1	05000389	0.2	2.6E-04	0.1	4.6E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Salem 2	05000272	0.2	2.6E-04	n/a	9.3E-06	seismic PRA	GI-199
San Onofre 2	05000361	0.67	1.2E-04	n/a	1.7E-05	seismic PRA	IPEEE
San Onofre 3	05000362	0.67	1.2E-04	n/a	1.7E-05	seismic PRA	IPEEE
Seabrook	05000311	0.25	1.3E-04	n/a	9.3E-06	seismic PRA	GI-199
Sequoyah 1	05000443	0.18	7.1E-04	n/a	2.2E-05	seismic PRA	GI-199
Sequoyah 2	05000327	0.18	7.1E-04	0.27	5.1E-05	0.3g full-scope EPRI SMA	GI-199
Shearon Harris 1	05000328	0.15	4.6E-05	0.27	5.1E-05	0.3g full-scope EPRI SMA	GI-199
South Texas 1	05000498	0.1	3.0E-05	n/a	6.2E-06	seismic PRA	GI-199
South Texas 2	05000499	0.1	3.0E-05	n/a	6.2E-06	seismic PRA	GI-199
Summer	05000395	0.15	3.9E-04	0.22	3.8E-05	0.3g focused-scope EPRI SMA	GI-199
Surry 1	05000280	0.15	2.2E-04	n/a	5.7E-06	seismic PRA	GI-199
Surry 2	05000281	0.15	2.2E-04	n/a	5.7E-06	seismic PRA	GI-199
Susquehanna 1	05000387	0.1	1.9E-04	0.21	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Susquehanna 2	05000388	0.1	1.9E-04	0.21	1.3E-05	0.3g focused-scope EPRI SMA	GI-199
Three Mile Island 1	05000289	0.12	1.0E-04	n/a	4.0E-05	seismic PRA	GI-199
Turkey Point 3	05000250	0.15	3.8E-05	0.15	1.0E-05	site-specific approach; SSE=0.15g	GI-199
Turkey Point 4	05000251	0.15	3.8E-05	0.15	1.0E-05	site-specific approach; SSE=0.15g	GI-199
Vermont Yankee	05000271	0.14	1.2E-04	0.25	8.1E-06	0.3g focused-scope EPRI SMA	GI-199
Vogtle 1	05000424	0.2	1.5E-04	0.3	1.8E-05	0.3g focused-scope EPRI SMA	GI-199
Vogtle 2	05000425	0.2	1.5E-04	0.3	1.8E-05	0.3g focused-scope EPRI SMA	GI-199
Waterford 3	05000382	0.1	1.1E-04	0.1	2.0E-05	reduced-scope EPRI SMA; SSE = 0.1g	GI-199
Watts Bar	05000390	0.18	2.9E-04	0.3	3.6E-05	0.3g focused-	GI-199

Table From GI-199 Program Containing SSE, SSE Exceedance Frequencies, Review Level Earthquakes (RLE), and Seismic Core Damage Frequencies

Plant	Docket	SSE (g's)	Frequency of Exceeding the SSE (per year)	RLE (HCLPF) (g's)	Seismic Core Damage Frequency (per year)	IPEEE Method	Source
						scope EPRI SMA	
Wolf Creek	05000482	0.12	3.7E-05	0.2	1.8E-05	reduced-scope EPRI SMA	GI-199
		25th percentile	9.6E-05		6.0E-06		
		min	1.6E-05		2.0E-06		
		median	1.7E-04		1.5E-05		
		mean	3.1E-04		2.1E-05		
		max	3.9E-03		1.0E-04		
		75th percentile	2.6E-04		3.2E-05		

Table: Design Basis Ground Motions and New Review Level Ground Motions Used for Review of Japanese Plants

Plant sites	Contributing earthquakes	New DBGM S ₁	Original DBGM S ₂
Tomari	Earthquakes undefined specifically	550 Gal	370 Gal
Onagawa	Soutei Miyagiken-oki (M8.2)	580	375
Higashidoori	Earthquakes undefined specifically	450	375
Fukushima	Earthquake near the site (M7.1)	600*	370
Tokai	Earthquakes undefined specifically	600	380
Hamaoka	Assumed Tokai (M8.0), etc.	800	600
Shika	Sasanami-oki Fault (M7.6)	600	490
Tsuruga	Urazoko-Uchiikemi Fault (M6.9), etc. →Mera-Kareizaki - Kaburagi(M7.8), Shelf edge+B+Nosaka (M7.7)	800	532
Mihama	C, Fo-A Fault (M6.9)→ Shelf edge+B+Nosaka(M7.7)	750	405
Ohi	C, Fo-A Fault (M6.9)→Fo-A+Fo-B (M7.4)	700	405
Takahama	Fo-A Fault (M6.9) →Fo-A+Fo-B(M7.4)	550	370
Shimane	Shinji Fault (M7.1)	600	456
Ikata	Central Tectonic Structure (M7.6)	570	473
Genkai	Takekoba F. (M6.9) → Enhanced uncertainty consideration	540	370
Sendai	Gotandagawa F.(M6.9), F-A(M6.9)	540	372
Kashiwazaki-Kariwa	F-B Fault (M7.0), Nagaoka-plain-west Fault (M8.1)	2300 (R1 side) 1209 (R5 side)	450
Monju (Proto Type FBR)	Shiraki-Niu F.(M6.9) , C F.(M6.9)→Shelf edge+B+Nosaka(M7.7), Small Damping	760	408
Shimokita Reprocessing F.	Deto-Seiho F.(M6.8), Yokohama F.(M6.8)	450	320

*A recent news story contains information that conflicts with the estimate of 370gal. We believe that we have determined that these numbers are for the rock levels and that the estimates in the news story are at the foundation level of each power block. A figure is being developed to explain this.

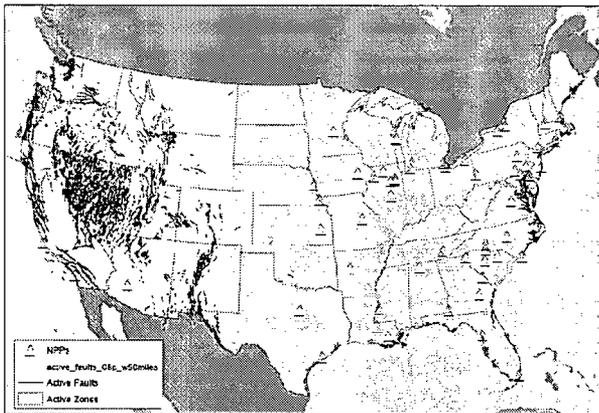
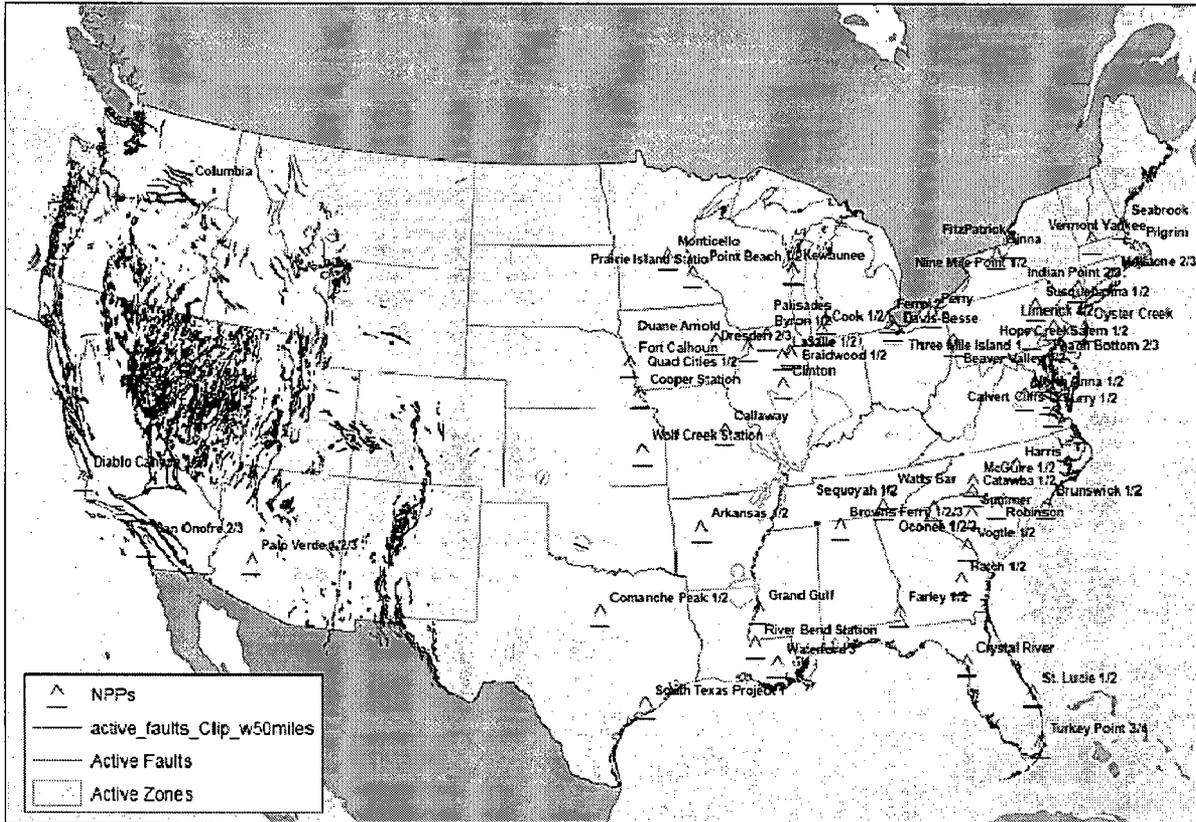
Table: Status of Review of Japanese NPPs to New Earthquake Levels Based on 2006 Guidance

Utility	Site (Unit)	Type	Dec.2010
Hokkaido	Tomari	PWR	△
Tohoku	Onagawa (Unit1)	BWR	◎
	Higashi-dori	BWR	△
Tokyo	Kashiwazaki-Kariwa	BWR	Unit 1,5,6,7 ◎
	Fukushima-No1	BWR	Unit 3 ◇, 5 ◎
	Fukushima-No2	BWR	Unit 4,5 ◎
Chubu	Hamaoka	BWR	△
Hokuriku	Shika (Unit 2)	BWR	◎
Kansai	Mihama(Unit 1)	PWR	◎
	Ohi(Unit 3,4)	PWR	◎
	Takahama (Unit 3,4)	PWR	◎
Chugoku	Shimane (Unit 1, 2)	BWR	◎
Shikoku	Ikata (Unit 3)	PWR	◎
Kyushu	Genkai (Unit 3)	PWR	◎
	Sendai (Unit 1)	PWR	◎
Japan Atomic Power	Tokai-Daini	BWR	○
	Tsuruga	BWR/PWR	△
JAEA	Monjyu	Proto Type FBR	◎
Japan Nuc. Fuel	Rokkasyo	Reprocessing	◎
◎: NSC review finished, ○: NISA review finished and in NSC review, △: Under review by NISA			

Additional Information: Useful Plots

Plot of Mapped Active Quaternary Faults and Nuclear Plants in the US

It is important to note that this plot somewhat misleading as faults in the central and eastern US are not well characterized. For example, the faults responsible for very large historic events, such as the 1811 and 1812 New Madrid Earthquakes, and the 1886 Charleston Earthquakes have not been conclusively located.



Nuclear Plants in the US Compared to the USGS National Seismic Hazard Maps

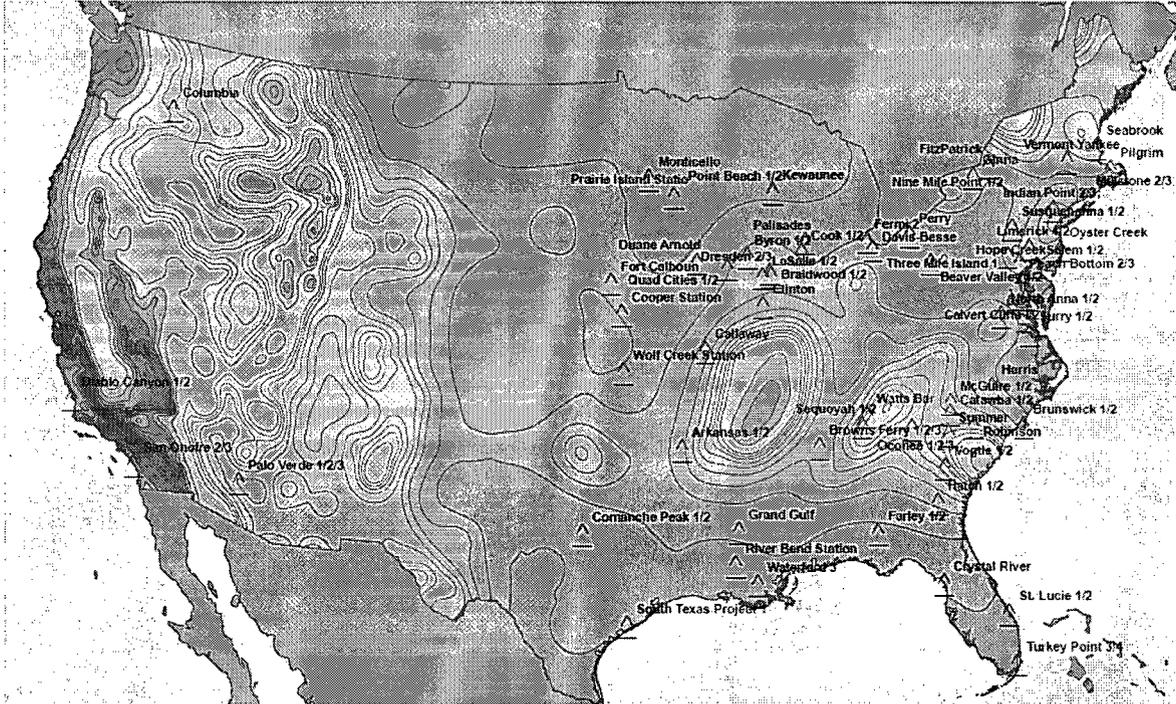
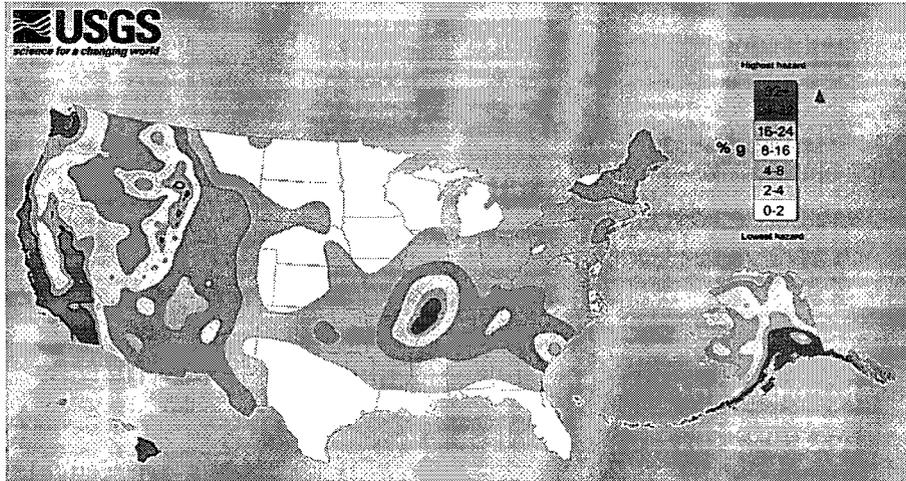


Figure 1: US Nuclear Plants overlain on the USGS National Seismic Hazard Map (PGA of 10% in 50 years from the USGS 2002 maps)

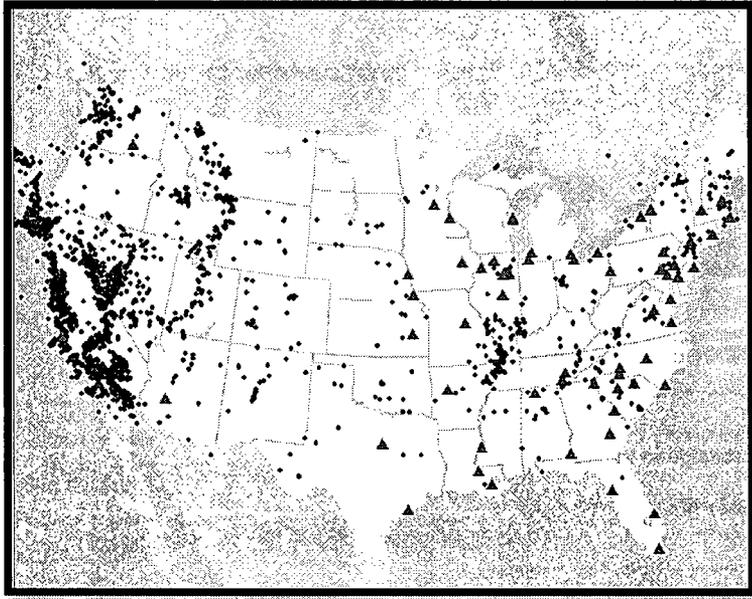
As you can see the seismic source regions in the central and eastern east are not well defined. So to state a specific number of plants that are in the moderate seismicity zones is challenging and open to interpretation. This is just one interpretation, which is provided by the USGS.

USGS US National Seismic Hazard Maps

Many version of this map are available at the USGS website at <http://earthquake.usgs.gov/hazards/>

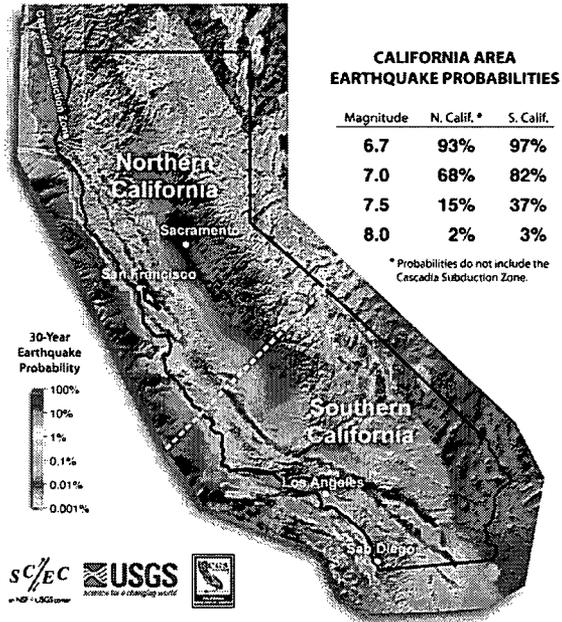


Plot of Nuclear Plants in the US Compared to Recent Earthquakes



UCERF Map of California Earthquake Probabilities for Northern versus Southern California

This is included in this document as Markey (inaccurately) used the below statistics to say that the probability of a magnitude 7 at SONGS was 82%. The dashed line of this California map is the boundary between northern and southern California used in the UCERF study. As shown in the table, the 30-year probability of an earthquake of magnitude 7.5 or larger is higher in the southern half of the state (37%) than in the northern half (15%).



Plot of ground motion acceleration (PGA) from Japanese earthquake

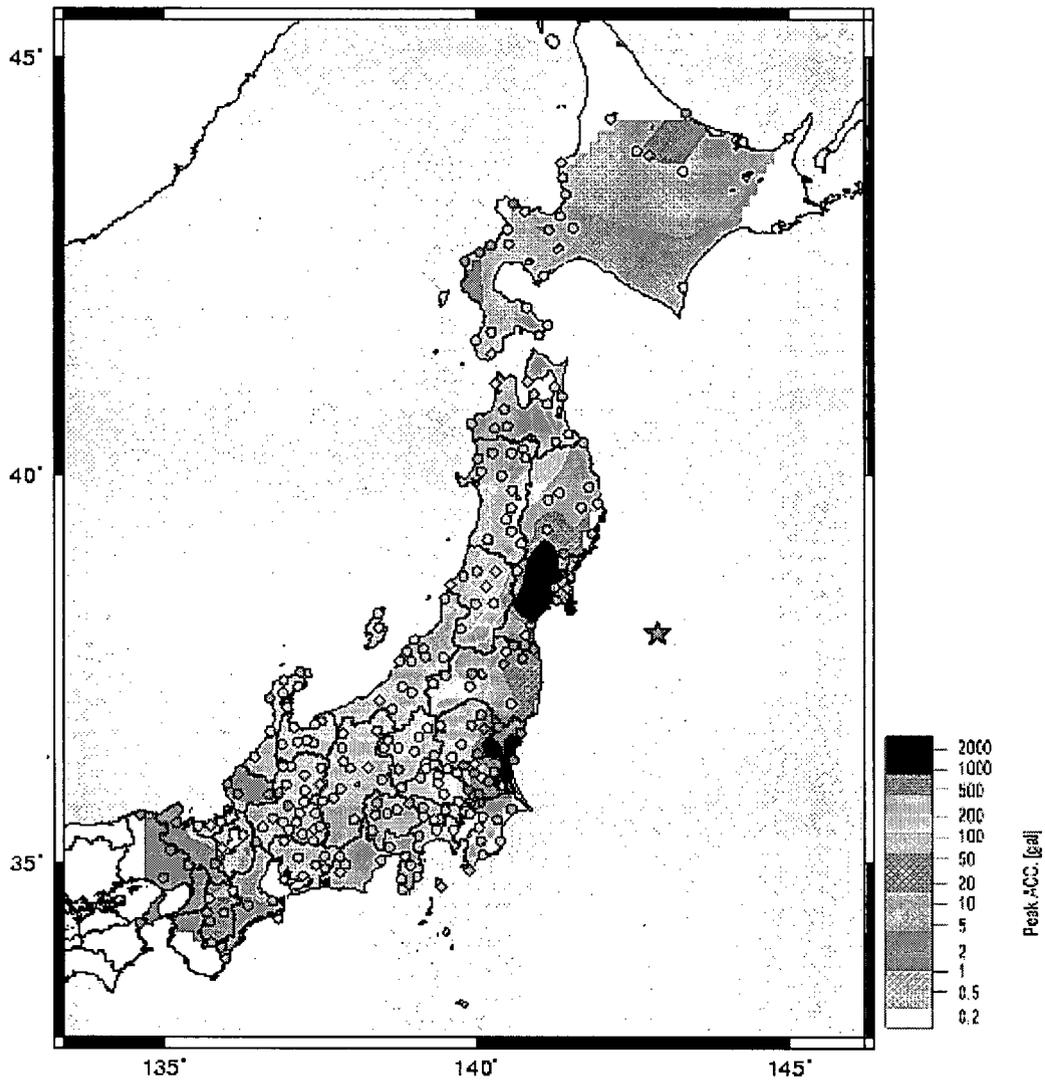
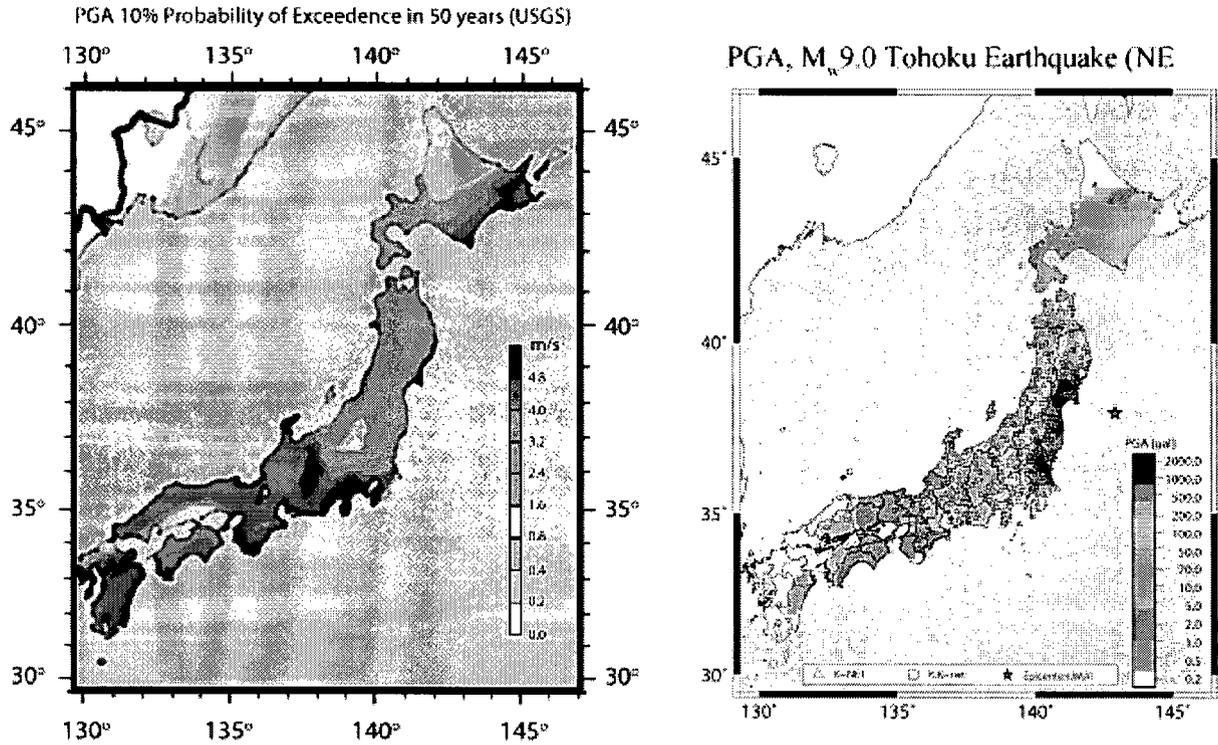


Table of Nuclear Plant Design and Review Ground Motions for the Plants that Automatically Tripped (JNES)

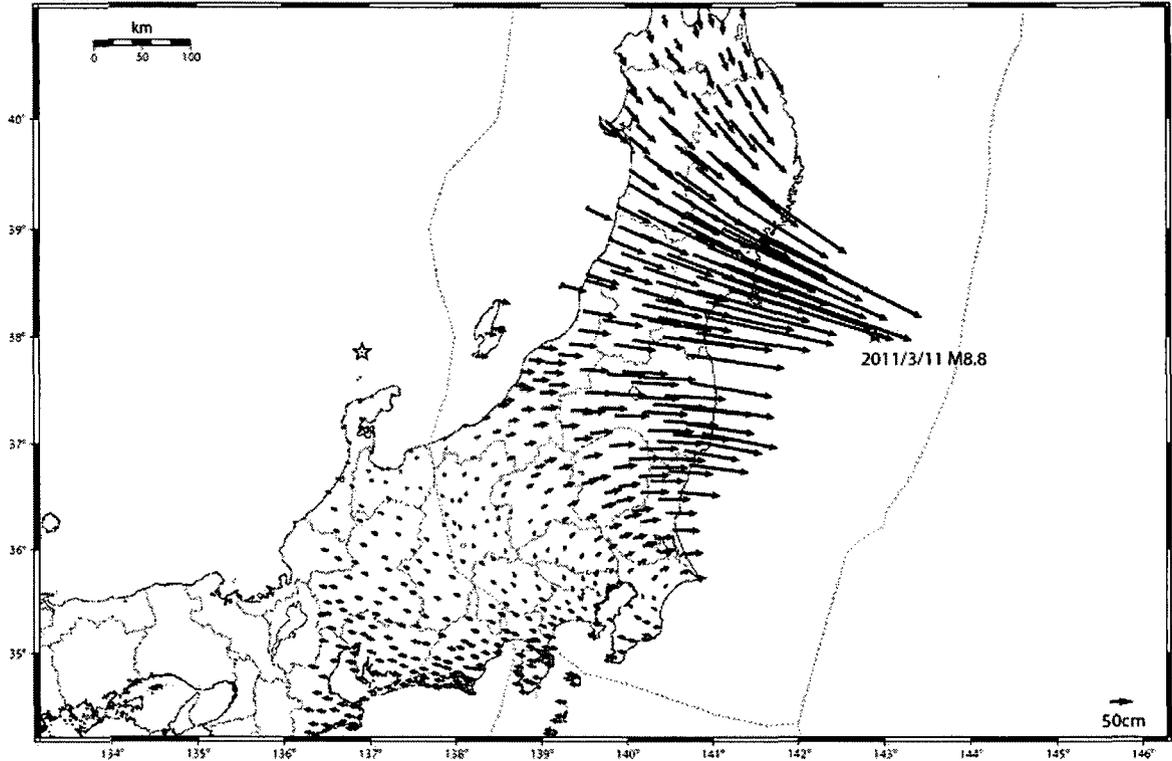
Plant sites	Contributing earthquakes used for determination of hazard	New DBGM S_2	Original DBGM S_1
Onagawa	Soutei Miyagiken-oki (M8.2)	580 gal (0.59g)	375 gal (0.38g)
Fukushima (both)	Earthquake near the site (M7.1)	600 gal (0.62g)	370 gal (0.37g)
Tokai	Earthquakes specifically undefined	600 gal (0.62g)	380 gal (0.39g)



PGA corresponding to a 10% probability of exceedance in 50 years (left) and the PGA experienced during the Tohoku Earthquake (right)

変動ベクトル図 (水平)

基準期間 : 2011/03/01 21:00 - 2011/03/08 21:00
比較期間 : 2011/03/11 16:30 - 2011/03/11 16:30



[基準 : R3 速報解 比較 : S3 速報解]

★観測局 : 釧路島 (950262)

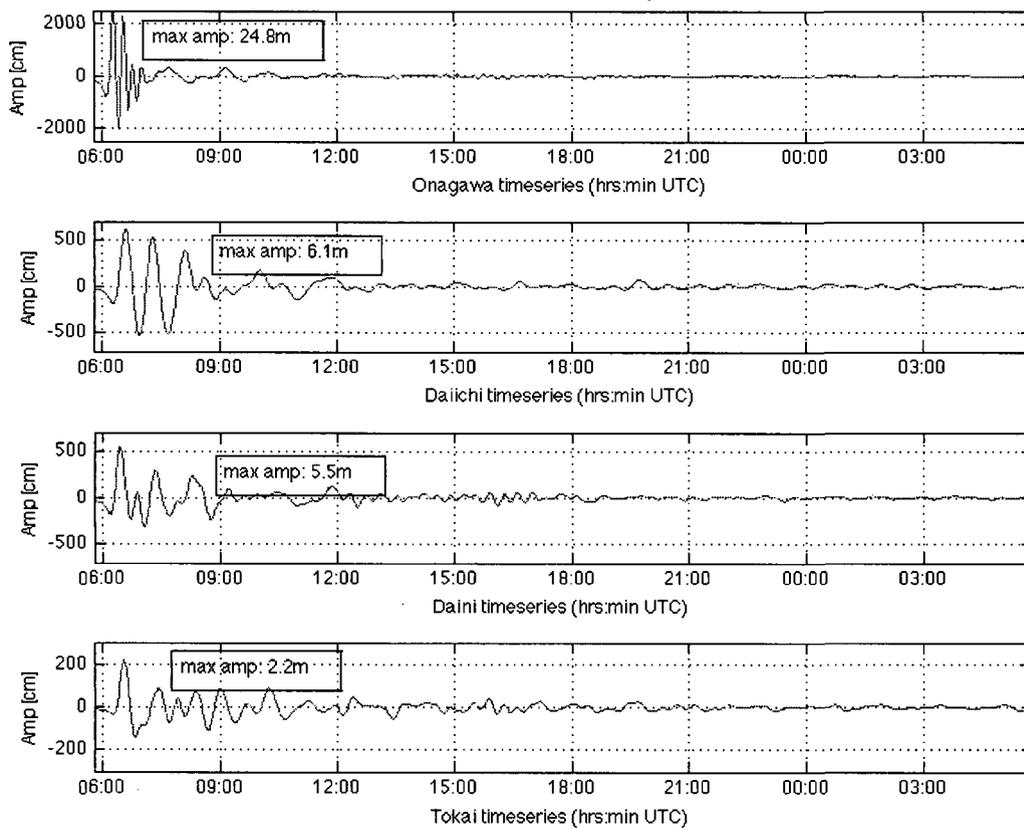
国土地理院

Coseismic slip during the M9.0 earthquake

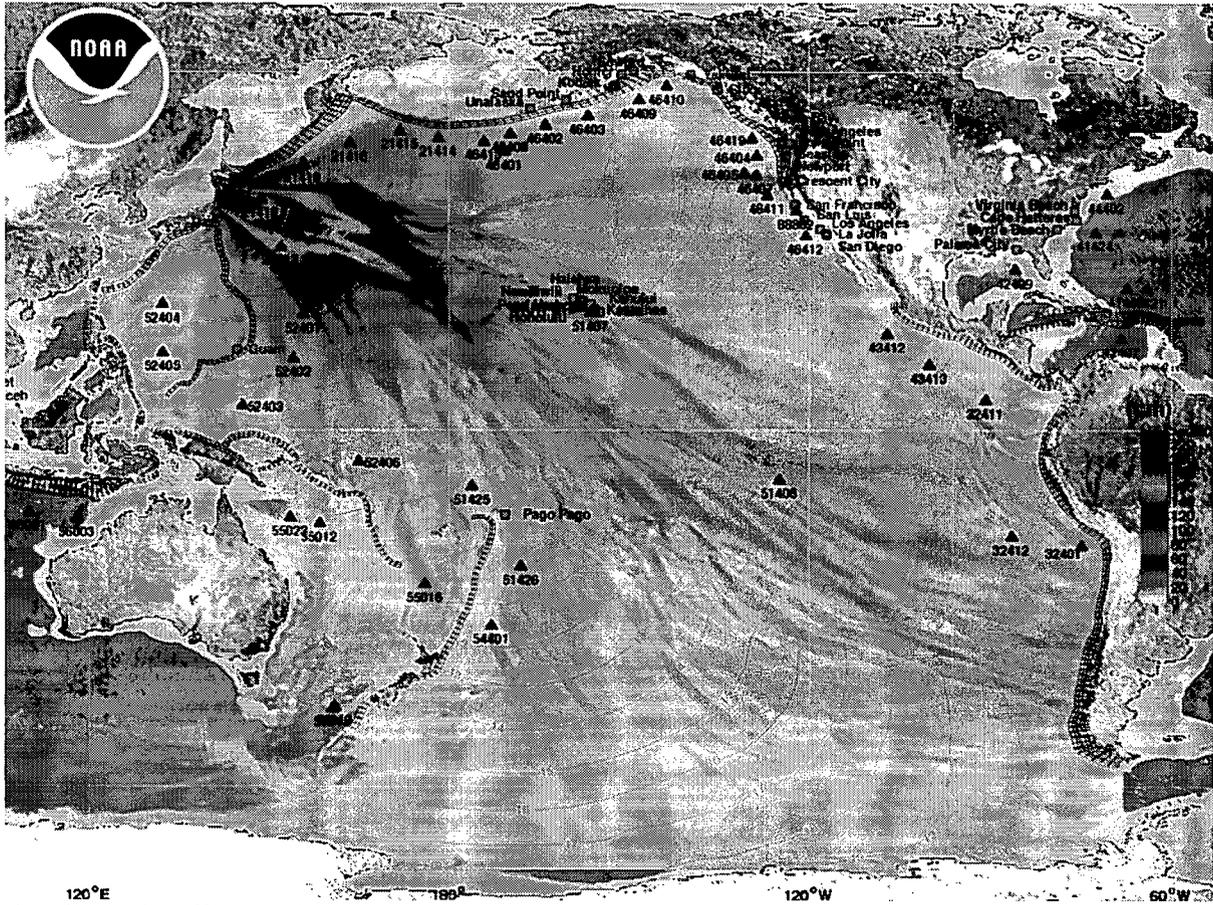
Plot of Tsunami Wave Heights at 5 Meter Bathymetry Offshore at the Japanese Plants (NOAA)

These are results from high-resolution models run by PMEL NOAA staff, who do modeling for the tsunami warning system. While the available bathymetry and topography data used in the model are not of the highest quality at that location, NOAA has confidence in the results, which show good comparisons between model flooding estimates and inundation observations inferred from satellite images. DART measurements are used in the modeling. The images show model time series very close to a shoreline, at about 5m depth. The runup heights (maximum elevation of flooded area) may be different from these amplitudes at shoreline (can be higher or lower, depending on the topographic profile). According to TEPCO, the wave height onshore at the Fukushima plant was 14 meters high.

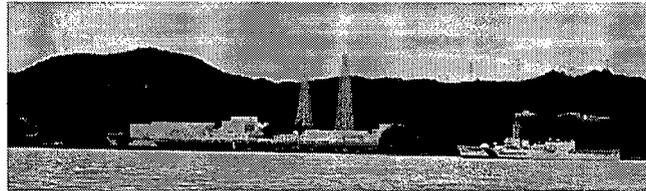
Offshore wave amplitudes, scaled to the coastline



Plot of Tsunami Wave Heights in the Pacific (NOAA)



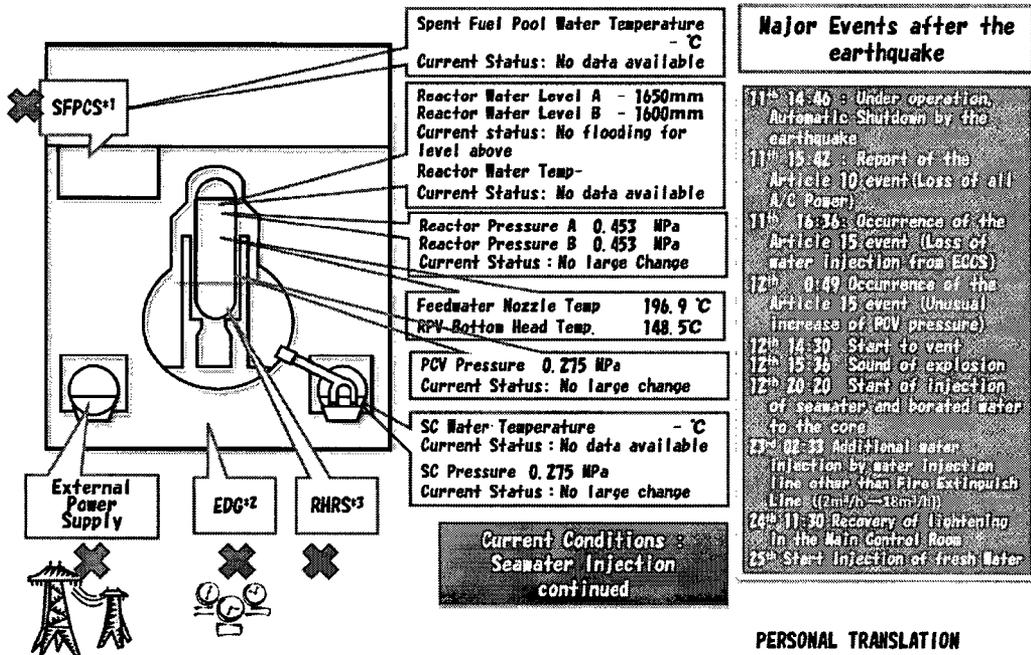
This shows the effect on the US coastline.



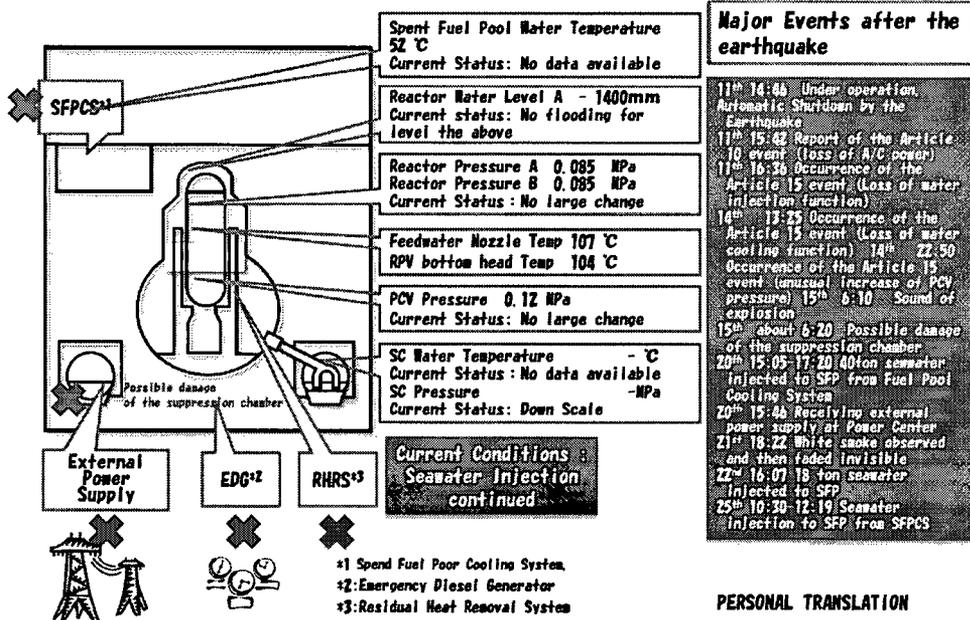
I found the numbers at the Onagawa plant unimaginable, so I found a side view picture. It's hard to tell the elevation of the plant.

Plant Status (6pm, Japan time, on 3-25-11)

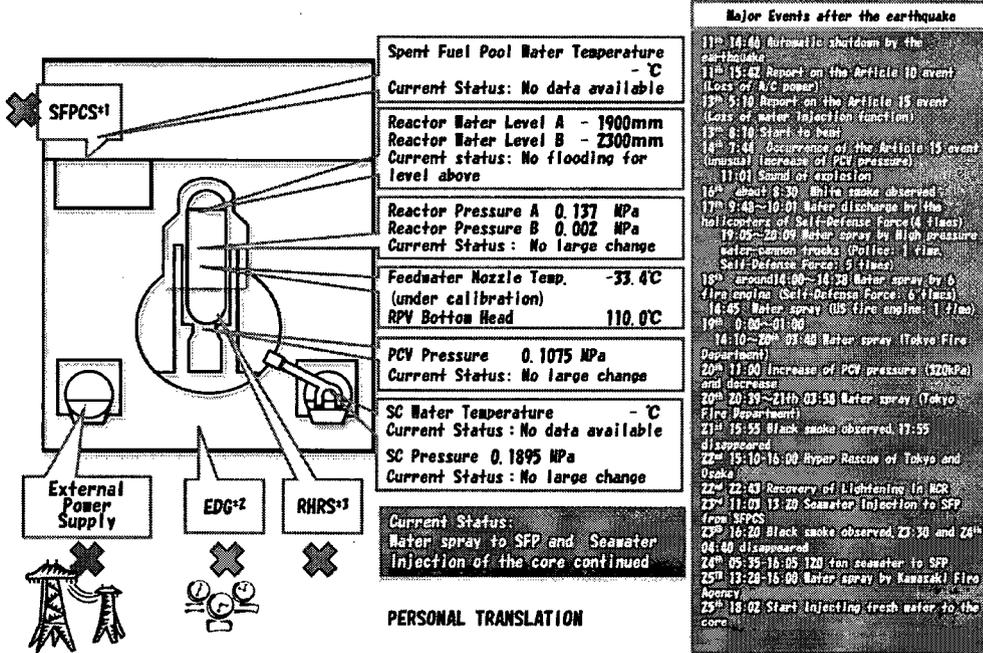
Current Status of Fukushima Dai-ichi Nuclear Power Stations Unit 1 (As of 18:00 March 25th, 2011)



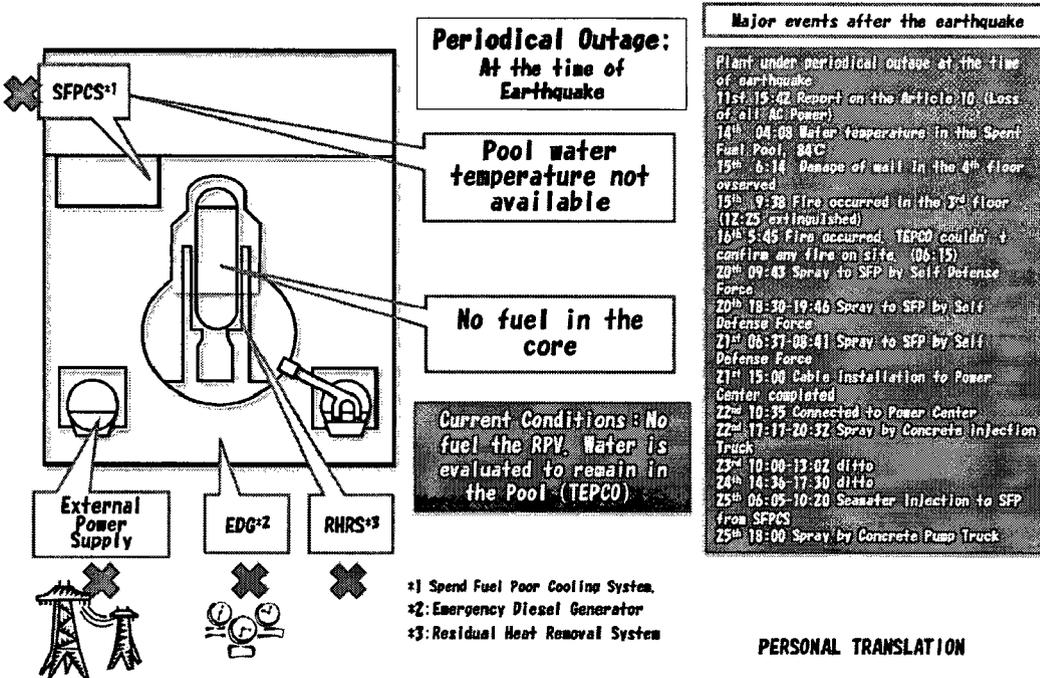
Current Status of Fukushima Dai-ichi Nuclear Power Stations Unit 2 (As of 18:00 March 25th, 2011)



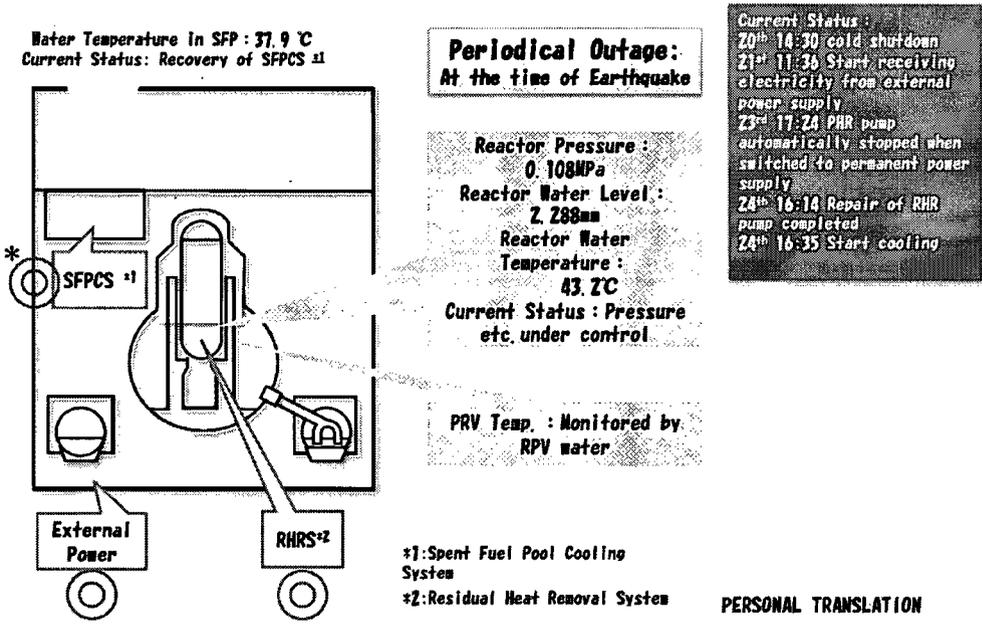
Current Status of Fukushima Dai-ichi Nuclear Power Stations Unit 3 (As of 18:00 March 25th, 2011)



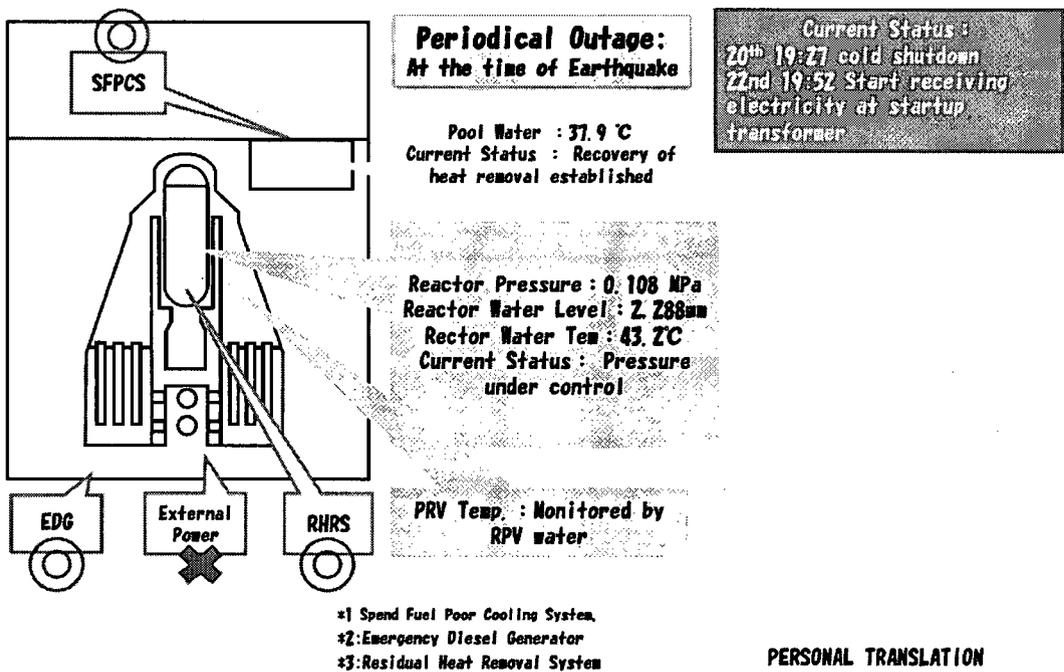
Current Status of Fukushima Dai-ichi Nuclear Power Stations Unit 4 (As of 18:00 March 25th, 2011)



Current Status of Fukushima Dai-ichi Nuclear Power Stations Unit 5 (As of 18:00 March 25th, 2011)



Conditions of Fukushima Dai-ichi Nuclear Power Stations Unit 6 (As of 18:00 March 25th, 2011)



Fact Sheets

Fact Sheet: Summarization of the NRC's Regulatory Framework for Seismic Safety (High level overview)

The seismic regulatory basis for licensing of the currently operating nuclear power reactors is contained in the following regulations: 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," including the "General Design Criteria for Nuclear Power Plants," and 10 CFR Part 100 ("Seismic and Geologic Siting Criteria For Nuclear Power Plants") and Appendix A to that Part, which describes the general criteria that guide the evaluation of the suitability of proposed sites for nuclear power plants. General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," in Appendix A requires that the structures and components in nuclear power plants be designed to withstand the effects of natural phenomena, including earthquakes and tsunamis, without loss of capability to perform their intended safety functions. GDC 2 also requires that the design bases include sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. The earthquake which could cause the maximum vibratory ground motion at the site is designated as the **Safe Shutdown Earthquake (SSE)**. Under SSE ground motions, nuclear power plant structures and components must remain functional and within applicable stress, strain, and deformation limits. Each plant must also have seismic instrumentation to determine if the **Operating Basis Earthquake (OBE)**, typically one-half or one-third the level of the SSE, has been exceeded. If the OBE is exceeded or significant plant damage has occurred, then the nuclear power plant must be shutdown.

Each plant is designed to a ground-shaking level (the SSE) that is appropriate for its location, given the possible earthquake sources that may affect the site and its tectonic environment. Ground shaking is a function of both the magnitude of the earthquake, the distance of the earthquake to the site, and the local geology. The magnitude alone cannot be used to predict ground motions. The existing plants were designed on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquake expected in the area around the plant. This required an assessment of earthquakes that had occurred in the region around each plant site.

Design basis loads for nuclear power plant structures include combined loads for seismic, wind, tornado, normal operating conditions (pressure and thermal), and accident conditions. Codes and standards, such as the American Society of Mechanical Engineers, the American Concrete Institute, and the American Institute of Steel Construction, are used in the design of nuclear power plant structures to ensure a conservative, safe design under design basis loads.

In the mid to late 1990s, NRC staff reviewed the potential consequences of severe earthquakes (earthquakes beyond the safety margin included in each plant's design basis), as part of the Individual Plant Examination of External Events (or IPEEE) program. From this review, the staff determined that seismic designs of operating plants in the United States have adequate safety margins, for withstanding earthquakes, built into the designs. Currently, the NRC staff is reassessing the seismic designs of operating plants through our Generic Issues program. The initial results of this assessment found that: 1) seismic hazard estimates have increased at some operating plants in the central and eastern US; 2) there is no immediate safety concern, plants have significant safety margin and overall seismic risk estimates remain small; and 3) assessment of updated seismic hazards and plant performance should continue.

Fact Sheet: Summarization of the NRC's Regulatory Framework for Seismic Safety (The policy work version)

(Jon to clean up upon his return from vaca) NRC's regulatory framework for seismic safety of nuclear reactors and facilities is based on: reactor site suitability with respect to geological, seismological, hydrological and other site specific hazards; classification of structures, systems and components (SSCs) as Seismic Category I, seismic design of Seismic Category I SSCs, seismic and environmental qualification of Category I SSCs; and maintenance and in-service inspection of equipment and structures, including the containment structure. The NRC's regulatory framework with respect to seismic issues has evolved through time.

Currently Operating Reactors (licensed prior to 1997):

The seismic regulatory basis for licensing of the currently operating nuclear power reactors is contained in the following regulations: 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," including the "General Design Criteria for Nuclear Power Plants," and 10 CFR Part 100 ("Seismic and Geologic Siting Criteria For Nuclear Power Plants") and Appendix A to that Part which describes general criteria that guide the evaluation of the suitability of proposed sites for nuclear power plants. General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," in Appendix A requires that the SSCs important to safety be designed to withstand the effects of natural phenomena, including earthquakes, tsunamis, and seiches without loss of capability to perform their intended safety functions. GDC 2 requires that the design bases shall include sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, and shall consider appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena. The earthquake which could cause the maximum vibratory ground motion at the site is designated the **Safe Shutdown Earthquake (SSE)**.

Each plant is designed to a ground-shaking level (the SSE) that is appropriate for its location, given the possible earthquake sources that may affect the site and its tectonic environment. Ground shaking is a function of both the magnitude of an earthquake and the distance from the fault to the site. The magnitude alone cannot be used to predict ground motions. The existing plants were designed on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquake expected in the area around the plant based on an assessment of earthquakes that had occurred in the region historically. There is no specification of frequency of occurrence in the deterministic approach. There is no requirement for a periodic reassessment of the seismic design basis.

Paragraph VI(a)(3) of Appendix A requires that suitable seismic instrumentation must be provided so that the seismic response of nuclear power plant features important to safety can be determined promptly after an earthquake to permit comparison of such response to that used as the design basis. Such a comparison is needed to decide whether the plant can continue to be operated safely and to permit appropriate action in a timely manner. Appendix A requires that in addition to seismic loads, including aftershocks, applicable concurrent functional and accident induced loads shall be taken into account in the design of safety-related SSCs. Paragraph VI(c) requires that seismically induced flood, water waves from either locally or distantly generated seismic activity and other design conditions shall be taken into account in nuclear power plant design.

Proposed New Reactors (submitted after 1997):

In 1997 new rules governing reactor siting were established. 10 CFR Part 50 Appendix A (GDC 2), 100.23 and Appendix S establish the seismic design basis for plants licensed after January 10, 1997. Similar to pre-1997, Appendix S defines the SSE as "the *Safe-shutdown earthquake ground motion* is the vibratory ground motion for which certain structures, systems, and components must be designed to remain functional." 10 CFR Part 100.23 "Geologic and Seismic Siting Criteria" requires that the applicant determine the SSE **and its uncertainty**, the potential for surface tectonic and nontectonic deformations.

Regulatory Guide 1.165 (and subsequently Regulatory Guide 1.208) provides guidance on satisfying 10 CFR Part 100.23, one of which is performing a probabilistic seismic hazard assessment (PSHA).

Appendix S to 10 CFR Part 50 requires for SSE ground motions, SSCs will remain functional and within applicable stress, strain, and deformation limits. The required safety functions of SSCs must be assured during and after the vibratory ground motion through design, testing, or qualification methods. The evaluation must take into account soil-structure interaction effects and the expected duration of the vibratory motions. Appendix S also requires that the horizontal component of the SSE ground motion in the free field at the foundation elevation of structures must be an appropriate response spectrum with a peak ground acceleration (PGA) of at least 0.10g. Design basis loads for nuclear power plant structures, important to safety, include combined loads for seismic, wind, tornado, normal operating conditions (pressure and thermal), and accident conditions. Codes and standards, such as the ASME B&PV Code, the American Institute of Concrete Institute (ACI-359/ASME Section III Division 2, ACI-349) and the American Institute of Steel Construction (AISC N690), are used in the design of nuclear power plant structures to ensure a conservative, safe design under design basis loads.

In contrast to the deterministic approach used prior to 1997, the probabilistic method is used and explicitly accounts for possible earthquakes of various magnitudes that come from all plausible potential sources (including background seismicity) and the likelihood that each particular hypothetical earthquake occurs. The PSHA process provides a complete characterization of the ground motion and comprehensively addresses uncertainties in nuclear power plant seismic demands. The PSHA results are major input to seismic risk evaluation using either SPRA or SMA approaches. As for plants licensed prior to 1997, there is no requirement for a periodic reassessment of the seismic design basis.

In addition to the nominal seismic design, all new generation reactors have to demonstrate a **Seismic margin of 1.67** relative to the site-specific seismic demands. These designs are required to perform a Probabilistic Risk Assessment (PRA) based seismic margins analysis (SMA) to identify the vulnerabilities of their design to seismic events. The minimum high confidence, low probability of failure (HCLPF) for the plant should be at least 1.67 times the ground motion acceleration of the design basis safe-shutdown earthquake (SSE).

The Standard Review Plan (NUREG-0800), Regulatory Guides and Interim Staff Guidance provide the basis for staff reviews of existing reactors and new license applications. Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires that suitable instrumentation must be provided so that the seismic response of nuclear power plant features important to safety can be evaluated promptly after an earthquake. Paragraph 10 CFR 50.54(ff) and Paragraph IV(a)(3) of Appendix S to 10 CFR Part 50 requires shutdown of the nuclear power plant if vibratory ground motion exceeding that of the operating basis earthquake ground motion (OBE) occurs. The OBE is typically one-half or one-third the level of the SSE. If systems, structures, or components necessary for the safe shutdown of the nuclear power plant are not available after occurrence of the OBE, the licensee must consult with the NRC and must propose a plan for the timely, safe shutdown of the nuclear power plant. Paragraph IV(c) requires that seismically induced flood, water waves from either locally or distantly generated seismic activity and other design conditions shall be taken into account in nuclear power plant design so as to prevent undue risk to health and safety of the public.

Fact Sheet: Summarization of the NRC's Regulatory Framework for Seismic Safety (The cliff notes)

NRC Regulations and Guidelines for Seismic Safety:

- The seismic regulatory basis for licensing of the currently operating nuclear power reactors is contained in the following regulations:
 - 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," including the "General Design Criteria for Nuclear Power Plants," and
 - 10 CFR Part 100 ("Seismic and Geologic Siting Criteria For Nuclear Power Plants") and Appendix A to that Part, which describes the general criteria that guide the evaluation of the suitability of proposed sites for nuclear power plants.
- In addition, General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," in Appendix A requires that:
 - The structures and components in nuclear power plants be designed to withstand the effects of natural phenomena, including earthquakes and tsunamis, without loss of capability to perform their intended safety functions.
 - GDC 2 also requires that the design bases include sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.
 - The earthquake which could cause the maximum vibratory ground motion at the site is designated as the **Safe Shutdown Earthquake (SSE)**. Under SSE ground motions, nuclear power plant structures and components must remain functional and within applicable stress, strain, and deformation limits.
 - Each plant must also have seismic instrumentation to determine if the **Operating Basis Earthquake (OBE)**, typically one-half or one-third the level of the SSE, has been exceeded. If the OBE is exceeded or significant plant damage has occurred, then the nuclear power plant must be shutdown.

Plant Design /Design Basis (Seismic):

- Each plant is designed to a ground-shaking level (the SSE) that is appropriate for its location, given the possible earthquake sources that may affect the site and its tectonic environment. Ground shaking is a function of both the magnitude of the earthquake, the distance of the earthquake to the site, and the local geology. The magnitude alone cannot be used to predict ground motions. The existing plants were designed on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquake expected in the area around the plant. This required an assessment of earthquakes that had occurred in the region around each plant site.
- Design basis loads for nuclear power plant structures include combined loads for seismic, wind, tornado, normal operating conditions (pressure and thermal), and accident conditions. Codes and standards, such as the American Society of Mechanical Engineers, the American Concrete Institute, and the American Institute of Steel Construction, are used in the design of nuclear power plant structures to ensure a conservative, safe design under design basis loads.

Fact Sheet: Summarization of the NRC's Regulatory Framework for Tsunami

Review Guidance and Guidelines Related to Tsunami:

- General Design Criterion 2 (GDC 2), 10CFR50, requires, in part, that structures, systems, and components important to safety be designed to withstand the effects of natural phenomena such as floods, tsunamis, and seiches without loss of capability to perform their safety functions. Design bases for these SSCs are also required to reflect:
- 10 CFR 100.23, requires, in part, that the size of seismically induced floods and water waves that could affect a site from either locally or distantly generated seismic activity must be determined.
- RG 1.102 – Flood Protection for Nuclear Power Plants, describes types of flood protection acceptable to the NRC staff
 - Exterior Barriers (e.g.)
 - Levee – embankment to protect land from inundation
 - Seawall or floodwall - a structure separating land and water areas, primarily to prevent erosion and other damages due to wave action
 - Bulkhead – similar to seawall, purpose is to restrain the land area
 - Incorporated Barriers
 - Protection provided by specially designed walls and penetration closures. Walls are usually reinforced concrete designed to resist static and dynamic forces of a Design Basis Flood Level of a Probable Maximum Flood.
- RG 1.59 – Design Basis Floods for Nuclear Power Plants
 - The most severe seismically induced floods reasonably possible should be considered for each site.
 - Tsunami requires consideration of seismic events of the severity of the Safe Shutdown Earthquake occurring at the location that would produce the worst such flood at the nuclear power plant site.
- US NRC, Standard Review Plan, “Probable Maximum Tsunami Flooding,” Section 2.4.6, Rev. 2
 - Areas of Review
 - Probable maximum tsunami postulated for a site should include wave runup and drawdown
 - Hydrologic characteristics of maximum locally and distantly generated tsunami (e.g., volcanoes, landslides)
 - Geological and seismic characteristics of potential tsunami faults (e.g., magnitude, focal depth, source dimensions, fault orientation, and vertical displacement)

Fact Sheet: Tsunami Assessment Method for Nuclear Power Plants in Japan

[This section is a placeholder and needs to be expanded]

- An overview of the tsunami assessment method for NPP in Japan is available in ADAMs: ML110770010
- Information is also available at:
http://www.jsce.or.jp/committee/ceofnp/Tsunami/eng/tsunami_eng.html
- The Japan Society of Civil Engineers is currently finalizing guidance PTHA = probabilistic tsunami hazard analysis

Fact Sheet: Summarization of the NRC's Regulatory Framework for Flooding

Flooding Issues:

- General Design Criterion 2 (GDC 2), 10CFR50, requires, in part, that structures, systems, and components important to safety be designed to withstand the effects of natural phenomena such as floods, tsunamis, and seiches without loss of capability to perform their safety functions. Design bases for these SSCs are also required to reflect:
 - Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding region, with sufficient margin for the limited accuracy and quantity of the historical data and the period of time in which the data have been accumulated.
 - Appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena.
 - The importance of the safety functions to be performed.
- Design basis floods for most of the present fleet of operating reactors were calculated using deterministic methods to determine the maximum credible flood levels at the site. These deterministic methods include the site specific calculation of parameters such as the probable maximum precipitation, which is defined as the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage basin. Other potential flooding hazards such as flooding due to storm surge, river flooding, coastal flooding including tsunamis, are evaluated at each site using maximum credible levels from each hazard. Over the life of the operating reactor, if new information becomes available that could affect the design basis, licensees are required to evaluate the new information. Based on this review, if needed, licensees are required to take appropriate mitigation measures, update their final safety analysis report and submit it to the NRC for review and approval.
- In order to impose new requirements on existing plants, the NRC must be able to justify the new requirements in accordance with the "Backfit Rule" (10 CFR 50.109).

Questions and Answers for Flooding Issues

180) Does the NRC consider severe floods in the design of nuclear power plants?

Yes. NRC regulations require that nuclear power plants are, at all times, capable of safely shutting down and maintaining a safe shutdown condition under severe flooding situations. Safety-related Structures, Systems and Components (SSCs) of Nuclear reactors in the U.S. are required to withstand the design basis flood (DBF). The design basis flood may be caused by the following natural Phenomena:

- Intense rainfall occurring at the site (known as local intense precipitation).
- Intense rainfall (known as the Probable Maximum Precipitation) occurring on other areas of the watershed leading to riverine or coastal flooding (known as Probable Maximum Flood" or "PMF".
- Floods from upstream dam failure or a combination of upstream dam failures.
- Failure of On-site Water Control or Storage Structures (i.e. tanks).
- Storm Surge, Seiche and Tsunami including wave effects.(See Tsunami Q&A Sheet)
- Flooding caused by ice effects (i.e. ice dams both upstream and downstream).
- Floods caused by diversions of stream channels toward the site.

- Other potential site specific flood hazard(s).

181) What about droughts and conditions which lead to low water? Are these considered?

Yes. Impacts to the plant from low water conditions brought about by ice effects, downstream dam breach, tsunamis, hurricanes and channel diversions away from the site are reviewed to ensure the plant remains safe under these scenerios.

182) Periods of long rainfall can cause the groundwater elevation to rise which can cause structures such as deeply embedded tanks to fail due to buoyancy. Are nuclear power plants designed to withstand this effect?

Yes. Worst-case groundwater levels are estimated for each site and the impacts of these levels are considered in the design of the plant to ensure the plant remains safe under these conditions. During the safety review, impacts due to groundwater levels and other hydrodynamic effects on the design bases of plant foundations and other safety-related structures systems and components (SSCs) are evaluated. Impacts to a safety-related structure such as a deeply embedded tank or a structure containing a deeply embedded tank are considered in the safety review.

183) Some of the Reports from the National Weather Service used to estimate the design precipitation are 30-40 years old. Are these estimates still valid?

The NRC has funded research by the U.S. Bureau of Reclamation to review the information and methods developed by the National Weather Service and the U.S. Army Corps of Engineers (HMR 51), focusing on South and North Carolina. To date, reviews of precipitation records from extreme storm events (e.g., tropical storms, hurricanes) since the publication of HMR 51 does not indicate any exceedance or potential for exceedance of those precipitation (PMP) estimates in this region. We have not seen any information or data that would indicate that HMR precipitation (PMP) estimates for the U.S. have been exceeded. As expected, individual point rainfall gauges have recorded rainfall amounts that have exceeded these areal estimates.

Fact Sheet: Summarization of Seismological Information from Regional Instrumentation

Placeholder: text document available from Rasool. It just needs to be formatted and added to this section.

- Focus on hazard impacts at annual exceedance levels of interest to Building Codes, potential for missing issues important to critical facilities.
- National fold and fault database a valuable tool for starting any new PSHA in WUS.

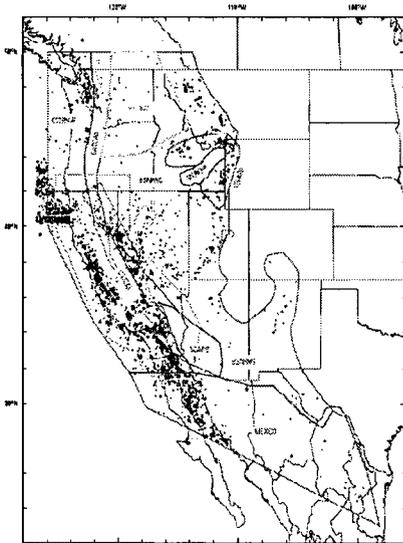
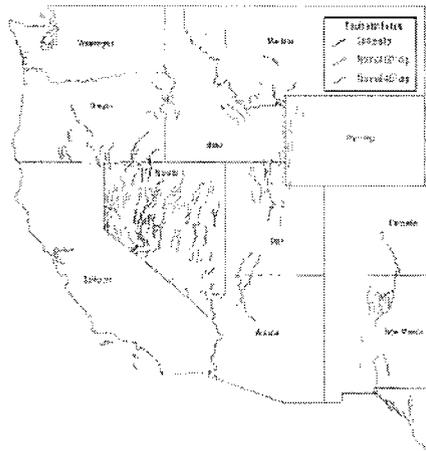


Figure 15. Historical seismicity patterns (shaded intensity), active broad regional zones (region of concern), and local seismically sensitive special zones used in Western United States background scenario model. Regions include: DENVER, Basin and Range; CASCAID, Cascade; COSTAL, Coastal California; SCARZ, Southern California and Arizona; SHASTA, Shasta-Elder Peak; TYPANA, Tribovision para el Norte; YAKIMA, Yakima; CO TYPAN, Central Pacific Northwest; MEXICO, Mexico; WCCED, Working Group on California Earthquake Probabilities. Other regions: U. Puget Lowlands, see Figure 14 for explanation.

Identified Faults in the WUS:

- There are many more identified faults in the WUS than in the CEUS. Not all well characterized.
- Within 320 km regional area of investigation potential for large number of sources requiring characterization.
- May require hazard informed, phased approach



Uncertainty and SSHAC:

- Significant uncertainties exist regarding appropriate ground motion and seismo-tectonic models, robustness and applicability of various of data sets, etc.

~~Official Use Only~~

- SSHAC provides a framework for incorporating experts into scientific assessments through structured processes and interactions
- Fundamental concepts behind guidelines
 - Views of the larger technical community are fundamental inputs
 - Competing scientific hypotheses can be considered and uncertainties captured
 - **PSHA is a snapshot in time of our knowledge and uncertainties**
- **Application of SSHAC Guidelines necessary for new WUS sites**

Significant Seismic Siting Considerations for WUS:

- Goal: Efficient review process consistent with NRC Regulations and Guidance
- Potential Issues:
 - Transition between CEUS and WUS ground motion characteristics, Intermountain West
 - Definition of “rock” shear-wave velocity
 - Specific details for performing hazard informed screening evaluations (focus on characterizing important sources)
 - Robustness of data used in screening assessments
 - Applicability of minimum slip-rate estimates as a screening tool
 - Development of comprehensive, regional moment magnitude based seismicity catalog
 - Maximum magnitude determination for background zones
 - Appropriate minimum magnitude for hazard calculations
 - Applicability of geodetic information for seismic source characterization
 - Appropriate SSHAC Level for new studies (Level 3/4)
 - Methodologies and bases for smoothing of seismicity
 - Development of realistic spectral shapes for regions influenced by Cascadia subduction zone
 - Consider what has been working in the CEUS

Path Forward:

- Interaction with Stakeholders (Industry, DOE, USGS)
- Develop Interim Staff Guidance
- Emphasize integration between site characterization/hazard assessment and engineering
- Evaluate the potential for engineering solutions (ex., base isolation)

Fact Sheet: Regulatory Framework for Protection of Nuclear Power Plants against Tsunami Flooding

Nuclear power plants are designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The word tsunami literally means harbor wave. Tsunamis can be generated by large offshore earthquakes (usually greater than magnitude 6.5), submarine or on shore land slides or volcanoes. Some large onshore earthquakes close to the shoreline can generate tsunami. The Nuclear Regulatory Commission (NRC) requires all nuclear power plants to be protected against earthquakes, tsunamis and other natural hazards.

Background

Protection against tsunami effects was required for all operating plants and is required for all new reactors. Following the Indian Ocean tsunami on December 26, 2004, the President moved to protect lives and property by launching an initiative to improve domestic tsunami warning capabilities. This plan was placed under the auspices of the National Science and Technology Council through the President's initiative in July 2005 in the context of a broad national effort of tsunami risk reduction, and United States participated in international efforts to reduce tsunami risk worldwide. In response to the president's initiative, the NRC reviewed its licensing criteria and conducted independent studies and participated in international forums under the auspices of the International Atomic Energy Agency with many participating countries including India and Japan. The final report of the study was published in April 2009 as NUREG/CR 6966, "Tsunami Hazard Assessment at Nuclear Power Plant Sites in the United States of America," ADAMS Accession # ML0915901933. NRC revised its Standard Review Plan for conducting safety reviews of nuclear power plants in 2007. Section 2.4.6 specifically addresses tsunamis. The Office of Nuclear Regulatory Research is conducting tsunami studies in collaboration with the United States Geological Survey and has published a report on tsunami hazard in the Atlantic, Gulf and Pacific coastal areas. Selected nuclear power plants now get tsunami warning notification. The agency requires plant designs to withstand the effects of natural phenomena including effects of tsunamis. The agency's requirements, including General Design Criteria for licensing a plant, are described in Title 10 of the *Code of Federal Regulations* (10 CFR). These license requirements consist of incorporating margins in the initiating hazard and additional margins are due to traditional engineering practices such as "safety factors." Practices such as these add an extra element of safety into design, construction, and operations.

The NRC has always required licensees to design, operate, and maintain safety-significant structures, systems, and components to withstand the effects of natural hazards and to maintain the capability to perform their intended safety functions. The agency ensures these requirements are satisfied through the licensing, reactor oversight, and enforcement processes.

Tsunami Hazard Evaluation

Tsunami hazard evaluation is one component of the complete hydrological review requirements provided in the Standard Review Plan under Chapter 2.4. The safety determination of reactor sites requires consideration of major flood causing events, including consideration of combined flood causing conditions. These conditions include Probable Maximum Flood (PMF) on Streams and Rivers, Potential Dam Failures, Probable Maximum Surge and Seiche Flooding and Probable Maximum Tsunami Hazards, among others. The most significant flooding event is called the design basis flood and flooding protection requirements are correlated to this flood level in 2.4.10.

The Probable Maximum Tsunami (PMT) is defined as that tsunami for which the impact at the site is derived from the use of best available scientific information to arrive at a set of scenarios reasonably expected to affect the nuclear power plant site taking into account (a) appropriate consideration of the most severe of the natural phenomena that have been historically reported or determine from

geological and physical data for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (b) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (c) the importance of the safety functions to be performed.

Site-specific tsunami data are collected from historical tsunami records, paleotsunami evidence, regional tsunami assessments, site-specific tsunami mechanisms, site-specific data, such as submarine survey of sea bed and approach channel geometry. Effects of tsunami on a nuclear power plant can be flooding due to water run up, hydro-dynamic pressure on exterior walls of structures, impact of floating debris, and foundation scouring. In addition, tsunami can draw down water from the intake source of plant cooling water.

The tsunami database is available for interactive search and downloads on the internet at <http://www.ngdc.noaa.gov/hazard/tsu.shtml>.

Tsunami Safety Assessment

The licensing bases for existing nuclear power plants are based on historical data at each site. This data is used to determine probable maximum tsunami and the tsunami effects are evaluated for each site with potential for tsunami flooding. The potential for tsunami hazard is determined on a hierarchical analysis process that can identify tsunami potential based primarily on distance from tsunami source and site elevation. The NRC also required existing plants to assess their potential vulnerability to external events, as part of the Individual Plant Examination of External Events Program. This process ensured that existing plants are not vulnerable to tsunami hazard, and they continue to provide adequate public health and safety.

Today, the NRC utilizes a risk-informed regulatory approach, including insights from probabilistic assessments and traditional deterministic engineering methods to make regulatory decisions about existing plants (e.g., licensing amendment decisions). Any new nuclear plant the NRC licenses will use a probabilistic, performance-based approach to establish the plant's seismic hazard and the seismic loads for the plant's design basis.

Operating Plants

The NRC is fully engaged in national international tsunami hazard mitigation programs, and is conducting active research to refine the tsunami sources in the Atlantic, Gulf Coast and Pacific Coast areas. Diablo Canyon (DC) and San Onofre (SONGS) are two nuclear plant sites that have potential for tsunami hazard. Both the DC (main plant) and SONGS are located above the flood level associated with tsunami. However, the intake structures and Auxiliary Sea Water System at DC are designed for combination of tsunami-storm wave activity to 45 ft msl. SONGS has a reinforced concrete cantilevered retaining seawall and screen well perimeter wall designed to withstand the design basis earthquake, followed by the maximum predicted tsunami with coincident storm wave action, designed to protect at approximately 27 ft msl. These reactors are adequately protected against tsunami effects. Distant tsunami sources for DC include the Aleutian area, Kuril-Kamchatka region, and the South American coast (for Songs the Aleutian area). Distant sources for SONGS is limited by the presence of a broad continental shelf. Local or near sources for DC include the Santa Lucia Bank and Santa Maria Basin Faults (for Songs the Santa Ana wind).

Additional Information

To read more about risk-related NRC policy, see the fact sheets on Probabilistic Risk Assessment (<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/probabilistic-risk-asses.html>) and Nuclear Reactor Risk (<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/reactor-risk.html>). Each provides more information on the use of probability in evaluating hazards (including earthquakes) and their potential impact on plant safety margins. Other regulatory framework includes General Design Criterion 2, 10 CFR Part 100.23, Regulatory Guide 1.102 "Flood Protection for Nuclear Power Plants", Rev. 1 1976,

~~Official Use Only~~

Regulatory Guide 1.59 "Design Basis for Nuclear Power Plants" Rev. 2 1977 (update in progress), and
USNRC Standard Review Plan "Probable Maximum Tsunami Flooding" Section 2.4.6, Rev. 2.
March 2011

Fact Sheet: Seismic Zones and US Plants

Note: This is some basic information...staff is developing this into a fact sheet

Some Key Points:

- Although we often think of the US as having “active” and “non-active” earthquake zones, earthquakes can actually happen almost anywhere. Seismologists typically separate the US into low, moderate, and high seismicity zones; not into “active” and “inactive”.
- The boundaries of the low, medium and high zones are not hard, are not well constrained, and are open to interpretation. Below we’ve pulled together a list based on our judgment and based on multiple interpretations in the technical community. But this is just for guidance; it is subjective.
- Faults are often well mapped and characterized in active zones, such as the west. But there are very few mapped faults in the east, which doesn’t mean that there aren’t earthquakes. For example, the most widely felt historical earthquakes in the US occurred in the New Madrid seismic zone in 1811 and 1812. The zones is (clearly shown on figure 1, the hazard map. However, the fault has never been identified and so is only shown as an area source on figure 2. In fact, most CEUS earthquakes are not tied to a known fault.
- The NRC has a seismic research program which has—with DOE and EPRI—sponsored and undertaken a ground breaking project to create a new state of the art seismic source model for the central and eastern US. This project, the Central and Eastern US Seismic Source Characterization for Nuclear Facilities project, is expected to finish at the end of this year.
- The NRC is also undertaking the Generic Issue 199 program to reassess seismic risk in light of the potential for higher seismic hazard (ground shaking) in the CEUS. This shows an ongoing dedication to seismic safety.
- The NRC requires that every nuclear plant be designed for site-specific ground motions that are appropriate for their locations. In addition, the NRC has specified a minimum ground motion level to which nuclear plants must be designed.

This is a preliminary (and subjective) list from seismic staff: Please consider this sensitive information

High Seismicity:

- Diablo Canyon
- SONGS

Moderate Seismicity:

Charleston Seismic Zone

- Brunswick
- Robinson
- Summer
- Vogtle
- Hatch (maybe depends on interpretation)

Wabash Valley Seismic Zone

- Clinton

East Tennessee Seismic Zone (a real point of contention)

- Watts Bar

- Sequoia
- Central Virginia Seismic Zone**
- North Anna

Notes:
Also minimum standard on shaking
Note that new Madrid has several subzones.

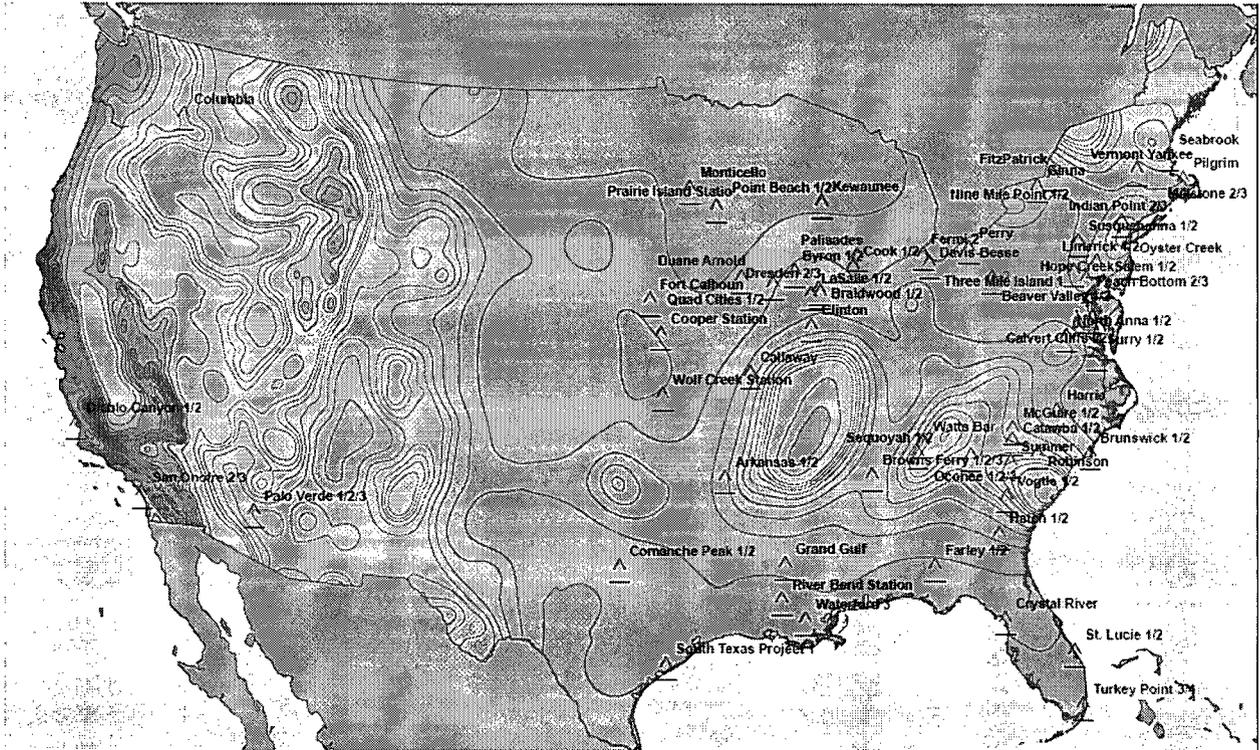


Figure 1: US Nuclear Plants overlain on the USGS National Seismic Hazard Map
As you can see the seismic source regions in the central and eastern east are not well defined. So to state a specific number of plants that are in the moderate seismicity zones is challenging and open to interpretation. This is just one interpretation, which is provided by the USGS.

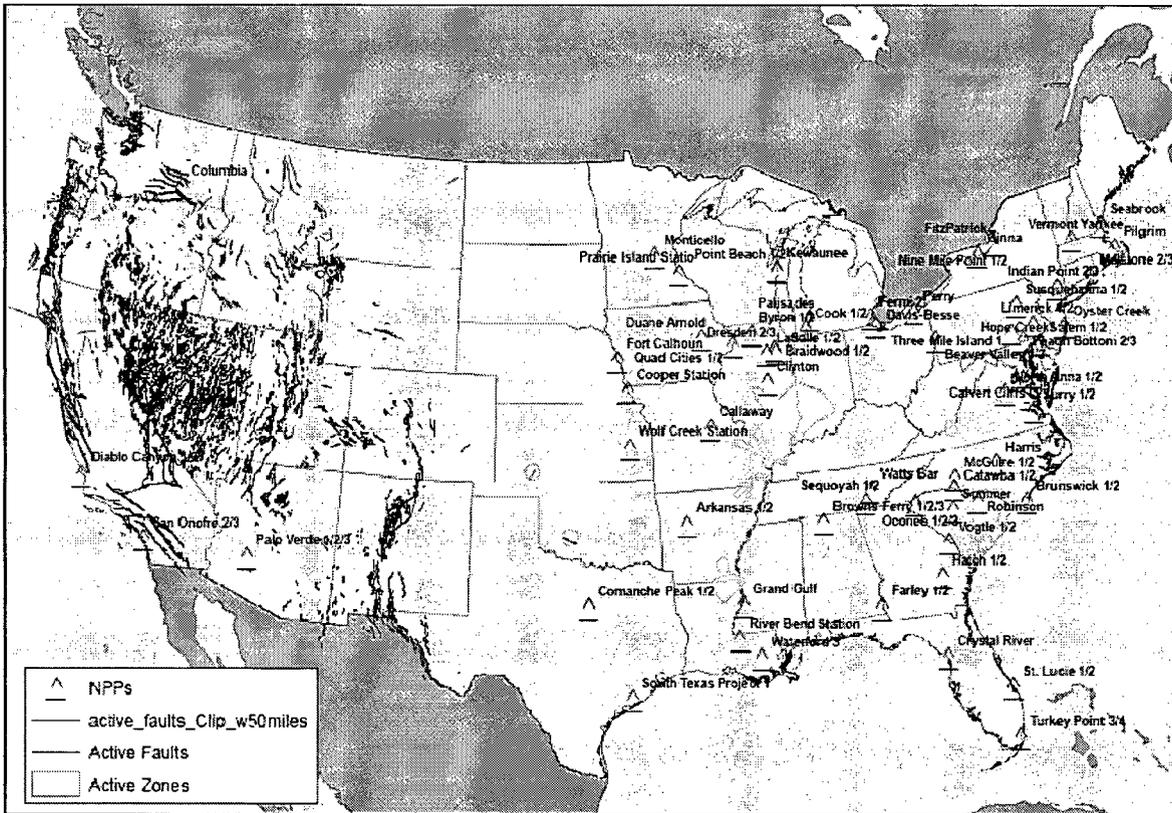


Figure 2: This figure shows mapped active faults and US Nuclear plants. As you can see, there are very few mapped active faults in the east, which doesn't mean that there aren't earthquakes. The most widely felt historical earthquakes in the US happened in the New Madrid seismic zone (clearly shown on figure 1, the hazard map). However, the fault is not shown here because we can't find it under all that Mississippi sand! You can (faintly) see the source one interpretation of a source zone on the figure. However, this is just the interpretation that was in the GIS map we were working with. We will likely put nested "blobs" onto this figure to the widest and narrowest zone interpretations.

If someone asks about plants being very near mapped active faults, there are two...but that doesn't mean that there isn't hazard elsewhere because in the central and eastern US the seismicity comes from "seismic zones" not faults. It's a hard balance between saying things that make it seem that we have a lot of problems and saying things that make it seem we are underestimate the hazard or not taking it seriously.

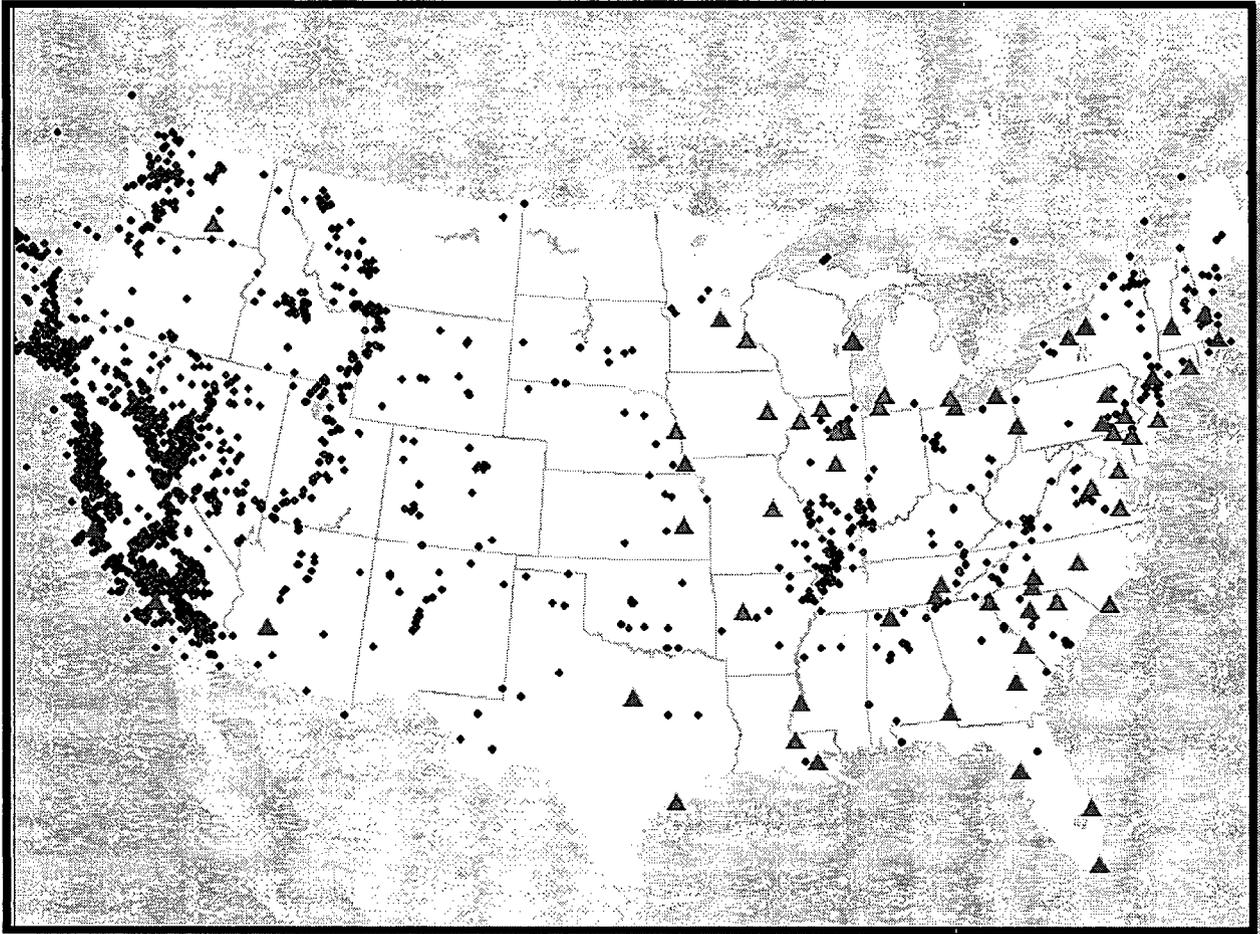


Figure 3: Earthquakes Plotted with US Nuclear Plants

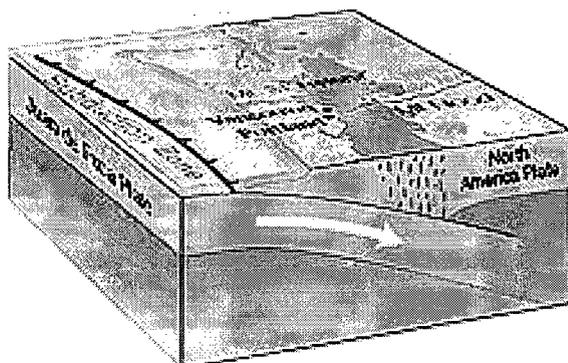
We are remaking a plot like this with a more complete set of earthquake (we're not sure that the time frame of the quakes is), this speaks to the fact that earthquakes occur everywhere, even where we don't have mapped faults.

Fact Sheet: Seismicity of the Central and Eastern US (In-depth technical information)

Key Points:

2. To date, very large earthquakes (Magnitudes greater than 8.25) have only occurred in specific geological settings, in particular the interfaces between tectonic plates in major **subduction zones**. The only subduction zone that potentially impacts the continental US is the Cascadia zone off the coast of northern California, Oregon and Washington.
3. Recent analyses of the magnitudes of the largest earthquakes **not associated** with subduction zones indicates magnitudes are less than ~8.25.
4. The size (magnitude) of earthquakes is proportional to the fault area that slips in a given earthquake. The prediction of earthquake magnitudes for a specific fault considers the dimensions of the fault. Extremely large earthquakes do not occur on small faults.
5. Nuclear power plants are licensed based on vibratory ground shaking, not earthquake magnitude. The ground shaking (accelerations) are used to estimate forces which are used in the seismic design process. In many cases smaller magnitude earthquakes closer to a site produce more severe ground shaking than larger, more distant earthquakes. Hence it is important to consider all potential earthquake sources regardless of magnitude.

Discussion: Earthquakes with very large magnitudes such as the March 2011 earthquake off the northeast coast of the Japanese island of Honshu occur within subduction zones, which are locations where one of the earth's tectonic plates is subducting beneath (being thrust under) another. The fault that defines the Japan Trench plate boundary dips to the west, i.e., becomes deeper towards the coast of Honshu. Large offshore earthquakes have historically occurred in the same subduction zone (in 1611, 1896, and 1933) all of which produced significant tsunami waves. The magnitudes of these previous large earthquakes have been estimated to be between 7.6 and 8.6. Prior to March 2011, the Japan Trench subduction zone has produced nine earthquakes with magnitudes greater than 7 just since 1973. The only subduction zone that is capable of directly impacting the continental US is the Cascadia subduction zone, which lies off of the coast of northern California, Oregon, and Washington. The fault surface defined by this interface dips to the east (becomes deeper) beneath the coast. The Cascadia subduction zone is capable of producing very large earthquakes if all or a large portion of the fault area ruptures in a single event. However, the rate of earthquake occurrence along the Cascadia subduction zone is much less than has been observed along the Japan Trench subduction zone. The only operating nuclear power plant in that area is Columbia, which is far from the coast (~220 miles/350 km) and the Cascadia subduction zone. *The occurrence of earthquakes on the Cascadia subduction zone has been considered in the evaluation of the Columbia NPP.*



Schematic Illustration of the Cascadia Subduction Zone

The size (magnitude) of earthquakes is proportional to the surface area of a fault that slips in a given earthquake. Large earthquakes are associated with large (long) faults. Hence, the prediction of earthquake magnitudes for a specific fault considers the dimensions of the fault. Identification of fault size

is usually based on geologic mapping or the evaluation of spatial patterns of small earthquakes. To provide **a point of comparison**, the length of the fault that slipped during the March 11, 2011 magnitude 9 Japanese earthquake was >620 km, the length of the fault(s) that slipped during the magnitude 7.3 1992 Landers, CA earthquake was ~90 km and the estimated length of the Hosgi fault near Diablo Canyon NPP is 140 km and a magnitude of 7.5 is assigned to that fault. A number of major crustal faults or fault zones (not associated with the Cascadia subduction zone) have been identified that have produced earthquakes of magnitude 7.5 to 8 in the continental US (including California). ***These fault sources have been identified and characterized in seismic hazard assessments.***

Seismic designs at US nuclear power plants are developed in terms of seismic ground motion spectra, which are called the Safe Shutdown Earthquake ground motion response spectra (SSE). Each nuclear power plant is designed to a ground motion level that is appropriate for the geology and tectonics in the region surrounding the plant location. Currently operating nuclear power plants developed their SSEs based on a "deterministic" or "scenario earthquake" basis that account for the largest earthquake expected in the area around the plant. Seismic activity in the regions surrounding US plants is much lower than that for Japan since **most US plants are located in the interior of the stable continental US**. The largest earthquakes within the continental US are the 1811-12 New Madrid sequence and the 1886 Charleston, SC, which were estimated to be between about magnitude 6.8 to 7.5. On the west coast of the US, the two nuclear power plants are designed to specific ground motions from earthquakes of about magnitude 7+ on faults located just offshore of the plants. The earthquakes on these faults are mainly strike-slip (horizontal motion on near vertical planes) type earthquakes, not subduction zone earthquakes. This fault geometry does not produce large tsunamigenic waves. Therefore, the likelihood of a significant tsunami from these faults is very remote.

Fact Sheet: US Portable Array Information

NOTE: This is provided because IRIS participants let us know that here was a discussion about the NRC's involvement in this program during a meeting with congressional staffers. We have been involved in this for the last couple years.



The Incorporated Research Institutions for Seismology is the Consortium of United States Universities with Major Research Programs in Seismology and Related Fields.

The Transportable Array: A Science Investment that Can Be Leveraged

IRIS is installing the Transportable Array – a set of 400 broadband seismic instruments – in each of more than 1600 sites across the contiguous United States. The instruments operate at each site for two years and then are removed and redeployed further east. Roughly 1100 stations have been installed since 2003, and instruments have been removed from more than 600 of those sites in the western United States.

The National Science Foundation is funding the full cost to “roll” the Transportable Array across the US, more than \$90,000,000 over ten years. Comparatively small incremental investments could add significant data that are relevant to the safety of nuclear power plants. These efforts would be uniquely cost effective, since NSF is already funding installation, and they would feed data into an existing, standardized and widely used data management system that already incorporates the vast majority of seismic data from US networks. But these opportunities are time constrained: the array will be fully installed in the contiguous 48 states by late 2013.

More Value from Longer Term Regional Observations

A dense, uniform seismic network is necessary for long-term, broad-area seismic monitoring of the central and eastern United States due to low event recurrence rates and the risk of significant earthquakes ($M > 5$) anywhere in the region. Monitoring seismicity in the central and eastern US can be improved by turning selected sites into permanent seismic stations. A total of more than 35 Transportable Array stations have already been “adopted” by several organizations, creating a permanent legacy, but only in the western United States.

A strategic “1-in-4” plan would involve “adoption” of systematically selected stations in the central and eastern United States – every other station in both the east-west and north-south directions, creating a uniform grid of some 250 stations. Long-term regional operation could be combined with two optional enhancements to create a unique observatory for the study of seismicity, source characteristics, attenuation, and local ground acceleration.

Enhancement 1: Acquire Higher Frequency Data

Crustal rigidity in the central and eastern US makes it desirable to record high frequency characteristics of local and regional earthquakes. The existing instruments could be reconfigured to record high frequencies but doing so would nearly triple the data flow, necessitating improvements to the communications infrastructure.

Enhancement 2: Add Strong Motion Sensors

Acquiring strong motion sensors and reconfiguring field computers that record and telemeter the data would help to measure unique effects of severe shaking. The design anticipated this augmentation, and several stations in California and Washington were operated that way. Upgrade would be more efficient at sites that have not yet been installed.

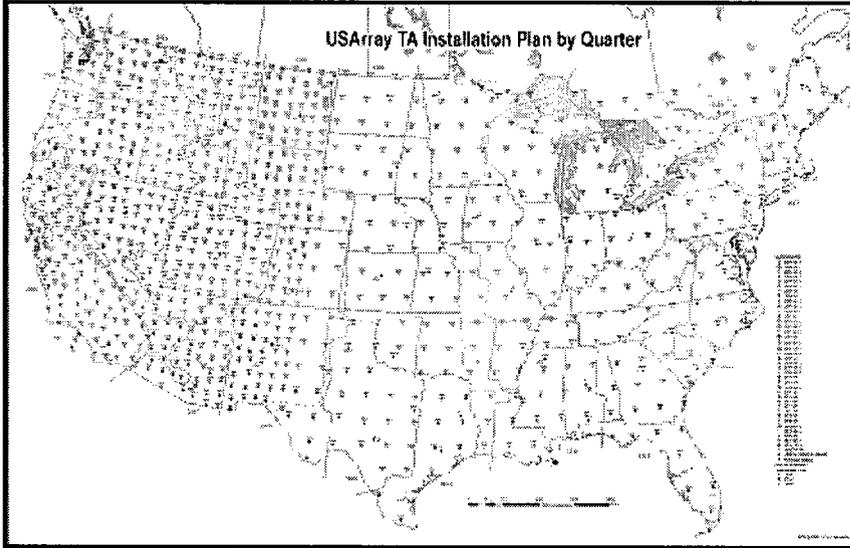
Estimate of annual acquisition and O&M costs for the 1-in-4, 250-station network in central and eastern US.

Year	Stations	Acquisition ¹	O&M ²	Total
2011	50	\$1,800,000	\$ 400,000	\$2,200,000
2012	50	\$1,800,000	\$ 800,000	\$2,600,000
2013	50	\$1,800,000	\$1,200,000	\$3,000,000
2014	50	\$1,800,000	\$1,600,000	\$3,400,000
2015	50	\$1,800,000	\$2,000,000	\$3,800,000
2016	–	–	\$2,000,000	\$2,000,000

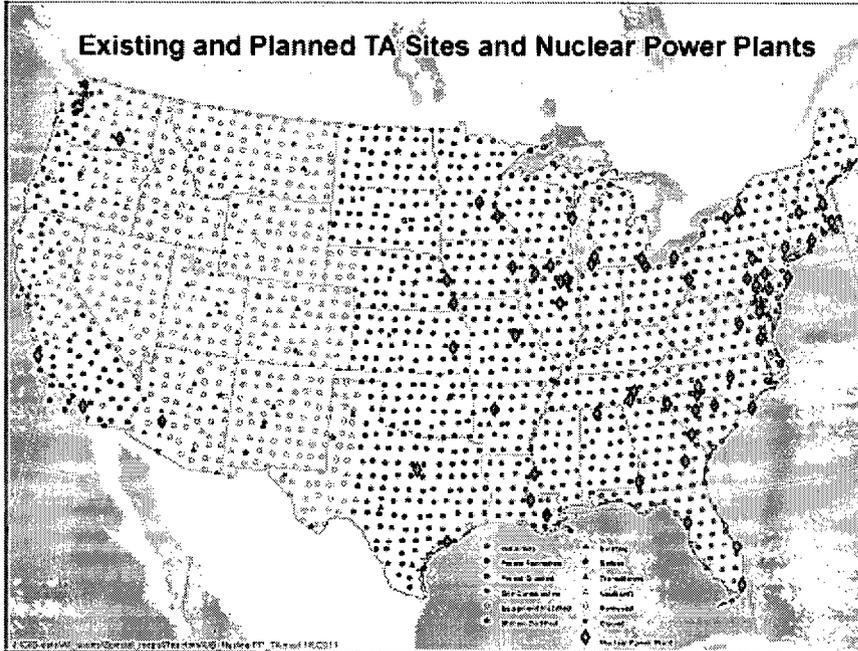
¹ Assumes upgrades to six channel data loggers with strong motion sensors.

² Assumes a conservative estimate of \$8,000/station/year.

The 1-in-4, 250-station network that could be created in the central and eastern US by "leaving behind" one out of every four Transportable Array stations during the years 2011 through 2015.



A large majority of nuclear power plants are located in the central and eastern parts of the US, where it is still possible to "leave behind" 1-in-4 Transportable Array stations for long-term regional observations.



Fact Sheet: The B.5.b Rule (10 CFR 50.54hh/B.5.b)

The following was taken from the Commission Briefing (3/21) notes:

Following the terrorist events of September 11, 2001, the NRC issued EA-02-026, "Order for Interim Safeguards and Security Compensatory Measures" (the ICM Order), February 25, 2002, (designated SGI), which specified interim safeguards and security compensatory measures. Section B.5.b of the ICM Order required licensees to adopt mitigation strategies using readily available resources to maintain or restore core cooling, containment, and SFP cooling capabilities to cope with the loss of large areas of the facility due to large fires and explosions from any cause, including beyond-design-basis aircraft impacts.

In June 2005 the NRC developed a phased approach to implement the B.5.b requirements:

- For Phase 1, the NRC expected licensees to use information from (1) existing programs and equipment and operational know-how, including maintaining capabilities currently in place, (2) industry best practices, and (3) application of generic lessons learned from engineering analyses.
- Phase 2 addressed assessment of SFPs including additional mitigation strategies that use existing or readily available resources to further enhance the plant's effectiveness in maintaining SFP cooling, and identify potential practicable options for the use of generic, deployable, or other backup mitigation capabilities that exceed the NRC's requirements.
- Phase 3 addressed assessment of the reactor and containment mitigation. This change allowed the staff to give priority to the assessment of SFPs before the reactor and containment.

On February 25, 2005, the NRC issued guidance for implementing Section B.5.b of the ICM Order. This included guidance on:

- Actions to Mitigate Fuel damage, which included:
 - Develop procedures to facilitate primary containment to secondary containment venting without AC power as an alternate remove heat from primary containment,
 - Develop/Modify procedures to start safety and or operate equipment to facilitate plant cooldown (Diesel generators, AFPs, RCIC) without DC power,
 - Identification and use of alternate water sources and pumping sources (such as a site fire pump as an alternate supply water for core cooling and SFP water),
 - Development of strategies for use of portable and offsite equipment to support recovery efforts (prefabricated and pre-staged cables, adapters, jumpers spool pieces, equipment needed for primary to secondary containment venting),
- Spent Fuel pool mitigation measures, which included:
 - Strategies for dispersing higher decay power (hottest) fuel amongst older low decay power (coolest) fuel to facilitate cooling, enabling air cooling if water level is lost in the reduced timeframes
 - Maintenance of empty space in the SFP to provide for a downcomer effect, facilitating natural circulation within the pool
 - Provide for emergency water makeup sources, and/or emergency repair

By December 2006, the staff had completed Phase 1 inspections at all operating reactor sites. In December 2006, the NRC endorsed NEI 06-12, Revision 2, "B.5.b Phase 2 & 3 Submittal Guideline," which provided specifications for standard mitigative strategies to address the maintenance or restoration of core cooling, containment and spent fuel pool cooling, including the use of some equipment that would have been beyond readily available. The strategies included those listed below:

- Adding make-up water to the SFP,
- Spraying water on the spent fuel,
- Enhanced initial command and control activities for challenges to core cooling and containment, and

- Enhanced response strategies for challenges to core cooling and containment.

The B.5.b Guidance and NEI 06-12, Revision 2, were used by each licensee in preparing information submitted to the NRC that describes a plant specific approach to implementing mitigating strategies and supports each plant specific license condition.

The NRC Performed Section B.5.b Phase 2 Assessments (June – December 2005) to Identify SFP Mitigation Strategies.

The NRC and Industry Performed B.5.b Phase 3 Assessments (October 2005 – June 2006) to Identify Reactor and Containment Mitigation Strategies.

In 2007, the NRC staff completed safety evaluations of licensee commitments submitted using the NEI 06-12 Guideline and imposed license conditions requiring them to provide a regulatory footprint. By December 2008 the NRC staff completed its inspection to verify the implementation of strategies and guidance at each facility.

On March 27, 2009, the NRC amended 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," and Part 73, "Physical Protection of Plants and Materials," with new requirements.

This rulemaking added 10 CFR 50.54(hh)(2) in order to impose the same mitigating strategies requirements on new reactor applicants and licensees as those imposed by the ICM Order and associated license conditions.

This rulemaking also added paragraph (i) to 10 CFR 50.34, "Contents of applications; technical information," to require submittal of a "description and plans for implementation of the guidance and strategies intended to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with the loss of large areas of the plant due to explosions or fire as required by § 50.54(hh)(2) of this chapter." (A parallel requirement was added as paragraph (d) to 10 CFR 52.80 for reactors licensed under 10 CFR Part 52, under the purview of the Office of New Reactors.)

The Statement of Considerations for this rulemaking specifically noted that the requirements described in Section 50.54(hh) are for addressing certain events that are the cause of large fires and explosions that affect a substantial portion of the nuclear power plant contemplates that the initiating event for such large fires and explosions could be any number of beyond-design basis events, including natural phenomena such as those described in General Design Criteria (i.e., earthquakes, tornadoes, floods, tsunami, and seiches).

Fact Sheet: Generic Issue GI-199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants"

The objective of the GI-199 Safety/Risk Assessment was to perform a conservative, screening-level assessment to evaluate if further investigations of seismic safety for operating reactors in the central and eastern U.S. (CEUS) are warranted consistent with NRC directives.

- (i) The results of the GI-199 safety risk assessment should not be interpreted as definitive estimates of plant-specific seismic risk.
- (ii) The nature of the information used (both seismic hazard data and plant-level fragility information) make these estimates useful only as a screening tool. The NRC does not rank plants by seismic risk.

Key Messages from the GI-199 Communications Plan:

- (i) In August 2010, the Safety/Risk Assessment for GI-199 was completed. That assessment found that operating nuclear power plants are safe: Plants have adequate safety margin for seismic issues. The NRC's Safety/Risk Assessment confirmed that overall seismic risk estimates remain small and that adequate protection is maintained.
- (ii) Though still small, some seismic hazard estimates have increased: Updates to seismic data and models indicate increased seismic hazard estimates for some operating nuclear power plant sites in the Central and Eastern United States.
- (iii) Assessment of GI-199 will continue: Plants are safe (see key message 1), but the NRC has separate criteria for evaluating whether plant improvements may be imposed.

The NRC's Safety/Risk Assessment used readily available information and found that for about one-quarter of the currently operating plants, the estimated core damage frequency change is large enough to warrant further attention. Action may include obtaining additional, updated information and developing methods to determine if plant improvements to reduce seismic risk are warranted.

Note: GI-199 Communication Plan is available in ADAMs: ML081850477.

Status of Operating Plants and Need of Additional Actions due to Japanese Event:

- Currently operating nuclear plants in the United States remain safe, with no need for immediate action.
- This determination is based on NRC staff reviews of updated seismic hazard information and the conclusions of the Generic Issue 199 Screening Panel.
- Existing plants were designed with considerable margin to be able to withstand the ground motions from the "deterministic" or "scenario earthquake" that accounted for the largest earthquake expected in the area around the plant.
- During the mid-to late-1990s, the NRC staff reassessed the margin beyond the design basis as part of the Individual Plant Examination of External Events (IPEEE) program.
- The results of the GI-199 assessment demonstrate that the probability of exceeding the design basis ground motion may have increased at some sites, but only by a relatively small amount. In addition, the Safety/Risk Assessment stage results indicate that the probabilities of seismic core damage are lower than the guidelines for taking immediate action.
- In summary, US plants are designed for appropriate earthquake levels and are safe. As addressed above, the NRC is conducting a program called Generic Issue 199, which is reviewing the adequacy of the earthquake design of US NPPs in central and eastern North America based

on the latest data and analysis techniques. The NRC will look closely at all aspects of the response of the plants in Japan to the earthquake and tsunami to determine if any actions need to be taken in US plants and if any changes are necessary to NRC regulations.

Timeline for Preparation and Issuance of GI-199 Generic Letter:

- The NRC is working on developing a Generic Letter (GL) to request information of all affected plants (96 plants that are east of the Rockies).
- The GL is planned to be issued in draft form within the next 2 months to stimulate discussions with industry in a public meeting.
- Process will be followed, i.e., Committee to Review Generic Requirements, Advisory Committee on Reactor Safeguards Meeting and then GL will be issued as a draft for formal public comments (60 days), followed by a second meeting with ACRS.
- We expect to issue the GL by the end of this calendar year, as the new consensus seismic hazard estimates become available. (This effort is being coordinated with US NRC, DOE, EPRI, and USGS).
- The information from licensees will likely require 3 to 6 months to complete. Staff's review will commence after receiving licensees' responses. Based on staff's review, a determination can be made regarding cost beneficial backfits where it can be justified.

Fact Sheet: Station Blackout Rule

The NRC designated station blackout (SBO), which is a loss of all offsite and onsite ac power concurrent with a turbine trip, as an Unresolved Safety Issue in 1980. In 1988, the Commission concluded that additional SBO regulatory requirements were justified and issued the SBO rule, 10 CFR 50.63, to provide further assurance that a loss of both offsite and onsite emergency AC power systems would not adversely affect public health and safety. As a result of the SBO rule all plants have (1) established SBO coping and recovery procedures; (2) completed training for these procedures; (3) implemented modifications as necessary to cope with an SBO; and (4) ensured a 4-16 hour coping capability. The coping capability was based on the reliability and redundancy of the on-site electrical system, the frequency of a loss of off-site power and the time needed to restore off-site power. The staff also performed pilot inspections at 8 sites to verify proper implementation of the SBO rule.

Based on the outcomes of those inspections the NRC staff concluded that the industry was properly implementing the rule. Each light-water-cooled nuclear power plant licensed to operate must be able to withstand for a specified duration and recover from a station blackout (as defined in 10 CFR 50.2). Forty-four (44) U.S. reactors rely on battery power (4-hour coping) and sixty (60) have opted to use an alternate AC source (4 to 16 hour coping) to cope with a SBO. The NRC staff reviewed the responses from every nuclear power plant and issued a SER accepting the proposed coping methods. Studies conducted by the NRC have shown that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense in depth. The NRC plans to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

Staff issued implementation guidance, Regulatory Guide (RG) 1.155, "Station Blackout," issued August 1988. Industry Issued SBO Rule Implementation Guidance NUMARC 87-00. During License renewal of power plants, staff reviewed aging management of SBO SSCs. SBO Rule requires that each light-water-cooled nuclear power plant licensed to operate under this part, each light-water-cooled nuclear power plant must be able to withstand for a specified duration and recover from a station blackout as defined in § 50.2. The specified station blackout duration shall be based on the following factors:

- (iv) The redundancy of the onsite emergency ac power sources;
- (v) The reliability of the onsite emergency ac power sources;
- (vi) The expected frequency of loss of offsite power; and
- (vii) The probable time needed to restore offsite power.

SBO Rule also requires that the reactor core and associated coolant, control, and protection systems, including station batteries and any other necessary support systems, must provide sufficient capacity and capability to ensure that the core is cooled and appropriate containment integrity is maintained in the event of a station blackout for the specified duration. The capability for coping with a station blackout of specified duration shall be determined by an appropriate coping analysis. Licensees are expected to have the baseline assumptions, analyses, and related information used in their coping evaluations available for NRC review. Currently, all plants are in compliance with 50.63, "Loss of all Alternating current Power". **All U.S. plants have the capability, capacity, and operating procedures in place to cope with a station blackout event.**

Additional reference: NUREG/CR-6890 (2005), "Reevaluation of Station Blackout Risk at Nuclear Power Plants."

Other useful resources:

• **Piping systems:**

- A paper was published in the Journal of Pressure Vessel Technology (May 1995, Volume 117) that provides a regulatory perspective on appropriate seismic loading stress criteria for advanced light-water reactor (ALWR) piping systems. It discusses the comprehensive review program by NRC and industry to develop appropriate design criteria for piping systems in ALWRs.
 - A note from the paper's author (David Terao): In light of the recent Tohoku earthquake, I thought it might be interesting to see what our (NRC's) thoughts on piping seismic design were at that time. In reading it after all these years, I find it provides a regulatory perspective that is still relevant and meaningful today.

Acronyms

A4NR – Alliance For Nuclear Responsibility
AAC – Alternate Alternating Current (AC)
ABWR (ABWRs) – Advanced Boiling Water Reactor(s)
ACRS – Advisory Committee on Reactor Safeguards
ACI – American Institute of Concrete
ADAMS – Agency wide Documents Access and Management System
AEF – Annual Exceedance Frequency
AISC – American Institute of Steel Construction
ANS – American Nuclear Society
ASME – American Society of Mechanical Engineers
B&PV – Boiler and Pressure Vessel
BWR (BWRs) – Boiling Water Reactor(s)
CAV – Cumulative Absolute Velocity
CCF – Common-Cause Failure
CEUS – Central and Eastern United States
CEUS-SSC – Central and Eastern United States Seismic Source Characterization
CDF – Core Damage Frequency
CDFM – Conservative Deterministic Failure Method
CFR – Code of Federal Regulations
COL – Combined License
COLA – Combined License Application
CSDRS – Certified Seismic Design Response Spectra
DART – Deep-ocean Assessment and Reporting of Tsunamis
DBE – Design Basis Earthquake
DBF – Design Basis Flood
DBGM – Design Basis Ground Motion
DC – Diablo Canyon, or Design Certification
DCD – Design Control Document
DCNPP – Diablo Canyon Nuclear Power Plant
DOE – Department of Energy
DORL – Division of Operating Reactor Licensing
EAL (EALs) – Emergency Action Level(s)
EDG (EDGs) – Emergency Diesel Generator(s)
EOP (EOPs) – Emergency Operating Procedure(s)
EPRI – Electric Power Research Institute
EPRI SMA – Electric Power Research Institute Seismic Margin Assessment
ESP (ESPs) – Early Site Permit(s)
FBR – Fast Breeder Reactor
FEMA – Federal Emergency Management Agency
FOSID – Frequency of Onset of Significant Inelastic Deformation
FSAR (FSARs) – Final Safety Analysis Report(s)
GDC – General Design Criterion
GMPE – Ground Motion Prediction Equation
GI – Generic Issue
GIP – Generic Issues Program

GIS – Graphic Information System
GL – Generic Letter
GMRS – Ground Motion Response Spectra
HCLPF – High Confidence of Low Probability of Failure
HMR – Hydrometeorological Reports
HQ – Headquarters
IAEA – International Atomic Energy Agency
ICM – Interim Compensatory Measures
IE (IEs) – Internal Event(s), or Initiating Event(s)
IEEE – Institute of Electrical and Electronics Engineers
IP – Office of International Programs
IPEEE (IPEEEs) – Individual plant examination for external event(s)
IRIS – Incorporated Research Institutions for Seismology
ISLOCA – Interfacing Systems Loss-of-Coolant Accident
KKNPP – Kashiwazaki-Kariwa Nuclear Power Plant
LERF – Large Early Release Frequency
LIC – a type of NRC document
LOCA – Loss-of-Coolant Accident
LOSP – Loss of Offsite Power
LTSBO – Long-Term Station Blackout
MLLW – Mean Lower Low Water
MLLWL – Mean Lower Low Water Line
MLW – Mean Low Water
MMI – Modified Mercalli Intensity
MSL – MEAN Sea Level
MSNBC – Microsoft/National Broadcasting Company
N/A (n/a) – Not applicable
NFPA – National Fire Protection Association
NISA – Nuclear and Industrial Safety Agency
NOAA – National Oceanic and Atmospheric Administration
NPP (NPPs) – Nuclear Power Plant(s)
NRC – Nuclear Regulatory Commission
NRO – Office of New Reactors
NRR – Office of Reactor Regulations
NSF – National Science Foundation
NUREG – NRC Regulatory Guidance Document
NWS – National Weather Service
OBE – Operating-Basis Earthquake
OPA – Office of Public Affairs
OSID – Onset of Significant Inelastic Deformation
PDF – Portable Document Format
PF – Target Performance Goal
PGA – Peak Ground Acceleration
PMEL – Pacific Marine Environmental Laboratory
PMF – Probable Maximum Flood
PMH – Probable Maximum Hurricane
PMP – Probable Maximum Precipitation
PMT – Probable Maximum Tsunami

PRA – Probabilistic Risk Assessment
PSA – Probabilistic Safety Assessment
PSHA – Probabilistic Seismic Hazard Analysis
PWR (PWRs) – Pressurized Water Reactor(s)
QME – Qualification of Active Mechanical Equipment
Q&As – Questions and Answers
RCP (RCPs) – Reactor Cooling Pump(s)
RCS – Reactor Coolant System
RES – Office of Nuclear Regulatory Research
RG – Regulatory Guide
RIL – Research Information Letter
RLE – Review Level Earthquake
RSZ – Ramapo Source Zone
SAMG (SAMGs) – Severe Accident Mitigation Guidelines(s)
SBO – Station blackout
SCDF – Seismic Core Damage Frequency
SCEC – Southern California Earthquake Center
SCR – Stable Continental Region
SDC – Seismic Design Category
SEL – Seismic Equipment List
SMA – Seismic Margin Assessment
SONGS – San Onofre Nuclear Generating Station
SPRA – Seismic Probabilistic Risk Assessment
SRA – Seismic Risk Assessment
S₁, S₂, S₃ – Specified Earthquake Ground Motions
SSC (SSCs) – Seismic Source Characteristics (Characterizations), or Structure, System, or Component
SSE – Safe Shutdown Earthquake
SSEL – Safe Shutdown Equipment List
SSHAC – Senior Seismic Hazard Analysis Committee
SZ – Seismic Zone
TEPCO – Tokyo Electric Power Company
UCERF – Uniform California Earthquake Rupture Forecast
UHRs (UHS) – Uniform Hazard Response Spectra
US – United States
USACE – United States Army Corps of Engineers
USGS – United States Geological Survey
VCT – Volume Control Tank
VDC – Volts Direct Current (DC)

Terms and Definitions

Acceptable Method – In many places, this standard contains statements indicating that a certain reference provides an “acceptable method” for satisfying the intent of a given requirement. The plain meaning of such a statement is that the referenced method is one way to meet the given requirement. The intent is to be permissive, meaning that the analysis team can use another method, if justified, without prejudice. However, it is important to understand that the intent of the standard goes beyond the plain meaning, as follows: Whenever the phrasing “acceptable method” is used, the intent is that if the analysis uses another method, the other method must satisfy the stated requirement with a comparable level of conservatism considering a similar level of details pertinent to the analysis scope. It is not acceptable to use another method that does not satisfy the requirement at least as well as the acceptable method would satisfy it. Whenever an alternative to the acceptable method is selected, it is understood that the peer review team will pay particular attention to this topic.

Accident Consequences – The extent of plant damage or the radiological release and health effects to the public or the economic costs of a core damage accident.

Accident Sequence – A representation in terms of an initiating event (IE) followed by a sequence of failures or successes of events (such as system, function, or operator performance) that can lead to undesired consequences, with a specified end state (e.g., core damage or large early release).

Accident Sequence Analysis – The process to determine the combinations of IEs, safety functions, and system failures and successes that may lead to core damage or large early release.

Active or Seismogenic Fault – need to add definition of active fault

Aleatory Variability (or Aleatory Uncertainty) – The variability inherent in a nondeterministic (i.e., stochastic, random) phenomenon. Aleatory variability is accounted for by modeling the phenomenon in terms of a probability model. In principle, aleatory uncertainty cannot be reduced by the accumulation of more data or additional information, but the detailed characteristics of the probability model can be improved. Sometimes aleatory variability is called “randomness.”

Annual Exceedance Frequency (AEF) – Number of times per year that a site’s ground motion is expected to exceed a specified acceleration.

Area Source – An area at the surface of the earth’s crust that is assumed to have experienced relatively uniform earthquake source characteristics for use in the PSHA. (See also “Volumetric Source Zone”.)

At Power – Those plant operating states characterized by the reactor being critical and producing power, with automatic actuation of critical safety systems not blocked and with essential support systems aligned in their normal power operation configuration.

Background Source Zone – A part of the earth’s crust, usually of large surface area dimension, within which potentially damaging earthquakes could occur that are not associated either with known fault sources or even with the uniform pattern, rate, or style of deformation or seismicity commonly identified with volumetric seismic source zones. In PSHA calculations, earthquakes that cannot be associated with other sources default to a background source zone.

Basic Event – An event in a fault tree model that requires no further development, because the appropriate limit of resolution has been reached.

Bounding Analysis – Analysis that uses assumptions such that the assessed outcome will meet or exceed the maximum severity of all credible outcomes.

Capable Tectonic Source – A capable tectonic source is a tectonic structure that can generate both vibratory ground motion and tectonic surface deformation such as faulting or folding at or near the earth’s surface in the present seismotectonic regime. It is described by at least one of the following characteristics:

1. presence of surface or near-surface deformation of landforms or geologic deposits of a recurring nature within the last approximately 500,000 years or at least once in the last approximately 50,000 years
2. a reasonable association with one or more moderate to large earthquakes or sustained earthquake activity that are usually accompanied by significant surface deformation
3. a structural association with a capable tectonic source that has characteristics of either item a or b (above), such that movement on one could be reasonably expected to be accompanied by movement on the other

In some cases, the geological evidence of past activity at or near the ground surface along a potential capable tectonic source may be obscured at a particular site. This might occur, for example, at a site having a deep overburden. For these cases, evidence may exist elsewhere along the structure from which an evaluation of its characteristics in the vicinity of the site can be reasonably based. Such evidence is to be used in determining whether the structure is a capable tectonic source within this definition. Notwithstanding the foregoing paragraphs, the association of a structure with geological structures that are at least pre-Quaternary, such as many of those found in the central and eastern regions of the United States, in the absence of conflicting evidence, will demonstrate that the structure is not a capable tectonic source within this definition.

CDFM Method – Refers to the Conservative Deterministic Failure Margin (CDFM) method as described in EPRI NP-6041-56, Rev. 1 wherein the seismic margin of the component is calculated using a set of deterministic rules that are more realistic than the design procedures.

Central and Eastern United States (CEUS) – That portion of the United States east of the Rocky Mountains (approximately the 104th parallel).

Certified Seismic Design Response Spectra (CSDRS) – Site-independent seismic design response spectra that have been approved under Subpart B of 10 CFR Part 52 as the seismic design response spectra for an approved certified standard design nuclear power plant. The input or control location for the CSDRS is specified in the certified standard design.

Combined License – A combined construction permit and operating license with conditions for a nuclear power facility issued pursuant to Subpart C of 10 CFR Part 52.

Common-Cause Failure (CCF) – A failure of two or more components during a short period of time as a result of a single shared cause.

Component – An item in a nuclear power plant, such as a vessel, pump, valve, or circuit breaker.

Composite Variability – The composite variability includes the aleatory (randomness) uncertainty (β_R) and the epistemic (modeling and data) uncertainty (β_U). The logarithmic standard deviation of composite variability, β_c , is expressed as $(\beta_R^2 + \beta_U^2)^{1/2}$.

Containment Analysis – The process to evaluate the failure thresholds or leakage rates of the containment.

Containment Failure – Loss of integrity of the containment pressure boundary from a core damage accident that results in unacceptable leakage of radionuclides to the environment.

Controlling Earthquakes – Earthquakes used to determine spectral shapes or to estimate ground motions at the site for some methods of dynamic site response. There may be several controlling earthquakes for a site. As a result of the probabilistic seismic hazard analysis (PSHA), controlling earthquakes are characterized as mean magnitudes and distances derived from a deaggregation analysis of the mean estimate of the PSHA.

Core Damage Frequency (CDF) – Expected number of core damage events per unit of time.

Core Damage – Refers to the uncovering and heat-up of the reactor core, to the point that prolonged oxidation and severe fuel damage are not only anticipated but also involve enough of the core to result

in off-site public health effects if released. *Seismic core damage frequency* refers to the component of total CDF that is due to seismic events.

Cumulative Absolute Velocity (CAV) – For each component of the free-field ground motion, the CAV should be calculated as follows: (1) the absolute acceleration (g units) time-history is divided into 1-second intervals, (2) each 1-second interval that has at least 1 exceedance of 0.025g is integrated over time, and (3) all the integrated values are summed together to arrive at the CAV. The CAV is exceeded if the calculation is greater than 0.16 g-second. The application of the CAV in siting requires the development of a CAV model because the PSHA calculation does not use time histories directly.

Deaggregation – The process for determining the fractional contribution of each magnitude-distance pair to the total seismic hazard. To accomplish this, a set of magnitude and distance bins are selected and the annual probability of exceeding selected ground acceleration parameters from each magnitude-distance pair is computed and divided by the total probability for earthquakes.

Dependency – Requirement external to an item and upon which its function depends and is associated with dependent events that are determined by, influenced by, or correlated to other events or occurrences.

Design Basis Earthquake (DBE) or Safe Shutdown Earthquake (SSE) – A *design basis earthquake* is a commonly employed term for the *safe shutdown earthquake (SSE)*; the SSE is the earthquake ground shaking for which certain structures, systems, and components are designed to remain functional. In the past, the SSE has been commonly characterized by a standardized spectral shape associated with a peak *ground acceleration* value.

Design Factor – The ratio between the site-specific GMRS and the UHRS. The design factor is aimed at achieving the target annual probability of failure associated with the target performance goals.

Distribution System – Piping, raceway, duct, or tubing that carries or conducts fluids, electricity, or signals from one point to another.

Early Site Permit (ESP) – A Commission approval, issued pursuant to Subpart A of 10 CFR Part 52, for a site or sites for one or more nuclear power facilities.

Earthquake Recurrence – The frequency of occurrence of earthquakes as a function of magnitude. Recurrence relationships or curves are developed for each seismic source, and they reflect the frequency of occurrence (usually expressed on an annual basis) of magnitudes up to the maximum, including measures of uncertainty.

Epicenter – The point on the earth's surface directly above the focus (i.e., hypocenter) of the earthquake source.

Epistemic Uncertainty – Uncertainty attributable to incomplete knowledge about a phenomenon that affects the ability to model it. Epistemic uncertainty is captured by considering a range of model parameters within a given expert interpretation or multiple expert interpretations and each of which is assigned an associated weight representing statistical confidence in the alternatives. In principle, epistemic uncertainty can be reduced by the accumulation of additional information associated with the phenomenon. The uncertainty in the parameters of the probability distribution of a random phenomenon is epistemic.

Event Tree – A logic diagram that begins with an IE or condition and progresses through a series of branches that represent expected system or operator performance that either succeeds or fails and arrives at either a successful or failed end state.

External Event – An IE originating outside a nuclear power plant that causes safety system failures, operator errors, or both, that in turn may lead to core damage or large early release. Events such as earthquakes, tornadoes, and floods from sources outside the plant and fires from sources inside or outside the plant are considered external events (see also internal event). By convention, LOSEP not caused by another external event is considered by convention to be an internal event.

Failure Mechanism – Any of the processes that result in failure modes, including chemical, electrical, mechanical, physical, thermal, and human error.

Failure Mode – A specific functional manifestation of a failure (i.e., the means by which an observer can determine that a failure has occurred) by precluding the successful operation of a piece of equipment, a component, or a system (e.g., fails to start, fails to run, leaks).

Failure Probability – The likelihood that an SSC will fail to operate upon demand or fail to operate for a specific mission time.

Failure Rate – Expected number of failures per unit of time, evaluated, for example, by the ratio of the number of failures in a total population of components to the total time observed for that population.

Fault – A fracture in the earth along which blocks of crust on either side have moved with respect to one another.

Fault Source – A fault or zone for which the tectonic features causing earthquakes have been identified. These are usually individual faults, but they may be zones comprising multiple faults or regions of faulting if surface evidence of these faults is lacking but the faults are suspected from seismicity patterns, tectonic interpretations of crustal stress and strain, and other evidence. Regions of blind thrust faults are a good example of the latter.

Fault Tree – A deductive logic diagram that depicts how a particular undesired event can occur as a logical combination of other undesired events.

Fractile Hazard Curve – Epistemic uncertainty is expressed by a distribution of exceedence probability values; a distribution of hazard curves, rather than a single value; or a single curve. In a fractile hazard curve, all the points on the curve correspond to the same fractile of the distribution of the probability of exceedence. A 5% percentile hazard curve indicates that we have a 5% confidence that the calculated hazard would be less than that given by the curve. A 95% percentile hazard curve indicates that we are 95% confident that the hazard is below the hazard given by the hazard curve.

Fragility – Fragility of an SSC is the conditional probability of its failure at a given hazard input level. The input could be earthquake motion, wind speed, or flood level. The fragility model used in seismic PRA is known as a double lognormal model with three parameters, A_m , b_R , and b_U , which are, respectively, the median acceleration capacity, the logarithmic standard deviation of the aleatory (randomness) uncertainty in capacity, and the logarithmic standard deviation of the epistemic (modeling and data) uncertainty in the median capacity.

Frequency of Onset of Significant Inelastic Deformation (FOSID) – The annual probability of the onset of significant inelastic deformation (OSID). OSID is just beyond the occurrence of insignificant (or localized) inelastic deformation, and in this way corresponds to “essentially elastic behavior.” As such, OSID of a

structure, system, or component (SSC) can be expected to occur well before seismically induced core damage, resulting in much larger frequencies of OSID than seismic core damage frequency (SCDF) values. In fact, OSID occurs before SSC "failure," where the term failure refers to impaired functionality.

Ground Acceleration – Acceleration produced at the ground surface by seismic waves, typically expressed in units of g , the acceleration of gravity at the earth's surface.

Ground Motion Response Spectra (GMRS) – A site-specific ground motion response spectra characterized by horizontal and vertical response spectra determined as free-field motions on the ground surface or as free-field outcrop motions on the uppermost in-situ competent material using performance-based procedures. When the GMRS are determined as free-field outcrop motions on the uppermost in-situ competent material, only the effects of the materials below this elevation are included in the site response analysis.

Ground Motion Slope Ratio – Ratio of the spectral accelerations, frequency by frequency, from a seismic hazard curve corresponding to a 10-fold reduction in hazard exceedance frequency. (See Equation 3 in Regulatory Position 5.1.)

Hazard – The physical effects of a natural phenomenon such as flooding, tornado, or earthquake that can pose potential danger (for example, the physical effects such as ground shaking, faulting, landsliding, and liquefaction that underlie an earthquake's potential danger).

Hazard (as used in probabilistic hazard assessment) – Represents the estimate of expected frequency of exceedance (over some specified time interval) of various levels of some characteristic measure of a natural phenomenon [for example, peak ground acceleration (PGA) to characterize ground shaking from earthquakes]. The time period of interest is often taken as 1 year, in which case the estimate is called the annual frequency of exceedance.

Hazard Curve – A curve that gives the probability of a certain ground motion parameter (usually the PGA, PGV, or response spectral values) being exceeded. Hazard curves are generally generated for periods of exposure of one year, and they give annual probabilities of exceedence.

HCLPF Capacity – Refers to the High Confidence of Low Probability of Failure capacity, which is a measure of seismic margin. In seismic PRA, this is defined as the earthquake motion level at which there is a high (95 percent) confidence of a low (at most 5 percent) probability of failure. Using the lognormal fragility model, the HCLPF capacity is expressed as $A_m \exp[-1.65(\beta_R + \beta_U)]$. When the logarithmic standard deviation of composite variability β_c is used, the HCLPF capacity could be approximated as the ground motion level at which the composite probability of failure is at most 1 percent. In this case, HCLPF capacity is expressed as $A_m \exp[-2.33\beta_c]$. In deterministic SMAs, the HCLPF capacity is calculated using the CDFM method.

High Confidence of Low Probability of Failure (HCLPF) Capacity – A measure of *seismic margin*. In seismic risk assessment, *HCLPF capacity* is defined as the earthquake motion level, at which there is high confidence (95%) of a low probability (at most 5%) of failure of a structure, system, or component.

High Winds – Tornadoes, hurricanes (or cyclones or typhoons as they are known outside the United States), extratropical (thunderstorm) winds, and other wind phenomena depending on the site location.

Hypocenter – The point of the earth's crust where a rupture initiates, creating an earthquake.

In-column Motion – Motion that is within a soil column, as opposed to the motion at the surface or treated as if it is at the surface.

Initiating Event (IE) – Any event either internal or external to the plant that perturbs the steady-state operation of the plant, if operating, thereby initiating an abnormal event such as a transient or loss-of-coolant accident (LOCA) within the plant. Initiating events trigger sequences of events that challenge plant control and safety systems whose failure could potentially lead to core damage or large early release.

Intensity – The intensity of an earthquake is a qualitative description of the effects of the earthquake at a particular location, as evidenced by observed effects on humans, on human-built structures, and on the earth's surface at a particular location. Commonly used scales to specify intensity are the Rossi-Forel, Mercalli, and Modified Mercalli. The Modified Mercalli Intensity (MMI) scale describes intensities with values ranging from I to XII in the order of severity. MMI of I indicates an earthquake that was not felt except by a very few, whereas MMI of XII indicates total damage of all works of construction, either partially or completely.

Interfacing Systems LOCA (ISLOCA) – A loss-of-coolant accident (LOCA) when a breach occurs in a system that interfaces with the reactor coolant system (RCS), where isolation between the breached system and the RCS fails. An ISLOCA is usually characterized by the overpressurization of a low-pressure system when subjected to RCS pressure and can result in containment bypass.

Internal Event – An event originating within a nuclear power plant that in combination with safety system failures, operator errors, or both, can affect the operability of plant systems and may lead to core damage or large early release. By convention, loss of off-site power not caused by an external event is considered to be an internal event, and internal fire is considered to be an external event.

Key Assumption – An assumption made in response to a key source of uncertainty in the knowledge that a different reasonable alternative assumption would produce different results, or an assumption that results in an approximation made for modeling convenience in the knowledge that a more detailed model would produce different results. For the base PRA, the term “different results” refers to a change in the plant risk profile (e.g., total CDF and total LERF, the set of initiating events and accident sequences that contribute most to CDF and to LERF) and the associated changes in insights derived from the changes in risk profile. A “reasonable alternative” assumption is one that has broad acceptance within the technical community and for which the technical basis for consideration is at least as sound as that of the assumption being challenged.

Key Source of Uncertainty – A source of uncertainty that is related to an issue for which there is no consensus approach or model and where the choice of approach or model is known to have an impact on the risk profile (e.g., total CDF and total LERF, the set of initiating events and accident sequences that contribute most to CDF and LERF) or a decision being made using the PRA. Such an impact might occur, for example, by introducing a new functional accident sequence or a change to the overall CDF or LERF estimates significant enough to affect insights gained from the PRA.

Large Early Release – The rapid, unmitigated release of airborne fission products from the containment to the environment occurring before the effective implementation of off-site emergency response and protective actions, such that there is a potential for early health effects.

Large Early Release Frequency (LERF) – The expected number of large early releases per unit of time. A *large early release* is the rapid, unmitigated release of airborne fission products from the containment building to the environment, occurring before the effective implementation of off-site emergency

response and protective actions, such that there is a potential for early health effects. *Seismic large early release frequency* refers to the component of total LERF that is due to seismic events.

Level 1 Analysis – Identification and quantification of the sequences of events leading to the onset of core damage.

Level 2 Analysis – Evaluation of containment response to severe accident challenges and quantification of the mechanisms, amounts, and probabilities of subsequent radioactive material releases from the containment.

Liquefaction – The sudden loss of shear strength and rigidity of saturated, cohesionless soils, due to steady-state groundwater flow or vibratory ground motion. The term “seismic liquefaction” is used in this standard for liquefaction phenomena induced by seismic motions.

Magnitude – An earthquake’s magnitude is a measure of the strength of the earthquake as determined from seismographic observations and is an objective, quantitative measure of the size of an earthquake. The magnitude can be expressed in various ways based on seismographic records (e.g., Richter Local Magnitude, Surface Wave Magnitude, Body Wave Magnitude, and Moment Magnitude). Currently, the most commonly used magnitude measurement is the Moment Magnitude, M_w , which is based on the seismic moment computed as the rupture force along the fault multiplied by the average amount of slip, and thus is a direct measure of the energy released during an earthquake.

Maximum Magnitude – The maximum magnitude is the upper bound to earthquake recurrence curves.

Median Hazard Curve – Corresponds to a 50%, or the 50th fractile, hazard curve.

Mean Hazard Curve – Corresponds to the mean of the probability distribution of hazard curves.

Mean Site Amplification Function – The mean amplification function is obtained for each controlling earthquake, by dividing the response spectrum from the computed surface motion by the response spectrum from the input hard rock motion, and computing the arithmetic mean of the individual response spectral ratios.

Nontectonic Deformation – Nontectonic deformation is distortion of surface or near-surface soils or rocks that is not directly attributable to tectonic activity. Such deformation includes features associated with subsidence, karst terrain, glaciation or deglaciation, and growth faulting.

Operating-Basis Earthquake (OBE) – To satisfy the requirements of paragraph IV(a)(2)(A) of Appendix S to 10 CFR Part 50, the operating-basis earthquake (OBE) ground motion is defined as follows:

- For the certified design portion of the plant, the OBE ground motion is one-third of the CSDRS.
- For the safety-related noncertified design portion of the plant, the OBE ground motion is one-third of the design motion response spectra, as stipulated in the design certification conditions specified in design control document (DCD).
- The spectrum ordinate criterion to be used in conjunction with Regulatory Guide 1.166, “Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-earthquake Actions,” issued March 1997, is the lowest of (i) and (ii).

That earthquake ground motion that, when exceeded (along with a CAV value exceedance) requires shutdown of the plant. In the past, the OBE was commonly chosen to be one-half of the safe shutdown earthquake (SSE). However, newer guidance sets the OBE at 1/3 of the SSE unless additional calculations are performed.

Peak Ground Acceleration (PGA) – Maximum absolute value of acceleration displayed on an accelerogram, the largest ground acceleration produced by an earthquake at a site.

Peak Ground Displacement – The largest ground displacements produced by an earthquake at a site.

Peak Ground Velocity – The largest ground velocity produced by an earthquake at a site.

Plant – A general term used to refer to a nuclear power facility (for example, “plant” could be used to refer to a single unit or multiunit site).

Point Estimate – Estimate of a parameter in the form of a single number.

Probabilistic Risk Assessment (PRA) – A qualitative and quantitative assessment of the risk associated with plant operation and maintenance that is measured in terms of frequency of occurrence of risk metrics, such as core damage or a radioactive material release and its effects on the health of the public [also referred to as a probabilistic safety assessment (PSA)].

Probability of Exceedence – The probability that a specified level of seismic hazard will be exceeded at a site or in a region during a specified exposure time.

PRA Configuration Control Plan – The process and document used by the owner of the PRA to define the PRA technical elements that are to be periodically maintained and/or upgraded and to document the methods and strategies for maintenance and upgrading of those PRA technical elements.

Randomness (as used in seismic-fragility analysis) – The variability in seismic capacity arising from the randomness of the earthquake characteristics for the same acceleration and to the structural response parameters that relate to these characteristics. Also see “Aleatory Variability.”

Response Spectrum – A plot of the maximum responses (acceleration, velocity, or displacement) of idealized single-degree-of-freedom oscillators as a function of the natural frequencies of the oscillators for a given damping value. The response spectrum is calculated for a specified vibratory motion input at the oscillators’ supports.

Review Level Earthquake (RLE) – An earthquake larger than the plant SSE and is chosen in seismic margin assessment (SMA) for initial screening purposes. Typically, the RLE is defined in terms of a ground motion spectrum. (Note—A majority of plants in the Eastern and Midwestern United States have conducted SMA reviews for an RLE of 0.3g PGA anchored to a median NUREGOCR-0098 spectrum.)

Ring Area – Annular region bounded by radii associated with the distance rings used in hazard deaggregation (RG 1.208, Appendix D, Table D.1, “Recommended Magnitude and Distance Bins”).

Risk – Probability and consequences of an event, as expressed by the “risk triplet” that is the answer to the following three questions: (a) What can go wrong? (b) How likely is it? and (c) What are the consequences if it occurs?

Safe Shutdown Earthquake Ground Motion (SSE) – The vibratory ground motion for which certain structures, systems, and components are designed, pursuant to Appendix S to 10 CFR Part 50, to remain functional. The SSE for the site is characterized by both horizontal and vertical free-field ground motion response spectra at the free ground surface. [paragraph IV(a)(1)(i) of Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants,” to Title 10, Part 50, “Domestic Licensing of Production and Utilization Facilities,” of the Code of Federal Regulations (10 CFR Part 50).] Staff’s current guidance on SSE is found in Regulatory Guide 1.208 (2007)

Safe Shutdown Equipment List (SSEL) – The list of all SSCs that require evaluation in the seismic-margins-calculation task of an SMA. Note that this list can be different from the seismic equipment list (SEL) used in a seismic PRA.

Safety Function – Function that must be performed to control the sources of energy in the plant and radiation hazards.

Safety Related – SSCs that are relied upon to remain functional during and following design-basis events to ensure (a) the integrity of the reactor coolant pressure boundary, (b) the capability to shut down the reactor and maintain it in a safe shutdown condition, or (c) the capability to prevent or mitigate the consequences of accidents that could result in potential off-site exposures comparable to the applicable exposures established by the regulatory authority.

Safety Systems – Those systems that are designed to prevent or mitigate a design-basis accident.

Screening Analysis – An analysis that eliminates items from further consideration based on their negligible contribution to the frequency of an accident or of its consequences.

Screening Criteria – The values and conditions used to determine whether an item is a negligible contributor to the probability of an accident sequence or its consequences.

Seismic Design Category (SDC) – A category assigned to an SSC that is a function of the severity of adverse radiological and toxicological effects of the hazards that may result from the seismic failure of the SSC on workers, the public, and the environment. SSCs may be assigned to SDCs that range from 1 through 5. For example, a conventional building whose failure may not result in any radiological or toxicological consequences is assigned to SDC-1; a safety-related SSC in a nuclear material processing facility with a large inventory of radioactive material may be placed in SDC-5. In this standard, the term SDC has a different meaning than in the International Building Code. ANSI/ANS-2.26-2004 [1] provides guidance on the assignment of SSCs to SDCs.

Seismic Equipment List (SEL) – The list of all SSCs that require evaluation in the seismic-fragilities task of a seismic PRA. Note that this list can be different from the SSEL used in an SMA.

Seismic Hazard – Any physical phenomenon, such as ground motion or ground failure, that is associated with an earthquake and may produce adverse effects on human activities (such as posing a risk to a nuclear facility).

Seismic margin – The difference between a plant's capacity and its seismic design basis (*safe shutdown earthquake, or SSE*).

Seismic Margin Assessment (SMA) – The process or activity to estimate the seismic margin of the plant and to identify any seismic vulnerabilities in the plant. This is described further in Appendix C.

Seismic Risk – The risk (frequency of occurrence multiplied by its consequence) of severe earthquake-initiated accidents at a nuclear power plant. A severe accident is an accident that causes core damage, and, possibly, a subsequent release of radioactive materials into the environment. Several risk metrics may be used to express *seismic risk*, such as *seismic core damage frequency* and *seismic large early release frequency*.

Seismic Source – A general term referring to both seismogenic sources and capable tectonic sources. A seismogenic source is a portion of the earth assumed to have a uniform earthquake potential (same expected maximum earthquake and recurrence frequency), distinct from the seismicity of the surrounding regions. A capable tectonic source is a tectonic structure that can generate both vibratory ground motion and tectonic surface deformation such as faulting or folding at or near the earth's surface. In a probabilistic seismic hazard analysis (PSHA), all seismic sources in the site region with a potential to contribute to the frequency of ground motions (i.e., the hazard) are considered.

Seismic Spatial Interaction – An interaction that could cause an equipment item to fail to perform its intended safety function. It is the physical interaction of a structure, pipe, distribution system, or other equipment item with a nearby item of safety equipment caused by relative motions from an earthquake. The interactions of concern are (a) proximity effects, (b) structural failure and falling, and (c) flexibility of attached lines and cables.

Seismic Source Characteristics (SSC) – The parameters that characterize a seismic source for PSHA, including source geometry, probability of activity, maximum magnitude, and earthquake recurrence.

Seismic Wave Transmission (Site Amplification) – The amplification (increase or decrease) of earthquake ground motion by rock and soil near the earth's surface in the vicinity of the site of interest. Topographic effects, the effect of the water table, and basin edge wave-propagation effects are sometimes included under site response.

Seismogenic Crust – The brittle portion of the earth's crust capable of generating earthquakes.

Seismogenic Source – A portion of the earth that is assumed to have a uniform earthquake potential (same expected maximum earthquake and recurrence frequency), distinct from that of surrounding sources. A seismogenic source will generate vibratory ground motion but is assumed to not cause surface displacement. Seismogenic sources cover a wide range of seismotectonic conditions, from a well-defined tectonic structure to simply a large region of diffuse seismicity.

Seismotectonic – Rock-deforming processes and resulting structures and seismicity that occur over large sections of the earth's crust and upper mantle.

Senior Seismic Hazard Analysis Committee (SSHAC) – A committee sponsored by the NRC, DOE, and EPRI to review the state of the art and improve the overall stability of the PSHA process. SSHAC [4] concluded that most of the differences were consequences of differences in the process of elicitation of the information from experts. SSHAC made recommendations on the process, which are now almost uniformly adopted by analysts worldwide.

Severe Accident – An accident that usually involves extensive core damage and fission product release into the reactor vessel, containment, or the environment.

Shall, Should, and May – The word “shall” is used to denote a requirement; the word “should” is used to denote a recommendation; and the word “may” is used to denote permission, neither a requirement nor a recommendation.

Required Plant Shutdown Criteria– Appendix S to 10 CFR Part 50 (3) has the following information: Required Plant Shutdown. If vibratory ground motion exceeding that of the Operating Basis Earthquake Ground Motion or if significant plant damage occurs, the licensee must shut down the nuclear power plant. If systems, structures, or components necessary for the safe shutdown of the nuclear power plant are not available after the occurrence of the Operating Basis Earthquake Ground Motion, the licensee must consult with the Commission and must propose a plan for the timely, safe shutdown of the nuclear power plant. Prior to resuming operations, the licensee must demonstrate to the Commission that no functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public and the licensing basis is maintained.

Significant Contributor – (a) In the context of an accident sequence, a significant basic event or an initiating event that contributes to a significant sequence; (b) in the context of an accident progression

sequence, a contributor that is an essential characteristic (e.g., containment failure mode, physical phenomena) of a significant accident progression sequence, and if not modeled would lead to the omission of the sequence.

Significant Basic Event – A basic event that has a Fussell-Vesely importance greater than 0.005 OR a risk-achievement worth greater than 2. significant cutset (relative to sequence): Those cutsets that, when rank ordered by decreasing frequency, comprise 95 percent of the sequence CDF OR that individually contribute more than 1 percent to the sequence CDF.

Significant Cutset (relative to CDF) – Those cutsets that, when rank ordered by decreasing frequency, comprise 95 percent of the CDF OR that individually contribute more than 1 percent to CDF.

Significant Accident Sequence – A significant accident sequence is one of the set of sequences, defined at the functional or systemic level that, when rank ordered by decreasing frequency, comprise 95 percent of the core damage frequency (CDF), OR that individually contribute more than; 1 percent to the CDF.

Significant Accident Progression Sequence – One of a set of containment event tree sequences that, when rank ordered by decreasing frequency, comprise 95 percent of the large early release frequency (LERF), OR that individually contribute more than; 1 percent to the LERF.

Site Response (Amplification) – The amplification (i.e., increase or decrease) of earthquake ground motion by rock and soil near the earth's surface in the vicinity of the site of interest. Topographic effects, the effect of the water table, and basin edge wave-propagation effects are sometimes included under site response.

Spectral Acceleration – Peak acceleration response of an oscillator as a function of period or frequency and damping ratio when subjected to an acceleration time history. It is equal to the peak relative displacement of a linear oscillator of frequency, f , attached to the ground, times the quantity $(2Bf)^2$. It is expressed in units of gravity (g) or cm/second².

Stable Continental Region (SCR) – An SCR is composed of continental crust, including continental shelves, slopes, and attenuated continental crust, and excludes active plate boundaries and zones of currently active tectonics directly influenced by plate margin processes. It exhibits no significant deformation associated with the major Mesozoic-to-Cenozoic (last 240 million years) orogenic belts. It excludes major zones of Neogene (last 25 million years) rifting, volcanism, or suturing.

Stationary Poisson Process – A probabilistic model of the occurrence of an event over time (or space) that has the following characteristics: (1) the occurrence of the event in small intervals is constant over time (or space), (2) the occurrence of two (or more) events in a small interval is negligible, and (3) the occurrence of the event in non-overlapping intervals is independent.

Structure, System, or Component – A “structure” is an element, or a collection of elements, to provide support or enclosure, such as a building, free-standing tanks, basins, dikes, or stacks. A “system” is a collection of components assembled to perform a function, such as piping; cable trays; conduits; or heating, ventilation, and air-conditioning. A “component” is an item of mechanical or electrical equipment, such as a pump, valve, or relay, or an element of a larger array, such as a length of pipe, elbow, or reducer.

Support System – A system that provides a support function (e.g., electric power, control power, or cooling) for one or more other systems.

System Failure – Loss of the ability of a system to perform a modeled function.

Systems Analysis – That portion of the external events PRA analysis that applies to evaluating the impact of external events within the plant PRA model. In this context, the term “systems analysis” encompasses the tasks related to identification of the SSCs to be included in the analysis, event sequence modeling, analysis of the failure of individual system functions within the sequences, and the integration and quantification of the overall PRA model.

Target Performance Goal (PF) – Target annual probability of exceeding the 1 E-05 frequency of onset of significant inelastic deformation (FOSID) limit state.

Tectonic Structure – A large-scale dislocation or distortion, usually within the earth’s crust. Its extent may be on the order of tens of meters (yards) to hundreds of kilometers (miles).

Uncertainty – A representation of the confidence in the state of knowledge about the parameter values and models used in constructing the PRA. Also see “Variability,” “Epistemic Uncertainty,” and “Aleatory Variability.”

Uncertainty (as used in seismic-fragility analysis) – The variability in the median seismic capacity arising from imperfect knowledge about the models and model parameters used to calculate the median capacity.

Uniform Hazard Response Spectrum (UHRS) – A plot of a ground response parameter (for example, spectral acceleration or spectral velocity) that has an equal likelihood of exceedance at different frequencies.

Up to Date – As used in this standard [for example, when the standard speaks of an “up-to-date database” in (HLR-HA-B)], the concept is that a reasonable attempt should be made to use all available data at the time of the application. However, routine updating of the data is not required if the data used reasonably represent what is needed for the application.

Variability – See “Epistemic Uncertainty” and “Aleatory Variability.”

Verify – To determine that a particular action has been performed in accordance with the rules and requirements of this standard, either by witnessing the action or by reviewing records.

Volumetric Source Zone – A volume of the earth’s crust within which future seismicity is assumed to have distributions of source properties and locations of energy release that do not vary in time and space.

Walkdown – Inspection of local areas in a nuclear power plant where SSCs are physically located in order to ensure accuracy of procedures and drawings, equipment location, operating status, and environmental effects or system interaction effects on the equipment that could occur during accident conditions. For seismic-PRA and SMA reviews, the walkdown is explicitly used to confirm preliminary screening and to collect additional information for fragility or margin calculations.

Within Motion – An earthquake record modified for use in a site response model. Within motions are developed through deconvolution of a surface recording to account for the properties of the overburden material at the level at which the record is to be applied. The within motion can also be called the “bedrock motion” if it occurs at a high-impedance boundary where rock is first encountered.

List of Questions

Natural Hazards and Ground Shaking Design Levels	1
1) Does the NRC consider earthquakes of magnitude 9?	1
2) Did the Japanese underestimate the size of the maximum credible earthquake that could affect the plants?	1
3) Can an earthquake and tsunami as large as happened in Japan also happen here?	1
4) What if an earthquake like the Sendai earthquake occurred near a US plant?	1
5) What magnitude earthquake are US nuclear plants designed to?	1
6) How many US reactors are located in active earthquake zones?	2
7) Has this changed our perception of earthquake risk to the plants in the US?	3
8) Why do we have confidence that US nuclear power plants are adequately designed for earthquakes and tsunamis?	3
9) Can significant damage to a nuclear plant like we see in Japan happen in the US due to an earthquake? Are the Japanese nuclear plants similar to US nuclear plants?	3
10) If the earthquake in Japan was a larger magnitude than considered by plant design, why can't the same thing happen in the US?	3
11) What level of earthquake hazard are the US reactors designed for?	3
12) How was the seismic design basis for existing nuclear plants established?	4
13) What is the likelihood of the design basis or "SSE" ground motions being exceeded over the life of a nuclear plant?	4
14) What is magnitude anyway? What is the Richter Scale? What is intensity?	4
15) How do magnitude and ground motion relate to each other?	5
16) What is a seismic response spectrum?	5
17) Which reactors are along coastal areas that could be affected by a tsunami?	6
18) How are combined seismic and tsunami events treated in risk space? Are they considered together?	6
19) How are aftershocks treated in terms of risk assessment?	6
20) Could a "mega-tsunami" strike the U.S. East Coast as indicated in a recent Washington Post Weather Gang article?	6
Design Against Natural Hazards & Plant Safety in the US	8
21) Are US nuclear plants designed for tsunamis? If so, what level of tsunami are they designed for?	8
22) Is there a minimum earthquake shaking that nuclear plants are designed for?	8

23) Which plants are close to known active faults? What are the faults and how far away are they from the plants? 8

24) Is there margin above the design basis?..... 8

25) Are US plants safe? Would a plant in the U.S. be able to withstand a large earthquake?..... 9

26) Could an accident sequence like the one at Japan’s Fukushima Daiichi nuclear plants happen in the US? 9

27) Should US nuclear facilities be required to withstand earthquakes and tsunamis of the kind just experienced in Japan? If not, why not? 9

28) Do any plants have special design considerations associated with seismic design?..... 10

29) How do we know equipment will work if the magnitude is bigger than expected, like in Japan? 10

30) How do we know that the equipment in plants is safe in earthquakes? 10

31) Are US plants susceptible to the same kind of loss of power as happened in Japan? 10

32) How do we know that the emergency diesel generators will not fail to operate like in Japan? 11

33) Is there a risk of loss of water during tsunami drawdown? Is it considered in design? 11

34) Are aftershocks considered in the design of equipment at the plants? Are aftershocks considered in design of the structure? 11

35) Are there any special issues associated with seismic design at the plants? For example, Diablo Canyon has special requirements. Are there any others?..... 11

36) Is the NRC planning to require seismic isolators for the next generation of nuclear power plants? How does that differ from current requirements and/or precautions at existing US nuclear power plants? 11

37) Are there any US nuclear power plants that incorporate seismic isolators? What precautions are taken in earthquake-prone areas? 11

38) Do you think that the recent Japan disaster will cause any rethinking of the planned seismic isolation guidelines, particularly as it regards earthquakes and secondary effects such as tsunamis? 12

Seismically Induced Fire 13

39) How does the NRC address seismic-induced fire?..... 13

40) Does the NRC require the fire protection water supply system be designed to withstand an earthquake? 13

41) How are safe shutdown equipment protected from an oil spill which can cause potential fire? 13

42) How are safe shutdown equipment protected from a hydrogen fire? 14

Seismically Induced Internal Flooding..... 15

43) How does the NRC consider seismically induced equipment failures leading to internal flooding? 15

44) How is the potential source of internal flooding from the seismically induced equipment failures postulated in the internal flood analysis?..... 15

45) Are the non-safety-related equipment failures assumed to occur at the same time? 15

About Japanese Hazard, Design and Earthquake Impact..... 17

46) Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?..... 17

47) What was the disposition of the plant during the time after the earthquake struck and before the tsunami arrived? Was there indication of damage to the plant solely from the earthquake (if so, what systems) and did emergency procedures function during this time..... 17

48) What magnitude earthquake was the plant designed to withstand? For example, what magnitude earthquake was the plant expected to sustain with damage but continued operation? And with an expected shutdown but no release of radioactive material? 17

49) Did this reactor sustain damage in the July 16, 2007 earthquake, as the Kashiwazaki power plant did? What damage and how serious was it? 17

50) Was the Fukushima power plant designed to withstand a tsunami of any size? What specific design criteria were applied?..... 18

51) What is the design level of the Japanese plants? Was it exceeded?..... 18

52) What are the Japanese S_1 and S_s ground motions and how are they determined? 18

53) Did this earthquake affect the Kashiwazaki-Kariwa nuclear power plant? 19

54) How high was the tsunami at the Fukushima nuclear power plants?..... 19

55) Wikileaks has a story that quotes US embassy correspondence and some un-named IAEA expert stating that the Japanese were warned about this ... Does the NRC want to comment? 19

Impact at US Nuclear Power Plants During the March 11, 2011 Earthquake and Tsunami? ... 20

56) Was there any damage to US reactors from either the earthquake or the resulting tsunami? 20

57) Have any lessons for US plants been identified? 20

58) It appears that the estimates of the tsunami are changing frequently. The NOAA and TEPCO estimates are different. Why? 20

59) How well can we predict a tsunami wave height? What have we learned about our prediction abilities based on the events in Japan? 20

NRC Response and Future Licensing Actions..... 22

60) What is the NRC doing about the emergencies at the nuclear power plants in Japan? Are you sending staff over there? 22

61) With NRC moving to design certification, at what point is seismic capability tested – during design or modified to be site-specific? If in design, what strength seismic event must these be built to withstand? 22

62) What are the near term actions that U.S. plants are taking in consideration of the events in Japan?22

63) What are the immediate steps NRC is taking? 23

64) Should U.S. residents be using Potassium iodide? 23

Reassessment of US Plants and Generic Issue 199 (GI-199)..... 24

65) What is Generic Issue 199 about? 24

66) Does the NRC have a position on the MSNBC article that ranked the safety of US plants? .. 24

67) A recent Can we get the rankings of the plants in terms of safety? (Actually this answer should be considered any time GI-199 data is used to “rank” plants) 24

68) What are the current findings of GI-199?..... 24

69) If the plants are designed to withstand the ground shaking why is there so much risk from the design level earthquake..... 24

70) Overall, how would the NRC characterize the CDF numbers? A quirk of numbers? A serious concern?..... 25

71) Describe the study and what it factored in – plant design, soils, previous quakes, etc. 25

72) Explain “seismic curve” and “plant level fragility curve” 25

73) Explain the “weakest link model” 25

74) What would constitute fragility at a plant? 26

75) Can someone put that risk factor into perspective, using something other than MSNBC’s chances of winning the lottery?..... 26

76) What, if anything, can be done at a site experiencing such a risk? (Or at Limerick in particular.)..... 26

77) Has anyone determined that anything SHOULD be done at Limerick or any of the other PA plants?26

78) Page 20 of the report: This result confirms NRR’s conclusion that currently operating plants are adequately protected against the change in seismic hazard estimates because the guidelines in NRR Office Instruction LIC-504 “Integrated Risk-Informed Decision Making Process for Emergent Issues” are not exceeded. Can someone please explain? 26

79) Is the earthquake safety of US plants reviewed once the plants are constructed? 26

80) Does the NRC ever review tsunami risk for existing plants? 26

81) Does GI-199 consider tsunami? 27

82) Where can I get current information about Generic Issue 199? 27

83) Are all US plants being evaluated as a part of Generic Issue 199? 27

84) Are the plants safe? If you are not sure they are safe, why are they not being shut down? If you are sure they are safe, why are you continuing evaluations related to this generic issue? 27

85) What do you mean by "increased estimates of seismic hazards" at nuclear power plant sites? 28

86) Does the SCDF represent a measurement of the risk of radiation RELEASE or only the risk of core damage (not accounting for secondary containment, etc.)? 28

87) Did an NRC spokesperson tell MSNBC's Bill Dedman that the weighted risk average was invalid and useless? He contends to us that this is the case. 28

88) 3. If it was "invalid" as he claims, why would the USGS include that metric? 29

89) Can you explain the weighted average and how it compares to the weakest link average?. 29

90) Ultimately would you suggest using one of the models (average, weighted, weakest link) or to combine the information from all three? 29

91) Were there any other factual inaccuracies or flaws in Mr. Dedman's piece you would like clarify/point out. 29

92) Mr. Dedman infers that the plant quake risk has grown (between the 1989 and 2008 estimates) to the threshold of danger and may cross it in the next study. Is this the NRC's position? 29

93) What document has the latest seismic hazard estimates (probabilistic or not) for existing nuclear power plants in the western US? 30

94) The GI-199 documents refer to newer data on the way. Have NRC, USGS et al. released those? I'm referring to this: "New consensus seismic-hazard estimates will become available in late 2010 or early 2011 (these are a product of a joint NRC, US Department of Energy, US Geological Survey (USGS) and Electric Power Research Institute (EPRI) project). These consensus seismic hazard estimates will supersede the existing EPRI, Lawrence Livermore National Laboratory, and USGS hazard estimates used in the GI-199 Safety/Risk Assessment." 30

95) What is the timetable now for consideration of any regulatory changes from the GI-199 research? 30

Seismic Probabilistic Risk Assessment (SPRA) 32

96) The NRC increasingly uses risk-information in regulatory decisions. Are risk-informed PRAs useful in assessing an event such as this? 32

State-of-the-art Reactor Consequence Analysis (SOARCA) 33

97) What severe accident research is the U.S. Nuclear Regulatory Commission (NRC) doing? ... 33

98) Why is the NRC performing the SOARCA study? 33

99) Does the NRC intend to revisit previous risk studies? 33

100) How will the SOARCA study be different from earlier studies?..... 34

Defense-in-Depth and Severe Accident Management..... 35

102) Although there undoubtedly will be many lessons learned about severe accidents from the tragic events at Fukushima, have you identified any early lessons? 35

103) What procedures do U.S. plants have for responding to an unexpected event like the events in Japan. 35

104) What are Severe Accident Management Guidelines 36

Spent Fuel Pools and Independent Spent Fuel Storage Installations 37

105) Are Independent Spent Fuel Storage Installations (ISFSIs) required to withstand the same ground shaking as the reactor? 37

106) What do we know about the potential for and consequences of a zirconium fire in the spent fuel pool? 37

107) Can a zirconium fuel fire be prevented by wide spacing of spent fuel assemblies in the spent fuel pool? 37

108) Are the implications of new seismic hazard estimates being considered for the storage of spent fuel? 37

109) What are the design acceptance criteria for cooling systems for the spent fuel pools? 38

110) How does B.5.b apply to spent fuel pools?..... 38

Station Blackout 40

111) What is the definition of station blackout? 40

112) What is the existing regulatory requirement regarding SBO?..... 40

113) How many plants have an alternate ac (AAC) source with the existing EDGs..... 40

114) How many plants cope with existing class 1E batteries?..... 40

115) What are the coping duration determined for the plants based on the SBO Rule ?..... 40

116) How is coping duration determined? 41

117) When does the SBO event start?..... 41

118) When does the SBO event end? 41

119) Did the NRC review the licensee’s actions to meet the SBO rule? 41

120) Are all plants designed to mitigate a station blackout event? 41

Emergency Preparedness (Emphasis on B.5.b)..... 42

121) Is the emergency preparedness planning basis for nuclear power plants is valid? 42

122) What is B.5.b? 42

123) What were Phases 1, 2, and 3 of the B.5.b? 42

124) Has the NRC inspected full implementation of the mitigating strategies? 43

125) What additional action has been taken? 43

126) Is more information available about the mitigating strategies and inspections and reviews conducted? 43

Other External Hazards..... 44

127) How many plants are in hurricane zones?..... 44

128) How many plants are susceptible to flooding?..... 44

129) How many plants are susceptible to blizzard?..... 44

130) How many plants are susceptible to tornadoes? 44

Plant-Specific Questions 45

San Onofre Nuclear Generating Station (SONGS) Questions 45

131) Could an earthquake and tsunami the size of the one in Japan happen at San Onofre?..... 45

132) What magnitude earthquake are currently operating US nuclear plants such as SONGS designed to?..... 45

133) Could San Onofre withstand an earthquake of the magnitude of the Japanese earthquake? 45

134) Is possible to have a tsunami at San Onofre that is capable of damaging the plant? 45

135) Has the earthquake hazard at San Onofre been reviewed like Diablo Canyon nuclear power plant is doing? Are they planning on doing an update before relicensing? 46

136) How do we know that the emergency diesel generators in San Onofre will not fail to operate like in Japan? 46

137) Was there any damage to San Onofre from either the earthquake or the resulting tsunami? 46

138) What about emergency planning for San Onofre. Does it consider tsunami? 47

139) SONGS received a white finding in 2008 for 125VDC battery issue related to the EDGs that went undetected for 4 years. NRC issued the white finding as there was increased risk that one EDG may not have started due to a low voltage condition on the battery on one Unit (Unit 2). Aren't all plants susceptible to the unknown? Is there any assurance the emergency cooling systems will function as desired in a Japan-like emergency? 47

140) What is the height of water that SONGS is designed to withstand? 47

141) What about drawdown and debris? 47

142) Will this be reviewed in light of the Japan earthquake. 47

143) Could all onsite and offsite power be disrupted from SONGS in the event of a tsunami, and if that happened, could the plant be safely cooled down if power wasn't restored for days after? 47

144) Are there any faults nearby SONGS that could generate a significant tsunami? 48

145) What magnitude or shaking level is SONGS designed to withstand? How likely is an earthquake of that magnitude for the SONGS site? 48

146) Could SONGS withstand an earthquake of the magnitude of the Japanese earthquake? 48

147) What about the evacuation routes at SONGS? How do we know they are reasonable?..... 48

148) Regarding tsunami at DCNPP and SONGS, is the tsunami considered separately from flooding in licensing? And from the design perspective, is the flood still the controlling event for those plants rather than the tsunami? 49

149) What is the design level flooding for San Onofre? Can a tsunami be larger? 49

150) Is there potential linkage between the South Coast Offshore fault near SONGS and the Newport-Inglewood Fault system and/or the Rose Canyon fault? Does this potential linkage impact the maximum magnitude that would be assigned to the South Coast Offshore fault and ultimately to the design basis ground motions for this facility? 1

151) Recently, a new fault was discovered near Diablo Canyon Nuclear Power Plant.. Have any new faults been discovered near SONGS?..... 1

Diablo Canyon Nuclear Power Plant (DCNPP) Questions 49

152) Could an earthquake and tsunami the size of the one in Japan happen at Diablo Canyon? . 49

153) What magnitude earthquake are currently operating US nuclear plants such as Diablo Canyon designed to?..... 49

154) Could the newly discovered Shoreline Fault produce a larger "Scenario Earthquake"?..... 49

155) Could Diablo Canyon withstand an earthquake of the magnitude of the Japanese earthquake? 50

156) Is Diablo Canyon's equipment vulnerable to tsunami? 50

157) How do we know that the emergency diesel generators in Diablo Canyon will not fail to operate like in Japan? 50

158) Was there any damage to Diablo Canyon from either the earthquake or the resulting tsunami?..... 50

159) How do we know the evacuation routes in the region around Diablo Canyon are realistic? 50

160) Now after the Japan tragedy, will the NRC finally hear us (A4NR) and postpone DC license renewal until seismic studies are complete? How can you be sure that what happened there is not going to happen at Diablo with a worse cast earthquake and tsunami? 51

161) The evacuation routes at DCNPP see are not realistic. Highway 101 is small...and can you imagine what it will be like with 40K people on it? Has the evacuation plan been updated w/ all the population growth? 51

~~Official Use Only~~

162) Are there local offshore fault sources capable of producing a tsunami with very short warning times?..... 51

163) Are there other seismically induced failure modes (other than tsunami) that would yield LTSBO? Flooding due to dam failure or widespread liquefaction are examples. 51

164) Ramifications of beyond design basis events (seismic and tsunami) and potential LTSBO on spent fuel storage facilities? 51

165) Why did the Emergency Warning go out for a 'tsunami' that was only 6 ft (1.8 m) high? Do these guys really know what they're doing? Would they know it if a big one was really coming? Crying wolf all the time doesn't instill a lot of confidence. 51

The Japanese were supposed to have one of the best tsunami warning systems around. What went wrong last week? 51

166) Shouldn't the NRC make licensees consider a Tsunami coincident with a seismic event that triggers the Tsunami? 52

167) Given that SSCs get fatigued over time, shouldn't the NRC consider after-shocks in seismic hazard analyses? 52

168) Did the Japanese also consider an 8.9 magnitude earthquake and resulting tsunami "way too low a probability for consideration"?..... 52

169) GI-199 shows that the scientific community doesn't know everything about the seismicity of CEUS. And isn't there a prediction that the West coast is likely to get hit with some huge earthquake in the next 30 years or so? Why does the NRC continue to license plants on the west coast? 52

170) Has anyone done work to look at the effect of many cycles of low amplitude acceleration following a larger event. How do we know a plant would be fit to start back up after an event? We cannot possibly do NDE on everything to determine if flaws have propagated to the point where they need to be replaced..... 52

171) Aren't the California plants right on the San Andreas fault?..... 53

172) I heard that, at the urging of PG&E, effective acceleration was calculated at an average value, rather than peak. For a magnitude 7.5 quake, peak ground acceleration would be 1.25 times gravity at the plant. The change reduced that to .75g, with the adjustment from peak ground acceleration to effective ground acceleration. Is this true? 54

173) (Continued from previous question) A so-called "tau factor" was used, which reduced it again to .67g. Can you please explain this? 54

174) (Continued from previous question) To assess the strength of concrete, actual values were used, rather than code allowable minimums. Can you please explain this?..... 55

Indian Point Questions..... 56

175) Why is Indian Point safe if there is a fault line so close to it?..... 56

Questions posed by utilities 57

176) We are trying to understand why our plants in low-seismic areas (see below) would appear on the list of 27 plants that the NRC intends to review for seismic issues. While the story below notes that these plants have been identified based on "largest increase in seismic risk from a 1980s-era USGS study," the USGS maps show a low probability for seismic activity. I'm not aware of any major changes that would have increased seismic risk... can you help explain? 57

177) My basic understanding - especially in the case of St. Lucie and Duane Arnold - is that highly conservative values were input into your screening process for plants with low-seismic probability, therefore moving plants like those previously mentioned up in the listing. Can you help me to understand this? 57

Pending and Unanswered Questions from Members of Congress and industry 58

178) Received 3/16/11 from Congresswoman Lowey 58

179) From 3/16/11 Press Release from Senators Boxer and Feinstein 58

180) From 3/15/11 Press Release from Congresspeople Markey and Capps..... 60

181) Questions suggested by ANS for inclusion in a public FAQ document: 61

Additional Information: Useful Tables 62

Table of Design Basis Ground Motions for US Plants 62

Table of SSE, OBE and Tsunami Water Levels..... 64

Table of Plants Near Known Active Faults or in High or Moderate Seismicity Zones..... 69

Table From GI-199 Program Containing SSE, SSE Exceedance Frequencies, Review Level Earthquakes (RLE), and Seismic Core Damage Frequencies 70

Table: Design Basis Ground Motions and New Review Level Ground Motions Used for Review of Japanese Plants 75

Table: Status of Review of Japanese NPPs to New Earthquake Levels Based on 2006 Guidance 76

Additional Information: Useful Plots 77

Plot of Mapped Active Quaternary Faults and Nuclear Plants in the US..... 77

Nuclear Plants in the US Compared to the USGS National Seismic Hazard Maps..... 78

USGS US National Seismic Hazard Maps..... 78

Plot of Nuclear Plants in the US Compared to Recent Earthquakes..... 79

UCERF Map of California Earthquake Probabilities for Northern versus Southern California 79

Plot of ground motion acceleration (PGA) from Japanese earthquake..... 80

Plot of Tsunami Wave Heights at 5 Meter Bathymetry Offshore at the Japanese Plants (NOAA) 83

Plot of Tsunami Wave Heights in the Pacific (NOAA) 84

Plant Status (6pm, Japan time, on 3-25-11) 85

Fact Sheets 88

~~Official Use Only~~

Fact Sheet: Summarization of the NRC’s Regulatory Framework for Seismic Safety (High level overview) 88

Fact Sheet: Summarization of the NRC’s Regulatory Framework for Seismic Safety (The policy work version) 89

Fact Sheet: Summarization of the NRC’s Regulatory Framework for Seismic Safety (The cliff notes)... 91

Fact Sheet: Summarization of the NRC’s Regulatory Framework for Tsunami 92

Fact Sheet: Tsunami Assessment Method for Nuclear Power Plants in Japan..... 93

Fact Sheet: Summarization of the NRC’s Regulatory Framework for Flooding 94

182) Does the NRC consider severe floods in the design of nuclear power plants? 94

183) What about droughts and conditions which lead to low water? Are these considered? 95

184) Periods of long rainfall can cause the groundwater elevation to rise which can cause structures such as deeply embedded tanks to fail due to buoyancy. Are nuclear power plants designed to withstand this effect? 95

185) Some of the Reports from the National Weather Service used to estimate the design precipitation are 30-40 years old. Are these estimates still valid? 95

Fact Sheet: Summarization of Seismological Information from Regional Instrumentation 96

Fact Sheet: Seismic considerations of Western U.S. NPP sites 97

Fact Sheet: Regulatory Framework for Protection of Nuclear Power Plants against Tsunami Flooding 100

Fact Sheet: Seismic Zones and US Plants 103

Fact Sheet: Seismicity of the Central and Eastern US (In-depth technical information) 107

Fact Sheet: US Portable Array Information..... 109

Fact Sheet: The B.5.b Rule (10 CFR 50.54hh/B.5.b) 111

Fact Sheet: Generic Issue GI-199, “Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants” 113

Fact Sheet: Station Blackout Rule 115

Other useful resources: 116

Acronyms 117

Terms and Definitions 120

List of Questions 132

Pro-R-Ed

Bensi, Michelle

From: Bensi, Michelle
Sent: Monday, March 28, 2011 5:25 PM
To: Kammerer, Annie
Subject: documents
Attachments: Seismic Questions for Incident Response 3-28-11,5pm.docx; Seismic Questions for Incident Response 3-28-11 5pm.pdf

Annie,

I have attached a Word document of the most recent seismic Q&A document. I haven't done much with it today b/c I've been working on paper. If you want to send something out, I have attached a pdf of the document (but not showing the tracked changes). If you want, you can send this out as the final "data-dump" document (though it will have all those changes in it without your approval). And then you can let everyone know that we are working on a reformatted document that will be more organized and user-friendly (and that should appear soon). Either way, it would probably be good to let everyone know not to expect anything for a few more days.

-Shelby

TT/49

NRC frequently asked questions related to the March 11, 2011 Japanese Earthquake and Tsunami

3-29-11 Version

Compiled by Annie Kammerer, Jon Ake, Cliff Munson, and Michelle Bensi for submission to OPA and NRR. We would appreciate getting an edited word file back to assure that the public comments and the internal document are consistent.

PT/41

List of Questions

- 1) Can an earthquake and tsunami as large as happened in Japan also happen here?1
- 2) Did the Japanese underestimate the size of the maximum credible earthquake that could affect the plants?.....1
- 3) How high was the tsunami at the Fukushima nuclear plants? Was it higher than was expected?
1
- 4) Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?.2
- 5) Have any lessons for US nuclear plants been identified?2
- 6) Was there any damage to US reactors from either the earthquake or the resulting tsunami? ...2
- 7) Is radiation in the US expected to reach levels that are harmful to humans as a result of the events in Japan?2
- 8) How many US reactors are located in active earthquake zones?.....2
- 9) What level of earthquake hazard are the US reactors designed for?.....2
- 10) What magnitude earthquake are currently operating US nuclear plants designed to?.....3
- 11) Have the events in Japan changed our perception of earthquake risk to the nuclear plants in the US?3
- 12) Can significant damage to a nuclear plant like we saw in Japan happen in the US due to an earthquake? Are the Japanese nuclear plants similar to US nuclear plants?3
- 13) What is the likelihood of the design basis or "SSE" ground motions being exceeded over the life of a nuclear plant?.....4
- 14) Which reactors are located along coastal areas that could be affected by a tsunami?4
- 15) What is magnitude? What is the Richter Scale? What is intensity?4
- 16) How do magnitude and ground motion relate to each other?.....5
- 17) What is Generic Issue 199 about?.....5
- 18) Does GI-199 provide rankings of US nuclear plants in terms of safety?5
- 19) What are the current findings of GI-199?5
- 20) What do you mean by "increased estimates of seismic hazards" at nuclear plant sites?.....5
- 21) Does the Seismic Core Damage Frequency represent a measurement of the risk of radiation release or only the risk of core damage (not accounting for additional containment)?6
- 22) Where can I get current information about Generic Issue 199?6
- 23) Could an accident sequence like the one at Japan's Fukushima Daiichi nuclear plants happen in the US?6
- 24) Are the spent fuel pools designed to resist earthquake shaking?6

25) Does the NRC have a research program that studies seismic and tsunami issues?7

1) Can an earthquake and tsunami as large as happened in Japan also happen here?

The March 2011 Tohoku earthquake occurred on a “subduction zone,” which is the type of tectonic region that produces earthquakes of the largest magnitude. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Severe tsunamis like the one experienced in Japan are only produced by earthquakes occurring at this type of plate boundary. The only subduction zone that could affect the continental US is the Cascadia subduction zone, which lies off the coasts of Oregon, Washington, and the northernmost portion of California. Consequently, a continental earthquake and tsunami as large as the one experienced in Japan could only happen in that coastal region. The only nuclear plant near the Cascadia subduction zone is the Columbia Generating Station. This plant is located a large distance from both the coast (approximately 225 miles) and the offshore subduction zone. Because of the distance between the plant and the Cascadia subduction zone, the strength of ground motion expected at the plant is far lower than the ground motion experienced at the Fukushima plants during the Tohoku earthquake. The large distance between the Columbia Generating Station and the coast also precludes the possibility of a tsunami affecting the plant. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25, which is significantly smaller than the magnitude of the Tohoku earthquake. Magnitude is measured on a log scale and thus a magnitude 9 earthquake produces about ten times stronger shaking and releases about 32 times more energy than a magnitude 8 earthquake. See Question (15) for additional information about earthquake magnitude.

2) Did the Japanese underestimate the size of the maximum credible earthquake that could affect the plants?

The magnitude of the Tohoku earthquake was somewhat greater than was expected for the part of the subduction zone on which the earthquake occurred. However, the Japanese nuclear plants were recently reassessed using ground motion levels similar to those that are believed to have occurred at the sites during the Tohoku earthquake. The ground motions against which the Japanese nuclear plants were reassessed were expected to result from earthquakes that were of smaller magnitude, but that were much closer to the sites.

3) How high was the tsunami at the Fukushima nuclear plants? Was it higher than was expected?

The tsunami modeling team at the National Oceanic and Atmospheric Administration’s Pacific Marine Environmental Lab have estimated the wave height just offshore (at the 5 meter bathymetric line) to be approximately 8 meters in height at Fukushima Daiichi and approximately 7 meters at Fukushima Daini. This estimate is based on recordings from NOAA’s Deep-ocean Assessment and Reporting of Tsunamis (DART) buoys and a high resolution numerical model developed for the tsunami warning system.

A recent estimate released by TEPCO indicates that the tsunami water at the Fukushima Daiichi site reached a height of 14 meters. The report also indicates that the design basis tsunami height was 5.7 meters and that the emergency diesel generators were located 10-13 meters above sea level. This data was provided by TEPCO and has not been confirmed by the NRC. Because a tsunami will rise up as it comes ashore, water level estimates of 8 meters offshore and 14 meters onshore appear to be consistent.

4) Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?

Because this event occurred in Japan, it will be hard for NRC staff to understand exactly what happened until comprehensive assessments can be performed. Preliminary information suggests that important safety systems performed their required function in the period between the occurrence of the earthquake and the impact of the tsunami. It appears that the emergency diesel generators successfully started once offsite power was lost. Therefore, the tsunami appears to have played a key role in the loss of backup power sources at the site (including the diesel generators), ultimately resulting in a condition known as station blackout. The station blackout was a critical factor in the problems experienced at Fukushima Daiichi nuclear plant.

5) Have any lessons for US nuclear plants been identified?

The NRC is in the process of following and reviewing the events in real time. This review will undoubtedly lead to the identification of issues that warrant further study. A complete understanding of lessons learned will require more information than is currently available to NRC staff.

6) Was there any damage to US reactors from either the earthquake or the resulting tsunami?

No.

7) Is radiation in the US expected to reach levels that are harmful to humans as a result of the events in Japan?

No.

8) How many US reactors are located in active earthquake zones?

Although we often think of the US as having "active" and "non-active" earthquake zones, earthquakes can actually happen almost anywhere. Seismologists typically separate the US into low, moderate, and high seismicity zones. However, the boundaries between the zones are not well defined and depend on the interpretation of the various seismic sources. The United States Geological Survey (USGS) provides an interpretation of seismic hazard in the US. The USGS Earthquake Hazards Program website provides information about earthquakes in the US and around the world: <http://earthquake.usgs.gov/>. USGS also provides earthquake hazard maps and data: <http://earthquake.usgs.gov/hazards/products/>.

In the US, there are approximately 9 nuclear plants located in moderate seismicity zones and two plants located in high seismicity zones. These numbers may vary slightly depending on the scientific interpretation of earthquake hazard that is used. The NRC requires that every nuclear plant be designed for site-specific earthquake ground motions that are appropriate for its location. In addition, the NRC has specified a minimum ground motion level to which nuclear plants must be designed.

9) What level of earthquake hazard are the US reactors designed for?

Each reactor is designed for a ground motion level that is determined on a site-specific basis. The existing nuclear plants were designed using a "deterministic" or "scenario earthquake" approach that accounted for the largest earthquakes expected in the area around the plant, without consideration of the likelihood of the earthquakes occurring. New reactors are designed using probabilistic techniques that characterize both the ground motion levels and associated uncertainty in the assessment of the seismic hazard at the proposed site. These probabilistic techniques account for the ground motions that may result from all potential seismic sources in the region around the site. Technically speaking, new

nuclear plants are designed for the ground motion with an annual frequency of occurrence of $1 * 10^{-4}$ /year. This can be thought of as the ground motion that occurs every 10,000 years, on average. One important aspect associated with the use of probabilistic seismic hazard and other risk-assessment techniques is that they account for beyond-design basis events. NRC's Generic Issue 199 (GI-199) project is using state-of-the-art probabilistic techniques to review the seismic safety of the existing plants. [see questions (17) to (22) for more information about GI-199]

10) What magnitude earthquake are currently operating US nuclear plants designed to?

Ground motion is a function of the magnitude of an earthquake, the distance from the earthquake source to the site, and other geologic characteristics. Nuclear plants, and in fact all engineered structures, are designed based on *ground motion* levels, not earthquake magnitudes. The existing nuclear plants were designed using a "deterministic" or "scenario earthquake" approach 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 additional robustness.

11) Have the events in Japan changed our perception of earthquake risk to the nuclear plants in the US?

The NRC continues to determine that US nuclear plants are safe. The events transpiring in Japan following the Tohoku earthquake do not change the NRC's perception of earthquake hazard (i.e. ground motion levels) at US nuclear plants. It is too early to identify the lessons that may be learned from the Tohoku earthquake. The NRC will look closely at all aspects of the response of the Fukushima plants to the earthquake and tsunami to determine if any actions need to be taken in US nuclear plants and if any changes are necessary to NRC regulations.

12) Can significant damage to a nuclear plant like we saw in Japan happen in the US due to an earthquake? Are the Japanese nuclear plants similar to US nuclear plants?

All US nuclear plants are built to withstand environmental hazards, including earthquakes and tsunamis. Even nuclear plants that are located in areas with low and moderate seismic activity are designed for safety in the event of such natural disasters. In addition to the design of the plants, significant effort is devoted to emergency response planning and severe accident management. This approach is called defense-in-depth.

The Japanese facilities at Fukushima are similar in design to some US facilities. However, the NRC has required modifications to US plants since they were designed and built. Examples of these modifications include design changes to control hydrogen and pressure in the containment. The NRC also requires plants to have additional equipment and measures in place to mitigate damage stemming from large fires and explosions resulting from a beyond-design-basis event. The measures include providing core and spent fuel pool cooling and an additional means to power other equipment on site.

In addition, the NRC instituted a rule in the 1980s that required nuclear plants to further assure that a loss of both offsite and onsite emergency AC power systems (a condition known as a station blackout) would not adversely affect public health and safety. As a result of this rule, all plants have (1) established station blackout coping and recovery procedures; (2) completed training for these procedures; (3) implemented modifications as necessary to cope with a station blackout; and (4) ensured a 4-16 hour coping capability. Subsequently, studies conducted by the NRC have shown that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in a significant risk reduction and have further enhanced defense-in-depth.

13) What is the likelihood of the design basis or “SSE” ground motions being exceeded over the life of a nuclear plant?

The ground motion that is used as the seismic design basis at US nuclear plants is called the Safe Shutdown Earthquake ground motion (SSE). It is important to remember that structures, systems and components are required to have “adequate margin,” meaning that they must be able to withstand shaking levels that are above the plant’s design basis. In the mid to late 1990s, the NRC staff reviewed the potential for ground motions beyond the design basis as part of the Individual Plant Examination of External Events (IPEEE). From this review, the staff determined that seismic designs of operating nuclear plants in the US have adequate safety margins for withstanding earthquakes. Currently, the NRC is in the process of conducting GI-199 to again assess the resistance of US nuclear plants to earthquakes. Based on NRC’s preliminary analyses to date, the mean probability of ground motions exceeding the SSE over the life of the plant, for the plants in the Central and Eastern United States, is less than about 1%.

14) Which reactors are located along coastal areas that could be affected by a tsunami?

Many nuclear plants are located in coastal areas that could potentially be affected by a tsunami. Two nuclear plants, Diablo Canyon and San Onofre, are on the Pacific Coast, which is known to have a tsunami hazard. Two nuclear plants on the Gulf Coast, South Texas and Crystal River, could also be affected by tsunami. There are many nuclear plants on the Atlantic Coast or on rivers that may be affected by a tidal bore resulting from a tsunami. These include St. Lucie, Turkey Point, Brunswick, Oyster Creek, Millstone, Pilgrim, Seabrook, Calvert Cliffs, Salem/Hope Creek, and Surry. Tsunami on the Gulf and Atlantic Coasts occur, but are very rare. Generally, the flooding anticipated from hurricane storm surge exceeds the flooding expected from a tsunami for nuclear plants on the Atlantic and Gulf Coast. Regardless, all nuclear plants are designed to withstand the tsunami level appropriate for their site as well as other natural hazards such as earthquakes and hurricanes.

15) What is magnitude? What is the Richter Scale? What is intensity?

An earthquake’s magnitude is a measure of the strength of the earthquake as determined from seismographic observations. Magnitude is essentially an objective, quantitative measure of the size of an earthquake. The magnitude can be expressed in various ways based on seismographic records (e.g., Richter Local Magnitude, Surface Wave Magnitude, Body Wave Magnitude, and Moment Magnitude). Currently, the most commonly used magnitude measurement is the Moment Magnitude, Mw, which is based on the strength of the rock that ruptured, the area of the fault that ruptured, and the average amount of slip. Moment magnitude is, therefore, a direct measure of the *energy* released during an earthquake. Because of the logarithmic basis of the scale, each whole number increase in magnitude corresponds to a tenfold increase in measured wave amplitude and about 32 times more energy.

The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology and was based on the behavior of a specific seismograph that was manufactured at that time. The instruments are no longer in use and the magnitude scale is, therefore, no longer used in the technical community. However, the Richter Scale is a term that is so commonly used by the public that scientists generally just answer questions about “Richter” magnitude by substituting moment magnitude without correcting the misunderstanding. Like moment magnitude, the Richter Scale is a logarithmic scale.

The intensity of an earthquake is a qualitative assessment of the effects of the earthquake at a particular location. The intensity is assigned based on observed effects on humans, on human-built structures, and on the earth’s surface at a particular location. The most commonly used scale in the US is the Modified Mercalli Intensity (MMI) scale, which has values ranging from I to XII in the order of severity.

MMI of I indicates an earthquake that was not felt except by a very few, whereas MMI of XII indicates total damage of all works of construction, either partially or completely. While an earthquake has only one magnitude, it produces a range of intensities that depend on the effects at each particular location.

16) How do magnitude and ground motion relate to each other?

The ground motion experienced at a particular location is a function of the magnitude of the earthquake, the distance from the fault to the location of interest, and other elements such as the geologic materials through which the seismic waves pass.

17) What is Generic Issue 199 about?

GI-199 investigates the safety and risk implications of updated earthquake-related data and models on existing nuclear plants. For some nuclear plants in the Central and Eastern United States, these updated data and models suggest that there has been a slight increase in the estimated probability that the earthquake ground motion experienced at the site during a future earthquake could exceed the seismic design basis. While the updated data and models suggest that this probability has increased slightly relative to previous estimates, it is important to understand that, overall, this probability remains low.

18) Does GI-199 provide rankings of US nuclear plants in terms of safety?

The NRC does not rank nuclear plants by seismic risk. The objective of the GI-199 Safety/Risk Assessment was to evaluate whether further investigations of seismic safety for operating reactors in the central and eastern US (CEUS) are warranted, consistent with NRC directives. The results of the GI-199 safety risk assessment should not be interpreted as definitive estimates of plant-specific seismic risk because some analyses were conservative. The nature of the information used in the analyses makes these estimates useful only as a screening tool.

19) What are the current findings of GI-199?

Currently operating nuclear plants in the US remain safe, with no need for immediate action. This determination is based on NRC staff reviews of updated seismic hazard information and the conclusions of the safety/risk assessment stage of GI-199. Existing nuclear plants were designed, with considerable margin, to be able to withstand the ground motions from the “deterministic” or “scenario earthquake,” which accounted for the largest earthquakes expected in the area around the plant. The results of the GI-199 assessment demonstrate that the probability of exceeding the design basis ground motion may have increased at some sites, but only by a relatively small amount. In addition, the probabilities of seismic core damage are lower than the guidelines for taking immediate action. Although there is not an immediate safety concern, the NRC is focused on assuring safety even during very rare and extreme events. Therefore, the NRC has determined that assessment of updated seismic hazards and plant performance should continue. GI-199 originally focused on the 96 reactors located in the Central and Eastern United States. As a result of the Tohoku earthquake, the NRC has expanded the scope of the next stage of the GI-199 assessment activities to include all 104 operating reactors.

20) What do you mean by “increased estimates of seismic hazards” at nuclear plant sites?

Seismic hazard (earthquake hazard) represents the chance (or probability) that a specific level of ground motion could be observed or exceeded at a given location. Our estimates of seismic hazard at some Central and Eastern United States locations have changed based on results from recent research, indicating that earthquakes occurred more often in some locations than previously estimated. Our estimates of seismic hazard have also changed because the models used to predict the level of ground motion experienced at a site during an earthquake have improved. The increased estimates of seismic

hazard at some locations in the Central and Eastern United States were discussed in a memorandum to the Commission, dated July 26, 2006. (The memorandum is available in the NRC Agencywide Documents Access and Management System [ADAMS] under Accession No. ML052360044). It is important to note that it is not the underlying seismic hazard that has changed, but rather our scientific ability to understand and assess the hazard that has improved.

21) Does the Seismic Core Damage Frequency represent a measurement of the risk of radiation release or only the risk of core damage (not accounting for additional containment)?

Seismic core damage frequency is the probability of damage to the core resulting from a seismic initiating event. It does not imply either a meltdown or the loss of containment, which is necessary for radiological release to occur. The likelihood of radiation release is far lower than the core damage frequency.

22) Where can I get current information about Generic Issue 199?

The public NRC Generic Issues Program (GIP) website (<http://www.nrc.gov/about-nrc/regulatory/gen-issues.html>) contains program information and documents, background and historical information, generic issue status information, and links to related programs. The latest Generic Issue Management Control System quarterly report, which has regularly updated GI-199 information, is publicly available at <http://www.nrc.gov/reading-rm/doc-collections/generic-issues/quarterly/index.html>. Additionally, the US Geological Survey provides data and results that are publicly available at <http://earthquake.usgs.gov/hazards/products/conterminous/2008/>.

23) Could an accident sequence like the one at Japan's Fukushima Daiichi nuclear plants happen in the US?

It is difficult to answer this question until we have a better understanding of the precise problems and conditions that faced the operators at Fukushima Daiichi. We do know, however, that Fukushima Daiichi Units 1-3 lost all offsite power and emergency diesel generators. This situation is called "station blackout." The Nuclear Regulatory Commission's detailed regulations address this scenario. US nuclear plants are designed to cope with a station blackout event that involves a loss of offsite power and onsite emergency power. In addition to design features, US nuclear plants are required to conduct a "coping" assessment, perform modifications if necessary, and develop a strategy to demonstrate to the NRC that they could maintain the plant in a safe condition during a station blackout scenario. These assessments, proposed modifications to the plant, and operating procedures were reviewed and approved by the NRC. Several plants added additional AC power sources to comply with this regulation. Additional information about the NRC's station blackout rule is contained in question (12).

In addition, in response to the terrorist events of September 11, 2001, the NRC issued an Interim Compensatory Measures (ICM) Order requiring licensees to take certain actions to mitigate severe accident scenarios such as aircraft impact. These scenarios include the complete loss of offsite power and all on-site emergency power sources.

24) Are the spent fuel pools designed to resist earthquake shaking?

Spent fuel pools are constructed of reinforced concrete, several feet thick, with a stainless steel liner to prevent leakage and maintain water quality. Due to their configuration, spent fuel pools are inherently structurally-rugged and are designed to the same seismic requirements and ground motion levels as the nuclear plant.

25) Does the NRC have a research program that studies seismic and tsunami issues?

There is an extensive seismic and structural research program ongoing at the NRC. The Office of Nuclear Regulatory Research has several ongoing projects related to seismic hazard assessment for the Central and Eastern US. Research topics include seismic source characterization, development of improved ground motion prediction equations, and development of practical procedures to standardize the application of probabilistic seismic hazard assessment to nuclear plants. The Office of Nuclear Regulatory Research also manages a tsunami research program that focuses on bringing state-of-the-art technical advances to the NRC regulatory process. Key focus areas of the program include landslide-induced tsunami, development of probabilistic methods of tsunami hazard assessment, and development of technical bases for new NRC guidance. Though the tsunami research program focuses on topics related specifically to nuclear facilities, more general scientific advances in assessment of tsunami hazard on the Atlantic Coast of the US has resulted from collaboration between NRC staff, the US Geological Survey (USGS); and the National Oceanic and Atmospheric Administration (NOAA). Information about the above programs and other NRC research activities can be found in NUREG-1925, which is available online at: <http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1925/r1/>.

Table of contents

1. Forward 6

2. General Information (Background info; static info) 6

 2.1. Introduction/Background 6

 2.2. Q&As: Seismic Hazard 6

 2.3. Q&As: Seismic Design 6

3. Seismic Design of US nuclear plants (Static information) 6

 3.1. Introduction/Overview 6

 3.2. Q&As: Spent Fuel Installations 6

 3.3. Fact Sheets 6

4. Other design considerations (Static information) 7

 4.1. Introduction 7

 4.2. Q&As: Other extreme events (hurricanes, flooding, blizzard, tornados) 7

 4.3. Q&As: Extreme accident management 7

 4.4. Q&As: Station Blackout 7

 Q:1.1 Are all plants designed to mitigate a station blackout event? 7

 Q:1.2 What is the definition of station blackout? 8

 Q:1.3 What are the existing regulatory requirements regarding SBO? 8

 Q:1.4 SBO Implementation Questions 9

 RQ: 1.4-1 How many plants have an alternate ac (AAC) source with the existing EDGs 9

 RQ: 1.4-2 How many plants cope with existing class 1E batteries? 9

 RQ: 1.4-3 What are the coping durations determined for the plants based on the SBO Rule? 9

 RQ: 1.4-4 When does the SBO event start? When does the SBO event end? 9

 RQ: 1.4-5 Did the NRC review the licensee's actions to meet the SBO rule? 10

 4.5. Factsheets 10

5. Ongoing NRC activities related to seismic risk (static and dynamic portions) 10

 5.1. Introduction 10

 5.2. Q&As: GI-199 10

 Q:1.5 What is Generic Issue 199 about? 10

 RQ: 1.5-1 Describe the study and what it factored in - plant design, soils, previous quakes, etc. 11

 Q:1.6 Are all US plants being evaluated as a part of Generic Issue 199? 11

 Q:1.7 What are the current findings of GI-199? 11

 Q:1.8 Where can I get current information about Generic Issue 199? 12

 Q:1.9 Which Plants Are in the GI-199 "Continue Region" 12

 Q:1.10 Are the plants safe? If you are not sure they are safe, why are they not being shut down? If you are sure they are safe, why are you continuing evaluations related to this generic issue? 14

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

RQ: 1.10-1 Page 20 of the report: This result confirms NRR's conclusion that currently operating plants are adequately protected against the change in seismic hazard estimates because the guidelines in NRR Office Instruction LIC-504 "Integrated Risk-Informed Decision Making Process for Emergent Issues" are not exceeded. Can someone please explain?.....14

Q:1.11 What is the timetable now for consideration of any regulatory changes from the GI-199 research? 15

Q:1.12 Questions Related to New Seismic Hazard Information.....16

RQ: 1.12-1 What document has the latest seismic hazard estimates (probabilistic or not) for existing nuclear power plants in the western US?.....16

RQ: 1.12-2 The GI-199 documents refer to newer data on the way. Have NRC, USGS et al. released those? I'm referring to this: "New consensus seismic-hazard estimates will become available in late 2010 or early 2011 (these are a product of a joint NRC, US Department of Energy, US Geological Survey (USGS) and Electric Power Research Institute (EPRI) project). These consensus seismic hazard estimates will supersede the existing EPRI, Lawrence Livermore National Laboratory, and USGS hazard estimates used in the GI-199 Safety/Risk Assessment."16

Q:1.13 What, if anything, can be done at a site to reduce the seismic risk at a plant site?.....17

RQ: 1.13-1 Has anyone determined that anything SHOULD be done at Plant X?.....17

Q:1.14 Is the earthquake safety of US plants reviewed once the plants are constructed?17

Q:1.15 Technical Questions on the Terms in the GI-199 Safety/Risk Assessment.....17

RQ: 1.15-1 What do you mean by "increased estimates of seismic hazards" at nuclear power plant sites? 17

RQ: 1.15-2 Explain "seismic hazard curve" and "plant level fragility curve".18

RQ: 1.15-3 What would constitute fragility at a plant?.....18

RQ: 1.15-4 Does the SCDE represent a measurement of the risk of radiation RELEASE or only the risk of core damage (not accounting for secondary containment, etc.)?.....18

Q:1.16 Questions Related to the GI-199 models.....19

RQ: 1.16-1 Can you explain the weighted average and how it compares to the weakest link average? 19

RQ: 1.16-2 Explain the "weakest link model".....19

RQ: 1.16-3 Ultimately would you suggest using one of the models (average, weighted, weakest link) or to combine the information from all three?.....19

Q:1.17 Questions Related to Bill Dedman's MSNBC article19

RQ: 1.17-1 Does the NRC have a position on the MSNBC article that ranked the seismic safety of US plants? 19

RQ: 1.17-2 Can we get the rankings of the plants in terms of safety? (Actually this answer should be considered any time GI-199 data is used to "rank" plants)20

RQ: 1.17-3 Can someone put that risk factor into perspective, using something other than MSNBC's chances of winning the lottery?20

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

RQ: 1.17-4 Did an NRC spokesperson tell MSNBC's Bill Dedman that the weighted risk average was invalid and useless? He contends to us that this is the case.....20

RQ: 1.17-5 If it was "invalid" as he claims, why would the USGS include that metric?20

RQ: 1.17-6 Were there any other factual inaccuracies or flaws in Mr. Dedman's piece you would like clarify/point out20

RQ: 1.17-7 Mr. Dedman infers that the plant quake risk has grown (between the 1989 and 2008 estimates) to the threshold of danger and may cross it in the next study. Is this the NRC's position?21

5.3. Q&As: SOARCA.....21

5.4. Q&As: Other programs21

5.5. Factsheets21

6. March 11, 2011 Earthquake an Japan22

6.1. Overview.....22

6.2. Earthquake Tectonics23

6.3. Tsunami25

6.4. Ground motion.....27

6.5. Historical perspective.....31

6.6. Q&A: General information about the March 11, 2011 Tohoku earthquake and tsunami32

Q:1.18 How high was the tsunami at the Fukushima nuclear plants? Was it higher than was expected? 32

RQ: 1.18-1 Why are there different estimates of wave height for the tsunami generated by the March 11 earthquake?.....32

RQ: 1.18-2 It appears that the estimates of the tsunami are changing frequently. Why?32

RQ: 1.18-3 The NOAA and TEPCO estimates are different. Why?32

RQ: 1.18-4 How high was the tsunami at the Fukushima nuclear power plants?32

Q:1.19 How well can we predict a tsunami/wave height? What have we learned about our prediction abilities based on the events in Japan?33

6.7. Q&A: Affect of earthquake and tsunami on Japanese nuclear plants34

Q:1.20 Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami? 34

RQ: 1.20-1 What was the disposition of the plant during the time after the earthquake struck and before the tsunami arrived?.....34

RQ: 1.20-2 Was there indication of damage to the plant solely from the earthquake and did emergency procedures function during this time?34

Q:1.21 Did this earthquake affect the Kashiwazaki-Kariwa nuclear power plant?34

RQ: 1.21-1 Did Fukushima plants sustain damage in the July 16, 2007 earthquake, as the Kashiwazaki power plant did?.....34

6.8. Q&A: Design of Japanese NPPs (Regulatory Approach)35

Q:1.22 Did the Japanese underestimate the size of the maximum credible earthquake that could affect the plants?.....35

04/13/2011

~~OUO (Pre-decisional) DRAFT~~

Q:1.23	Was the Fukushima power plant designed to withstand a tsunami of any size? What specific design criteria were applied?.....	35
Q:1.24	What are the Japanese S_1 and S_s ground motions and how are they determined?	35
RQ: 1.24-1	For what earthquake was the plant expected to sustain with damage but continued operation? And with an expected shutdown but no release of radioactive material?	35
Q:1.25	What is the design level of the Japanese plants? Was it exceeded?	36
RQ: 1.25-1	What magnitude earthquake was the plant designed to withstand? For example, what magnitude earthquake was the plant expected to sustain with damage but continued operation?.....	36
6.9.	Implications of events in Japan on US plants	38
Q:1.26	Can an earthquake and tsunami as large as happened in Japan also happen here?.....	38
RQ: 1.26-1	What if an earthquake like the Sendai earthquake occurred near a US plant?	38
Q:1.27	Have the events in Japan changed our perception of earthquake risk to the nuclear plants in the US?	38
Q:1.28	Can significant damage to a nuclear plant like we see in Japan happen in the US due to an earthquake?	39
RQ: 1.28-1	Are the Japanese nuclear plants similar to US nuclear plants?	39
RQ: 1.28-2	Why do we have confidence that US nuclear power plants are adequately designed for earthquakes and tsunamis?	39
Q:1.29	If the earthquake in Japan was a larger magnitude than considered by plant design, why can't the same thing happen in the US?	40
Q:1.30	Could an accident sequence like the one at Japan's Fukushima Daiichi nuclear plants happen in the US?.....	40
Q:1.31	Should US nuclear facilities be required to withstand earthquakes and tsunamis of the kind just experienced in Japan? If not, why not?	41
Q:1.32	Are US plants susceptible to the same kind of loss of power as happened in Japan?	41
Q:1.33	How do we know that the emergency diesel generators will not fail to operate like in Japan?	42
Q:1.34	Do you think that the recent Japan disaster will cause any rethinking of the planned seismic isolation guidelines, particularly as it regards earthquakes and secondary effects such as tsunamis?	43
Q:1.35	Was there any damage to US reactors from either the earthquake or the resulting tsunami?	43
Q:1.36	Have any lessons for US plants been identified?	43
RQ: 1.36-1	What is the NRC doing about the emergencies at the nuclear power plants in Japan? Are you sending staff over there?	43
RQ: 1.36-2	What are the near term actions that U.S. plants are taking in consideration of the events in Japan?	43
RQ: 1.36-3	What are the immediate steps NRC is taking?	43
Q:1.37	What procedures do U.S. plants have for responding to an unexpected event like the events in Japan.	45

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

Q:1.38 Could an earthquake and tsunami the size of the one in Japan happen at San Onofre or Diablo Canyon?.....46

Q:1.39 Could San Onofre and Diablo Canyon withstand an earthquake of the magnitude of the Japanese earthquake?.....46

Q:1.40 How do we know that the emergency diesel generators in a US plant will not fail to operate like in Japan?.....47

6.10. Q&A: Miscellaneous.....48

Q:1.41 Wikileaks has a story that quotes US embassy correspondence and some un-named IAEA expert stating that the Japanese were warned about this ... Does the NRC want to comment?48

7. Bibliography48

DRAFT

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

1. Forward

2. General Information (Background info; static info)

2.1. Introduction/Background

2.2. Q&As: Seismic Hazard

2.3. Q&As: Seismic Design

3. Seismic Design of US nuclear plants (Static information)

3.1. Introduction/Overview

3.1.1 Q&As: Power generation components

3.1.2 Ground shaking

3.1.3 Tsunami

3.1.4 Liquefaction, slope stability, lateral deformation

3.1.5 Fire

3.1.6 Flood (dam safety)

3.1.7 Plant-specific questions

SONGS

Diablo Canyon

Indian Point

3.2. Q&As: Spent Fuel Installations

3.2.1 Ground shaking

3.2.2 Tsunami

3.2.3 Fire

3.2.4 Flood

3.3. Fact Sheets

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

3.3.1 Summarization of NRC's regulatory framework for seismic safety

High-level overview

Policy-work version

Cliff notes

3.3.2 Summarization of NRC's regulatory framework for tsunami

3.3.3 Summarization of NRC's regulatory framework for flooding

3.3.4 Seismic considerations for US nuclear plants

Seismic zones

Seismicity of the Central and Eastern US

Seismic Considerations of Western US nuclear plant sites

4. Other design considerations (Static information)

4.1. Introduction

4.2. Q&As: Other extreme events (hurricanes, flooding, blizzard, tornados)

4.3. Q&As: Extreme accident management

4.3.1 Defense-in-Depth

4.3.2 Emergency Preparedness

4.4. Q&As: Station Blackout

Q:1.1 Are all plants designed to mitigate a station blackout event?

Public Answer: Yes. All plants have the capability to withstand and recover from a SBO event. In 1988, the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems—a station blackout condition--would not adversely affect public health and safety. Studies conducted by the NRC have shown that the hardware and procedures that have been implemented to meet the station

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

blackout requirements have resulted in significant risk reduction and have further enhanced defense in depth.

Q:1.2 What is the definition of station blackout?

Public Answer: (Quoted from 10CFR50.2 definition.) Station blackout (SBO) means the complete loss of alternating current (ac) electric power to the essential and nonessential switchgear buses in a nuclear power plant (i.e., loss of offsite electric power system concurrent with turbine trip and unavailability of the onsite emergency ac power system). Station blackout does not include the loss of available ac power to buses fed by station batteries through inverters or by alternate ac sources as defined in this section, nor does it assume a concurrent single failure or design basis accident. At single unit sites, any emergency ac power source(s) in excess of the number required to meet minimum redundancy requirements (i.e., single failure) for safe shutdown (non-DBA) is assumed to be available and may be designated as an alternate power source(s) provided the applicable requirements are met. At multi-unit sites, where the combination of emergency ac power sources exceeds the minimum redundancy requirements for safe shutdown (non-DBA) of all units, the remaining emergency ac power sources may be used as alternate ac power sources provided they meet the applicable requirements. If these criteria are not met, station blackout must be assumed on all the units.

Q:1.3 What are the existing regulatory requirements regarding SBO?

Public Answer: (a) Requirements are contained in 10CFR50.63 (summarized below)

Each light-water-cooled nuclear power plant licensed to operate must be able to withstand for a specified duration and recover from a station blackout. The specified station blackout duration shall be based on the following factors:

- (i) The redundancy of the onsite emergency ac power sources;
- (ii) The reliability of the onsite emergency ac power sources;
- (iii) The expected frequency of loss of offsite power; and
- (iv) The probable time needed to restore offsite power.

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

The reactor core and associated coolant, control, and protection systems, including station batteries and any other necessary support systems, must provide sufficient capacity and capability to ensure that the core is cooled and appropriate containment integrity is maintained in the event of a station blackout for the specified duration. The capability for coping with a station blackout of specified duration shall be determined by an appropriate coping analysis. Licensees are expected to have the baseline assumptions, analyses, and related information used in their coping evaluations available for NRC review.

Q:1.4 SBO Implementation Questions

RQ: 1.4-1 How many plants have an alternate ac (AAC) source with the existing EDGs

Public Answer: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional information: 60 plants

RQ: 1.4-2 How many plants cope with existing class 1E batteries?

Public Answer: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional information: 44 plants

RQ: 1.4-3 What are the coping durations determined for the plants based on the SBO Rule?

Public Answer: The below comes from the Q&As for the 3/21 commissioner's briefing. Please make sure these are OK to provide to the public before doing so.

Additional information: 4-16 hours (4 hours only with batteries; 4-16 with AAC)

RQ: 1.4-4 When does the SBO event start? When does the SBO event end?

Public Answer: The onset of a loss of offsite power and onsite power as verified by the control room indications. The SBO event ends when either onsite or offsite power is recovered.

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

RQ: 1.4-5 Did the NRC review the licensee's actions to meet the SBO rule?

Public Answer: Yes. The NRC staff reviewed the responses from each licensee and issued a SER accepting the proposed coping methods. All plants have (1) established SBO coping and recovery procedures; (2) completed training for these procedures; (3) implemented modifications as necessary to cope with an SBO; and (4) ensured a 4-16 hour coping capability. In addition, the staff performed pilot inspections at 8 sites to verify the implementation of the SBO rule implementation. No issues were identified during initial implementation.

4.5. Factsheets

4.5.1 B.5.b

4.5.2 Station Blackout Rule

5. Ongoing NRC activities related to seismic risk (static and dynamic portions)

5.1. Introduction

5.1.1 Seismic research

5.1.2 GI-199

5.1.3 Other programs

5.2. Q&As: GI-199

Q:1.5 What is Generic Issue 199 about?

Public Answer: Generic Issue 199 investigates the safety and risk implications of updated earthquake-related data and models. These data and models suggest that the probability for earthquake ground motion above the seismic design basis for some nuclear plants in the Central and Eastern United States, although is still low, is larger than previous estimates.

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

RQ: 1.5-1 Describe the study and what it factored in – plant design, soils, previous quakes, etc.

Additional information: See additional summary/discussion of GI-199 and terms below.

The study considers the factors that impact estimates of both the seismic hazard (i.e. ground shaking levels) at the site and the plants resistance to earthquakes (mathematically represented by the plant level fragility curve). Previous quakes, the tectonic environment, and the soils that underlie the site are all used in the development of the ground shaking estimates used in the analyses. Plant design and the seismic resistance of the important structures, systems, and components are all used in the development of plant level fragility curves.

Q:1.6 Are all US plants being evaluated as a part of Generic Issue 199?

Public Answer: Currently the scope of the Generic Issue 199 (GI-199) Safety/Risk Assessment is limited to all plants in the Central and Eastern United States. Although plants at the Columbia, Diablo Canyon, Palo Verde, and San Onofre sites are not included in the GI-199 Safety/Risk Assessment, the Information Notice on GI-199 is addressed to all operating power plants in the US (as well as all independent spent fuel storage installation licensees). The staff will also consider inclusion of operating reactors in the Western US in its future generic communication information requests.

Additional information: The staff is currently developing specific information needs to be included in a Generic Letter to licensees in the CEUS.

Q:1.7 What are the current findings of GI-199?

Public Answer: Currently operating nuclear plants in the US remain safe, with no need for immediate action. This determination is based on NRC staff reviews of updated seismic hazard information and the conclusions of the safety/risk assessment of GI-199. Existing nuclear plants were designed with considerable margin to be able to withstand the ground motions from the “deterministic” or “scenario earthquake” that accounted for the largest earthquakes expected in the area around the plant. The results of the GI-199 safety/risk assessment demonstrate that the probability of exceeding the design basis ground motion may have increased at some sites, but only by a relatively small amount. In addition, the probabilities of seismic core damage are lower than the guidelines for

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

taking immediate action. Although there is not an immediate safety concern, the NRC is focused on assuring safety during even very rare and extreme events. Therefore, the NRC has determined that assessment of updated seismic hazards and plant performance should continue. If at any time the NRC determines that an immediate safety concern exists, action to address the issue will be taken.

Q:1.8 Where can I get current information about Generic Issue 199?

Public Answer: The public NRC Generic Issues Program (GIP) website (<http://www.nrc.gov/about-nrc/regulatory/gen-issues.html>) contains program information and documents, background and historical information, generic issue status information, and links to related programs. The latest Generic Issue Management Control System quarterly report, which has regularly updated GI-199 information, is publicly available at <http://www.nrc.gov/reading-rm/doc-collections/generic-issues/quarterly/index.html>. Additionally, the US Geological Survey provides data and results that are publicly available at <http://earthquake.usgs.gov/hazards/products/conterminous/2008/>.

Additional, technical, non-public information: The GI-199 section of the NRC internal GIP website (<http://www.internal.nrc.gov/RES/projects/GIP/Individual%20GIs/GI-0199.html>) contains additional information about Generic Issue 199 (GI-199) and is available to NRC staff.

Q:1.9 Which Plants Are in the GI-199 “Continue Region”

Public Answer: Plant-specific results are included in the Safety/Risk Assessment report (in appendix D) and have been used in the aggregate to determine that further, plant-specific information and analysis is needed to investigate possible plant-specific improvements. Listed below are plants that are currently above the Generic Issues Program (GIP) numerical risk threshold for an issue to continue to be evaluated for possible regulatory action (Note: that the plants are listed in alphabetical order by NRC region.)

Additional Information: As more information becomes available and more detailed analysis is performed, this group of plants *will* change.

Region I

04/13/2011

~~DUO (Pre-decisional) - DRAFT~~

Indian Point 2
Indian Point 3
Limerick 1
Limerick 2
Peach Bottom 2
Peach Bottom 3
Seabrook 1

Region II

Crystal River 3
Farley 1
Farley 2
North Anna 1
North Anna 2
Oconee 1
Oconee 2
Oconee 3
Saint Lucie 1
Saint Lucie 2
Sequoyah 1
Sequoyah 2

Summer
Watts Bar 1

Region III

Dresden 2
Dresden 3
Duane Arnold
Perry 1

Region IV

River Bend 1
Wolf Creek 1

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

Q:1.10 Are the plants safe? If you are not sure they are safe, why are they not being shut down? If you are sure they are safe, why are you continuing evaluations related to this generic issue?

Public Answer: Yes, currently operating nuclear plants in the United States remain safe, with no need for immediate action. This determination is based on NRC staff reviews associated with Early Site Permits (ESP) and updated seismic hazard information, the conclusions of the Generic Issue 199 Screening Panel (comprised of technical experts), and the conclusions of the Safety/Risk Assessment Panel (also comprised of technical experts).

No immediate action is needed because: (1) existing plants were designed to withstand anticipated earthquakes with substantial design margins, as confirmed by the results of the Individual Plant Examination of External Events program; (2) the probability of exceeding the *safe shutdown earthquake* ground motion may have increased at some sites, but only by a relatively small amount; and (3) the Safety/Risk Assessment Stage results indicate that the probabilities of seismic core damage are lower than the guidelines for taking immediate action.

Even though the staff has determined that existing plants remain safe, the Generic Issues Program criteria (Management Directive 6.4) direct staff to continue their analysis to determine whether any cost-justified plant improvements can be identified to enhance plant safety.

RQ: 1.10-1 Page 20 of the report: This result confirms NRR's conclusion that currently operating plants are adequately protected against the change in seismic hazard estimates because the guidelines in NRR Office Instruction LIC-504 "Integrated Risk-Informed Decision Making Process for Emergent Issues" are not exceeded. Can someone please explain?

The Safety/Risk Assessment results confirm that plants are safe. The relevant risk criterion for GI-199 is total *core damage frequency* (CDF). The threshold for taking immediate regulatory action (found in NRR Office Instruction LIC-504, see below) is a total CDF greater than or on the order of 10^{-3} (0.001) per year. For GI-199, the staff calculated seismic CDFs of 10^{-4} (0.0001) per year and below for nuclear power plants operating in the Central and Eastern US (CEUS) (based on the new US Geological Survey seismic hazard curves). The CDF from internal events (estimated using the

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

staff-developed Standardized Plant Analysis of Risk models) and fires (as reported by licensees during the IPEEE process and documented in NUREG-1742), when added to the seismic CDF estimates results in the total risk for each plant to be, at most, 4×10^{-4} (0.0004) per year or below. This is well below the threshold (a CDF of 10^{-3} [0.001] per year) for taking immediate action. Based on the determination that there is no need for immediate action, and that this issue has not changed the licensing basis for any operating plant, the CEUS operating nuclear power plants are considered safe. In addition, as detailed in the GI-199 Safety/Risk Assessment there are additional, qualitative considerations that provide further support to the conclusion that plants are safe.

Note: The NRC has an integrated, risk-informed decision-making process for emergent reactor issues (NRR Office Instruction LIC-504, ADAMS Accession No. ML100541776 [not publically available]). In addition to deterministic criteria, LIC-504 contains risk criteria for determining when an emergent issue requires regulatory action to place or maintain a plant in a safe condition.

Q:1.11 What is the timetable now for consideration of any regulatory changes from the GI-199 research?

Public Response: The NRC is working on developing a Generic Letter (GL) to request information from affected licensees. The GL will likely be issued in a draft form within the next 2 months to stimulate discussions with industry in a public meeting. After that it has to be approved by the Committee to Review Generic Requirements, presented to the Advisory Committee on Reactor Safeguards and issued as a draft for formal public comments (60 days). After evaluation of the public comments it can then be finalized for issuance. We expect to issue the GL by the end of this calendar year, as the new consensus seismic hazard estimates become available. The information from licensees will likely require 3 to 6 months to complete. Staff's review will commence after receiving licensees' responses. Based on staff's review, a determination can be made regarding cost beneficial backfits where it can be justified.

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

Q:1.12 Questions Related to New Seismic Hazard Information

RQ: 1.12-1 What document has the latest seismic hazard estimates (probabilistic or not) for existing nuclear power plants in the western US?

Public Response: At this time the staff has not formally developed updated probabilistic seismic hazard estimates for the existing nuclear power plants in the Western US. However, NRC staff during the mid- to late-1990's reviewed the plants' assessments of potential consequences of severe ground motion from earthquakes beyond the plant design basis as part of the Individual Plant Examination of External Events (IPEEE) program. From this review, the NRC staff determined that the seismic designs of operating plants in the US have adequate safety margin. NRC staff has continued to stay abreast of the latest research on seismic hazards in the Western US and interface with colleagues at the US Geological Survey. The focus of Generic Issue 199 has been on the CEUS. However, the Information Notice that summarized the results of the Safety/Risk Assessment was sent to all existing power reactor licensees. The documents that summarize existing hazard estimates are contained in the Final Safety Analysis Reports (FSARS) and in the IPEEE submittals. It must be noted that following 9/11 the IPEEE documents are no longer publicly available.

RQ: 1.12-2 The GI-199 documents refer to newer data on the way. Have NRC, USGS et al. released those? I'm referring to this: "New consensus seismic-hazard estimates will become available in late 2010 or early 2011 (these are a product of a joint NRC, US Department of Energy, US Geological Survey (USGS) and Electric Power Research Institute (EPRI) project). These consensus seismic hazard estimates will supersede the existing EPRI, Lawrence Livermore National Laboratory, and USGS hazard estimates used in the GI-199 Safety/Risk Assessment."

Public Response: The new consensus hazard curves are being developed in a cooperative project that has NRC, US Department of Energy, US Geological Survey (USGS) and Electric Power Research Institute (EPRI) participation. The title is: The Central and Eastern US Seismic Source Characterization (CEUS-SSC) project. The project is being conducted following comprehensive standards to ensure quality and regulatory defensibility. It is in its final phase and is expected to be publicly released in the fall of 2011. The project manager is Larry Salamone

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

(Lawrence.salamone@srs.gov, 803-645-9195) and the technical lead on the project is Dr. Kevin Coppersmith (925-974-3335, kcoppersmith@earthlink.net). Additional information on this project can be found at: <http://mydocs.epri.com/docs/ANT/2008-04.pdf>, and http://my.epri.com/portal/server.pt?open=512&objID=319&&PageID=218833&mode=2&in_hi_userid=2&cached=true.

Q:1.13 What, if anything, can be done at a site to reduce the seismic risk at a plant site?

RQ: 1.13-1 Has anyone determined that anything SHOULD be done at Plant X?

Public Answer: The fundamental conclusion of the report is that “work to date supports a decision to continue ...; the methodology, input assumptions, and data are not sufficiently developed to support other regulatory actions or decisions.” The NRC is planning to issue a Generic Communication to operating reactor licensees in the CEUS requesting additional information needed for NRC to perform regulatory analyses in support of plant-specific backfits.

NRC may impose cost-justified backfits (modifications such as installation of stronger component anchorages or snubbers for specific components) that are driving the seismic risk at individual sites. Additionally, licensees may voluntarily take actions to reduce their seismic risk.

Q:1.14 Is the earthquake safety of US plants reviewed once the plants are constructed?

Public response: Yes, earthquake safety is reviewed during focused design inspections, under the Generic Issues Program (GI-199) and as part of the Individual Plant Evaluation of External Events program (IPEEE) that was conducted in response to Generic Letter 88-20 Supplement 4.

Q:1.15 Technical Questions on the Terms in the GI-199 Safety/Risk Assessment

RQ: 1.15-1 What do you mean by “increased estimates of seismic hazards” at nuclear power plant sites?

Public Answer: *Seismic hazard* (earthquake hazard) represents the chance (or probability) that a specific level of ground motion could be observed or

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

exceeded at a given location. Our estimates of seismic hazard at some Central and Eastern United States locations have changed based on results from recent research, indicating that earthquakes occurred more often in some locations than previously estimated. Our estimates of seismic hazard have also changed because the models used to predict the level of ground motion, as caused by a specific magnitude earthquake at a certain distance from a site, changed. The increased estimates of seismic hazard at some locations in the Central and Eastern United States were discussed in a memorandum to the Commission, dated July 26, 2006. (The memorandum is available in the NRC Agencywide Documents Access and Management System [ADAMS] under Accession No. ML052360044).

RQ: 1.15-2 Explain “seismic hazard curve” and “plant level fragility curve”.

Public Answer: A seismic hazard curve is a graphical representation of seismic hazard. Seismic hazard in this context is the highest level of ground motion expected to occur (on average) at a site over different periods of time. Plant level fragility is the probability of damage to plant structures, systems and components as a function of ground shaking levels.

RQ: 1.15-3 What would constitute fragility at a plant?

Public Answer: Fragility is a term that relates the probability of failure of an individual structure, system or component to the level of seismic shaking it experiences. Plant level fragility is the probability of damage to sets of plant structures, systems and components as a function of ground shaking levels.

RQ: 1.15-4 Does the SCDF represent a measurement of the risk of radiation RELEASE or only the risk of core damage (not accounting for secondary containment, etc.)?

Public Response: Seismic core damage frequency is the probability of damage to the core resulting from a seismic initiating event. It does not imply either a meltdown or the loss of containment, which would be required for radiological release to occur. The likelihood of radiation release is far lower.

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

Q:1.16 Questions Related to the GI-199 models

RQ: 1.16-1 Can you explain the weighted average and how it compares to the weakest link average?

Public Response: Tables D-1 through D-3 in Appendix D of the US NRC study show the “simple” average of the four spectral frequencies (1, Hz, 5 Hz, 10 Hz, peak ground acceleration (PGA)), the “IPEEE weighted” average and the “weakest link” model. These different averaging approaches are explained in Appendix A.3 (simple average and IPEEE weighted average) and Appendix A.4 (weakest link model). The weighted average uses a combination of the three spectral frequencies (1, 5, and 10 Hz) at which most important structures, systems, and components of nuclear power plants will resonate. The weakest link is the largest SCDF value from among the four spectral frequencies noted above.

RQ: 1.16-2 Explain the “weakest link model”.

The weakest link model is a method for evaluating the importance of different frequencies of ground vibration to the overall plant performance. The model and its details are not integral to understanding the fundamental conclusions of the study.

RQ: 1.16-3 Ultimately would you suggest using one of the models (average, weighted, weakest link) or to combine the information from all three?

Public Response: Most nuclear power plant structures, systems, and components resonate at frequencies between 1 and 10 Hz, so there are different approaches to averaging the Seismic Core Damage Frequency (SCDF) values. By using multiple approaches, the NRC staff gains a better understanding of the uncertainties involved in the assessments.

Q:1.17 Questions Related to Bill Dedman’s MSNBC article

RQ: 1.17-1 Does the NRC have a position on the MSNBC article that ranked the seismic safety of US plants?

See Answer below.

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

RQ: 1.17-2 Can we get the rankings of the plants in terms of safety? (Actually this answer should be considered any time GI-199 data is used to "rank" plants)

Public Answer: The NRC does not rank nuclear plants by seismic risk. The objective of the GI-199 Safety/Risk Assessment was to perform a conservative, screening-level assessment to evaluate if further investigations of seismic safety for operating reactors in the central and eastern US (CEUS) are warranted, consistent with NRC directives. The results of the GI-199 safety risk assessment should not be interpreted as definitive estimates of plant-specific seismic risk because the nature of the information used (both seismic hazard data and plant-level fragility information) make these estimates useful only as a screening tool.

RQ: 1.17-3 Can someone put that risk factor into perspective, using something other than MSNBC's chances of winning the lottery?

As noted above, the risk factors determined in GI-199 were conservative estimates of risk intended for use as a screening tool. Use of these factors beyond this intended purpose is inappropriate.

RQ: 1.17-4 Did an NRC spokesperson tell MSNBC's Bill Dedman that the weighted risk average was invalid and useless? He contends to us that this is the case.

Public Answer: No. See Answers below.

RQ: 1.17-5 If it was "invalid" as he claims, why would the USGS include that metric?

Public Answer: The weighted average is not invalid. All of the values in Appendix D were developed by NRC staff. Table D-1 in Appendix D uses the (2008) US Geological Survey (USGS) seismic source model, but the Seismic Core Damage Frequency results were developed by US NRC staff. The USGS seismic source model is the same one used to develop the USGS National Seismic Hazard Maps.

RQ: 1.17-6 Were there any other factual inaccuracies or flaws in Mr. Dedman's piece you would like clarify/point out.

Public Answer: The US Nuclear Regulatory Commission study, released in September, 2010, was prepared as a screening assessment to evaluate if further investigations of seismic safety for operating reactors in the central

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

and eastern US (CEUS) are warranted, consistent with NRC directives. The report clearly states that “work to date supports a decision to continue ...; the methodology, input assumptions, and data are not sufficiently developed to support other regulatory actions or decisions.” Accordingly, the results were not used to rank or compare plants. The study produced plant-specific results of the estimated change in risk from seismic hazards. The study did not rely on the absolute value of the seismic risk except to assure that all operating plants are safe. The plant-specific results were used in aggregate to determine the need for continued evaluation and were included in the report for openness and transparency. The use of the absolute value of the seismic hazard-related risk, as done in the MSNBC article, is not the intended use, and the NRC considers it an inappropriate use of the results.

RQ: 1.17-7 Mr. Dedman infers that the plant quake risk has grown (between the 1989 and 2008 estimates) to the threshold of danger and may cross it in the next study. Is this the NRC's position?

Public Answer: The US NRC evaluation is still underway and it is too early to predict the final outcome. However, staff has determined that there is no immediate safety concern and that overall seismic risk estimates remain small. If at any time the NRC determines that an immediate safety concern exists, action to address the issue will be taken. Even though the staff has determined that existing plants remain safe, the Generic Issues Program criteria (Management Directive 6.4) direct staff to continue their analysis to determine whether any cost-justified plant improvements can be identified to enhance plant safety.

- 5.3. Q&As: SOARCA
- 5.4. Q&As: Other programs
- 5.5. Factsheets
 - 5.5.1 GI-199

04/13/2011

~~OUO (Pre-decisional) DRAFT~~

6. March 11, 2011 Earthquake in Japan

6.1. Overview

On March 11, 2011, the magnitude 9.0 Tohoku earthquake occurred near the northeast coast of Honshu, Japan. The epicenter of the earthquake was 129 km (80 miles) east of Sendai, Honshu, Japan and 373km (231 miles) northeast of Tokyo. The earthquake occurred at a depth of 32 km (20 miles) (USGS 2011c). The earthquake resulted in a large tsunami that caused significant damage along the coast of Japan.

The earthquake was preceded by a series of seismic events beginning two days before the main shock with a magnitude 7.2 event located approximately 40 km away from epicenter of the March 11 earthquake. These events can now be identified as foreshocks. A series of aftershocks followed the main shock. The map in Figure 1 (produced by the Japan Meteorological Agency) shows the main shock and aftershocks. According to USGS, aftershocks are expected in region due to continuing stress readjustments. The frequency of aftershocks is expected to decrease with time, but episodes of higher aftershock activity may be experienced. USGS does not believe this earthquake has increased or decreased the probability of a future major earthquake (USGS 2011c).

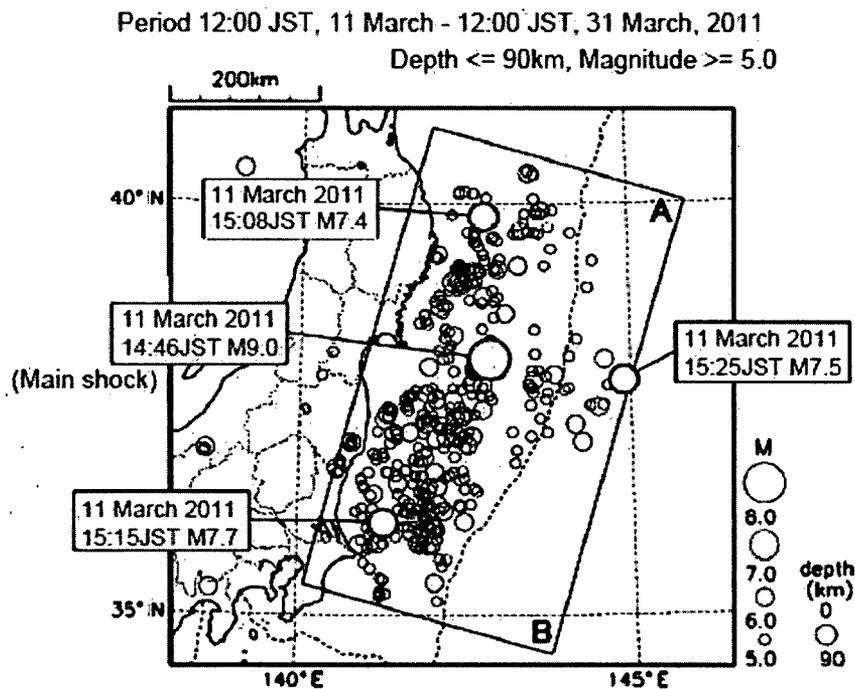


Figure 1: Location of main shock and aftershocks (March 11 to March 31, 2011) (JMA 2011)

04/13/2011

~~000 (Pre-decisional) - DRAFT~~

6.2. Earthquake Tectonics

The Tohoku earthquake resulted from thrust faulting on or near the major subduction zone plate boundary between the Pacific plate and the extension of North America plate that runs beneath the Sea of Japan and northeast Asia. Figure 2 provides a representation of the geometric boundaries of major tectonic plates. At the latitude on which the earthquake occurred, the Pacific plate moves approximately westward with respect to the North American plate at a rate of 83 mm/yr. The Pacific Plate then descends beneath Japan at the Japan Trench. Modeling of the rupture indicates that its slip area is approximately 500 km (along-strike) by 200 km (in the down-dip direction) and that the fault moved upward approximately 30-40 meters. The rupture zone is centered roughly on the earthquake epicenter, along the strike. Peak slips were up-dip of the hypocenter (towards the Japan Trench axis) (USGS 2011c). Figure 3 provides a USGS graphical illustration of the approximate rupture plane. Figure 4 shows the preliminary slip distribution and vertical deformation for the earthquake. This figure is available from the Geospatial Information Authority of Japan. Data from the Geospatial Information Authority (GSI) of Japan was processed by the Jet Propulsion Laboratory (JPL) and Caltech to produce the GPS slip model shown in Figure 5.

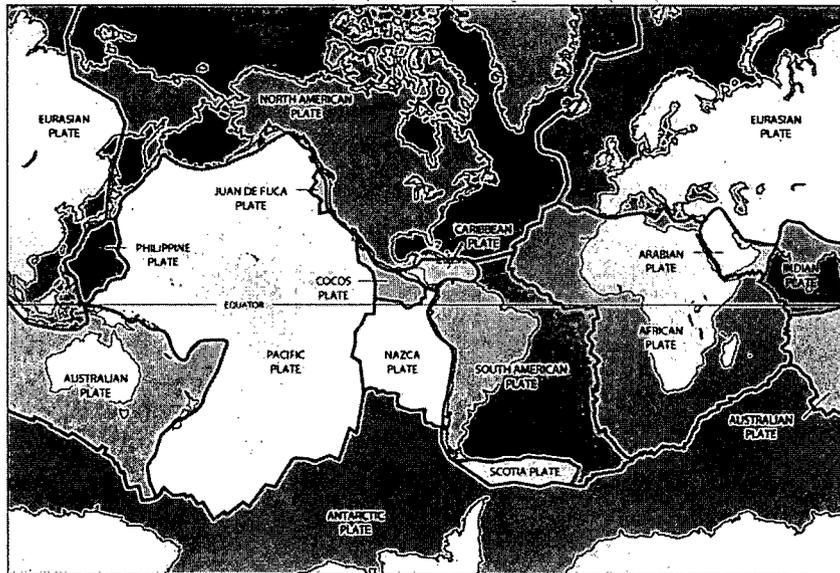


Figure 2: Major tectonic plates (USGS 2008)

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

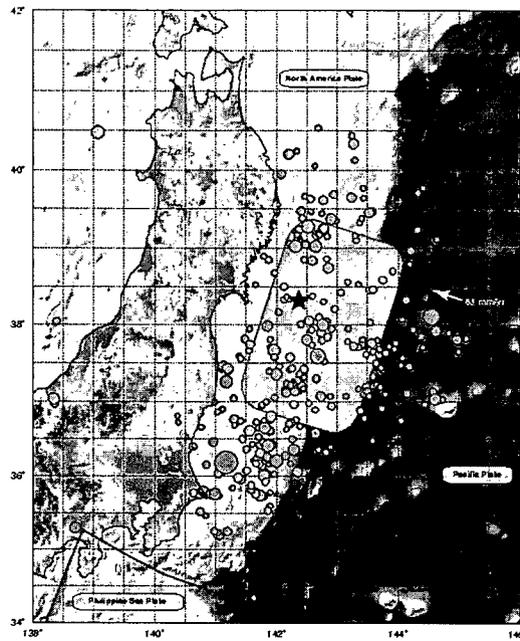


Figure 3: USGS figure showing Approximate Earthquake Rupture Zone (USGS 2011b)

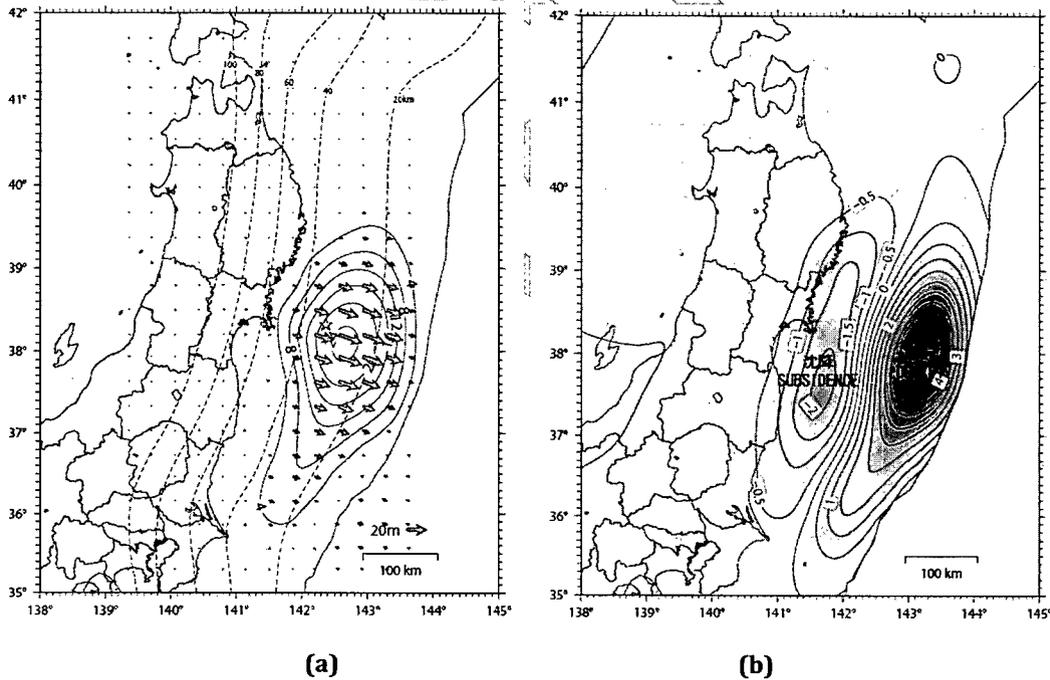


Figure 4: Preliminary results released (on 03-15-2011) by the Geospatial Information Authority of Japan for (a) the slip distribution on the plate interface of the mainshock, and (b) vertical deformation calculated from slip distribution model (GSI 2011)

04/13/2011

~~DUU (Pre-decisional) - DRAFT~~

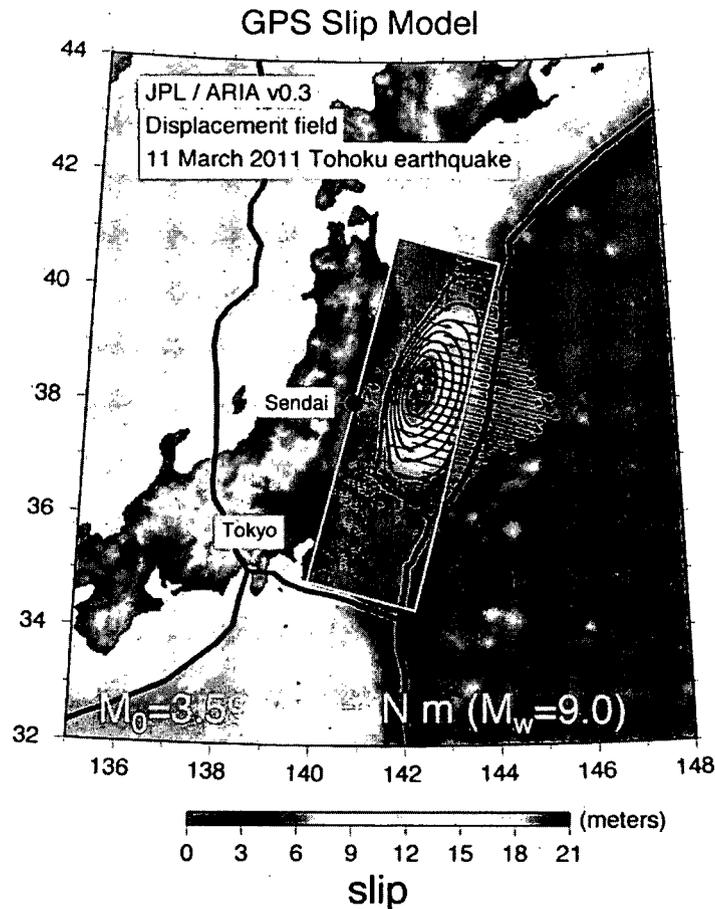


Figure 5: GPS slip model (USGS 2011a)

6.3. Tsunami

The Tohoku earthquake was large magnitude, subduction zone event that occur at a relatively shallow depth beneath the ocean. Tsunamis are likely to result from such events. The coastline near Honshu, Japan is particularly vulnerable to tsunami waves because it has many deep coastal embayments that amplify tsunami waves and result in large wave inundations (USGS 2011c). Figure 6 shows the maximum computed tsunami amplitude (in cm) during 24 hours of wave propagation across the Pacific Ocean (NOAA 2011). Figure 7 gives the timeseries of wave heights and maximum offshore wave amplitudes for locations offshore of four Japanese nuclear plants. These offshore amplitudes estimates were obtained by taking the nearest gridpoint to the site in the NOAA tsunami propagation grid, and then scaling to the coastline using Green's Law. The wave runup heights (i.e. the maximum elevation of a flooded onshore area) observed onshore will typically differ from these offshore amplitudes depending on the onshore topographic profile. TEPCO has

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

reported water levels reaching 14 meters (46 ft) onshore at the Fukushima Daiichi site. The same report indicates that the design basis tsunami for the site was 5.7 meters, and that the reactors and backup power sources were located 10 to 13 meters above sea level (NEI 2011).

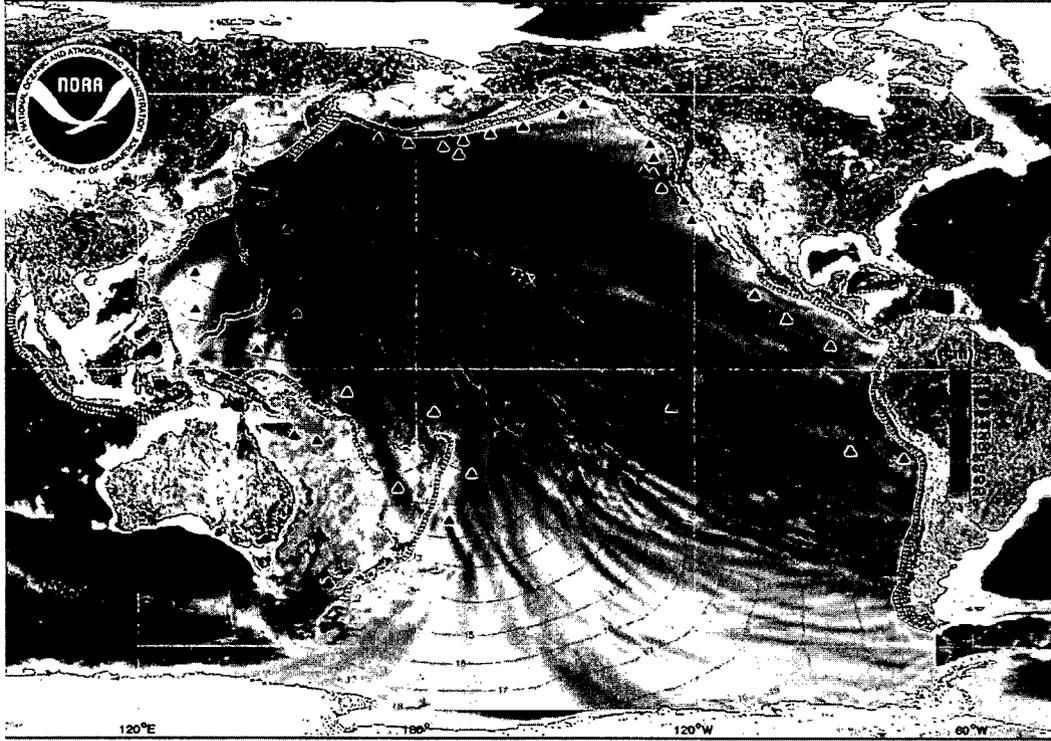


Figure 6: Maximum computed tsunami amplitude during 24 hours of wave propagation (NOAA 2011)

DRAFT

04/13/2011

~~000 (Pre-decisional) - DRAFT~~

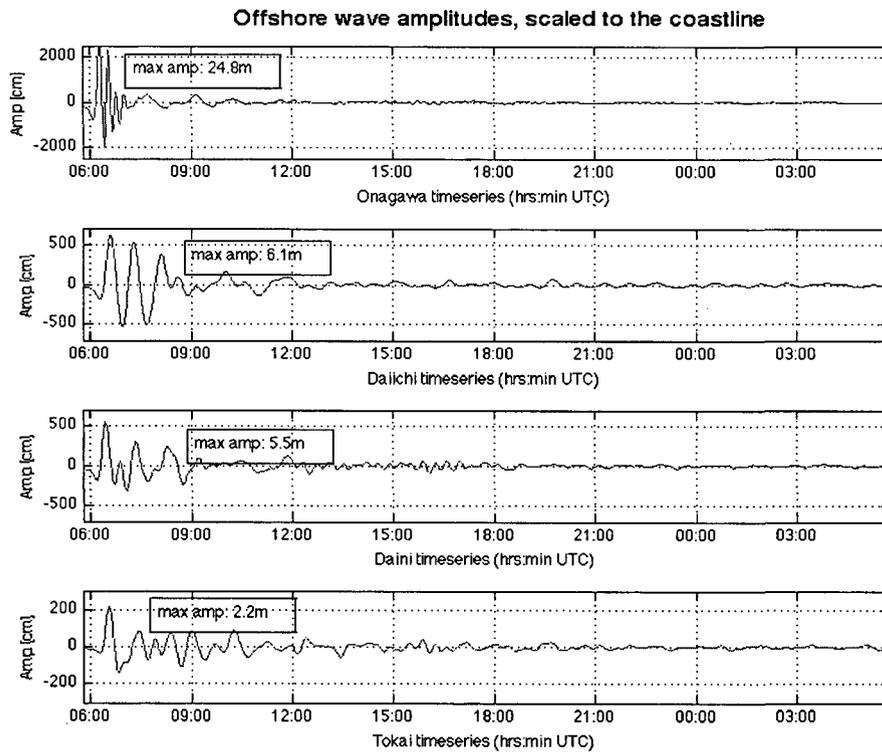


Figure 7: Wave amplitudes offshore of Japanese nuclear plants (Moore 2011)

6.4. Ground motion

The Tohoku earthquake resulted in strong and long duration ground shaking. Figure 8 provides a ShakeMap of instrumental intensity for the Tohoku earthquake. (A ShakeMap provides a near-real-time map of ground motion and shaking intensity following a significant earthquake.) The dark red and orange portions of the map represent locations of the most intense shaking. Figure 9 provides maps of PGA and PGV at the ground surface. The largest recorded PGA (3 component vector summation) was measured at 2933 gals (nearly 3g). This measurement appears to be a case of resonance. There were ten recording stations at which the measured PGA exceeded 1305gal (1.3g). The duration of strong shaking was as long as in some locations. The near-source acceleration waveforms recorded at locations in the northern regions of the affected region display two distinct ground motion phases. This is indicative of two areas of large slip at the rupture plane. The distinctive phases are not evident in ground motion recordings from the southern regions of the affected area. Overall, several secondary phases are observed in waveforms, indicating a complex source process (NIED n.d.).

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

Figure 10 provides a preliminary comparison of the observed ground motion (versus source-to-site distance) with the Si & Midorikawa (1999) empirical attenuation relationship. The dashed lines represents the median value; the dotted lines represent the median values. While the magnitude 9.0 event is outside the applicable range of the Si & Midorikawa (1999) model, preliminary results suggest the ground motion are generally below the empirical attenuation relationship, particularly at larger distances (NIED n.d.).

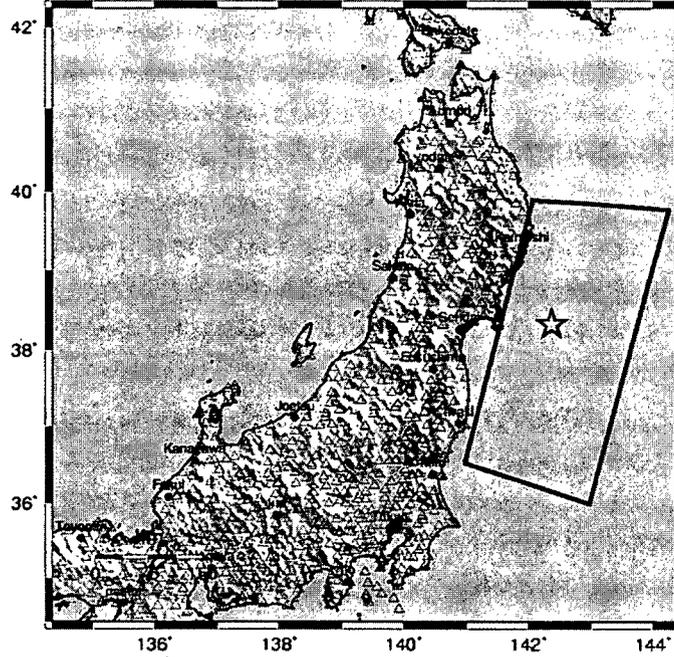
Figure 11 compares the hazard map for Japan corresponding the PGA with a 10% probability of exceedance in 50 years with the observed ground motions. This map indicates that the expected ground motion intensity along the east coast of Honshu, Japan corresponding to this probability of exceedance is lower than the ground shaking observed during the Tohoku earthquake.

Table 1 provides a comparison between the ground motions observed at the basement of the reactor buildings at the Fukushima Daiichi and Fukushima Daini units with their respective design basis ground motions at the building foundations (which are de-amplified relative to the hypothetical rock outcrop). Exceedance of the design basis motions did not occur at the Daini plant. However, the observed E-W component of ground motion at the Daiichi plant exceeded the design basis at 3 of the units and nearly exceeded the design basis at a fourth unit. Table 2 presents the threshold for reactor scram at each unit. The ground motions exceeded the scram-threshold for all units at both plants.

DRAFT

USGS ShakeMap : NEAR THE EAST COAST OF HONSHU, JAPAN

Fri Mar 11, 2011 05:46:23 GMT M 9.0 N38.32 E142.37 Depth: 32.0km ID:c0001xgp



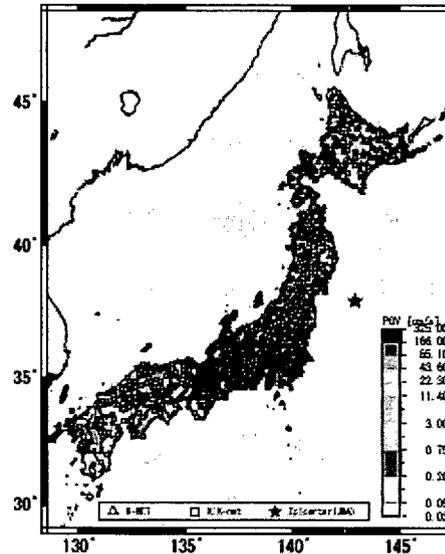
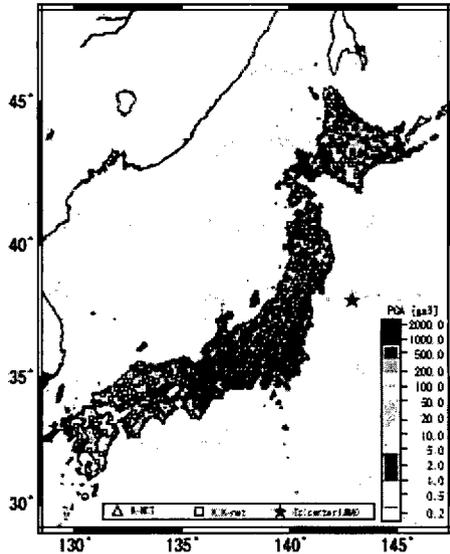
Map Version 11 Processed Sat Mar 26, 2011 07:04:10 AM MDT - NOT REVIEWED BY HUMAN

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/heavy	Heavy	Very Heavy
PEAK ACC. (mg)	<0.17	0.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL. (cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII		

Figure 8: USGS ShakeMap of instrumental intensity (USGS 2011b)

Peak Ground Acceleration (surface)

Peak Ground Velocity (surface)



04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

Figure 9: PGA and PGV (NIED n.d.)

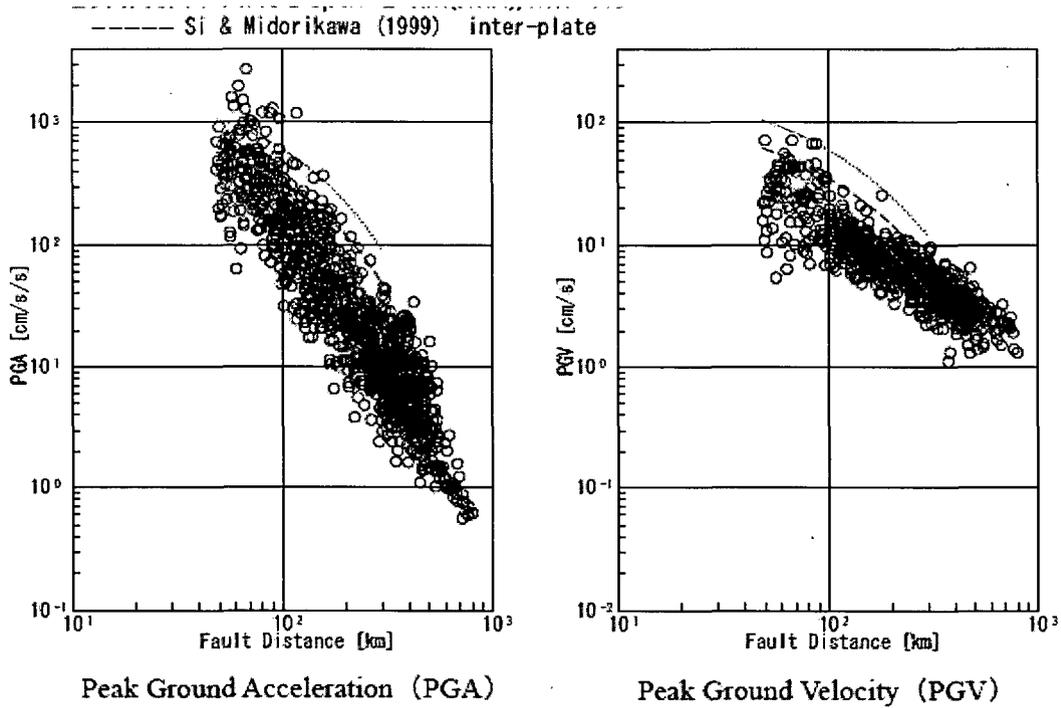
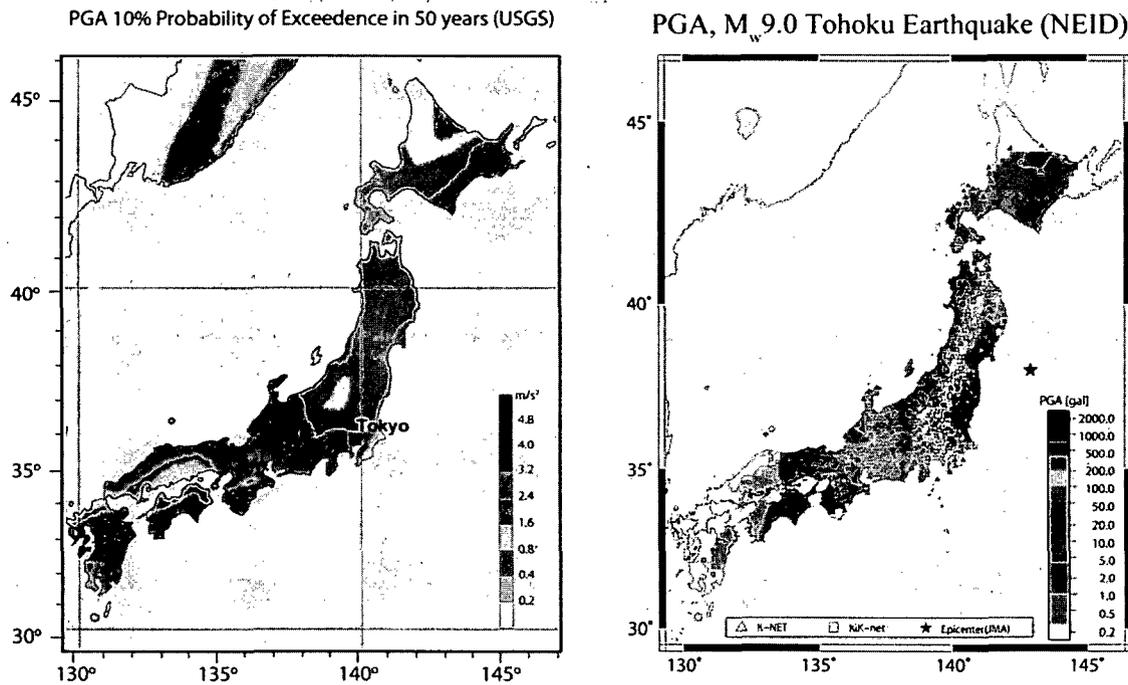


Figure 10: Comparison of observed values of PGA and PGV with ground motion empirical attenuation laws (preliminary) (NIED n.d.)



04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

Figure 11: Hazard map of Japan for PGA with 10% probability of exceedance in 50 years (left) and PGA observed during the Tohoku earthquake (right) [##need source]

Table 1: Comparison between recorded ground motion at the Fukushima Plants and the design basis ground motions (TEPCO 2011)

Observation Point (The lowest basement of reactor buildings)		Observed data (interim*1)			Maximum Response Acceleration against Basic Earthquake Ground Motion (gal)		
		Maximum Response Acceleration (gal)			Horizontal (N-S)	Horizontal (E-W)	Vertical
		Horizontal (N-S)	Horizontal (E-W)	Vertical			
Fukushima Daiichi	Unit 1	460**2	447**2	258**2	487	489	412
	Unit 2	348**2	550**2	302**2	441	438	420
	Unit 3	322**2	507**2	231**2	449	441	429
	Unit 4	281**2	319**2	200**2	447	445	422
	Unit 5	311**2	548**2	256**2	452	452	427
	Unit 6	298**2	444**2	244	445	448	415
Fukushima Daini	Unit 1	254	230**2	305	434	434	512
	Unit 2	243	196**2	232**2	428	429	504
	Unit 3	277**2	216**2	208**2	428	430	504
	Unit 4	210**2	205**2	288**2	415	415	504

* 1: The data above is interim and can be changed. * 2: The recording time was about 130-150 seconds.

Table 2: Threshold for reactor scram the Fukushima plants (TEPCO 2011)

	Threshold for reactor scram (gal)				
	Unit	Horizontal	Observation point	Vertical	Observation point
Fukushima Daiichi	1 - 5	135	B1F	100	B1F
	6		B2F		B2F
Fukushima Daini	1 - 4	150	2F	100	B2F
		135	B2F		

6.5. Historical perspective

Since 1973, nine earthquakes of magnitude 7 or greater have occurred on the Japan Trench subduction zone, including a magnitude 7.7 event in 1978 and a magnitude 7.8 event in 1994. The 1978 event occurred 35km southwest of the epicenter of the March 11 earthquake. The 1994 earthquake occurred 260km north of the epicenter of the March 11 event. The 1978 earthquake resulted in 22 fatalities and over 400 injuries while the 1994 event resulted in 3 fatalities and 700 injuries. In comparison, the March 11, 2011 event resulted in __ fatalities and __ injuries. In 1611, 1896, and 1933m large offshore earthquakes produced on the same subduction zone damaging tsunamis on the Sanriku coast of Japan. In 1896, waves as high as 38 meters resulted from a magnitude 7.6 subduction earthquake. The reported death toll is 27,000. In 1933, a magnitude 8.6

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

earthquake caused tsunami waves as high as 29 meters and resulted in more than 3000 deaths. The 1933 event did not result from thrust faulting at the subduction zone plate interface. It occurred seaward of the Japan Trench within the Pacific plate. An event similar to the March 11 event may have occurred in 869. Scientists have identified written records and sand sheets that indicate the Sendai area was swept away by a large tsunami (USGS 2011b).

6.6. Q&A: General information about the March 11, 2011 Tohoku earthquake and tsunami

Q:1.18 How high was the tsunami at the Fukushima nuclear plants? Was it higher than was expected?

RQ: 1.18-1 Why are there different estimates of wave height for the tsunami generated by the March 11 earthquake?

RQ: 1.18-2 It appears that the estimates of the tsunami are changing frequently. Why?

RQ: 1.18-3 The NOAA and TEPCO estimates are different. Why?

RQ: 1.18-4 How high was the tsunami at the Fukushima nuclear power plants?

Answer: A tsunami has two phases of response. In the open ocean it behaves predictably and calculations are highly accurate. As the wave gets closer to shore and the shoaling effect begins, the behavior starts to become non-linear. High resolution bathymetric (and topographic) information is required to obtain precise predictions of runup onto land at any particular point on the coastline. However, it is well understood that as a tsunami wave comes onshore it grows in size significantly.

The tsunami modeling team at the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Lab have estimated the wave height just offshore (at the 5 meter bathymetric line) to be approximately 8 meters in height at Fukushima Daiichi and approximately 7 meters at Fukushima Daini. This estimate is based on recordings from NOAA's Deep-ocean Assessment and Reporting of Tsunamis (DART) buoys and a high resolution numerical model developed for the tsunami warning system. ##need citation for this information

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

A recent estimate released by TEPCO indicates that the tsunami water at the Fukushima Daiichi site reached a height of 14 meters. The report also indicates that the design basis tsunami height was 5.7 meters and that the emergency diesel generators were located 10-13 meters above sea level. This data was provided by TEPCO and has not been confirmed by the NRC. This is the third estimate that TEPCO has published, and we do not have information about why their estimates are changing. Because a tsunami will rise up as it comes ashore, water level estimates of 8 meters offshore and 14 meters onshore appear to be consistent.

Additional information: NOAA's PMEL center has provided us their best numbers for all the plants on the NW coast of Japan.

Q:1.19 How well can we predict a tsunami wave height? What have we learned about our prediction abilities based on the events in Japan?

Answer: The method used by the Japanese nuclear industry is different from how assessments are made in the US. Consequently, the under-prediction of the possible tsunami in Japan does not indicate a problem in the US. The Japanese approach focuses on using their extensive database of past events and doing modeling based on segmented faults.

In the US, NOAA's tsunami warning system models have been extremely well validated over time (with hundreds of real tsunami), but the models are limited to water depths where necessary resolution of bathymetric data is available and where the non-linear response begins. As a result, there is an effort currently to collect very high resolution data for the entire US Pacific coast and to implement it in the NOAA database (currently the resolution of US data is not uniform). This will make US Pacific coast onshore runup predictions highly accurate.

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

6.7. Q&A: Affect of earthquake and tsunami on Japanese nuclear plants

Q:1.20 Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?

RQ: 1.20-1 What was the disposition of the plant during the time after the earthquake struck and before the tsunami arrived?

RQ: 1.20-2 Was there indication of damage to the plant solely from the earthquake and did emergency procedures function during this time?

Answer: Because this event occurred in Japan, it will be hard for NRC staff to understand exactly what happened until comprehensive assessments can be performed. Preliminary information suggests that important safety systems performed their required function in the period between the occurrence of the earthquake and the impact of the tsunami. It appears that the emergency diesel generators successfully started once offsite power was lost. Therefore, the tsunami appears to have played a key role in the loss of backup power sources at the site, ultimately resulting in a condition known as station blackout. The station blackout was a critical factor in the problems experienced at Fukushima Daiichi nuclear plant.

Additional technical information: None

Q:1.21 Did this earthquake affect the Kashiwazaki-Kariwa nuclear power plant?

RQ: 1.21-1 Did Fukushima plants sustain damage in the July 16, 2007 earthquake, as the Kashiwazaki power plant did?

Answer: The Tohoku earthquake did not affect Kashiwazaki-Kariwa nuclear power plant and all reactors remained in the state of operation prior to the March 11, 2011, Japan earthquake. It also did not trip during an earthquake of magnitude XX that occurred on the western side subsequent to the 8.9 earthquake. This is very important for the stability of Japan's energy supply due to the loss of production at TEPCO's Fukushima nuclear power plants.

Neither Fukushima power plant was affected by the 2007 earthquake.

Additional information: None

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

6.8. Q&A: Design of Japanese NPPs (Regulatory Approach)

Q:1.22 Did the Japanese underestimate the size of the maximum credible earthquake that could affect the plants?

Answer: The magnitude of the Tohoku earthquake was somewhat greater than was expected for the part of the subduction zone on which the earthquake occurred. However, the Japanese nuclear plants were recently reassessed using ground motion levels similar to those that are believed to have occurred at the sites during the Tohoku earthquake. The ground motions against which the Japanese nuclear plants were reassessed were expected to result from earthquakes that were of smaller magnitude, but that were much closer to the sites.

Additional, technical information: Jon Ake is doing some review of the data to determine the likely return period of this motion.

Q:1.23 Was the Fukushima power plant designed to withstand a tsunami of any size? What specific design criteria were applied?

Public response: Japanese plants are designed to withstand both earthquake and tsunami. An English explanation of how Tsunami hazard assessments are undertaken for Japanese plants is found in Annex II to IAEA Guidance on Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations Assessment of Tsunami Hazard: Current Practice in Some States in Japan.

Additional, technical, non-public information: Annie has a copy of the draft annex and will put them into ADAMS

Q:1.24 What are the Japanese S_1 and S_s ground motions and how are they determined?

RQ: 1.24-1 For what earthquake was the plant expected to sustain with damage but continued operation? And with an expected shutdown but no release of radioactive material?

Answer: Japanese nuclear power plants are designed to withstand specified earthquake ground motions, previously specified as S_1 and S_2 , but now simply S_s . The design basis earthquake ground motion S_1 was defined as the largest earthquake that can reasonably be expected to occur at the site of a nuclear power plant, based on the known seismicity of the area and local faults that have shown activity during the past 10,000 years. A power

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

reactor could continue to operate safely during an S_1 level earthquake, though in practice they are set to trip at lower levels. The S_2 level ground motion was based on a larger earthquake from faults that have shown activity during the past 50,000 years and assumed to be closer to the site. The revised seismic regulations in May 2007 replaced S_1 and S_2 with S_S . The S_S design basis earthquake is based on evaluating potential earthquakes from faults that have shown activity during the past 130,000 years. The ground motion from these potential earthquakes are simulated for each of the sites and used to determine the revised S_S design basis ground motion level. Along with the change in definition, came a requirement to consider “residual risk”, which is a consideration of the beyond-design-basis event.

Additional information: None

Q:1.25 What is the design level of the Japanese plants? Was it exceeded?

RQ: 1.25-1 What magnitude earthquake was the plant designed to withstand? For example, what magnitude earthquake was the plant expected to sustain with damage but continued operation?

Answer: There are two shaking levels relevant to the Fukushima plant, the original design level ground motion and a newer review level ground motion. As a result of a significant change in seismic regulations in 2006, NISA, the Japanese regulator initiated a program to reassess seismic hazard and seismic risk for all nuclear plants in Japan. This resulted in new assessments of higher ground shaking levels (i.e. seismic hazard) and a review of seismic safety for all Japanese plants. The program is still ongoing, but has already resulted in retrofit in some plants. Therefore, it is useful to discuss both the design level and a review level ground motion for the plants.

Table 3 provides the original design basis ground motions (S_2) and the new review level ground motions (SS) for four Japanese nuclear plants. (See question Q:1.24 for an explanation of S_1 and SS .) The table also provides the scenario earthquake contributing to the hazard. Design basis ground motions are for the free surface of base stratum, i.e. hypothetical rock outcrop. Table 1 (above) provides a comparison of the ground motion level observed at the Fukushima reactors versus the design basis for each component of ground motion at the foundation of the reactor. Figure 12 provides an illustration of the difference between the outcrop design ground motion and the resulting response ground motion at the foundation

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

of the reactor building. In general, the design basis response ground motions are not exceeded at the Fukushima Daini plant but are exceeded at 3 of the 6 reactors at the Fukushima Daiichi plant

Table 3: Original Design Basis Ground Motions (S₂) and New Review Level Ground Motions (S_s) Used for Review of Japanese Plants

Plant sites	Contributing earthquakes used for determination of hazard	New DBGM S _s	Original DBGM S ₁
Onagawa	Soutei Miyagiken-oki (M8.2)	580 gal (0.59g)	375 gal (0.38g)
Fukushima	Earthquake near the site (M7.1)	600 gal (0.62g)	370 gal (0.37g)
Tokai	Earthquakes specifically undefined	600 gal (0.62g)	380 gal (0.39g)
Hamaoka	Assumed Tokai (M8.0), etc.	800 gal (0.82g)	600 gal (0.62g)

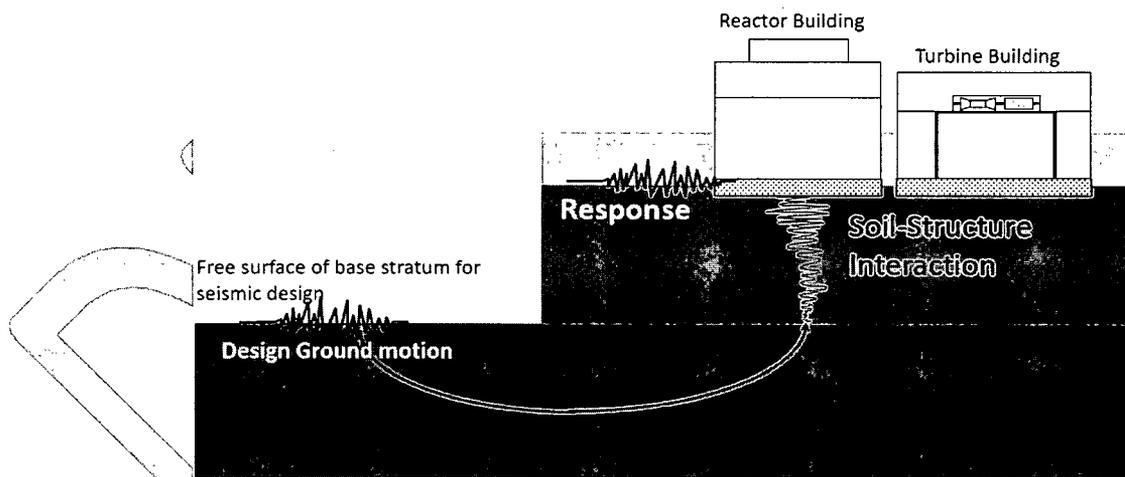


Figure 12: Illustration of design ground motion at rock outcrop and resulting response ground motion at the foundation of the reactor building

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

6.9. Implications of events in Japan on US plants

Q:1.26 Can an earthquake and tsunami as large as happened in Japan also happen here?

RQ: 1.26-1 What if an earthquake like the Sendai earthquake occurred near a US plant?

Answer: The March 2011 Tohoku earthquake occurred on a “subduction zone,” which is the type of tectonic region that produces earthquakes of the largest magnitude. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Severe tsunamis like the one experienced in Japan are only produced by earthquakes occurring at this type of plate boundary. The only subduction zone that could affect the continental US is the Cascadia subduction zone, which lies off the coasts of Oregon, Washington, and the northernmost portion of California. Consequently, a continental earthquake and tsunami as large as the one experienced in Japan could only happen in that coastal region. The only nuclear plant near the Cascadia subduction zone is the Columbia Generating Station. This plant is located a large distance from both the coast (approximately 225 miles) and the offshore subduction zone. Because of the distance between the plant and the Cascadia subduction zone, the strength of ground motion expected at the plant is far lower than the ground motion experienced at the Fukushima plants during the Tohoku earthquake. The large distance between the Columbia Generating Station and the coast also precludes the possibility of a tsunami affecting the plant. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25, which is significantly smaller than the magnitude of the Tohoku earthquake. Magnitude is measured on a log scale and thus a magnitude 9 earthquake produces about ten times stronger shaking and releases about 32 times more energy than a magnitude 8 earthquake. See Question (15) for additional information about earthquake magnitude.

Additional, technical information: None.

Q:1.27 Have the events in Japan changed our perception of earthquake risk to the nuclear plants in the US?

Public Answer: The NRC continues to determine that US nuclear plants are safe. The events transpiring in Japan following the Tohoku earthquake do not change the NRC’s perception of earthquake hazard (i.e. ground

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

motion levels) at US nuclear plants. It is too early to identify the lessons that may be learned from the Tohoku earthquake. The NRC will look closely at all aspects of the response of the Fukushima plants to the earthquake and tsunami to determine if any actions need to be taken in US nuclear plants and if any changes are necessary to NRC regulations.

Additional information: We expect that there would be lessons learned and we may need to seriously relook at common cause failures, including dam failure and tsunami.

Q:1.28 Can significant damage to a nuclear plant like we see in Japan happen in the US due to an earthquake?

RQ: 1.28-1 Are the Japanese nuclear plants similar to US nuclear plants?

RQ: 1.28-2 Why do we have confidence that US nuclear power plants are adequately designed for earthquakes and tsunamis?

Answer: All US nuclear plants are built to withstand environmental hazards, including earthquakes and tsunamis. Even nuclear plants that are located in areas with low and moderate seismic activity are designed for safety in the event of such natural disasters. In addition to the design of the plants, significant effort is devoted to emergency response planning and severe accident management. This approach is called defense-in-depth.

The Japanese facilities at Fukushima are similar in design to some US facilities. However, the NRC has required modifications to US plants since they were designed and built. Examples of these modifications include design changes to control hydrogen and pressure in the containment. The NRC also requires plants to have additional equipment and measures in place to mitigate damage stemming from large fires and explosions resulting from a beyond-design-basis event. The measures include providing core and spent fuel pool cooling and an additional means to power other equipment on site.

In addition, the NRC instituted a rule in the 1980s that required nuclear plants to further assure that a loss of both offsite and onsite emergency AC power systems (a condition known as a station blackout) would not adversely affect public health and safety. As a result of this rule, all plants have (1) established station blackout coping and recovery procedures; (2) completed training for these procedures; (3) implemented modifications as necessary to cope with a station blackout; and (4) ensured a 4-16 hour

04/13/2011

~~OOO (Pre-decisional) DRAFT~~

coping capability. Subsequently, studies conducted by the NRC have shown that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in a significant risk reduction and have further enhanced defense-in-depth.

Additional information: See notes under question "What magnitude earthquake are US nuclear plants designed to?"

Q:1.29 If the earthquake in Japan was a larger magnitude than considered by plant design, why can't the same thing happen in the US?

Public response: Discuss in terms of, IPEEE, Seismic PRA to be provided by Niles

Additional, technical, non-public information: ADD

Q:1.30 Could an accident sequence like the one at Japan's Fukushima Daiichi nuclear plants happen in the US?

Answer: It is difficult to answer this question until we have a better understanding of the precise problems and conditions that faced the operators at Fukushima Daiichi. We do know, however, that Fukushima Daiichi Units 1-3 lost all offsite power and emergency diesel generators. This situation is called "station blackout." The Nuclear Regulatory Commission's detailed regulations address this scenario. US nuclear plants are designed to cope with a station blackout event that involves a loss of offsite power and onsite emergency power. In addition to design features, US nuclear plants are required to conduct a "coping" assessment, perform modifications if necessary, and develop a strategy to demonstrate to the NRC that they could maintain the plant in a safe condition during a station blackout scenario. These assessments, proposed modifications to the plant, and operating procedures were reviewed and approved by the NRC. Several plants added additional AC power sources to comply with this regulation. Additional information about the NRC's station blackout rule is contained in question (12).

In addition, in response to the terrorist events of September 11, 2001, the NRC issued an Interim Compensatory Measures (ICM) Order requiring licensees to take certain actions to mitigate severe accident scenarios such as aircraft impact. These scenarios include the complete loss of offsite power and all on-site emergency power sources.

Additional information: US nuclear plant designs include consideration of seismic events and tsunamis'. It is important not to extrapolate earthquake

04/13/2011

~~OUO (Pre-decisional) DRAFT~~

and tsunami data from one location of the world to another when evaluating these natural hazards. These catastrophic natural events are very region- and location-specific, based on tectonic and geological fault line locations.

Q:1.31 Should US nuclear facilities be required to withstand earthquakes and tsunamis of the kind just experienced in Japan? If not, why not?

Answer: US nuclear reactors are designed to withstand an earthquake equal to the most significant historical event or the maximum projected seismic event and associated tsunami. It is important not to extrapolate earthquake and tsunami data from one location of the world to another when evaluating these natural hazards. Catastrophic natural events are very region- and location-specific because they are based on tectonic and geological fault locations.

The United States Geological Survey (USGS) conducts continuous research of earthquake history and geology and publishes updated seismic hazard curves for various regions in the continental US approximately every six years. NRC identified a generic issue (GI-199) that is currently undergoing an evaluation to assess implications of the latest hazard curves to nuclear plant sites located in the central and eastern United States. The industry is working with the NRC to address this issue.

Furthermore, the lessons learned from the events in Japan will be carefully reviewed to determine whether they apply to US nuclear power plants.

Additional information: None

Q:1.32 Are US plants susceptible to the same kind of loss of power as happened in Japan?

Public response: NRC previously recognized that there is the possibility of a total loss of AC power at a site, called a 'Station Blackout', or SBO. Existing Regulations require the sites to be prepared for the possibility of an SBO. In addition to battery powered back-up system to immediately provide power for emergency systems, NRC regulations require the sites to have a detailed plan of action to address the loss of AC power while maintaining control of the reactor.

There has also been an understanding that sites can lose offsite power as well. Of course, this can be caused by earthquake. However, hurricane- or tornado-related high winds may potentially damage the transmission

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

network in the vicinity of a nuclear plant as well. Flood waters can also affect transformers used to power station auxiliary system. These types of weather related events have the potential to degrade the offsite power source to a plant.

The onsite Emergency Diesel Generators need fuel oil stored in tanks that are normally buried underground. These tanks and associated pumps and piping require protection from the elements. Above ground tanks have tornado and missile protection.

In case both offsite and onsite power supplies fail, NRC has required all licensee to evaluate for a loss of all AC power (station blackout) scenario and implement coping measures to safely shutdown the plant law 10 CFR 50.63.

Additional information: Additional SBO information is found in a fact sheet on the subject at the back of the document (~~##change this reference~~). Some plants have safeguards equipment below sea level and rely on watertight doors or Bilge pumps to remove water from equipment required to support safe shutdown. Overflowing rivers can result in insurmountable volume of water flooding the vulnerable areas. SBO definition in 10CFR50.2, SBO plan requirements in 10CFR50.63.

Q:1.33 How do we know that the emergency diesel generators will not fail to operate like in Japan?

Public response: Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure and are seismic Category I equipment. Even if these EDGs did fail, plants can safely shutdown using station blackout power source law 10 CFR 50.63. In 1988 the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

Additional information: None.

04/13/2011

~~OUO (Pre-decisional) DRAFT~~

Q:1.34 Do you think that the recent Japan disaster will cause any rethinking of the planned seismic isolation guidelines, particularly as it regards earthquakes and secondary effects such as tsunamis?

Public response: Whenever an event like this happens, the NRC thoroughly reviews the experience and tries to identify any lessons learned. The NRC further considers the need to change guidance or regulations. In this case, the event will be studied and any necessary changes will be made to the guidance under development. However, it should be noted that Japan does not have seismically isolated nuclear plants.

Additional information: None.

Q:1.35 Was there any damage to US reactors from either the earthquake or the resulting tsunami?

Answer: No

Additional information: Two US plants on the Pacific Ocean (Diablo Canyon and San Onofre) experienced higher than normal sea level due to tsunami. However, the wave heights were consistent with previously predicted levels and this had no negative impact to the plants. In response, Diablo Canyon Units 1 and 2 declared an "unusual event" based on tsunami warning following the Japanese earthquake. They have since exited the "unusual event" declaration, based on a downgrade to a tsunami advisory.

Q:1.36 Have any lessons for US plants been identified?

RQ: 1.36-1 What is the NRC doing about the emergencies at the nuclear power plants in Japan? Are you sending staff over there?

RQ: 1.36-2 What are the near term actions that U.S. plants are taking in consideration of the events in Japan?

RQ: 1.36-3 What are the immediate steps NRC is taking?

Answer: The NRC is closely following and reviewing the events in Japan in real time. However, a complete understanding of lessons learned will require more information than is currently available to NRC staff.

The NRC is working with other agencies of the federal government and with our counterparts in that country. In addition, NRC has send experts in boiling water reactors to Japan to offer technical assistance.

04/13/2011

~~OUO (Pre-decisional) DRAFT~~

The U.S. nuclear energy industry has already started an assessment of the events in Japan and is taking steps to ensure that U.S. reactors could respond to events that may challenge safe operation of the facilities. These actions include:

- Verify each plant's capability to manage major challenges, such as aircraft impacts and losses of large areas of the plant due to natural events, fires or explosions. Verify each plant's capability to manage a total loss of off-site power.
- Verify the capability to mitigate flooding and the impact of floods on systems inside and outside the plant.
- Perform walk-downs and inspection of important equipment needed to respond successfully to extreme events like fires and floods.

To date (march 20, 2011) the NRC has taken the following steps:

- The Nuclear Regulatory Commission has issued an Information Notice to all currently operating U.S. nuclear power plants, describing the effects of the March 11 earthquake and tsunami on Japanese nuclear power plants.
- The notice provides a brief overview of how the earthquake and tsunami are understood to have disabled several key cooling systems at the Fukushima Daiichi nuclear power station, and also hampered efforts to return those systems to service. The notice is based on the NRC's current understanding of the damage to the reactors and associated spent fuel pools as of Friday, March 18.
- The notice reflects the current belief that the combined effects of the March 11 earthquake and tsunami exceeded the Fukushima Daiichi plant's design limits. The notice also recounts the NRC's efforts, post-9/11, to enhance U.S. plants' abilities to cope with severe events, such as the loss of large areas of a site, including safety systems and power supplies.
- The NRC expects U.S. nuclear power plants will review the entire notice to determine how it applies to their facilities and consider actions, as appropriate.

Additional information: The NRC may need to take a closer look at common cause failures, such as earthquake and tsunami, and earthquake and dam failure.

There will undoubtedly be many lessons learned in the months and years to come as we learn more about the tragic events at the Fukushima Daiichi

04/13/2011

~~OUO (Pre-decisional) DRAFT~~

plant in Japan. However, one of the early lessons is this: You can't anticipate — either in the deterministic design basis of the plant or through probabilistic risk assessment models — everything that could happen. That is why the NRC's defense-in-depth philosophy is fundamental to ensuring that safety is achieved, even under extreme circumstances, such as those experienced at the Fukushima Daiichi plant. This NRC focus on defense-in-depth has led to a number of improvements in the design and operation of U.S. Nuclear Power Plants:

- Studies of severe accident prevention and mitigation in the 1980s led to a number of improvements at plants, such as installation of hardened vents at BWRs with Mark I containments. (See "fact sheet" for more detail.)
- Also, in the 1980s (specifically in 1988) the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted. (See "fact sheet" on station black-out.)
- Operator procedures that are symptom-based and ensure that operators primary focus is maintaining the critical safety functions such as ensuring the core is cooled and covered.
- Addition procedures for operators to use in the event of a severe accident (Severe Accident Mitigation Guidelines (SAMG)).
- Provisions in 10 CFR 50.54hh that require licensees to develop and implement guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities in situations involving loss of large areas of the plant due to explosions or fire.

Q:1.37 What procedures do U.S. plants have for responding to an unexpected event like the events in Japan.

Answer: One of the most significant lessons learned from the Three Mile Island Accident in 1979 was that operating procedures need to be symptom based and less prescriptive. Procedures that previously directed operators to take a series of actions based on a preestablished accident were replaced

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

with procedures that directed operators to maintain the critical safety functions, such as keeping the core covered and cooled. Operators routinely practice these procedures on a plant specific simulator to ensure that they can be implemented for a wide range of accident scenarios, including a station blackout scenario, or other events caused by an earthquake or a flood.

Additional information: none

Q:1.38 Could an earthquake and tsunami the size of the one in Japan happen at San Onofre or Diablo Canyon?

Answer: The March 2011 Tohoku earthquake occurred on a subduction zone, which is the type of tectonic region that produces earthquakes of the largest magnitude. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Severe tsunamis like the one experienced in Japan are only produced by earthquakes occurring at this type of plate boundary. The only subduction zone affecting the continental US is the Cascadia subduction zone, which lies off the coasts of Oregon, Washington, and the northernmost portion of California. Consequently, an earthquake and tsunami as large as the one experienced in Japan could only happen in that coastal region of the continental US.

Earthquakes occurring outside of the Cascadia subduction zone are not expected to exceed a magnitude of approximately 8.25. Earthquakes of this magnitude would only occur on the largest fault lines, such as the San Andreas fault, which is 50 miles away from San Onofre and Diablo Canyon. Furthermore, the San Andreas is an onshore fault and thus not capable of producing a tsunami.

Additional Information: None.

Q:1.39 Could San Onofre and Diablo Canyon withstand an earthquake of the magnitude of the Japanese earthquake?

Answer: San Onofre was designed to withstand a ground motion of 0.67g, more than 2 times the design motion at average US plants. (It is the ground motions, not the magnitude, that structures, systems, and components "feel".) The ground motion at the Japanese nuclear reactors is provided in Table 1. Thus the ground shaking is similar to the peak ground acceleration to which San Onofre has been designed/analyzed. Diablo Canyon was designed to withstand 0.75g peak ground acceleration, which is larger than the ground motion experienced at the Fukushima plants during the Tohoku

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

earthquake. Furthermore, US nuclear plants have seismic margin beyond the design basis ground motion, as demonstrated by the results of the Individual Plant Examination of External Events program carried out by the NRC in the mid-90s.

Available information indicates that, the Fukushima plant withstood the ground shaking resulting from the Tohoku earthquake and that important safety systems performed their required function in the period between the occurrence of the earthquake and the impact of the tsunami. It appears that the emergency diesel generators successfully started once offsite power was lost following the earthquake. Therefore, the tsunami appears to have played a key role in the loss of power sources at the site (including the diesel generators), ultimately resulting in a condition known as station blackout. The station blackout was a critical factor in the problems experienced at the plant.

Additional information: San Onofre was designed for approximately a 7.0 magnitude earthquake 4 miles (6.4 km) away. The Tohoku earthquake was much larger (8.9), but was also almost 9 miles (14.5 km) away. The local ground motion at a particular plant is significantly affected by the local soil and bedrock conditions.

Q:1.40 How do we know that the emergency diesel generators in a US plant will not fail to operate like in Japan?

Answer: Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure and are seismic Category I equipment. In addition, in the 1980s, the NRC instituted a rule that requires nuclear power plants to further assure that a loss of both offsite and onsite emergency AC power systems (a condition known as a station blackout) would not adversely affect public health and safety. As a result of this rule all plants have (1) established station blackout coping and recovery procedures; (2) completed training for these procedures; (3) implemented modifications as necessary to cope with a station blackout; and (4) ensured a 4-16 hour coping capability. Subsequently, studies conducted by the NRC have shown that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in a significant risk reduction and have further enhanced defense-in-depth. However, NRC plans to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

04/13/2011

~~OUO (Pre-decisional) DRAFT~~

6.10. Q&A: Miscellaneous

Q:1.41 **Wikileaks has a story that quotes US embassy correspondence and some un-named IAEA expert stating that the Japanese were warned about this ... Does the NRC want to comment?**

<http://www.dailymail.co.uk/news/article-1366721/Japan-tsunami-Government-warned-nuclear-plants-withstand-earthquake.html>

Public response: TBD Annie to explain the history of their recent retrofit program.

Additional, technical, non-public information: The article talks about that the plants and that they were checked for a magnitude 7, but the earthquake was a 9. The reality is that they assumed the magnitude 7 close in had similar ground motions to a 9 farther away. They did check (and retrofit) the plant to the ground motions that they probably saw (or nearly). The problem was the tsunami. We probably need a small write up so that staff understands, even if we keep it internal.

7. Bibliography

GSI. *Geospatial Information Authority of Japan: The 2011 off the Pacific coast of Tohoku Earthquake: Coseismic Slip Distribution Model (Preliminary)* . 03 15, 2011. <http://www.gsi.go.jp/cais/topic110315-index-e.html> (accessed 03 30, 2011).

JMA. *Japan Meteorological Agency: The 2011 off the Pacific coast of Tohoku Earthquake - Portal*. 03 31, 2011. http://www.jma.go.jp/jma/en/2011_Earthquake.html (accessed 03 31, 2011).

NIED. *National Research Institute for Earth Science and Disaster Prevention: Preliminary information on the recorded strong ground motions during the 2011 Off the Pacific Coast of Tohoku earthquake*
http://www.kik.bosai.go.jp/kik/topic/TohokuTaiheiyo_20110311/nied_kyoshin2e.pdf
(accessed 03 31, 2011).

NOAA. *NOAA / PMEL / Center for Tsunami Research: Japan (East Coast of Honshu) Tsunami, March 11, 2011 - Main Event Page*. <http://nctr.pmel.noaa.gov/honshu20110311/> (accessed 03 31, 2011).

Titov, Vasily, interview by Annie Kammerer. *Personal Communication with Vasily Titov of National Oceanica and Atmospheric Administration Pacific Marine Environmental Lab*

04/13/2011

~~OUO (Pre-decisional) - DRAFT~~

USGS. *United States Geological Survey: Preliminary Geodetic Slip Model of the 2011 M9.0 Tohoku-chiho Taiheiyo-oki Earthquake.* 03 23, 2011. http://earthquake.usgs.gov/earthquakes/world/japan/031111_M9.0prelim_geodetic_slip.php (accessed 03 30, 2011).

—. *United States Geological Survey: Approximate Earthquake Rupture Zone, Magnitude 9.0 near the East Coast of Honshu, Japan.* 03 18, 2011. <http://earthquake.usgs.gov/earthquakes/eqinthenews/2011/usc0001xgp/rupturezone.php> (accessed 03 30, 2011).

—. *United States Geological Survey: Magnitude 9.0 - Near the East Coast of Honshu, Japan.* 03 14, 2011. <http://earthquake.usgs.gov/earthquakes/eqinthenews/2011/usc0001xgp/> (accessed 03 30, 2011).

—. *United States Geological Survey: Tectonic Plates.* 11 25, 2008. <http://pubs.usgs.gov/gip/dynamic/slabs.html> (accessed 03 25, 2011).

DRAFT

Bensi, Michelle

From: Bensi, Michelle
Sent: Wednesday, April 06, 2011 9:00 AM
To: Beasley, Benjamin
Subject: outline
Attachments: March2011 Nuclear Event in Japan - Seismic Report Outline.docx

See attached.

TT/42

- 1. Forward**
- 2. General Information (Background info; static info)**
 - 2.1. Introduction/Background**
 - 2.2. Q&As: Seismic Hazard**
 - 2.3. Q&As: Seismic Design**
- 3. Seismic Design of US nuclear plants (Static information)**
 - 3.1. Introduction/Overview**
 - 3.2. Q&As: Power generation components**
 - 3.2.1. Ground shaking
 - 3.2.2. Tsunami
 - 3.2.3. Liquefaction, slope stability, lateral deformation
 - 3.2.4. Fire
 - 3.2.5. Flood (including dam safety?)
 - 3.2.6. Plant-specific questions
 - 3.2.6.1. SONGS
 - 3.2.6.2. Diablo Canyon
 - 3.2.6.3. Indian Point
 - 3.3. Q&As: Spent Fuel Installations**
 - 3.3.1. Ground shaking
 - 3.3.2. Tsunami
 - 3.3.3. Fire
 - 3.3.4. Flood
 - 3.4. Fact Sheets**
 - 3.4.1. Summarization of NRC's regulatory framework for seismic safety
 - 3.4.1.1. High-level overview
 - 3.4.1.2. Policy-work version
 - 3.4.1.3. Cliff notes
 - 3.4.2. Summarization of NRC's regulatory framework for tsunami
 - 3.4.3. Summarization of NRC's regulatory framework for flooding
 - 3.4.4. Seismic considerations for US nuclear plants
 - 3.4.4.1. Seismic zones
 - 3.4.4.2. Seismicity of the Central and Eastern US
 - 3.4.4.3. Seismic Considerations of Western US nuclear plant sites
- 4. Other design considerations (Static information)**
 - 4.1. Introduction**
 - 4.2. Q&As: Other extreme events (hurricanes, flooding, blizzard, tornados)**
 - 4.3. Q&As: Extreme accident management**
 - 4.3.1. Defense-in-Depth
 - 4.3.2. Emergency Preparedness
 - 4.4. Q&As: Station Blackout**
 - 4.5. Factsheets**
 - 4.5.1. B.5.b
 - 4.5.2. Station Blackout Rule

Ongoing NRC activities related to seismic risk (static and dynamic information)

5.1. Introduction

5.1.1. Seismic research

5.1.2. GI-199

5.1.3. Other programs

5.2. Q&As: GI-199

5.3. Q&As: SOARCA

5.4. Q&As: Other programs

5.5. Factsheets

5.5.1. GI-199

6. March 11, 2011 Earthquake in Japan (dynamic information)

6.1. Information about the event

6.2. Information about Japanese NPP (including design)

6.2.1. 3.2. Q&As: Japanese design vs. demands from the EQ

6.3. Q&As: Implications of events in Japan US Plants ("Could it happen here?" questions)

6.4. Q&As: Implications of events in Japan on NRC activities ("What is the NRC going to do questions")

6.4.1. Seismic design of US plants

6.4.1.1. Ground-shaking

6.4.1.2. Tsunami

6.4.1.3. Fire

6.4.1.4. Flood

6.4.1.5. Plant-specific questions

6.4.1.5.1. Songs

6.4.1.5.2. Diablo Canyon

6.4.1.5.3. Indian Point

6.4.2. Other design considerations

6.5. Fact Sheets

6.5.1. Tsunami Assessment method for nuclear plants in Japan

6.5.2. Summarization for Seismological Information from Regional Instrumentation in Japan

7. Acronyms

8. Definitions

Bensi, Michelle

From: Bensi, Michelle
Sent: Thursday, April 07, 2011 5:10 PM
To: Correia, Richard
Cc: Beasley, Benjamin
Subject: outline for seismic Q&A document
Attachments: March2011 Nuclear Event in Japan - Seismic Report Outline _v03_28_2011.docx

Hello Rich,

Ben asked me to send you a copy of the outline for the seismic Q&A document on which we are currently working. As you are probably already aware, the document originally served to record questions/answers and other seismic-related information collected in the weeks following the Tohoku earthquake. Now that things have settled down a bit, we are working to revise/reformat the document.

I have attached the outline. Please let me know if you have any questions or need any additional information.

Thank you,

Michelle (Shelby) Bensi, Ph.D.
Reliability and Risk Engineer
Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Risk Analysis
Operating Experience and Generic Issues Branch

TT/43

- EX 5
1. **Forward**
 2. **General Information (Background info; static info)**
 - 2.1. **Introduction/Background**
 - 2.2. **Q&As: Seismic Hazard**
 - 2.3. **Q&As: Seismic Design**
 3. **Seismic Design of US nuclear plants (Static information)**
 - 3.1. **Introduction/Overview**
 - 3.2. **Q&As: Power generation components**
 - 3.2.1. Ground shaking
 - 3.2.2. Tsunami
 - 3.2.3. Liquefaction, slope stability, lateral deformation
 - 3.2.4. Fire
 - 3.2.5. Flood (dam safety)
 - 3.2.6. Plant-specific questions
 - 3.2.6.1. SONGS
 - 3.2.6.2. Diablo Canyon
 - 3.2.6.3. Indian Point
 - 3.3. **Q&As: Spent Fuel Installations**
 - 3.3.1. Ground shaking
 - 3.3.2. Tsunami
 - 3.3.3. Fire
 - 3.3.4. Flood
 - 3.4. **Fact Sheets**
 - 3.4.1. Summarization of NRC's regulatory framework for seismic safety
 - 3.4.1.1. High-level overview
 - 3.4.1.2. Policy-work version
 - 3.4.1.3. Cliff notes
 - 3.4.2. Summarization of NRC's regulatory framework for tsunami
 - 3.4.3. Summarization of NRC's regulatory framework for flooding
 - 3.4.4. Seismic considerations for US nuclear plants
 - 3.4.4.1. Seismic zones
 - 3.4.4.2. Seismicity of the Central and Eastern US
 - 3.4.4.3. Seismic Considerations of Western US nuclear plant sites
 4. **Other design considerations (Static information)**
 - 4.1. **Introduction**
 - 4.2. **Q&As: Other extreme events (hurricanes, flooding, blizzard, tornados)**
 - 4.3. **Q&As: Extreme accident management**
 - 4.3.1. Defense-in-Depth
 - 4.3.2. Emergency Preparedness
 - 4.4. **Q&As: Station Blackout**
 - 4.5. **Factsheets**
 - 4.5.1. B.5.b
 - 4.5.2. Station Blackout Rule

5. Ongoing NRC activities related to seismic risk (static and dynamic portions)

5.1. Introduction

5.1.1. Seismic research

5.1.2. GI-199

5.1.3. Other programs

5.2. Q&As: GI-199

5.3. Q&As: SOARCA

5.4. Q&As: Other programs

5.5. Factsheets

5.5.1. GI-199

6. March 11, 2011 Earthquake in Japan (dynamic information)

6.1. Information about the event

6.2. Information about Japanese NPP (including design)

6.2.1. 3.2. Q&As: Japanese design vs. demands from the EQ

6.3. Q&As: Implications of events in Japan US Plants (“Could it happen here?” questions)

6.4. Q&As: Implications of events in Japan on NRC activities (“What is the NRC going to do questions”)

6.4.1. Seismic design of US plants

6.4.1.1. Ground-shaking

6.4.1.2. Tsunami

6.4.1.3. Fire

6.4.1.4. Flood

6.4.1.5. Plant-specific questions

6.4.1.5.1. Songs

6.4.1.5.2. Diablo Canyon

6.4.1.5.3. Indian Point

6.4.2. Other design considerations

6.5. Fact Sheets

6.5.1. Tsunami Assessment method for nuclear plants in Japan

6.5.2. Summarization for Seismological Information from Regional Instrumentation in Japan

7. Acronyms

8. Definitions

Bensi, Michelle

From: Bensi, Michelle
Sent: Wednesday, April 13, 2011 4:41 PM
To: Beasley, Benjamin
Subject: seismic FAQs
Attachments: Seismic Questions for Incident Response 3-28-11 9pm (2).pdf; SeismicQ&A_v9.docx; Frequently asked questions related to the March 11 2011 Earthquake and Tsunami 3-30-2011_ChangesAccepted.docx

Ben,

With regard to the Q&A SharePoint site:

- (1) As we've discussed, it appears that many of the seismic-related questions on the SharePoint site come out of the version of the Public FAQ document that was posted online. A revision of the public FAQ document has been made. I compared the SharePoint site against the updated public FAQ document for inconsistencies/inaccuracies. The answers on the SharePoint site are not entirely consistent with the most recent revision of document (that Annie and I put together and that I think was also reviewed by J. Ake). I do not know if the revision of the public FAQ document was ever posted online. Most of the differences between the new and old versions of the public FAQ document are not substantial, but rather reflect that the newer version of the FAQ document is more clearly written, provides more information, etc. However, there are a couple questions from the old document (that appear on the SharePoint site) that should probably be changed/updated (based on the current state of information) before going public. I have included some comments below for a couple specific questions. In addition, I have attached the most recent version of the revised public FAQ document that I have, though I cannot be certain this is the version Annie sent to OPA. Annie is out of the office until next week, so we can't get the document from her until that time.
- (2) I have included the most recent version of the "large" seismic Q&A document that we are revising/restructuring. This revision will take some time to complete and should probably be reviewed by others before "going public." For reference, I have attached the most recent version of the seismic Q&A document that was circulated internally (and which is the basis for the new, restructured document).
- (3) For your reference, the SharePoint site is:
http://portal.nrc.gov/edo/nrr/dorl/japan/Shared%20Documents/Questions%20and%20Answers.aspx?Page=TRUE&p_ID=100&View=%7b5F211F6A%2d3716%2d4AF2%2d957D%2dC96D1239577D%7d&PageFirstRow=101

-Shelby

A few comments regarding questions posted on the SharePoint site:

Title	Did the Japanese underestimate the size of the maximum credible earthquake and tsunami that could affect the plants?
answer	The magnitude of the earthquake was somewhat greater than was expected for that part of the subduction zone. However, the Japanese nuclear plants were recently reassessed using ground motion levels similar to those that are believed to have occurred at the sites. The ground motions against which the Japanese nuclear plants were reviewed were expected to result from earthquakes that were smaller, but were much closer to the sites. The NRC does not currently have information on the maximum tsunami height that was

TT/44

expected at the sites.

Comment:

See the following NEI update from March 21:

<http://nei.org/newsandevents/information-on-the-japanese-earthquake-and-reactors-in-that-region/japan-earthquake-additional-nei-updates/japan-earthquake-nei-updates-for-monday-march-21/>

Also, see the following update from the TEPCO website:

<http://www.tepco.co.jp/en/press/corp-com/release/11040910-e.html>

Title	How high was the tsunami at the Fukushima nuclear plants?
answer	The tsunami modeling team at the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Lab have estimated the wave height just offshore to be approximately 8 meters in height at Fukushima Daiichi and approximately 7 meters in Fukushima Daini. This is based on recordings from NOAA's Deep-ocean Assessment and Reporting of Tsunamis (DART) buoys and a high resolution numerical model developed for the tsunami warning system. If plant recordings exist they were not yet provided to the NRC.

Comment:

See the following NEI update from March 21:

<http://nei.org/newsandevents/information-on-the-japanese-earthquake-and-reactors-in-that-region/japan-earthquake-additional-nei-updates/japan-earthquake-nei-updates-for-monday-march-21/>

Also, see the following update from the TEPCO website:

<http://www.tepco.co.jp/en/press/corp-com/release/11040910-e.html>

It is also important to note that the NOAA estimates are offshore while the TEPCO estimates are onshore. This is the reason for the difference in the estimates.

Title	Does GI-199 provide rankings of US nuclear plants in terms of safety?
answer	The NRC does not rank nuclear plants by seismic risk. The objective of the GI-199 Safety/Risk Assessment was to perform a conservative, screening-level assessment to evaluate if further investigations of seismic safety for operating reactors in the central and eastern US (CEUS) are warranted, consistent with NRC directives. The results of the GI-199 safety risk assessment should not be interpreted as definitive estimates of plant-specific seismic risk because some analyses were very conservative making the calculated risk higher than in reality. The nature of the information used (both seismic hazard data and plant-level fragility information) make these estimates useful only as a screening tool.

Comment:

“Very conservative” is not an accurate descriptor.

Title	What is Generic Issue 199 about?
answer	GI-199 investigates the safety and risk implications of updated earthquake-related data and models. These data and models suggest that the probability for earthquake ground motion above the seismic design basis for some nuclear plants in the Central and Eastern United States, although is still low, is larger than previous estimates.

Comment:

Somewhere in the questions related to GI-199, it should probably be noted that NRR has extended the scope to include **all operating reactors**. It does not appear that this update is reflected in the FAQs currently on the SharePoint site.

Wilson, George

From: Wilson, George
Sent: Monday, March 14, 2011 2:45 PM
To: Mathew, Roy
Subject: Re: Japanese Earthquake Questions

Please send attachment

Sent from nrc blackberry
George wilson

(b)(6)

er 6

From: Mathew, Roy *MR*
To: Hiland, Patrick
Cc: Manoly, Kamal; Khanna, Meena; Wilson, George; Murphy, Martin
Sent: Mon Mar 14 14:43:11 2011
Subject: RE: Japanese Earthquake Questions

See attached.

Meena/Kamal: please add more from a civil/structural perspective.

From: Hiland, Patrick *HP*
Sent: Monday, March 14, 2011 12:29 PM
To: Khanna, Meena; Wilson, George; Murphy, Martin; Mathew, Roy
Cc: Manoly, Kamal
Subject: FW: Japanese Earthquake Questions
Importance: High

All, please look at the attached and let me know which ones you have staff to answer. I'd like to at least get back early this afternoon on whether or not we will answer the question. Yes, I know we have CR meeting between 1:30 and 2:30.

From: Kammerer, Annie *AKS*
Sent: Monday, March 14, 2011 12:20 PM
To: Hiland, Patrick
Cc: Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Uhle, Jennifer; Case, Michael; Skeen, David; Munson, Clifford; Ake, Jon
Subject: RE: Japanese Earthquake Questions

Pat,

I currently have about 17 pages of questions that we should have pulled together in a pretty useful form later today.

Attached, please see a list of unanswered engineering type questions that I pulled from the larger Q&A document. If you can get your guys working on these it would be very helpful. I am hoping to publish a version at about 4 or 5 today. So, if I can get something on these by perhaps 3 or 4, that would be great. Otherwise, we will note that we are working on it.

FYI, Jon Ake and Cliff Munson are working on a separate set of the seismic questions.

WJH

Also, I don't have any questions on Seismic PRA, which is a hot topic with industry lately (as evidenced by the recent letter from NEI asserting that SPRA is too undeveloped). I have asked Nilesh to develop some Q&As that we may see coming from industry to us as a result of all of this. Those are not likely to make it into the version I want to get out today, but we can add later.

Annie

From: Hiland, Patrick *PKR*
Sent: Monday, March 14, 2011 11:05 AM
To: Kammerer, Annie
Cc: Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Uhle, Jennifer; Case, Michael; Skeen, David
Subject: RE: Japanese Earthquake Questions

NR/DE has Kamal (seismic structures) to review specific questions. I also have several very experienced structural design engineers on staff (George Thomas & Farhead Farzam) If electrical, I have qualified staff and George Wilson that can help.

From: Kammerer, Annie *AKS*
Sent: Monday, March 14, 2011 10:49 AM
To: Case, Michael; Skeen, David; Hiland, Patrick
Cc: Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Uhle, Jennifer
Subject: RE: Japanese Earthquake Questions

I have compiled a set of questions from all available sources, which I think are pretty complete. I am organizing them now and I have cliff and jon helping me with some of the answers. I've pulled from the questions we got at kashiwazaki, the questions we have that have come in, the GI-199 com plan, the DCNPP com plan, and other places.

I do have a request from RIV to pull a Q&A list for SONGS. If I brainstorm a list can I get help with answers?

What kind of experts do you have?

From: Case, Michael *MC*
Sent: Monday, March 14, 2011 7:51 AM
To: Skeen, David; Hiland, Patrick
Cc: Murphy, Andrew; Pires, Jose; Kammerer, Annie; Hogan, Rosemary; Sheron, Brian; Uhle, Jennifer
Subject: Japanese Earthquake Questions

Hi guys. I don't know where we stand on the seismic related questions after Sunday's day shift activities (I assume Annie was able to continue). Nevertheless, I have access to some more experts here this morning. If there are residual activities, just let me know and we'll get them working.

+Guidance: please answer the question in two parts (1) a "public response" that is high level and in layman's terms and (2) additional technical or sensitive information that in-house staff should know.

Questions:

How do we know that the equipment in plants is safe in earthquakes?

Public response: All equipment important to safety (required to safely shutdown a nuclear power plant) is qualified to withstand earthquakes in accordance with plants' licensing basis and NRC regulations.

Additional, technical, non-public information: 10 CFR 50, Appendix A, General Design Criterion 2 and 4, 10 Part 100, and Appendix S.

Guidance: Regulatory Guides 1.100, IEEE 344 and ASME QME-I

How do we know equipment will work if the magnitude is bigger than expected, like in Japan?

Public response: Plant systems are designed to mitigate a design basis earthquake which includes margin above the postulated site specific earthquake.

Additional, technical, non-public information: See part 100 Reactor Site Criteria

Are US plants susceptible to the same kind of loss of power as happened in Japan?

Public response: *Yes. Also, hurricane or tornado related high winds may potentially damage the transmission network in the vicinity of a nuclear plant. Flood waters can also affect transformers used to power station auxiliary system. These types of weather related events have the potential to degrade the offsite power source to a plant.*

The onsite Emergency Diesel Generators need fuel oil stored in tanks that are normally buried underground. These tanks and associated pumps/piping require protection from the elements. Above ground tanks have tornado/missile protection.

In case both offsite and onsite power supplies fail, NRC has required all licensee to evaluate for a loss of all AC power (station blackout) scenario and implement coping measures to safely shutdown the plant iaw 10 CFR 50.63.

Additional, technical, non-public information: *Some plants have safeguards equipment below sea level and rely on watertight doors or Bilge pumps to remove water from equipment required to support safe shutdown. Overflowing rivers can result in insurmountable volume of water flooding the vulnerable areas.*

How do we know that the EDGs in Diablo Canyon and SONGS will not fail to operate like in Japan?

Public response: EDGs are installed in a seismically qualified structure. Even if these EDGs fail, plants can safely shutdown using station blackout power source iaw 10 CFR 50.63.

Additional, technical, non-public information: ADD

Is the earthquake safety of US plants periodically reviewed?

Public response: Yes, during focused design inspections and through Generic Issues Resolution Program such as GI-199.

Additional, technical, non-public information: ADD

Is all equipment at the plant vulnerable to tsunami?

Public response: Plants are designed iaw GDC 2 to withstand protection against natural phenomena such as tsunami, earthquakes.

Additional, technical, non-public information: ADD

What protection measures do plants have against tsunami?

Public response: See above response.

Additional, technical, non-public information: ADD

Is there a risk of loss of water during tsunami drawdown? Is it considered in design?

Public response: ADD

Additional, technical, non-public information: ADD

What is the design level flooding for DNCPP and SONGS? Can a tsunami be larger?

Public response: ADD

Additional, technical, non-public information: ADD

Are nuclear building built to withstand earthquakes? What about tsunami?

Public response: Yes. See above response
Additional, technical, non-public information: ADD

Are aftershocks considered in the design of equipment at the plants? Are aftershocks considered in design of the structure?

Public response: Yes. See above response.
Additional, technical, non-public information: ADD

Why do we have confidence that US nuclear power plants are adequately designed for earthquakes and tsunamis?

Public response: See above response.
Additional, technical, non-public information: ADD

If the earthquake in Japan was a larger magnitude than considered by plant design, why can't the same thing happen in the US?

Public response: See above response.
Additional, technical, non-public information: To be reviewed part of GI-199

What would be the results of a tsunami generated off the coast of a US plant? (Or why are we confident that large tsunamis will not occur relatively close to US shores?)

Public response: ADD
Additional, technical, non-public information. ADD

Are there any special issues associated with seismic design at the plants? For example, Diablo Canyon has special requirements. Anyone else?

Public response: Diablo canyon is licensed with an ESF trip for seismic event due to its susceptibility for earthquakes.

Additional, technical, non-public information: ADD

Does GI-199 consider tsunami?

Public response: ADD
Additional, technical, non-public information: ADD

From: Hiland, Patrick *mark*
To: Brown, Frederick
Subject: FW: latest version of Q&As
Date: Tuesday, March 15, 2011 7:36:00 AM
Attachments: Seismic Questions for incident response center 3-15-11 3am.pdf

Fred, I will continue to forward info to Eric, but I have a growing concern that there is not a single POC in the agency for this type of info. Why is there not a sole source with a data bank that they control? Note that the author of the attached indicates that they will update daily, and I assume distribute? Seems like one office should take the lead and maintain all such information in a single data base where they control revisions and file under the various subject headings. Sounds to me like NSIR and the IRC folks should be the POC? *office*

From: Kammerer, Annie *AS*
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Glitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Glitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

2/12

From: [Case, Michael](#)
To: [Murphy, Andrew](#)
Subject: FW: latest version of Q&As
Date: Tuesday, March 15, 2011 10:24:00 AM
Attachments: [Seismic Questions for incident response center 3-15-11 3am.pdf](#)

Dr. A, can you do some comments for me? Tks.

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

2/13

From: Hiland, Patrick *HPK*
To: Thomas, Eric
Cc: Manoly, Kamal
Bcc: Skeen, David
Subject: FW: latest version of Q&As
Date: Tuesday, March 15, 2011 7:28:00 AM
Attachments: Seismic Questions for incident response center 3-15-11 3am.pdf

Eric, not sure you are on distribution. Note that the attached is to be updated "daily." Who controls these tables? What am I to do if at 1:00 a.m. we need to obtain clarification? Who do I call?

HPK

From: Kammerer, Annie *AKES*
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

AKES

Pires, Jose

From: Pires, Jose
Sent: Tuesday, March 15, 2011 10:55 AM
To: Anooshehpoor, Rasool
Subject: FW: latest version of Q&As
Attachments: Seismic Questions for incident response center 3-15-11 3am.pdf

Please take a look. We can talk this afternoon or later today. Thanks, Jose.

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

2/2/5

From: [Case, Michael](#)
To: [Murphy, Andrew](#)
Subject: FW: Seismic Q&As 3-16-11 3am version
Date: Wednesday, March 16, 2011 9:55:00 AM
Attachments: [Seismic Questions for Incident Response 3-16-11 3am.pdf](#)

Here's my latest. Can you scan thru and let me know if we think the current questions are adequate to cover the article on Indian Point.

From: Kammerer, Annie
Sent: Wednesday, March 16, 2011 4:14 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Devlin, Stephanie; Nguyen, Quynh; Meighan, Sean; Vogel, Anton; Lantz, Ryan; Jones, Henry; Bagchi, Goutam; McIntyre, David; Thomas, Eric; Mahoney, Michael; Polickoski, James
Subject: Seismic Q&As 3-16-11 3am version

All,

Here's the latest version of the seismic Q&As. It is (I believe) a big improvement from yesterday. We had quite a few new questions today, which were included here (not all with answers yet).

A sharepoint site is being set up for the Q&As. The link will be provided as soon as we have it so that anyone can get the latest version.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me (annie) for compilation. Please also CC Cliff Munson and Jon Ake.

This is a living document and will be updated daily in the foreseeable future.

Cheers,
Annie

PS: the following people have questions assigned in this document or volunteered to help. Please look for your name or for the gaps in your area of expertise. Also, please review the questions in your area of expertise: Goutam Bagchi, Niles Chokshi, Henry Jones, Rich Raione, Mike Markley (if you can get me help on some), Jose Pires, Lara Uselding (help me get the RIV questions to the right people), Jon and Cliff. Thanks for the help!

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland,

2/2/16

William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Weber, Michael

ADD
From: Weber, Michael
Sent: Wednesday, March 16, 2011 6:39 PM
To: RST01 Hoc; LIA05 Hoc
Cc: Burnell, Scott; McIntyre, David
Subject: FYI - Seismic Q&As 3-16-11 3am version
Attachments: Seismic Questions for Incident Response 3-16-11 3am.pdf

RES
From: Kammerer, Annie
Sent: Wednesday, March 16, 2011 4:14 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Devlin, Stephanie; Nguyen, Quynh; Meighan, Sean; Vegel, Anton; Lantz, Ryan; Jones, Henry; Bagchi, Goutam; McIntyre, David; Thomas, Eric; Mahoney, Michael; Polickoski, James
Subject: Seismic Q&As 3-16-11 3am version

All,

Here's the latest version of the seismic Q&As. It is (I believe) a big improvement from yesterday. We had quite a few new questions today, which were included here (not all with answers yet).

A sharepoint site is being set up for the Q&As. The link will be provided as soon as we have it so that anyone can get the latest version.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me (annie) for compilation. Please also CC Cliff Munson and Jon Ake.

This is a living document and will be updated daily in the foreseeable future.

Cheers,
Annie

PS: the following people have questions assigned in this document or volunteered to help. Please look for your name or for the gaps in your area of expertise. Also, please review the questions in your area of expertise: Goutam Bagchi, Nilesh Chokshi, Henry Jones, Rich Raione, Mike Markley (if you can get me help on some), Jose Pires, Lara Uselding (help me get the RIV questions to the right people), Jon and Cliff. Thanks for the help!

RES
From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose;

Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB }

nee
From: Wilson, George
To: Sharon Davis; Hiland, Patrick; Mandy, Kamal; Mistral, Monna
Subject: FW: Seismic Q&As March 17th 2am update
Date: Thursday, March 17, 2011 7:43:29 AM
Attachments: Seismic Questions for Incident Response 3-17-11 from GWT

fyi

nee
From: Howe, Allen
Sent: Thursday, March 17, 2011 7:34 AM
To: Wilson, George
Subject: FW: Seismic Q&As March 17th 2am update

nee
From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Gitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snoderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Hoiahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occurring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM

nee

To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Gitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile
BB

Hogan, Rosemary

From: Pires, Jose
Sent: Thursday, March 17, 2011 9:32 AM
To: Kammerer, Annie; Ake, Jon; Anooshehpoor, Rasool; Candra, Hernando; Graves, Herman; Gupta, Abhinav; Herrity, Thomas; Hogan, Rosemary; Rivera-Lugo, Richard; Roche, Robert; Sircar, Madhumita; Stovall, Scott; Weaver, Thomas
Cc: Hogan, Rosemary
Subject: RE: in case you think i'm slacking off....
Attachments: General comments ops.docx; info for Annie's list.txt

Annie,

I read your document and it seems very good to me. I understand that it is work in progress and still needs editing (I did not attempt to do that). This email refers to the 3-16-11 3am version.

Attached are:

- A short file with overall comments that I came up with from reading the document (editing type)
- An email with an answer that Thom Herrity provided to question 26)
- A marked version of the document, 3-16-11 3am version with a few comments from Rasool. The first comment has some information on recorded seismic data and their relation to Japanese attenuation data. Rasool collected more information. Herman has it and can send to you. Since Rasool is on travel maybe another person, say someone in our branch, might synthesize it. The following web site (sent to me by Rasool) also has more ground motion information:
Information about strong-motion data from the 9.0Mw earthquake that occurred in Japan, 80 miles east of Sendai at 02:46 PM local time (05:46 UTC) on March 11, 2011 are available from the Center for Engineering Strong Motion Data (<http://www.strongmotioncenter.org>).

http://www.strongmotioncenter.org/cgi-bin/ncesmd/iqr_dist_DM2.pl?iqrID=Japan_11Mar2011&SFlag=0&Flag=1

>>> My more important comment relates to the questions to ask the Japanese. I have a comment in the attached MS-Word file, at the end, and a short list of what may be the first priority (and that not even urgent).

This is in great shape. A few questions not yet answered are already designated to the best experts in the agency. Others are such that I cannot help with it now as I have been pulled for a variety of other activities last week and this week. Please let me know if there is anything specific that you think that I might do.

Thanks,

Jose.

From: Kammerer, Annie
Sent: Wednesday, March 16, 2011 5:50 PM
To: Pires, Jose; Ake, Jon; Anooshehpoor, Rasool; Candra, Hernando; Graves, Herman; Gupta, Abhinav; Herrity, Thomas; Hogan, Rosemary; Rivera-Lugo, Richard; Roche, Robert; Sircar, Madhumita; Stovall, Scott; Weaver, Thomas
Subject: RE: in case you think i'm slacking off....

I really need this ASAP. If I don't get this tomorrow, I'll reassign to the structural team that starts in the center tomorrow.

From: Pires, Jose

Sent: Wednesday, March 16, 2011 9:44 AM

To: Kammerer, Annie; Ake, Jon; Anooshehpoor, Rasool; Candra, Hernando; Graves, Herman; Gupta, Abhinav; Herrity, Thomas; Hogan, Rosemary; Rivera-Lugo, Richard; Roche, Robert; Sircar, Madhumita; Stovall, Scott; Weaver, Thomas

Subject: RE: in case you think i'm slacking off....

Annie,

We are working on your request now. We will be checking among ourselves and then will send a single a document to you to avoid confusion.

If there is a specific item, also please let us know.

Thanks,

Jose.

From: Kammerer, Annie

Sent: Wednesday, March 16, 2011 4:20 AM

To: Ake, Jon; Anooshehpoor, Rasool; Candra, Hernando; Graves, Herman; Gupta, Abhinav; Herrity, Thomas; Hogan, Rosemary; Kammerer, Annie; Pires, Jose; Rivera-Lugo, Richard; Roche, Robert; Sircar, Madhumita; Stovall, Scott; Weaver, Thomas

Subject: in case you think i'm slacking off....

Here are the latest Seismic Q&As.

Annie

Dr. Annie Kammerer, PE

Senior Seismologist and Earthquake Engineer

US Nuclear Regulatory Commission

Office of Nuclear Regulatory Research

Washington DC 20555

(b)(6) mobile
BB

General comments

I understand that this is a work in progress and I provide the comments below in case they may assist the editing.

1) There are 92 questions. Because materials in some of the answers are repeated there may be inconsistencies. Some items with potential inconsistencies and some additional comments.

Annual probabilities, return period, CDFs, etc (ARE THEY ALL PER PLANT?)

#12) Return period of 10,000 years

#15) Discussion on return periods vs annual probabilities vs lifetime probabilities

#45) reference is only to Japan's guidelines (but it seems to bear some relation to annual probabilities)

#51) annual probabilities and return period

#60) The Note is in terms of annual probabilities

Page 19) Annual probability is defined but not return period

#63) Discussion on annual probabilities and return periods

#77) SONGS in terms on return periods

#92) No reference to probabilities or return periods (this seems great); may want to refer to when the Quaternary started

Table starting at Page 69

It includes annual probabilities and CDFs (no return periods)

>>> Comment: use of annual probabilities seems consistent with the definition of CDF.

Charleston and New Madrid

#5) Estimated magnitude range 7 to 7.75

#13) Estimated magnitude range 7 to 7.5

SONGS

Is MLLW defined?

#69) Closest fault is 5 miles

#78) Closest fault is 4 miles

#80) Implies that the Great earthquake was 9 miles from Fukushima

Natural Hazards etc.

#5) Refers to magnitude 8.7 (not 8.75)

#13) Refers to magnitude 7 (not 7.5)

#2) Discussion on magnitude log scale, for example, a magnitude 9 being 10 times bigger than a magnitude 8. For a specific site what does 10 times bigger mean? Does it mean the plant needs to be 10 times stronger?

>>> Comment: Many in the public know about the logarithmic scale and that an increase in 1 is an increase of 10. Why is it that PCA staff find a change of 2 or 3 to be significant when a change in magnitude from 6.5 to 7.5 means the earthquake is 10 times bigger?

>>> Comment: Any need to address differences on site specific vibratory ground motion and tsunami with magnitude?

Tables of Design Basis

Pages 32 - 33)

It has a limited number of plants and provides

MMI	Distance	SSE(g)	OBE(g)	Site
-----	----------	--------	--------	------

Pages 34-38)

Essentially all plants and has:

SSE (g)	OBE(g)	Tsunami
---------	--------	---------

Pages 39-43)

Essentially all plants and has:

Docket #	SSE(g)	Annual Prob	HCLPF	CDF	IPEEE meth.	Source
----------	--------	-------------	-------	-----	-------------	--------

Should all plants be included in the first table?

Ground acceleration

Page 19 - Definition says at the ground surface. Elsewhere there is a reference to the minimum SSE and if someone consults the regulation will see that it is at the foundation. If the definition of ground acceleration is not from Part 50 or 100 maybe specifying at the ground surface may be confused.

Definitions

I suggest using, as much as possible, definitions from Part 50 or Part 100, RGs or ISGs. I can help check them.

2) QUESTIONS TO THE JAPANESE

Maybe most of the questions to the Japanese are not urgent in relation to the current situation. It seems that questions of an earthquake reconnaissance can wait a few weeks or even a few months. For questions related to this, I would label them as urgent if they have direct bearing on the current situation.

For this document, the following is a list of items that appear to be related to the specific seismological and design aspects in some of the questions of your document and maybe they should be the first items in the prioritization:

- PGAs at the plants (Fukushima 1, Fukushima 2, Onagawa)
- Distance from the fault
- Design basis for the plants (current) (PGA)
- Design basis for each reactor (when built/modified) (PGA)
- Design basis for which retrofit was done (PGA)
- Tsunami design basis
- Tsunami wave height
- Height above MLLW of the land at the plant waterfront (where the small buildings are/were)
- Any update on the latest design basis and plant upgrade
- Systems experts might be interested on backup systems for AC power (including fuel tanks) and batteries as well as the location of some of these, and related damage

info for Annie's list .txt

From: Herrity, Thomas
Sent: Wednesday, March 16, 2011 11:07 AM
To: Pires, Jose
Subject: info for Annie's list

Jose,

I noticed that Annie was asking someone to help with Question 26. Here's my 2-cents worth:

26) Are US plants susceptible to the same sort of loss of all power?

NRC recognized that there is the possibility of a total loss of AC power at a site, called a 'Station Blackout', or SBO. Existing Regulations require the sites to be prepared for the possibility of an SBO. In addition to battery powered back-up system to immediately provide power for emergency systems, NRC regulations require the sites to have a detailed plan of action to address the loss of AC power while maintaining control of the reactor.

Additional info:

SBO definition in 10CFR40.62

SBO plan requirements in 10CFR40.63

Thomas J. Herrity
Structural, Geotechnical and Seismic Engineering Branch
Office of Research - Division of Engineering
US Nuclear Regulatory Commission
(301) 251-7444
ofc: CSB0511
ms: CSB05A24

Weber, Michael

From: Weber, Michael
Sent: Thursday, March 17, 2011 7:35 PM
To: Kammerer, Annie
Subject: RESPONSE - Seismic Q&As March 17th 2am update

Thanks, Annie.

Enjoy your evening.

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 7:34 PM
To: Weber, Michael
Subject: Fw: Seismic Q&As March 17th 2am update

As per Brian Sheron's request, please see the attached document. I will add you to the distribution list unless you prefer otherwise.

Cheers,
Annie

Sent from an NRC blackberry
Annie Kammerer
mobile (b)(6)
bb (b)(6)
annie.kammerer@nrc.gov

From: Kammerer, Annie
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Sent: Thu Mar 17 02:36:08 2011
Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE

Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile
BB

White, Bernard

From: Howe, Allen
Sent: Thursday, March 17, 2011 3:43 PM
To: Doane, Margaret; Westreich, Barry; Gratton, Christopher; Boska, John; Scott, Michael; Wittick, Susan; Merzke, Daniel; Deegan, George; Williams, Kevin; Milligan, Patricia; Bajwa, Chris; Andersen, James
Subject: FW: Seismic Q&As March 17th 2am update
Attachments: Seismic Questions for Incident Response 3-17-11 2am.pdf

Current version of Q&A from Ops center.

Allen

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Rihm, Roger

From: Rihm, Roger
Sent: Thursday, March 17, 2011 11:37 AM
To: Barkley, Richard
Subject: RE: I'll Have DRM Load This on The Projection System if You are Okay With it
Attachments: Seismic Q&As March 17th 2am update

Have you seen the INTERNAL seismic Qs and As? There's one on Indian Pt (page 30 of attached), and I see they added something based on Lowey's letter. (Note: NRR does not have lead for response.)

From: Barkley, Richard
Sent: Thursday, March 17, 2011 11:26 AM
To: Gray, Mel; Landau, Mindy; Rihm, Roger; Ellmers, Glenn
Subject: FW: I'll Have DRM Load This on The Projection System if You are Okay With it

This information runs along the line of the letter we just got in from Nita Lowey. I have not seen a letter yet from the Governor of NY.

From: McNamara, Nancy
Sent: Thursday, March 17, 2011 7:29 AM
To: Barkley, Richard; Dean, Bill
Cc: Tifft, Doug
Subject: RE: I'll Have DRM Load This on The Projection System if You are Okay With it

Yes Rich, we passed it along to the management team and OPA last night. Here is the link:
<http://www.capitaltonight.com/2011/03/cuomos-concern-over-indian-point-renewed/>

And Yes, OPA and SLOs we were answering to it all evening.

Thanks for having our back and keeping an eye open on information that is out there.

From: Barkley, Richard
Sent: Wednesday, March 16, 2011 7:00 PM
To: Dean, Bill
Cc: McNamara, Nancy
Subject: RE: I'll Have DRM Load This on The Projection System if You are Okay With it

You did well – I asked Keith Heater if he was able to follow you, and he said he could – That is what we were shooting for.

Watched the ABC news tonight – They mentioned that Governor Andrew Cuomo has called for an immediate review of the seismic adequacy of Indian Point.

I can't find any info of that on the Governor's website – I hope Nancy heard about this and fed it to you. It may be something very hot off the press.

R
From: Dean, Bill
Sent: Wednesday, March 16, 2011 6:33 PM
To: Barkley, Richard
Subject: RE: I'll Have DRM Load This on The Projection System if You are Okay With it

Thanks for doing this. It helped I think.

Bill

R
From: Barkley, Richard
Sent: Wednesday, March 16, 2011 1:29 PM
To: Dean, Bill
Subject: I'll Have DRM Load This on The Projection System if You are Okay With it
Importance: High

Richard S. Barkley, PE
Nuclear & Environmental Engineer
(610) 337-5065 Work

(b)(6) Cell

See, Kenneth

From: Khanna, Meena
Sent: Thursday, March 17, 2011 6:31 PM
To: Jones, Henry; See, Kenneth; Wescott, Rex
Cc: Mathew, Roy
Subject: FW: Seismic Q&As March 17th 2am update
Attachments: Seismic Questions for Incident Response 3-17-11 2am.pdf

Henry, Ken, and Rex,

We still would like the one pagers, pls. This will help in putting Eric and Bill's presentation together. I've attached the question database that Annie and Cliff have been leading the effort on, just as an fyi..thanks!
meena

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 6:08 PM
To: Khanna, Meena
Subject: Fw: Seismic Q&As March 17th 2am update

Cheers,
Annie

Sent from an NRC blackberry

Annie Kammerer

mobile (b)(6) → Exmp. W

bb (b)(6)

annie.kammerer@nrc.gov

From: Kammerer, Annie
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Gitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Sent: Thu Mar 17 02:36:08 2011
Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Firms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing

on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet... a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile BB } Exemp. 6

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Glitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Glitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

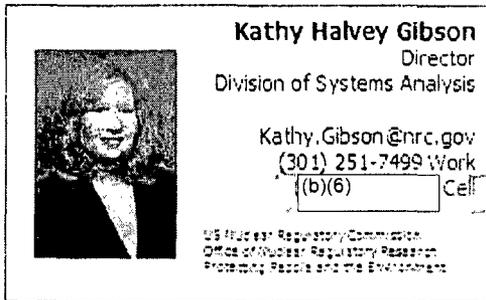
Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Greenwood, Carol

From: Gibson, Kathy
Sent: Thursday, March 17, 2011 2:08 PM
To: Gibson, Kathy; Tinkler, Charles
Subject: RE: Filtering in Fukushima
Attachments: Kathy Halvey Gibson2.vcf; image001.jpg

Also let me know what GRS wants after you talk to them.



Kathy Halvey Gibson
Director
Division of Systems Analysis

Kathy.Gibson@nrc.gov
(301) 251-7499 Work
(b)(6) Cell

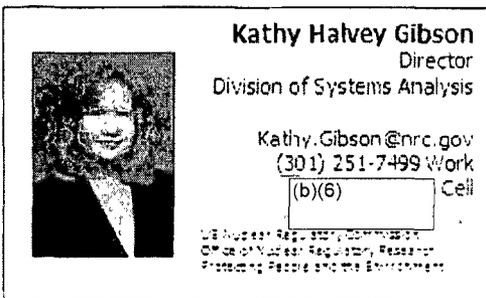
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Protecting People and the Environment

From: Gibson, Kathy
Sent: Thursday, March 17, 2011 2:07 PM
To: Tinkler, Charles
Subject: FW: Filtering in Fukushima

FYI

Please make sure you pass along requests for information to Katie so we have a complete picture of what the questions are that are being contemplated by our counterparts.

Thanks



Kathy Halvey Gibson
Director
Division of Systems Analysis

Kathy.Gibson@nrc.gov
(301) 251-7499 Work
(b)(6) Cell

US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Protecting People and the Environment

From: Gavrilas, Mirela
Sent: Thursday, March 17, 2011 2:04 PM
To: Gibson, Kathy; Case, Michael
Subject: FW: Filtering in Fukushima

I wish I would know what data the Germans collected used to suggest the 2mm particle size, but the recommendation is sound.

M.

2/2/14

From: Farmer, Mitchell T. [mailto:farmer@anl.gov]
Sent: Thursday, March 17, 2011 1:54 PM
To: Peters, Mark T.; Khalil, Hussein S.
Cc: 'dhalsmeyer@web.de'; Sattelberger, Alfred P.; Grandy, Christopher; Basu, Sudhamay; Lee, Richard; Tinkler, Charles; Gavrilas, Mirela; 'sehgal@safety.sci.kth.se'
Subject: FW: Filtering in Fukushima

Hi Mark and Hussein,
See the suggestion below from Hans Alsmeyer who is a German colleague from KfK/FZK who has many years of experience in severe accident analysis and testing. Could you please pass on to DOE for consideration.

Hans, we all share your deep concern about the situation in Japan and we are trying to do all we can to help.

Mitch

From: (b)(6)
Sent: Thursday, March 17, 2011 11:58 AM
To: Farmer, Mitchell T.; Bal Raj Sehgal
Cc: Lomperski, Stephen W.; Tromm, Walter; Alex Miassoedow
Subject: Filtering in Fukushima

Dear Mitch and Ray,

after some discussions with my German friends I propose a possible action to reduce long term aerosol release from the Fukushima reactors by a simple filter:

Cover the critical zones with coarse sand. Particle size about 2 mm to allow water and gas permeation. Finer particles are not allowed, as they could block gases or water. Sand may be silica or granite etc (heat resistant, ...), but no carbonates. This may be applied also in combination with water, in the storage tanks as well as near the inner containment or those areas where steam or aerosols are escaping.

The retention capability is however not high for very fine aerosol particles, but better than the present state, and would be higher when the sand is wet. The sand must be transported through helicopters, long cables must be used for the transfer of the sand bags, to be released close to the surface to be covered.

As at the present time I don't have good contact with Japanese organizations, I think that this suggestion would best be proposed by you to competent Japanese persons, if you don't have objections.

I am deeply concerned that all our hypothetical scenarios are occurring.

Best regards,

Hans

--
Hans Alsmeyer

(b)(6)

(b)(6)

10

Weber, Michael

From: Weber, Michael
Sent: Friday, March 18, 2011 4:57 PM
To: Case, Michael
Subject: RESPONSE - Seismic Q&As March 18th 5am update

Thanks, Mike

From: Case, Michael
Sent: Friday, March 18, 2011 12:50 PM
To: Weber, Michael
Subject: FW: Seismic Q&As March 18th 5am update

Hi Mike. Brian had asked that we send you the latest copy of the "Seismic Questions"

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

*We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)

*The "additional information" section has been split into tables, plots, and fact sheets

*A high-level draft fact sheet on NRC's seismic regulations has been added

*We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!..We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick;

Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Glitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet... a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Weber, Michael

From: Weber, Michael
Sent: Friday, March 18, 2011 7:34 AM
To: Sheron, Brian
Subject: Seismic Q&As March 18th 5am update

Thanks. I forwarded yesterday's version to the Chairman. That was the version I understood you gave to the Secretary.

From: Sheron, Brian
To: Weber, Michael
Sent: Fri Mar 18 07:14:31 2011
Subject: Fw: Seismic Q&As March 18th 5am update

FYI.

From: Kammerer, Annie
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Sent: Fri Mar 18 06:50:33 2011
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added
- *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Firms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet... a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Case, Michael
To: Weber, Michael
Subject: FW: Seismic Q&As March 18th 5am update
Date: Friday, March 18, 2011 12:50:00 PM
Attachments: Seismic Questions for Incident Response 3-18-11 Sanj.pdf

Hi Mike. Brian had asked that we send you the latest copy of the "Seismic Questions"

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Elliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added
- *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week! We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Gitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Elliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

2/21/17

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hilland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Glitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Glitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Bunnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All;

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Refer to RESIDE

Martin, Karnisha

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update
Attachments: Seismic Questions for Incident Response 3-18-11 5am.pdf

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added
- *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update

All,

will 18

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile BB

Ex 6

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

EX 6

Refer to NRR

Martin, Karnisha

From: Khanna, Meena
Sent: Friday, March 18, 2011 5:55 PM
To: Farzam, Farhad; Mathew, Roy; Matharu, Gurcharan; Jones, Henry; See, Kenneth; Wescott, Rex; Hiser, Allen; Pelton, David; Terao, David; Cook, Christopher
Subject: FW: Seismic Q&As March 18th 5am update
Attachments: Seismic Questions for Incident Response 3-18-11 5am.pdf

Just wanted to share the Q&A database that Annie and Cliff, et al have been working on...this is the latest that I have and I believe the updates are posted on a website (NRR?)

thanks

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added
- *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose;

2/2/11

Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet... a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile BB

Ex 6

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown,

Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Weaver, Tonna

From: Kammerer, Annie
Sent: Saturday, March 19, 2011 9:00 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 19th 8am update
Attachments: Seismic Questions for Incident Response 3-19-11 8am.pdf

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added

*We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers;
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Glitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Glitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brennan, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA@source.nrc.gov
Subject: Seismic Q&As March 19th 8am update
Date: Saturday, March 19, 2011 9:00:13 AM
Attachments: Seismic Questions for Incident Response 2-19-11 8am.pdf

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brennan, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added
- *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week! We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Gitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brennan, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20occurring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority

2/21/21

question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers.
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nitesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Refer to RESIDE

Martin, Karnisha

From: Kammerer, Annie
Sent: Saturday, March 19, 2011 9:00 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 19th 8am update
Attachments: Seismic Questions for Incident Response 3-19-11 8am.pdf

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added

2/2/22

*We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet... a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Ex 6

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Glitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Glitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Ex 6

From: Kammerer, Annie
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Resource.hoc.Resource; Bopp, Michelle
Subject: Seismic Q&As March 20th 8pm update
Date: Sunday, March 20, 2011 11:00:26 PM
Attachments: Seismic Questions for Incident Response 3-20-11 (8pm).pdf

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie
Sent: Saturday, March 19, 2011 9:00 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added
- *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many

2/21/23

email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giltter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giltter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael;

Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20IA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile
88

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giltter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giltter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile

BB

From: Kammerer, Annie
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 20th 8pm update
Date: Sunday, March 20, 2011 11:00:41 PM
Attachments: Seismic Questions for Important Responses, 1-28-11 Final.pdf

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bonsi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie
Sent: Saturday, March 19, 2011 9:00 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

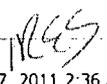
- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added
- *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many

2/24/24

email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie 
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Gitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet... a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Gitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Refer to RES/DE

Martin, Karnisha

From: Kammerer, Annie
Sent: Sunday, March 20, 2011 11:00 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update
Attachments: Seismic Questions for Incident Response 3-20-11 8pm.pdf

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it, which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie
Sent: Saturday, March 19, 2011 9:00 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

2/2/11

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie

Sent: Friday, March 18, 2011 6:51 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean

Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

*We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)

*The "additional information" section has been split into tables, plots, and fact sheets

*A high-level draft fact sheet on NRC's seismic regulations has been added

*We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile } Ex 6
BB }

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Case, Michael
To: Richards, Stuart
Subject: FW: Seismic Q&As March 20th 8pm update
Date: Monday, March 21, 2011 6:38:00 AM
Attachments: Seismic Questions for Incident Response 3-20-11 8pm.pdf

FYI

From: Kammerer, Annie
Sent: Sunday, March 20, 2011 11:00 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it, which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie
Sent: Saturday, March 19, 2011 9:00 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

2/2/26

Please see the updated version of the Seismic Q&As.

Among today's highlights:

*We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)

*The "additional information" section has been split into tables, plots, and fact sheets

*A high-level draft fact sheet on NRC's seismic regulations has been added

*We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Glitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Glitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Glitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Glitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research

Washington DC 20555

(b)(6)

mobile

BB

From: Case, Michael
To: Loretic, Phillip
Subject: FW: Action: Seismic Q&As
Date: Monday, March 21, 2011 6:57:00 AM
Attachments: Frequently asked questions related to the March 11 2011 Earthquake and Tsunami 3-19-2011.docx
img-00.png

Please print.

From: Kammerer, Annie
Sent: Saturday, March 19, 2011 8:33 AM
To: Nelson, Robert
Cc: Roberts, Darrell; Croteau, Rick; Kennedy, Kriss; Lara, Julio; West, Steven; Shear, Gary; Ruland, William; Boger, Bruce; Meighan, Sean; Nguyen, Quynh; Gitter, Joseph; Burnell, Scott; Brenner, Eliot; Case, Michael; Munson, Clifford; Ake, Jon; Hogan, Rosemary
Subject: RE: Action: Seismic Q&As

OK. Here is the proposed set of public Q&As for publication next week. I think it's pretty good, at least it's the best I can do. Jennifer Uhle did a pretty thorough review for me.

I didn't end up including the plant specific questions because it was too awkward. We could theoretically do a separate add on.

Annie

From: Nelson, Robert
Sent: Thursday, March 17, 2011 2:18 PM
To: Kammerer, Annie
Cc: Roberts, Darrell; Croteau, Rick; Kennedy, Kriss; Lara, Julio; West, Steven; Shear, Gary; Ruland, William; Boger, Bruce; Meighan, Sean; Nguyen, Quynh; Gitter, Joseph
Subject: Action: Seismic Q&As
Importance: High

Annie:

The regions have a critical need for publicly releasable seismic info (Qs & As) to support public meetings beginning next week. We need a releasable version of your document. Can you assemble the info that you have prepared that you believe is good to go. We can then get that reviewed by OPA. Need your input tomorrow.

Robert A. Nelson
Deputy Director
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation



E-mail: robert.nelson@nrc.gov | Office: (301) 415-1453 | Cell: (b)(6) | Fax: (301) 415-2102

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nitesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Gitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edq/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50

2/27

miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giltter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nitesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giltter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

~~Draft - OUO~~

NRC frequently asked questions related to the March 11, 2011 Japanese Earthquake and Tsunami

3-19-11 Version

Compiled by Annie Kammerer, Jon Ake, and Cliff Munson for submission to OPA and NRR. We would appreciate getting an edited word file back to assure that the public comments and the internal document are consistent.

Printed 4/8/2011 1:24 PM

~~Draft - OUO~~

~~Draft - OUO~~

List of Questions

- 1) Can an earthquake and tsunami as large as happened in Japan also happen here? 1
- 2) Did the Japanese underestimate the size of the maximum credible earthquake and tsunami that could affect the plants? 1
- 3) How high was the tsunami at the Fukushima nuclear plants? 1
- 4) Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami? 1
- 5) Have any lessons for US nuclear plants been identified? 1
- 6) Was there any damage to US reactors from either the earthquake or the resulting tsunami?... 2
- 7) How many US reactors are located in active earthquake zones? 2
- 8) What level of earthquake hazard are the US reactors designed for? 2
- 9) What magnitude earthquake are currently operating US nuclear plants designed to? 2
- 10) Have events in Japan changed our perception of earthquake risk to the nuclear plants in the US? 2
- 11) Can significant damage to a nuclear plant like we see in Japan happen in the US due to an earthquake? Are the Japanese nuclear plants similar to US nuclear plants? 2
- 12) What is the likelihood of the design basis or "SSE" ground motions being exceeded over the life of a nuclear plant? 3
- 13) Which reactors are along coastal areas that could be affected by a tsunami? 3
- 14) What is magnitude anyway? What is the Richter Scale? What is intensity? 3
- 15) How do magnitude and ground motion relate to each other? 4
- 16) What is Generic Issue 199 about? 4
- 17) Does GI-199 provide rankings of US nuclear plants in terms of safety? 4
- 18) What are the current findings of GI-199? 4
- 19) What do you mean by "increased estimates of seismic hazards" at nuclear plant sites? 5
- 20) Does the Seismic Core Damage represent a measurement of the risk of radiation release or only the risk of core damage (not accounting for additional containment)? 5
- 21) Where can I get current information about Generic Issue 199? 5
- 22) Could an accident sequence like the one at Japan's Fukushima Daiichi nuclear plants happen in the US? 5
- 23) Are US plants susceptible to the same kind of loss of power as happened in Japan? **Error! Bookmark not defined.**

1) Can an earthquake and tsunami as large as happened in Japan also happen here?

This earthquake occurred on a "subduction zone", which is the type of tectonic region that produces earthquakes of the largest magnitude. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. The only nuclear plant near the Cascadia subduction zone is the Columbia Generating Station. This plant is located a large distance from the coast (approximately 225 miles) and the subduction zone (approximately 300 miles), so the ground motions estimated at the plant are far lower than those seen at the Fukushima plants. This distance also precludes the possibility of a tsunami affecting the plant. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8. Magnitude is measured on a log scale and so a magnitude 9 earthquake is ten times larger than a magnitude 8 earthquake.

2) Did the Japanese underestimate the size of the maximum credible earthquake and tsunami that could affect the plants?

The magnitude of the earthquake was somewhat greater than was expected for that part of the subduction zone. However, the Japanese nuclear plants were recently reassessed using ground motion levels similar to those that are believed to have occurred at the sites. The ground motions against which the Japanese nuclear plants were reviewed were expected to result from earthquakes that were smaller, but were much closer to the sites. The NRC does not currently have information on the maximum tsunami height that was expected at the sites.

3) How high was the tsunami at the Fukushima nuclear plants?

The tsunami modeling team at the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Lab have estimated the wave height just offshore to be approximately 8 meters in height at Fukushima Daiichi and approximately 7 meters in Fukushima Daini. This is based on recordings from NOAA's Deep-ocean Assessment and Reporting of Tsunamis (DART) buoys and a high resolution numerical model developed for the tsunami warning system. If plant recordings exist they were not yet provided to the NRC.

4) Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?

Because this event happened in Japan, it is hard for NRC staff to make the assessment necessary to understand exactly what happened at this time. In the nuclear plants there may have been some damage from the shaking, and the earthquake caused the loss of offsite power. However, the tsunami appears to have played a key role in the loss of other power sources at the site producing station blackout, which is a critical factor in the ongoing problems.

5) Have any lessons for US nuclear plants been identified?

The NRC is in the process of following and reviewing the event in real time. This will undoubtedly lead to the identification of issues that warrant further study. However, a complete understanding of lessons learned will require more information than is currently available to NRC staff.

6) Was there any damage to US reactors from either the earthquake or the resulting tsunami?

No.

7) How many US reactors are located in active earthquake zones?

Although we often think of the US as having "active" and "non-active" earthquake zones, earthquakes can actually happen almost anywhere. Seismologists typically separate the US into low, moderate, and high seismicity zones. The NRC requires that every nuclear plant be designed for site-specific ground motions that are appropriate for their locations. In addition, the NRC has specified a minimum ground motion level to which nuclear plants must be designed.

8) What level of earthquake hazard are the US reactors designed for?

Each reactor is designed for a different ground motion that is determined on a site-specific basis. 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, without consideration of the likelihood of the earthquakes considered. New reactors are designed using probabilistic techniques that characterize both the ground motion levels and uncertainty at the proposed site. These probabilistic techniques 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 occurrence of 1×10^{-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 hazard and risk-assessment techniques account for beyond-design basis events. NRC's Generic Issue 199 (GI-199) project is using the latest probabilistic techniques used for new nuclear plants to review the safety of the existing plants. [see questions 16 to 21 for more information about GI-199]

9) What magnitude earthquake are currently operating US nuclear plants designed to?

Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site. Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based 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.

10) Have events in Japan changed our perception of earthquake risk to the nuclear plants in the US?

The NRC continues to determine that US nuclear plants are safe. This does not change the NRC's perception of earthquake hazard (i.e., ground motion levels) at US nuclear plants. It is too early to tell what the lessons from this earthquake are. The NRC will look closely at all aspects of response of the plants to the earthquake and tsunami to determine if any actions need to be taken in US nuclear plants and if any changes are necessary to NRC regulations.

11) Can significant damage to a nuclear plant like we see in Japan happen in the US due to an earthquake? Are the Japanese nuclear plants similar to US nuclear plants?

All US nuclear plants are built to withstand environmental hazards, including earthquakes and tsunamis. Even those nuclear plants that are located within areas with low and moderate seismic activity are designed for safety in the event of such a natural disaster. The NRC requires that safety-significant structures, systems, and components be designed to take into account even rare and extreme seismic

and tsunami events. In addition to the design of the plants, significant effort goes into emergency response planning and accident management. This approach is called defense-in-depth.

The Japanese facilities are similar in design to some US facilities. However, the NRC has required modifications to the plants since they were built, including design changes to control hydrogen and pressure in the containment. The NRC has also required plants to have additional equipment and measures to mitigate damage stemming from large fires and explosions from a beyond-design-basis event. The measures include providing core and spent fuel pool cooling and an additional means to power other equipment on site.

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

The ground motions that are used as seismic design bases at US nuclear plants are called the Safe Shutdown Earthquake ground motion (SSE). In the mid to late 1990s, the NRC staff reviewed the potential for ground motions beyond the design basis as part of the Individual Plant Examination of External Events (IPEEE). From this review, the staff determined that seismic designs of operating nuclear plants in the US have adequate safety margins for withstanding earthquakes. Currently, the NRC is in the process of conducting GI-199 to again assess the resistance of US nuclear plants to earthquakes. Based on NRC's analyses to date, the probability of ground motions exceeding the SSE for the plants in the Central and Eastern United States is less than 2%, with values ranging from a low of 0.1% to a high of 6%.

It is important to remember that structures, systems and components are required to have "adequate margin," meaning that they must continue be able withstand shaking levels that are above the plant's design basis.

13) Which reactors are along coastal areas that could be affected by a tsunami?

Many nuclear plants are located in coastal areas that could potentially be affected by a tsunami. Two nuclear plants, Diablo Canyon and San Onofre, are on the Pacific Coast, which is known to have a tsunami hazard. Two nuclear plants on the Gulf Coast, South Texas and Crystal River, could also be affected by tsunami. There are many nuclear plants on the Atlantic Coast or on rivers that may be affected by a tidal bore resulting from a tsunami. These include St. Lucie, Turkey Point, Brunswick, Oyster Creek, Millstone, Pilgrim, Seabrook, Calvert Cliffs, Salem/Hope Creek, and Surry. Tsunami on the Gulf and Atlantic Coasts occur, but are very rare. Generally the flooding anticipated from hurricane storm surge exceeds the flooding expected from a tsunami for nuclear plants on the Atlantic and Gulf Coast. Regardless, all nuclear plants are designed to withstand a tsunami.

14) What is magnitude anyway? What is the Richter Scale? What is intensity?

An earthquake's magnitude is a measure of the strength of the earthquake as determined from seismographic observations. Magnitude is essentially an objective, quantitative measure of the size of an earthquake. The magnitude can be expressed in various ways based on seismographic records (e.g., Richter Local Magnitude, Surface Wave Magnitude, Body Wave Magnitude, and Moment Magnitude). Currently, the most commonly used magnitude measurement is the Moment Magnitude, Mw, which is based on the strength of the rock that ruptured, the area of the fault that ruptured, and the average amount of slip. Moment magnitude is, therefore, a direct measure of the energy released during an earthquake. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step

in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology and was based on the behavior of a specific seismograph that was manufactured at that time. The instruments are no longer in use and the magnitude scale is, therefore, no longer used in the technical community. However, the Richter Scale is a term that is so commonly used by the public that scientists generally just answer questions about "Richter" magnitude by substituting moment magnitude without correcting the misunderstanding.

The intensity of an earthquake is a qualitative assessment of effects of the earthquake at a particular location. The intensity assigned is based on observed effects on humans, on human-built structures, and on the earth's surface at a particular location. The most commonly used scale in the US is the Modified Mercalli Intensity (MMI) scale, which has values ranging from I to XII in the order of severity. MMI of I indicates an earthquake that was not felt except by a very few, whereas MMI of XII indicates total damage of all works of construction, either partially or completely. While an earthquake has only one magnitude, intensity depends on the effects at each particular location.

15) How do magnitude and ground motion relate to each other?

The ground motion experienced at a particular location is a function of the magnitude of the earthquake, the distance from the fault to the location of interest, and other elements such as the geologic materials through which the waves pass.

16) What is Generic Issue 199 about?

GI-199 investigates the safety and risk implications of updated earthquake-related data and models. These data and models suggest that the probability for earthquake ground motion above the seismic design basis for some nuclear plants in the Central and Eastern United States, although is still low, is larger than previous estimates.

17) Does GI-199 provide rankings of US nuclear plants in terms of safety?

The NRC does not rank nuclear plants by seismic risk. The objective of the GI-199 Safety/Risk Assessment was to perform a conservative, screening-level assessment to evaluate if further investigations of seismic safety for operating reactors in the central and eastern US (CEUS) are warranted, consistent with NRC directives. The results of the GI-199 safety risk assessment should not be interpreted as definitive estimates of plant-specific seismic risk because some analyses were very conservative making the calculated risk higher than in reality. The nature of the information used (both seismic hazard data and plant-level fragility information) make these estimates useful only as a screening tool.

18) What are the current findings of GI-199?

Currently operating nuclear plants in the US remain safe, with no need for immediate action. This determination is based on NRC staff reviews of updated seismic hazard information and the conclusions of the first stage of GI-199. Existing nuclear plants were designed with considerable margin to be able to withstand the ground motions from the "deterministic" or "scenario earthquake" that accounted for the largest earthquakes expected in the area around the plant. The results of the GI-199 assessment demonstrate that the probability of exceeding the design basis ground motion may have increased at some sites, but only by a relatively small amount. In addition, the probabilities of seismic core damage are lower than the guidelines for taking immediate action. Although there is not an immediate safety

concern, the NRC is focused on assuring safety during even very rare and extreme events. Therefore, the NRC has determined that assessment of updated seismic hazards and plant performance should continue.

19) What do you mean by “increased estimates of seismic hazards” at nuclear plant sites?

Seismic hazard (earthquake hazard) represents the chance (or probability) that a specific level of ground motion could be observed or exceeded at a given location. Our estimates of seismic hazard at some Central and Eastern United States locations have changed based on results from recent research, indicating that earthquakes occurred more often in some locations than previously estimated. Our estimates of seismic hazard have also changed because the models used to predict the level of ground motion, as caused by a specific magnitude earthquake at a certain distance from a site, changed. The increased estimates of seismic hazard at some locations in the Central and Eastern United States were discussed in a memorandum to the Commission, dated July 26, 2006. (The memorandum is available in the NRC Agencywide Documents Access and Management System [ADAMS] under Accession No. ML052360044).

20) Does the Seismic Core Damage represent a measurement of the risk of radiation release or only the risk of core damage (not accounting for additional containment)?

Seismic core damage frequency is the probability of damage to the core resulting from a seismic initiating event. It does not imply either a meltdown or the loss of containment, which would be required for radiological release to occur. The likelihood of radiation release is far lower.

21) Where can I get current information about Generic Issue 199?

The public NRC Generic Issues Program (GIP) website (<http://www.nrc.gov/about-nrc/regulatory/generic-issues.html>) contains program information and documents, background and historical information, generic issue status information, and links to related programs. The latest Generic Issue Management Control System quarterly report, which has regularly updated GI-199 information, is publicly available at <http://www.nrc.gov/reading-rm/doc-collections/generic-issues/quarterly/index.html>. Additionally, the US Geological Survey provides data and results that are publicly available at <http://earthquake.usgs.gov/hazards/products/conterminous/2008/>.

22) Could an accident sequence like the one at Japan’s Fukushima Daiichi nuclear plants happen in the US?

It is difficult to answer this question until we have a better understanding of the precise problems and conditions that faced the operators at Fukushima Daiichi. We do know, however, that Fukushima Daiichi Units 1-3 lost all offsite power and emergency diesel generators. This situation is called “station blackout.” US nuclear power plants are designed to cope with a station blackout event that involves a loss of offsite power and onsite emergency power. The Nuclear Regulatory Commission’s detailed regulations address this scenario. US nuclear plants are required to conduct a “coping” assessment and develop a strategy to demonstrate to the NRC that they could maintain the plant in a safe condition during a station blackout scenario. These assessments, proposed modifications to the plant, and operating procedures were reviewed and approved by the NRC. Several plants added additional AC power sources to comply with this regulation.

In addition, US nuclear plant designs and operating practices since the terrorist events of September 11, 2001, are designed to mitigate severe accident scenarios such as aircraft impact, which include the complete loss of offsite power and all on-site emergency power sources.

~~Draft - OUO~~

US nuclear plant designs include consideration of seismic events and tsunamis'. It is important not to extrapolate earthquake and tsunami data from one location of the world to another when evaluating these natural hazards. These catastrophic natural events are very region- and location-specific, based on tectonic and geological fault line locations.

WORLDSONARC

World Science Nuclear Regulatory Commission

Protecting People and the Environment

Turilin, Andrey

From: Hawkins, Justin
Sent: Monday, March 21, 2011 10:35 AM
To: Welling, Blake; Schroeder, Daniel; McKenna, Philip; Cline, Leonard; Burritt, Arthur; Turilin, Andrey; Raymond, William; Douglas, Christopher; Johnson, Jonathan; Ennis, Rick; Fuhrmeister, Roy
Subject: FW: Seismic Q&As March 20th 8pm update (FOUO)
Attachments: Seismic Questions for Incident Response 3-20-11 8pm.pdf

FYI – Not sure if Branch 3 has this. Q/A Fact Sheet for Seismic Questions – might be useful.

Thanks,
Justin Hawkins

From: Guzman, Richard
Sent: Monday, March 21, 2011 9:15 AM
To: Dentel, Glenn
Cc: Pickett, Douglas; Casey, Lauren; Cronk, Kevin; Dempsey, Douglas; Floyd, Niklas; Hawkins, Justin; Hunegs, Gordon; Kennedy, Silas; Kolaczyk, Kenneth; Montgomery, Richard; Osborn, Matthew; Perry, Neil; Patel, Amar
Subject: FW: Seismic Q&As March 20th 8pm update (FOUO)

Glenn – see updated Q&A / fact sheet in support of Agency's briefings and for general public inquiries.

Regards,
Rich

Rich Guzman
Sr. Project Manager
NRR/DORL
US NRC
301-415-1030
Richard.Guzman@nrc.gov

From: Kammerer, Annie
Sent: Sunday, March 20, 2011 11:00 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Glitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie

Sent: Saturday, March 19, 2011 9:00 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov

Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie

Sent: Friday, March 18, 2011 6:51 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean

Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

*We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)

*The "additional information" section has been split into tables, plots, and fact sheets

*A high-level draft fact sheet on NRC's seismic regulations has been added

*We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Torres, Edgardo

H8 B 4

From: Guzman, Richard
Sent: Monday, March 21, 2011 9:11 AM
To: Jackson, Donald
Cc: Kim, James; Sanders, Carleen; Dunham, Katrina; Setzer, Thomas; Dodson, Douglas; Keighley, Elizabeth; Spindler, David; Rich, Sarah; Shaffer, Steve; Krafty, James; Haagensen, Brian; Schneider, Max; Smith, Brian
Subject: FW: Seismic Q&As March 20th 8pm update (FOUO)
Attachments: Seismic Questions for Incident Response 3-20-11 8pm.pdf

Don – see updated Q&A and fact sheet. Should be useful in support of the upcoming annual assessment meetings.

Regards,
Rich

Rich Guzman
Sr. Project Manager
NRR/DORL
US NRC
301-415-1030
Richard.Guzman@nrc.gov

From: Kammerer, Annie
Sent: Sunday, March 20, 2011 11:00 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

2/21/29

From: Kammerer, Annie

Sent: Saturday, March 19, 2011 9:00 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov

Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie

Sent: Friday, March 18, 2011 6:51 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean

Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added
- *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission

Office of Nuclear Regulatory Research

Washington DC 20555

(b)(6)

mobile

BB

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile

BB

Bensi, Michelle

From: Kammerer, Annie
Sent: Monday, March 21, 2011 3:23 PM
To: Bensi, Michelle
Subject: FW: Q&A for sunday...
Attachments: Seismic Questions for Incident Response 3-20-11 8pm.docx; Seismic Questions for Incident Response 3-20-11 8pm.pdf

-----Original Message-----

From: Annie Kammerer (b)(6)
Sent: Monday, March 21, 2011 1:17 AM
To: Kammerer, Annie
Subject: Q&A for sunday...

--
Dr. Annie Kammerer, PE

(b)(6)

(b)(6)

bb

mobile

(b)(6)

2/24/30

Bensi, Michelle

From: Kammerer, Annie
Sent: Tuesday, March 22, 2011 12:18 PM
To: Bensi, Michelle
Subject: FW: Station blackout questions

We need to review this and see if there is any impact.

From: Burnell, Scott
Sent: Tuesday, March 22, 2011 10:48 AM
To: Mike Soraghan
Subject: RE: Station blackout questions

Mike;

Turns out there is more recent info on station blackouts – work we issued in 2005:

<http://www.nrc.gov/reading-rm/doc-collections/nureqs/contract/cr6890/>

I would think USGS might have information on the ground acceleration associated with well-researched quakes, but please keep in mind it's the acceleration AT THE REACTOR SITES that's important – saying something like "Plant X could withstand the acceleration from earthquake Y" is still going to be misleading. If I learn more I'll send that along.

As for the battery backups, we're saying the same thing different ways. A "four-hour" plant has provided supporting information that leads us to conclude that time period is acceptable; "eight-hour" plants have done the same for their sites. It's not appropriate to apply "eight-hour" standards to plants that meet the "four-hour" standards. And please keep in mind, the batteries must last AT LEAST as long as the standards; there's research out there that suggests they can last longer, particularly when operators can minimize the loads they have to carry – not every situation requires every switch to be turned on.

How's that?

Scott

From: Mike Soraghan [mailto:msoraghan@eenews.net]
Sent: Tuesday, March 22, 2011 10:30 AM
To: Burnell, Scott
Subject: RE: Station blackout questions

Sorry, yes the SSE numbers are helpful. Do you know of anyone who has found a way to translate those to a level of common understanding – maybe the "G-force" of a well-known California earthquake? Or Haiti or Chile etc?

On the question of "one-size fits all," please correct any misunderstanding on my part. There does seem to be a "two-size" fits all. According to the NUREG-1776 report I sent along, some plants must have four hours of battery backup, or "coping time" while the rest must have eight. Are there further site-specific parameters that I'm missing?

uu/31

From: Burnell, Scott [mailto:Scott.Burnell@nrc.gov]
Sent: Tuesday, March 22, 2011 10:21 AM
To: Mike Soraghan
Subject: RE: Station blackout questions

Hello Mike;

I'm checking with the folks most likely to help "translate" that NUREG you referenced in your original questions – my apologies on taking so long there. Were those "safe shutdown earthquake" ground acceleration numbers helpful?

As for your follow-ups:

Battery backup requirements, as with many other aspects of plant operation, are evaluated on a site- and design-specific basis. There is no "one size fits all" battery backup time – plants have to convince the NRC that their individual approaches meet our requirements. The NRC continues to conclude that existing battery backups at every plant are sufficient and acceptable for that plant's situation.

Spent fuel pools operate at normal atmospheric pressure and at temperatures well below the boiling point of water. They are as robust as any structures at a reactor, since they must meet seismic requirements for continuing to function while riding out the strongest earthquakes experienced at their site. These factors preclude the need for specific containment structures for the pools.

With regard to both questions, all U.S. plants have in place additional resources and procedures to deal with situations where significant portions of the plant have been rendered inoperable. The NRC has inspected those arrangements and the agency finds them capable of continuing to protect the public after severe events.

Please let me know what else you need. Thanks.

Scott

From: Mike Soraghan [mailto:msoraghan@eenews.net]
Sent: Tuesday, March 22, 2011 9:38 AM
To: Burnell, Scott
Subject: RE: Station blackout questions

Hi. I wanted to follow up on this, and tack on a question or two. I'm writing a story on the station blackout angle. I'm aiming to run it in our midday edition tomorrow (Wednesday); and I'm trying to complete the reporting by the end of today.

What is the NRC's response to critics such as the Union of Concerned Scientists who say that four hours of battery back-up, or "coping time" is inadequate for 93 of the 104 reactors. And that eight hours really isn't enough at the other 11.

And I'm also interested in finding out the NRC's take on critics, most prominently Robert Alvarez, who says that spent fuel pools are particularly under-protected, without battery backup or significant containment.

If there's someplace else I should direct these question, please let me know. Thanks for any help you can provide.

Mike Soraghan
Reporter

msoraghan@eenews.net

202-446-0423 (desk)

(b)(6)

(cell)

(Google Voice)

Environment & Energy Publishing, LLC

122 C Street, NW, Suite 722, Washington, DC 20001

www.eenews.net • www.eenews.tv

ClimateWire, E&E Daily, Greenwire, E&ENews PM, E&ETV, Land Letter

From: Mike Soraghan [mailto:msoraghan@eenews.net]

Sent: Thursday, March 17, 2011 9:18 PM

To: Burnell, Scott

Subject: RE: Station blackout questions

I'm sorry. I really thought I'd done that right. The report I meant to attach was "NUREG-1776"

I don't know if this link might work:

http://docs.google.com/viewer?a=v&q=cache:OWZ_Os3o9c8J:www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1776/sr1776.pdf+regulatory+effectiveness+of+the+station+black+out&hl=en&gl=us&pid=bl&srcid=ADGEEESghAaUTO60BEQtWGctmThZIpFrhHHLKn2OxIs7Ot1YvFZ8B9Jbfc39DkNG_aRB_RTZuLhb52vLJ8v28VN0H1KHpZsM2NqQ7b8JNcx2AxvqctSrgOxrTk-1X5kZV66TC0nldv5&sig=AHIEtbSXpVLCxGIXP0jw4HMM-heZ38neoA

It's called "Regulatory Effectiveness of the Station Blackout Rule."

I hope you got a little bit of a break, or at least some sleep.

Thanks,

Mike Soraghan

(b)(6)

From: Burnell, Scott [mailto:Scott.Burnell@nrc.gov]

Sent: Thu 3/17/2011 7:45 PM

To: Mike Soraghan

Subject: RE: Station blackout questions

Hi Mike;

The fact that "a moment ago" is now almost two hours gives you an idea of the crush we're dealing with. What we do have on "safe shutdown earthquake" standards (attached) is expressed in terms of "g," the force of

gravity. We don't use magnitude, so I don't have a "translation" available. There wasn't anything attached to your note – does that report have a "NUREG" number or something similar? Thanks.

Scott

From: Mike Soraghan [mailto:msoraghan@eenews.net]

Sent: Thursday, March 17, 2011 6:06 PM

To: Burnell, Scott

Subject: Station blackout questions

Mr. Burnell,

Thank you for taking my call a moment ago. I am looking at doing a story on station black out, with a little on seismic, that looks at all u.s. plants.

My simplest question is whether there is a list of the design basis each of the 104 reactors must meet in terms of what magnitude earthquake they must be able to withstand. I've been told that's not likely, so I'm pulling the information from news reports.

I have the 2000 report (attached) "Regulatory Effectiveness of the Station Blackout Rule." I've been looking at this, particularly the plant-by-plant chart, and I'm seeking some guidance.

First, has there been any update to these numbers?

"Coping time in hours" – is that the amount of battery power? And is it the amount the plant has, or is required to have?

"Loss of Power events" – if a combined plant with two reactors lists two events, did each shut down for a total of four?

Also, is there updated figures for the "loss of power events?"

Thank you,

Mike Soraghan

Reporter

msoraghan@eenews.net

202-446-0423 (desk)

(b)(6)

(cell)

(Google Voice)

Environment & Energy Publishing, LLC

122 C Street, NW, Suite 722, Washington, DC 20001

www.eenews.net • www.eenews.tv

ClimateWire, E&E Daily, Greenwire, E&ENews PM, E&ETV, Land Letter

From: [Kammerer, Annie](#)
To: [Kammerer, Annie](#); [Hiland, Patrick](#); [Skeen, David](#); [Case, Michael](#); [RST01 Hoc](#)
Cc: [Howe, Allen](#); [Nelson, Robert](#); [Stutzke, Martin](#); [Gitter, Joseph](#); [Rihm, Roger](#); [McDermott, Brian](#); [Hasselberg, Rick](#); [Chokshi, Nilesh](#); [Munson, Clifford](#); [Cook, Christopher](#); [Flanders, Scott](#); [Ross-Lee, MaryJane](#); [Brown, Frederick](#); [Ruland, William](#); [Dudes, Laura](#); [Karas, Rebecca](#); [Ake, Jon](#); [Hogan, Rosemary](#); [Uhle, Jennifer](#); [Marshall, Michael](#); [Uselding, Lara](#); [Randall, John](#); [Allen, Don](#); [Burnell, Scott](#); [Hayden, Elizabeth](#); [Pires, Jose](#); [Graves, Herman](#); [Candra, Hernando](#); [Murphy, Andrew](#); [Sheron, Brian](#); [Dricks, Victor](#); [Warnick, Greg](#); [Reynoso, John](#); [Lantz, Ryan](#); [Markley, Michael](#); [Orders, William](#); [Santiago, Patricia](#); [Snodderly, Michael](#); [Baggett, Steven](#); [Sosa, Belkys](#); [Davis, Roger](#); [Franovich, Mike](#); [Castleman, Patrick](#); [Sharkey, Jeffrey](#); [Boska, John](#); [Ma, John](#); [Tegeler, Bret](#); [Patel, Pravin](#); [Shams, Mohamed](#); [Morris, Scott](#); [Brenner, Eliot](#); [Harrington, Holly](#); [Seber, Dogan](#); [Ledford, Joey](#); [Johnson, Michael](#); [Virgilio, Martin](#); [Holahan, Vincent](#); [Bergman, Thomas](#); [Webb, Michael](#); [Manoly, Kamal](#); [Khanna, Meena](#); [Screnci, Diane](#); [Thomas, Eric](#); [Nguyen, Quynh](#); [Meighan, Sean](#); [FOIA Response.hoc Resource](#); [Bensi, Michelle](#)
Subject: Seismic Q&As March 22th 10pm update
Date: Wednesday, March 23, 2011 3:16:03 AM
Attachments: [Diablo Canyon Q&As.pdf](#)
[SONGS Q&As.pdf](#)
[Seismic Questions for Incident Response 3-22-11 10 pm.pdf](#)

All,

Attached please find an updated set of Q&As. I also included some new Q&As for SONGS and Diablo Canyon, just in case anyone is interested.

This version has an expanded set of definitions and new sections on station blackout, spent fuel, flooding and some other topics. It also has fewer duplicate questions.

Let me also pass on a tidbit of info. According to TEPCO (via an NEI press release), the tsunami at Fukushima was 14 meters and the design tsunami level was 5.7 meters. The reactors and backup power sources were at 10 meters and at 13 meters. Ouch.

Cheers,
Annie

From: Kammerer, Annie
Sent: Sunday, March 20, 2011 11:00 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie
Sent: Saturday, March 19, 2011 9:00 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna,

2/2/32

Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

*We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)

*The "additional information" section has been split into tables, plots, and fact sheets

*A high-level draft fact sheet on NRC's seismic regulations has been added

*We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50

miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile
BB

What does the Japanese Earthquake Mean to Diablo Canyon?

1) Could an earthquake and tsunami the size of the one in Japan happen at Diablo Canyon?

No. This earthquake occurred on a "subduction zone", which is the type of tectonic region that produces the largest magnitudes earthquake. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of far northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25; and that would only occur on the largest fault lines, such as the San Andreas fault, which is 50 miles away onshore.

2) What magnitude earthquake are currently operating US nuclear plants such as Diablo Canyon designed to?

Each reactor is designed for a different ground motion that is determined on a site-specific basis. Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site; and it is ground motion that causes damage. So, Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant. The scenario earthquake at Diablo is a magnitude 7.5 on the Hosgri Fault 3 miles from the main plant. This earthquake results in a ground motion that has a peak ground acceleration of 0.75g, that is 75% of the acceleration of gravity.

3) Could the newly discovered Shoreline Fault produce a larger "Scenario Earthquake"?

The NRC's preliminary analyses indicate that the ground motions from the largest earthquakes expected on the smaller Shoreline Fault do not exceed the ground motions from the Hosgri Fault, for which the plant has already been analyzed and been found to be safe. NRC is currently reviewing the Final Report on the Shoreline Fault that was submitted to the NRC earlier this year. The NRC is performing an independent analysis of potential ground motions based the data contained in the report and other information. Much of the data on the Shoreline Fault comes from the USGS in Menlo Park.

4) Could Diablo Canyon withstand an earthquake of the magnitude of the Japanese earthquake?

It could withstand the ground shaking experienced by the Japanese nuclear plants. As discussed above, it is actually ground motions that structures, systems, and components "feel". We do not have direct recordings of ground motion at the Japanese reactors. However, we do have estimates of shaking that come from a ShakeMap produced by the the K-NET system. The ground motion at the Japanese nuclear reactors is believed to be somewhat smaller than the 0.75g peak ground acceleration that Diablo Canyon has been analyzed to. Do, Diablo Canyon could withstand the ground shaking experienced by the Fukushima plant.

In fact, the Fukushima plant also withstood the earthquake. In the hour or so after the earthquake the Fukushima plant's safety systems, including the diesel generators, performed as expected and effectively shut down the reactor. The cause of the problems at the plant stemmed from the loss of emergency power that appears to be the direct result of the subsequent tsunami, which far exceeded the design basis tsunami for the Fukushima plant.

5) Is Diablo Canyon's equipment vulnerable to tsunami?

Nuclear plants are designed to withstand protection against natural phenomena such as tsunami, earthquakes. Diablo Canyon's main plant is located above the flood level associated with tsunami. The intake structures and Auxiliary Sea Water System at Diablo canyon are designed for combination of tsunami and storm wave activity.

6) How do we know that the emergency diesel generators in Diablo Canyon and SONGS will not fail to operate like in Japan?

Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure. Even if these EDGs did fail, plants can safely shutdown using station blackout power source law 10 CFR 50.63. In 1988 the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

7) Was there any damage to Diablo Canyon from either the earthquake or the resulting tsunami?

A small tsunami did hit the region around Diablo Canyon. There was no damage at the nuclear plant.

8) How do we know the evacuation routes in the region around Diablo Canyon are realistic?

FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at DCNPP.

What does the Japanese Earthquake Mean to San Onofre?

1) Could an earthquake and tsunami the size of the one in Japan happen at San Onofre?

No. This earthquake occurred on a "subduction zone", which is the type of tectonic region that produces the largest magnitude earthquake. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of far northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25; and that would only occur on the largest fault lines, such as the San Andreas fault, which is 50 miles away onshore.

2) What magnitude earthquake are currently operating US nuclear plants such as SONGS designed to?

Each reactor is designed for a different ground motion that is determined on a site-specific basis. Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site; and it is ground motion that causes damage. So, Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant. The scenario earthquake at SONGS is a magnitude 7 approximately 5 miles from the main plant. This earthquake results in a ground motion that has a peak ground acceleration of 0.67g, that is 67% of the acceleration of gravity.

3) Could San Onofre withstand an earthquake of the magnitude of the Japanese earthquake?

It could withstand the ground shaking experienced by the Japanese nuclear plants. As discussed above, it is actually ground motions that structures, systems, and components "feel". We do not have direct recordings of ground motion at the Japanese reactors. However, we do have estimates of shaking that come from a ShakeMap produced by the K-NET system. The ground motion at the Japanese nuclear reactors is believed to be somewhat on the order of the 0.67g, or possibly slightly higher, that San Onofre peak ground acceleration has been analyzed to. However, US nuclear plants have additional seismic margin, as demonstrated by the result of the Individual Plant Examination of External Events program carried out by the NRC in the mid-90s.

It should be noted that, the Fukushima plant also withstood the earthquake. In the hour or so after the earthquake the Fukushima plant's safety systems, including the diesel generators, performed as expected and effectively shut down the reactor. The cause of the problems at the plant stemmed from the loss of emergency power that appears to be the direct result of the subsequent tsunami, which far exceeded the design basis tsunami for the Fukushima plant.

4) Is possible to have a tsunami at San Onofre that is capable of damaging the plant?

The San Onofre Units 2 and 3 plant grade is elevation +30.0 feet MLLW. San Onofre has reinforced concrete cantilevered retaining seawall and screen well perimeter wall designed to withstand the design basis earthquake, followed by the maximum predicted tsunami with coincident storm wave action. The controlling tsunami for San Onofre occurring during simultaneous high tide and storm surge produces a maximum runup to elevation +15.6 feet MLLW at the Unit 2 and 3 seawall. When storm waves are superimposed, the predicted maximum runup is to elevation +27 MLLW. Tsunami protection for the

SONGS site is provided by a reinforced concrete seawall constructed to elevation +30.0 MLLW. A tsunami larger than this is extremely unlikely.

5) Has the earthquake hazard at San Onofre been reviewed like Diablo Canyon nuclear power plant is doing? Are they planning on doing an update before relicensing?

Relicensing does not evaluate seismic hazard or other siting issues. Seismic safety is part of NRC's ongoing licensing activities. If an immediate safety concern emerged, the issue would be addressed as part of NRC's response, regardless of relicensing status.

The closest active fault is approximately five miles offshore from San Onofre, a system of folds and faults exist called the offshore zone of deformation (OZD). The OZD includes the Newport-Inglewood-Rose Canyon fault system. The Cristianitos fault is ½ mile southeast, but is an inactive fault. Other faults such as the San Andreas and San Jacinto, which can generate a larger magnitude earthquake, are far enough away that they would produce ground motions much less severe than earthquakes in the OZD for San Onofre.

Notwithstanding the above, the NRC is considering extending the Generic Issue 199 program to all operating reactors. This would require a reassessment of hazard for San Onofre using the latest probabilistic seismic hazard assessment approaches. Based on a preliminary assessment using the source model developed by the USGS for the national seismic hazard maps, the annual probability of occurrence of a 0.67g ground motion at the San Onofre site is only slightly higher than is than the annual probability of occurrence that is recommended for new nuclear plants.

6) How do we know that the emergency diesel generators in San Onofre will not fail to operate like in Japan?

Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure and are seismic Category I equipment. Even if these EDGs did fail, plants can safely shutdown using station blackout power source law 10 CFR 50.63. In 1988 the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

7) Was there any damage to San Onofre from either the earthquake or the resulting tsunami?

There was no damage at the San Onofre nuclear plant from either the earthquake or tsunami.

8) What about emergency planning for San Onofre. Does it consider tsunami?

FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at San Onofre. The next such exercise is planned for April 12, 2011.

The San Onofre emergency plan initiates the emergency response organization and results in declaration of emergency conditions via their Emergency Action Levels. The facility would then make protective action recommendations to the Governor, who would then decide on what protective actions would be ordered for the residents around San Onofre. The consideration of tsunami would be contained in the State and local (City, County) emergency plans, which are reviewed by FEMA.

Rihm, Roger

From: Kammerer, Annie
Sent: Wednesday, March 23, 2011 3:15 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 22th 10pm update
Attachments: Diablo Canyon Q&As.pdf, SONGS Q&As.pdf, Seismic Questions for Incident Response 3-22-11 10 pm.pdf

All,

Attached please find an updated set of Q&As. I also included some new Q&As for SONGS and Diablo Canyon, just in case anyone is interested.

This version has an expanded set of definitions and new sections on station blackout, spent fuel, flooding and some other topics. It also has fewer duplicate questions.

Let me also pass on a tidbit of info. According to TEPCO (via an NEI press release), the tsunami at Fukushima was 14 meters and the design tsunami level was 5.7 meters. The reactors and backup power sources were at 10 meters and at 13 meters. Ouch.

Cheers,
Annie

From: Kammerer, Annie
Sent: Sunday, March 20, 2011 11:00 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie
Sent: Saturday, March 19, 2011 9:00 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan,

Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane;
Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

*We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little) *The "additional information" section has been split into tables, plots, and fact sheets *A high-level draft fact sheet on NRC's seismic regulations has been added *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie
Sent: Thursday, March 17, 2011 2:36 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...
<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Fo rms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of
Nuclear Regulatory Research Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of
Nuclear Regulatory Research Washington DC 20555

(b)(6) mobile
BB

What does the Japanese Earthquake Mean to Diablo Canyon?

1) Could an earthquake and tsunami the size of the one in Japan happen at Diablo Canyon?

No. This earthquake occurred on a "subduction zone", which is the type of tectonic region that produces the largest magnitude earthquake. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of far northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25; and that would only occur on the largest fault lines, such as the San Andreas fault, which is 50 miles away onshore.

2) What magnitude earthquake are currently operating US nuclear plants such as Diablo Canyon designed to?

Each reactor is designed for a different ground motion that is determined on a site-specific basis. Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site; and it is ground motion that causes damage. So, Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant. The scenario earthquake at Diablo is a magnitude 7.5 on the Hosgri Fault 3 miles from the main plant. This earthquake results in a ground motion that has a peak ground acceleration of 0.75g, that is 75% of the acceleration of gravity.

3) Could the newly discovered Shoreline Fault produce a larger "Scenario Earthquake"?

The NRC's preliminary analyses indicate that the ground motions from the largest earthquakes expected on the smaller Shoreline Fault do not exceed the ground motions from the Hosgri Fault, for which the plant has already been analyzed and been found to be safe. NRC is currently reviewing the Final Report on the Shoreline Fault that was submitted to the NRC earlier this year. The NRC is performing an independent analysis of potential ground motions based the data contained in the report and other information. Much of the data on the Shoreline Fault comes from the USGS in Menlo Park.

4) Could Diablo Canyon withstand an earthquake of the magnitude of the Japanese earthquake?

It could withstand the ground shaking experienced by the Japanese nuclear plants. As discussed above, it is actually ground motions that structures, systems, and components "feel". We do not have direct recordings of ground motion at the Japanese reactors. However, we do have estimates of shaking that come from a ShakeMap produced by the the K-NET system. The ground motion at the Japanese nuclear reactors is believed to be somewhat smaller than the 0.75g peak ground acceleration that Diablo Canyon has been analyzed to. Do, Diablo Canyon could withstand the ground shaking experienced by the Fukushima plant.

In fact, the Fukushima plant also withstood the earthquake. In the hour or so after the earthquake the Fukushima plant's safety systems, including the diesel generators, performed as expected and effectively shut down the reactor. The cause of the problems at the plant stemmed from the loss of emergency power that appears to be the direct result of the subsequent tsunami, which far exceeded the design basis tsunami for the Fukushima plant.

5) Is Diablo Canyon's equipment vulnerable to tsunami?

Nuclear plants are designed to withstand protection against natural phenomena such as tsunami, earthquakes. Diablo Canyon's main plant is located above the flood level associated with tsunami. The intake structures and Auxiliary Sea Water System at Diablo canyon are designed for combination of tsunami and storm wave activity.

6) How do we know that the emergency diesel generators in Diablo Canyon and SONGS will not fail to operate like in Japan?

Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure. Even if these EDGs did fail, plants can safely shutdown using station blackout power source law 10 CFR 50.63. In 1988 the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

7) Was there any damage to Diablo Canyon from either the earthquake or the resulting tsunami?

A small tsunami did hit the region around Diablo Canyon. There was no damage at the nuclear plant.

8) How do we know the evacuation routes in the region around Diablo Canyon are realistic?

FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at DCNPP.

What does the Japanese Earthquake Mean to San Onofre?

1) Could an earthquake and tsunami the size of the one in Japan happen at San Onofre?

No. This earthquake occurred on a "subduction zone", which is the type of tectonic region that produces the largest magnitude earthquake. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of far northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25; and that would only occur on the largest fault lines, such as the San Andreas fault, which is 50 miles away onshore.

2) What magnitude earthquake are currently operating US nuclear plants such as SONGS designed to?

Each reactor is designed for a different ground motion that is determined on a site-specific basis. Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site; and it is ground motion that causes damage. So, Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant. The scenario earthquake at SONGS is a magnitude 7 approximately 5 miles from the main plant. This earthquake results in a ground motion that has a peak ground acceleration of 0.67g, that is 67% of the acceleration of gravity.

3) Could San Onofre withstand an earthquake of the magnitude of the Japanese earthquake?

It could withstand the ground shaking experienced by the Japanese nuclear plants. As discussed above, it is actually ground motions that structures, systems, and components "feel". We do not have direct recordings of ground motion at the Japanese reactors. However, we do have estimates of shaking that come from a ShakeMap produced by the K-NET system. The ground motion at the Japanese nuclear reactors is believed to be somewhat on the order of the 0.67g, or possibly slightly higher, that San Onofre peak ground acceleration has been analyzed to. However, US nuclear plants have additional seismic margin, as demonstrated by the result of the Individual Plant Examination of External Events program carried out by the NRC in the mid-90s.

It should be noted that, the Fukushima plant also withstood the earthquake. In the hour or so after the earthquake the Fukushima plant's safety systems, including the diesel generators, performed as expected and effectively shut down the reactor. The cause of the problems at the plant stemmed from the loss of emergency power that appears to be the direct result of the subsequent tsunami, which far exceeded the design basis tsunami for the Fukushima plant.

4) Is possible to have a tsunami at San Onofre that is capable of damaging the plant?

The San Onofre Units 2 and 3 plant grade is elevation +30.0 feet MLLW. San Onofre has reinforced concrete cantilevered retaining seawall and screen well perimeter wall designed to withstand the design basis earthquake, followed by the maximum predicted tsunami with coincident storm wave action. The controlling tsunami for San Onofre occurring during simultaneous high tide and storm surge produces a maximum runup to elevation +15.6 feet MLLW at the Unit 2 and 3 seawall. When storm waves are superimposed, the predicted maximum runup is to elevation +27 MLLW. Tsunami protection for the

SONGS site is provided by a reinforced concrete seawall constructed to elevation +30.0 MLLW. A tsunami larger than this is extremely unlikely.

5) Has the earthquake hazard at San Onofre been reviewed like Diablo Canyon nuclear power plant is doing? Are they planning on doing an update before relicensing?

Relicensing does not evaluate seismic hazard or other siting issues. Seismic safety is part of NRC's ongoing licensing activities. If an immediate safety concern emerged, the issue would be addressed as part of NRC's response, regardless of relicensing status.

The closest active fault is approximately five miles offshore from San Onofre, a system of folds and faults exist called the offshore zone of deformation (OZD). The OZD includes the Newport-Inglewood-Rose Canyon fault system. The Cristianitos fault is ½ mile southeast, but is an inactive fault. Other faults such as the San Andreas and San Jacinto, which can generate a larger magnitude earthquake, are far enough away that they would produce ground motions much less severe than earthquakes in the OZD for San Onofre.

Notwithstanding the above, the NRC is considering extending the Generic Issue 199 program to all operating reactors. This would require a reassessment of hazard for San Onofre using the latest probabilistic seismic hazard assessment approaches. Based on a preliminary assessment using the source model developed by the USGS for the national seismic hazard maps, the annual probability of occurrence of a 0.67g ground motion at the San Onofre site is only slightly higher than is than the annual probability of occurrence that is recommended for new nuclear plants.

6) How do we know that the emergency diesel generators in San Onofre will not fail to operate like in Japan?

Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure and are seismic Category I equipment. Even if these EDGs did fail, plants can safely shutdown using station blackout power source law 10 CFR 50.63. In 1988 the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

7) Was there any damage to San Onofre from either the earthquake or the resulting tsunami?

There was no damage at the San Onofre nuclear plant from either the earthquake or tsunami.

8) What about emergency planning for San Onofre. Does it consider tsunami?

FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at San Onofre. The next such exercise is planned for April 12, 2011.

The San Onofre emergency plan initiates the emergency response organization and results in declaration of emergency conditions via their Emergency Action Levels. The facility would then make protective action recommendations to the Governor, who would then decide on what protective actions would be ordered for the residents around San Onofre. The consideration of tsunami would be contained in the State and local (City, County) emergency plans, which are reviewed by FEMA.

100A
From: Burnell, Scott
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Chokshi, Nilesh; Munson, Clifford; Karas, Rebecca; Ake, Jon; Uhle, Jennifer; Uselding, Lara; Hayden, Elizabeth; Dricks, Victor; Warnick, Greg
Subject: Re: Seismic Q&As March 22th 10pm update
Date: Wednesday, March 23, 2011 5:45:08 AM

Thanks Annie!

We'll give these a once-over and get them posted today.

It probably goes without saying, but NEI quoting TEPCO isn't the sort of "definitive" info we should be repeating outside the agency. They could well be right, but it's always better to be able to refer to the direct source instead of going through intermediaries. Thanks.

Scott

Sent from an NRC Blackberry
Scott Burnell

(b)(6)

----- Original Message -----

QES
From: Kammerer, Annie
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Sent: Wed Mar 23 03:14:31 2011
Subject: Seismic Q&As March 22th 10pm update

All,

Attached please find an updated set of Q&As. I also included some new Q&As for SONGS and Diablo Canyon, just in case anyone is interested.

This version has an expanded set of definitions and new sections on station blackout, spent fuel, flooding and some other topics. It also has fewer duplicate questions.

Let me also pass on a tidbit of info. According to TEPCO (via an NEI press release), the tsunami at Fukushima was 14 meters and the design tsunami level was 5.7 meters. The reactors and backup power sources were at 10 meters and at 13 meters. Ouch.

Cheers,
Annie

QES
From: Kammerer, Annie
Sent: Sunday, March 20, 2011 11:00 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been

22/34

streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

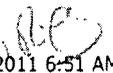
From: Kammerer, Annie 
Sent: Saturday, March 19, 2011 9:00 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie 
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

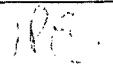
Please see the updated version of the Seismic Q&As.

Among today's highlights:

- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added
- *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie 

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update
All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington, DC 20555

(b)(6)

mobile
BB

Jeff

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile
BB

etp

What does the Japanese Earthquake Mean to Diablo Canyon?

1) Could an earthquake and tsunami the size of the one in Japan happen at Diablo Canyon?

No. This earthquake occurred on a "subduction zone", which is the type of tectonic region that produces the largest magnitudes earthquake. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of far northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25; and that would only occur on the largest fault lines, such as the San Andreas fault, which is 50 miles away onshore.

2) What magnitude earthquake are currently operating US nuclear plants such as Diablo Canyon designed to?

Each reactor is designed for a different ground motion that is determined on a site-specific basis. Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site; and it is ground motion that causes damage. So, Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant. The scenario earthquake at Diablo is a magnitude 7.5 on the Hosgri Fault 3 miles from the main plant. This earthquake results in a ground motion that has a peak ground acceleration of 0.75g, that is 75% of the acceleration of gravity.

3) Could the newly discovered Shoreline Fault produce a larger "Scenario Earthquake"?

The NRC's preliminary analyses indicate that the ground motions from the largest earthquakes expected on the smaller Shoreline Fault do not exceed the ground motions from the Hosgri Fault, for which the plant has already been analyzed and been found to be safe. NRC is currently reviewing the Final Report on the Shoreline Fault that was submitted to the NRC earlier this year. The NRC is performing an independent analysis of potential ground motions based the data contained in the report and other information. Much of the data on the Shoreline Fault comes from the USGS in Menlo Park.

4) Could Diablo Canyon withstand an earthquake of the magnitude of the Japanese earthquake?

It could withstand the ground shaking experienced by the Japanese nuclear plants. As discussed above, it is actually ground motions that structures, systems, and components "feel". We do not have direct recordings of ground motion at the Japanese reactors. However, we do have estimates of shaking that come from a ShakeMap produced by the the K-NET system. The ground motion at the Japanese nuclear reactors is believed to be somewhat smaller than the 0.75g peak ground acceleration that Diablo Canyon has been analyzed to. Do, Diablo Canyon could withstand the ground shaking experienced by the Fukushima plant.

In fact, the Fukushima plant also withstood the earthquake. In the hour or so after the earthquake the Fukushima plant's safety systems, including the diesel generators, performed as expected and effectively shut down the reactor. The cause of the problems at the plant stemmed from the loss of emergency power that appears to be the direct result of the subsequent tsunami, which far exceeded the design basis tsunami for the Fukushima plant.

5) Is Diablo Canyon's equipment vulnerable to tsunami?

Nuclear plants are designed to withstand protection against natural phenomena such as tsunami, earthquakes. Diablo Canyon's main plant is located above the flood level associated with tsunami. The intake structures and Auxiliary Sea Water System at Diablo canyon are designed for combination of tsunami and storm wave activity.

6) How do we know that the emergency diesel generators in Diablo Canyon and SONGS will not fail to operate like in Japan?

Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure. Even if these EDGs did fail, plants can safely shutdown using station blackout power source law 10 CFR 50.63. In 1988 the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

7) Was there any damage to Diablo Canyon from either the earthquake or the resulting tsunami?

A small tsunami did hit the region around Diablo Canyon. There was no damage at the nuclear plant.

8) How do we know the evacuation routes in the region around Diablo Canyon are realistic?

FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at DCNPP.

What does the Japanese Earthquake Mean to San Onofre?

1) Could an earthquake and tsunami the size of the one in Japan happen at San Onofre?

No. This earthquake occurred on a "subduction zone", which is the type of tectonic region that produces the largest magnitude earthquake. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of far northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25; and that would only occur on the largest fault lines, such as the San Andreas fault, which is 50 miles away onshore.

2) What magnitude earthquake are currently operating US nuclear plants such as SONGS designed to?

Each reactor is designed for a different ground motion that is determined on a site-specific basis. Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site; and it is ground motion that causes damage. So, Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant. The scenario earthquake at SONGS is a magnitude 7 approximately 5 miles from the main plant. This earthquake results in a ground motion that has a peak ground acceleration of 0.67g, that is 67% of the acceleration of gravity.

3) Could San Onofre withstand an earthquake of the magnitude of the Japanese earthquake?

It could withstand the ground shaking experienced by the Japanese nuclear plants. As discussed above, it is actually ground motions that structures, systems, and components "feel". We do not have direct recordings of ground motion at the Japanese reactors. However, we do have estimates of shaking that come from a ShakeMap produced by the K-NET system. The ground motion at the Japanese nuclear reactors is believed to be somewhat on the order of the 0.67g, or possibly slightly higher, that San Onofre peak ground acceleration has been analyzed to. However, US nuclear plants have additional seismic margin, as demonstrated by the result of the Individual Plant Examination of External Events program carried out by the NRC in the mid-90s.

It should be noted that, the Fukushima plant also withstood the earthquake. In the hour or so after the earthquake the Fukushima plant's safety systems, including the diesel generators, performed as expected and effectively shut down the reactor. The cause of the problems at the plant stemmed from the loss of emergency power that appears to be the direct result of the subsequent tsunami, which far exceeded the design basis tsunami for the Fukushima plant.

4) Is possible to have a tsunami at San Onofre that is capable of damaging the plant?

The San Onofre Units 2 and 3 plant grade is elevation +30.0 feet MLLW. San Onofre has reinforced concrete cantilevered retaining seawall and screen well perimeter wall designed to withstand the design basis earthquake, followed by the maximum predicted tsunami with coincident storm wave action. The controlling tsunami for San Onofre occurring during simultaneous high tide and storm surge produces a maximum runup to elevation +15.6 feet MLLW at the Unit 2 and 3 seawall. When storm waves are superimposed, the predicted maximum runup is to elevation +27 MLLW. Tsunami protection for the

SONGS site is provided by a reinforced concrete seawall constructed to elevation +30.0 MLLW. A tsunami larger than this is extremely unlikely.

5) Has the earthquake hazard at San Onofre been reviewed like Diablo Canyon nuclear power plant is doing? Are they planning on doing an update before relicensing?

Relicensing does not evaluate seismic hazard or other siting issues. Seismic safety is part of NRC's ongoing licensing activities. If an immediate safety concern emerged, the issue would be addressed as part of NRC's response, regardless of relicensing status.

The closest active fault is approximately five miles offshore from San Onofre, a system of folds and faults exist called the offshore zone of deformation (OZD). The OZD includes the Newport-Inglewood-Rose Canyon fault system. The Cristianitos fault is ½ mile southeast, but is an inactive fault. Other faults such as the San Andreas and San Jacinto, which can generate a larger magnitude earthquake, are far enough away that they would produce ground motions much less severe than earthquakes in the OZD for San Onofre.

Notwithstanding the above, the NRC is considering extending the Generic Issue 199 program to all operating reactors. This would require a reassessment of hazard for San Onofre using the latest probabilistic seismic hazard assessment approaches. Based on a preliminary assessment using the source model developed by the USGS for the national seismic hazard maps, the annual probability of occurrence of a 0.67g ground motion at the San Onofre site is only slightly higher than is than the annual probability of occurrence that is recommended for new nuclear plants.

6) How do we know that the emergency diesel generators in San Onofre will not fail to operate like in Japan?

Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure and are seismic Category I equipment. Even if these EDGs did fail, plants can safely shutdown using station blackout power source law 10 CFR 50.63. In 1988 the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

7) Was there any damage to San Onofre from either the earthquake or the resulting tsunami?

There was no damage at the San Onofre nuclear plant from either the earthquake or tsunami.

8) What about emergency planning for San Onofre. Does it consider tsunami?

FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at San Onofre. The next such exercise is planned for April 12, 2011.

The San Onofre emergency plan initiates the emergency response organization and results in declaration of emergency conditions via their Emergency Action Levels. The facility would then make protective action recommendations to the Governor, who would then decide on what protective actions would be ordered for the residents around San Onofre. The consideration of tsunami would be contained in the State and local (City, County) emergency plans, which are reviewed by FEMA.

Bensi, Michelle

From: Kammerer, Annie
Sent: Wednesday, March 23, 2011 5:24 PM
To: (b)(6); Ake, Jon
Cc: Bensi, Michelle
Subject: RE: Fukushima Data

Jim, the numbers that they are quoting for the design basis is not what JNES gave us.

JNES gave us a S1 of 370gal and an Ss of gal. Also, TEPCO said that the Ss comes from a magnitude 8, while JNES said it was a 7.1.

Foundation versus free field?

(b)(6)
From: (b)(6)
Sent: Wednesday, March 23, 2011 4:46 PM
To: (b)(6); Ake, Jon; Kammerer, Annie
Subject: FUKUSHIMA Data

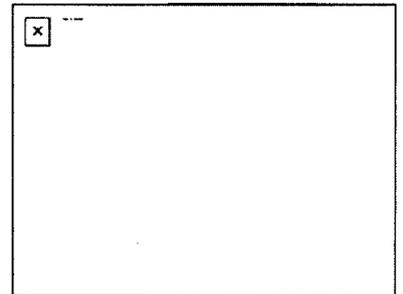
Annie and Jon ... you have probably seen this thru official channels but here is a news story on the EQ and tsunami ... available recorded motions seem slightly greater than Ss at Dai-ichi and less than Ss at Daini - tsunami at 14m both sites ... with best regards ... JJJ

Fukushima faced 14-metre tsunami
23 March 2011

Tokyo Electric Power Company has revised its estimated size of the earthquake and tsunami that hit the Fukushima Daiichi nuclear power plant.

This is the third upward revision of tsunami's scale since it disabled emergency power generators and heat removal pumps at Fukushima Daiichi on 11 March. The loss of these systems left units 1, 2 and 3 in severe trouble that has only stabilised after the write-off of the reactors, which are now being cooled by seawater injection. Some used fuel ponds at the site remain a serious concern and spraying to maintain water levels is ongoing.

In early statements, Tepco had said the tsunami was at least seven metres high. Later the company increased its estimate to ten metres at the Daiichi plant and 12 metres at Daini. Today's figures describe a 14-metre tsunami at both plants. By regulation, the Daiichi plant was fully prepared for a tsunami of up to 5.7 metres. At Daini, ten kilometres along the coast, the design basis was 5.2 metres.



Precision injection of water via concrete pump at Fukushima Daiichi 4

More detailed data of the ground acceleration rates caused by the magnitude 9.0 earthquake have also been made available by Tepco. Although not all the data has yet been collected, they record very powerful tremors that exceed the design basis in one dimension.

At the Daini plant, ground accelerations ranged from 186 gal in the vertical plane at unit 1 to 277 gal from north to south at unit 3, as recorded by sensors in the reactor building foundation. The range of design basis figures is a spread from 415 gal to 512 gal.

At Daiichi there is still no data for units 1, 2 and 5, but available figures put the maximum acceleration as 507 gal from east to west at unit 3. The design basis for this was 441 gal. Other readings were below design basis, although east-west readings at unit 6 of 431 gal approached the design basis of 448 gal.

22/35

Bensi, Michelle

From: Kammerer, Annie
Sent: Wednesday, March 23, 2011 11:41 AM
To: Bensi, Michelle
Subject: Fw: figure
Attachments: Japan_Hazard_map-3.jpg

We may already have this one. Can't see on the BB.

Cheers,
Annie

Sent from an NRC blackberry
Annie Kammerer
mobile (b)(6)
bb (b)(6)
annie.kammerer@nrc.gov

From: Anooshehpoor, Rasool
To: Kammerer, Annie
Sent: Wed Mar 23 11:17:06 2011
Subject:

Annie,

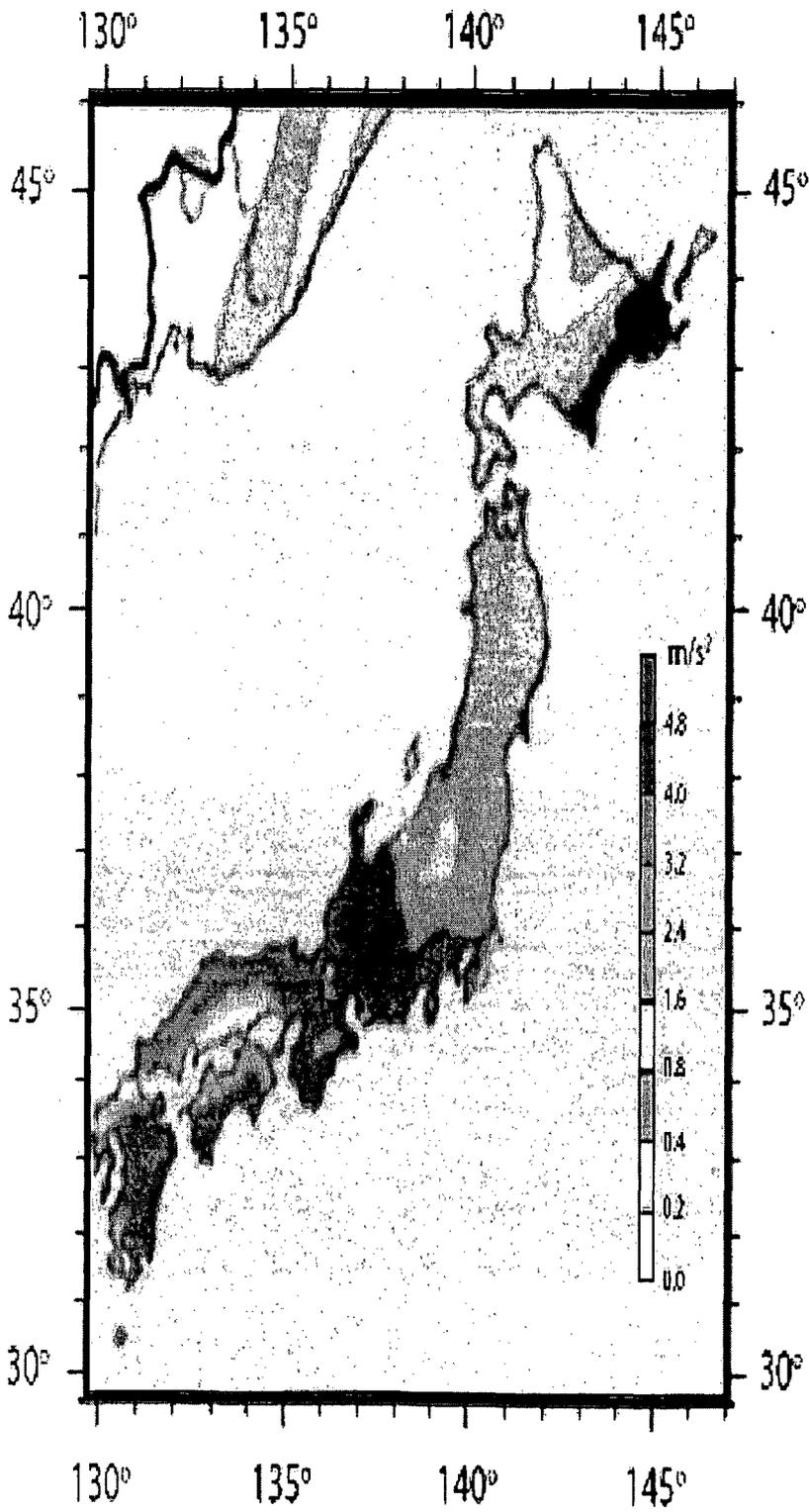
This is the figure that I was talking about over the phone and had forgotten to include in the file I sent you.

Rasool

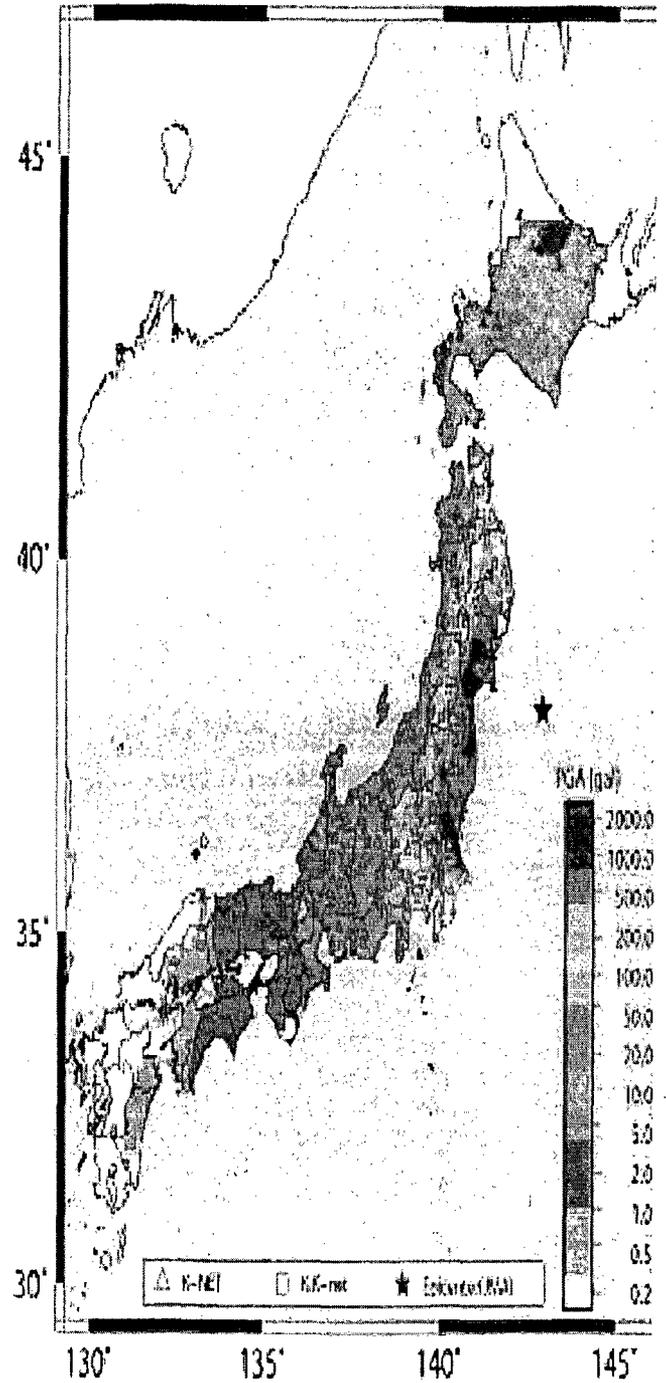
Rasool Anooshehpoor
U.S. Nuclear Regulatory Commission
MS C5A24M
Washington, DC 20555-0001
301-251-7620
Fax: 301-251-7425

22/36

PGA 10% Probability of Exceedence in 50 years (USGS)



PGA, M_w 9.0 Tohoku Earthquake (NE)



38

1

Gray, Mel

From: Kammerer, Annie
Sent: Wednesday, March 23, 2011 3:15 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 22th 10pm update
Attachments: Diablo Canyon Q&As.pdf; SONGS Q&As.pdf; Seismic Questions for Incident Response 3-22-11 10 pm.pdf

All,

Attached please find an updated set of Q&As. I also included some new Q&As for SONGS and Diablo Canyon, just in case anyone is interested.

This version has an expanded set of definitions and new sections on station blackout, spent fuel, flooding and some other topics. It also has fewer duplicate questions.

Let me also pass on a tidbit of info. According to TEPCO (via an NEI press release), the tsunami at Fukushima was 14 meters and the design tsunami level was 5.7 meters. The reactors and backup power sources were at 10 meters and at 13 meters. Ouch.

Cheers,
Annie

From: Kammerer, Annie
Sent: Sunday, March 20, 2011 11:00 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update

All,

uu/37

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie

Sent: Saturday, March 19, 2011 9:00 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov

Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie

Sent: Friday, March 18, 2011 6:51 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean

Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

*We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little) *The "additional information" section has been split into tables, plots, and fact sheets *A high-level draft fact sheet on NRC's seismic regulations has been added *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet... a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,

Annie

Dr. Annie Kammerer, PE

Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of Nuclear
Regulatory Research Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE

Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of Nuclear
Regulatory Research Washington DC 20555

(b)(6) mobile
BB

What does the Japanese Earthquake Mean to San Onofre?

1) Could an earthquake and tsunami the size of the one in Japan happen at San Onofre?

No. This earthquake occurred on a "subduction zone", which is the type of tectonic region that produces the largest magnitude earthquake. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of far northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25; and that would only occur on the largest fault lines, such as the San Andreas fault, which is 50 miles away onshore.

2) What magnitude earthquake are currently operating US nuclear plants such as SONGS designed to?

Each reactor is designed for a different ground motion that is determined on a site-specific basis. Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site; and it is ground motion that causes damage. So, Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant. The scenario earthquake at SONGS is a magnitude 7 approximately 5 miles from the main plant. This earthquake results in a ground motion that has a peak ground acceleration of 0.67g, that is 67% of the acceleration of gravity.

3) Could San Onofre withstand an earthquake of the magnitude of the Japanese earthquake?

It could withstand the ground shaking experienced by the Japanese nuclear plants. As discussed above, it is actually ground motions that structures, systems, and components "feel". We do not have direct recordings of ground motion at the Japanese reactors. However, we do have estimates of shaking that come from a ShakeMap produced by the K-NET system. The ground motion at the Japanese nuclear reactors is believed to be somewhat on the order of the 0.67g, or possibly slightly higher, that San Onofre peak ground acceleration has been analyzed to. However, US nuclear plants have additional seismic margin, as demonstrated by the result of the Individual Plant Examination of External Events program carried out by the NRC in the mid-90s.

It should be noted that, the Fukushima plant also withstood the earthquake. In the hour or so after the earthquake the Fukushima plant's safety systems, including the diesel generators, performed as expected and effectively shut down the reactor. The cause of the problems at the plant stemmed from the loss of emergency power that appears to be the direct result of the subsequent tsunami, which far exceeded the design basis tsunami for the Fukushima plant.

4) Is possible to have a tsunami at San Onofre that is capable of damaging the plant?

The San Onofre Units 2 and 3 plant grade is elevation +30.0 feet MLLW. San Onofre has reinforced concrete cantilevered retaining seawall and screen well perimeter wall designed to withstand the design basis earthquake, followed by the maximum predicted tsunami with coincident storm wave action. The controlling tsunami for San Onofre occurring during simultaneous high tide and storm surge produces a maximum runup to elevation +15.6 feet MLLW at the Unit 2 and 3 seawall. When storm waves are superimposed, the predicted maximum runup is to elevation +27 MLLW. Tsunami protection for the

SONGS site is provided by a reinforced concrete seawall constructed to elevation +30.0 MLLW. A tsunami larger than this is extremely unlikely.

5) Has the earthquake hazard at San Onofre been reviewed like Diablo Canyon nuclear power plant is doing? Are they planning on doing an update before relicensing?

Relicensing does not evaluate seismic hazard or other siting issues. Seismic safety is part of NRC's ongoing licensing activities. If an immediate safety concern is emerged, the issue would be addressed as part of NRC's response, regardless of relicensing status.

The closest active fault is approximately five miles offshore from San Onofre, a system of folds and faults exist called the offshore zone of deformation (OZD). The OZD includes the Newport-Inglewood-Rose Canyon fault system. The Cristianitos fault is ½ mile southeast, but is an inactive fault. Other faults such as the San Andreas and San Jacinto, which can generate a larger magnitude earthquake, are far enough away that they would produce ground motions much less severe than earthquakes in the OZD for San Onofre.

Notwithstanding the above, the NRC is considering extending the Generic Issue 199 program to all operating reactors. This would require a reassessment of hazard for San Onofre using the latest probabilistic seismic hazard assessment approaches. Based on a preliminary assessment using the source model developed by the USGS for the national seismic hazard maps, the annual probability of occurrence of a 0.67g ground motion at the San Onofre site is only slightly higher than is than the annual probability of occurrence that is recommended for new nuclear plants.

6) How do we know that the emergency diesel generators in San Onofre will not fail to operate like in Japan?

Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure and are seismic Category I equipment. Even if these EDGs did fail, plants can safely shutdown using station blackout power source law 10 CFR 50.63. In 1988 the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

7) Was there any damage to San Onofre from either the earthquake or the resulting tsunami?

There was no damage at the San Onofre nuclear plant from either the earthquake or tsunami.

8) What about emergency planning for San Onofre. Does it consider tsunami?

FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at San Onofre. The next such exercise is planned for April 12, 2011.

The San Onofre emergency plan initiates the emergency response organization and results in declaration of emergency conditions via their Emergency Action Levels. The facility would then make protective action recommendations to the Governor, who would then decide on what protective actions would be ordered for the residents around San Onofre. The consideration of tsunami would be contained in the State and local (City, County) emergency plans, which are reviewed by FEMA.

What does the Japanese Earthquake Mean to Diablo Canyon?

1) Could an earthquake and tsunami the size of the one in Japan happen at Diablo Canyon?

No. This earthquake occurred on a "subduction zone", which is the type of tectonic region that produces the largest magnitudes earthquake. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes are also required to produce the kind of massive tsunami seen in Japan. In the continental US, the only subduction zone is the Cascadia subduction zone which lies off the coast of far northern California, Oregon and Washington. So, a continental earthquake and tsunami as large as in Japan could only happen there. Outside of the Cascadia subduction zone, earthquakes are not expected to exceed a magnitude of approximately 8.25; and that would only occur on the largest fault lines, such as the San Andreas fault, which is 50 miles away onshore.

2) What magnitude earthquake are currently operating US nuclear plants such as Diablo Canyon designed to?

Each reactor is designed for a different ground motion that is determined on a site-specific basis. Ground motion is a function of both the magnitude of an earthquake and the distance from the fault to the site; and it is ground motion that causes damage. So, Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. The existing nuclear plants were designed based on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant. The scenario earthquake at Diablo is a magnitude 7.5 on the Hosgri Fault 3 miles from the main plant. This earthquake results in a ground motion that has a peak ground acceleration of 0.75g, that is 75% of the acceleration of gravity.

3) Could the newly discovered Shoreline Fault produce a larger "Scenario Earthquake"?

The NRC's preliminary analyses indicate that the ground motions from the largest earthquakes expected on the smaller Shoreline Fault do not exceed the ground motions from the Hosgri Fault, for which the plant has already been analyzed and been found to be safe. NRC is currently reviewing the Final Report on the Shoreline Fault that was submitted to the NRC earlier this year. The NRC is performing an independent analysis of potential ground motions based the data contained in the report and other information. Much of the data on the Shoreline Fault comes from the USGS in Menlo Park.

4) Could Diablo Canyon withstand an earthquake of the magnitude of the Japanese earthquake?

It could withstand the ground shaking experienced by the Japanese nuclear plants. As discussed above, it is actually ground motions that structures, systems, and components "feel". We do not have direct recordings of ground motion at the Japanese reactors. However, we do have estimates of shaking that come from a ShakeMap produced by the the K-NET system. The ground motion at the Japanese nuclear reactors is believed to be somewhat smaller than the 0.75g peak ground acceleration that Diablo Canyon has been analyzed to. Do, Diablo Canyon could withstand the ground shaking experienced by the Fukushima plant.

In fact, the Fukushima plant also withstood the earthquake. In the hour or so after the earthquake the Fukushima plant's safety systems, including the diesel generators, performed as expected and effectively shut down the reactor. The cause of the problems at the plant stemmed from the loss of emergency power that appears to be the direct result of the subsequent tsunami, which far exceeded the design basis tsunami for the Fukushima plant.

5) Is Diablo Canyon's equipment vulnerable to tsunami?

Nuclear plants are designed to withstand protection against natural phenomena such as tsunami, earthquakes. Diablo Canyon's main plant is located above the flood level associated with tsunami. The intake structures and Auxiliary Sea Water System at Diablo canyon are designed for combination of tsunami and storm wave activity.

6) How do we know that the emergency diesel generators in Diablo Canyon and SONGS will not fail to operate like in Japan?

Emergency Diesel Generators (EDGs) are installed in a seismically qualified structure. Even if these EDGs did fail, plants can safely shutdown using station blackout power source law 10 CFR 50.63. In 1988 the NRC concluded that additional regulatory requirements were justified in order to provide further assurance that a loss of both offsite and onsite emergency ac power systems would not adversely affect public health and safety and the station blackout rule was enacted. Studies conducted by the NRC since this rule has been in effect confirms that the hardware and procedures that have been implemented to meet the station blackout requirements have resulted in significant risk reduction and have further enhanced defense-in-depth. However, we plan to carefully evaluate the lessons learned from the events in Japan to determine if enhancements to the station blackout rule are warranted.

7) Was there any damage to Diablo Canyon from either the earthquake or the resulting tsunami?

A small tsunami did hit the region around Diablo Canyon. There was no damage at the nuclear plant.

8) How do we know the evacuation routes in the region around Diablo Canyon are realistic?

FEMA reviews off-site evacuation plans formally every 2 years during a biennial emergency preparedness exercise. NRC evaluates on-site evacuation plans during the same exercise. Population studies are formally done every 10 years, and evacuation time estimates are re-evaluated at that time. FEMA reviews these evacuation plans, and will conclude their acceptability through a finding of "reasonable assurance" that the off-site facilities and infrastructure is capable of protecting public health and safety in the event of an emergency at DCNPP.

Bensi, Michelle

From: Kammerer, Annie
Sent: Thursday, March 24, 2011 10:30 PM
To: (b)(6); Bensi, Michelle
Subject: re: Some info following Monday Meeting
Attachments: KK_NPPs_level_of_input_motion_and_base.pdf; Design_Ground_Motion_and_In-Structure_Response.pdf

Info on the Japanese design guidance and explanation of why our numbers and TEPCO's numbers differ. Ours are at the hypothetical outcrop at 1000m/s and theirs are at the building foundation (can't remember the Vs for the mat).

Cheers,
Annie

sent from an NRC blackberry
Annie Kammerer
mobile (b)(6)
bb (b)(6)
annie.kammerer@nrc.gov

From: (b)(6)
To: Kammerer, Annie
Sent: Thu Mar 24 10:33:53 2011
Subject: Some info following Monday Meeting

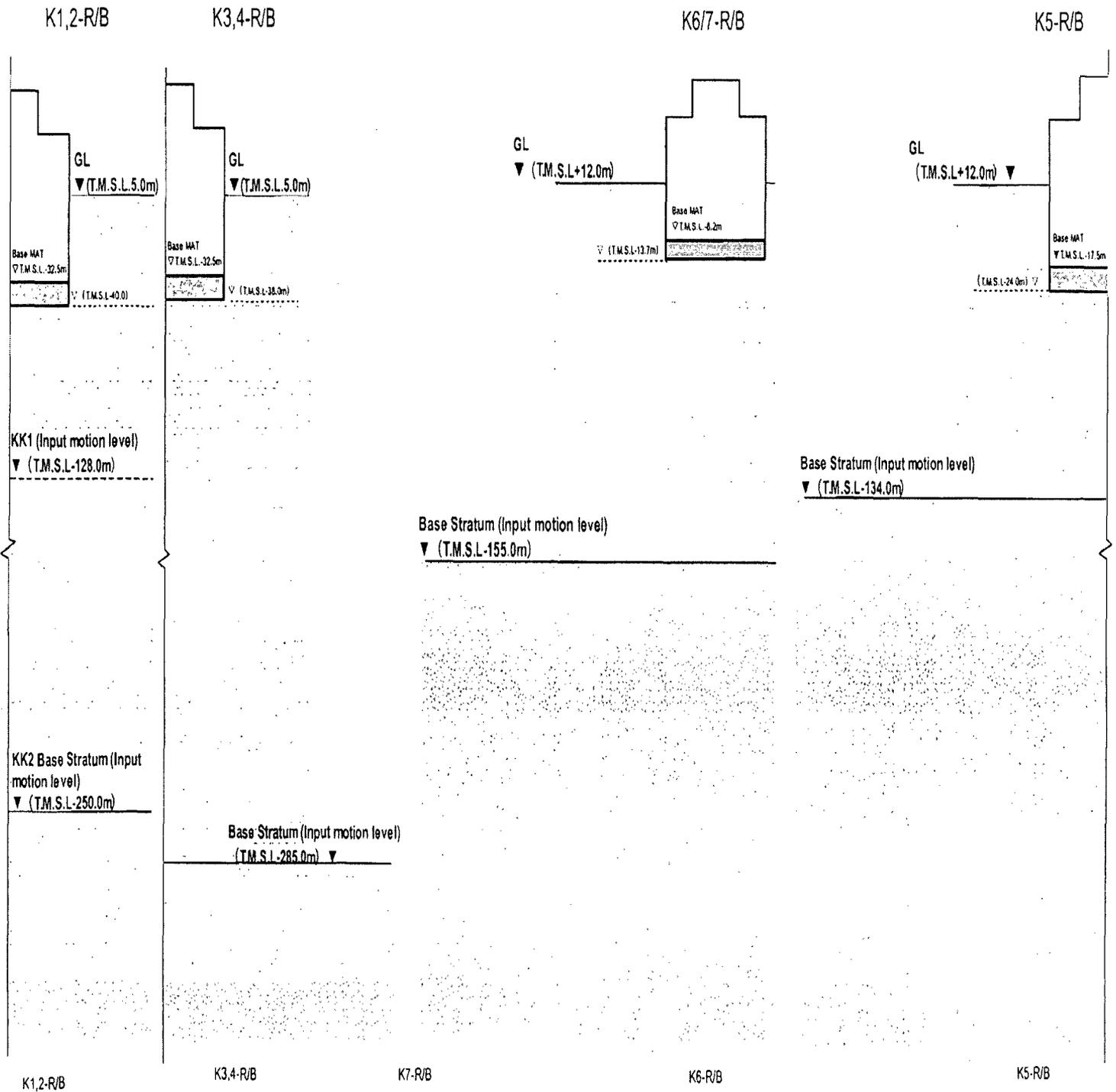
Annie ...

Attached are slides that show the control points and ground motion input locations for the 7 units at K-K (generally defined as hypothetical outcrops at depth) ...

With best regards ... JJJ

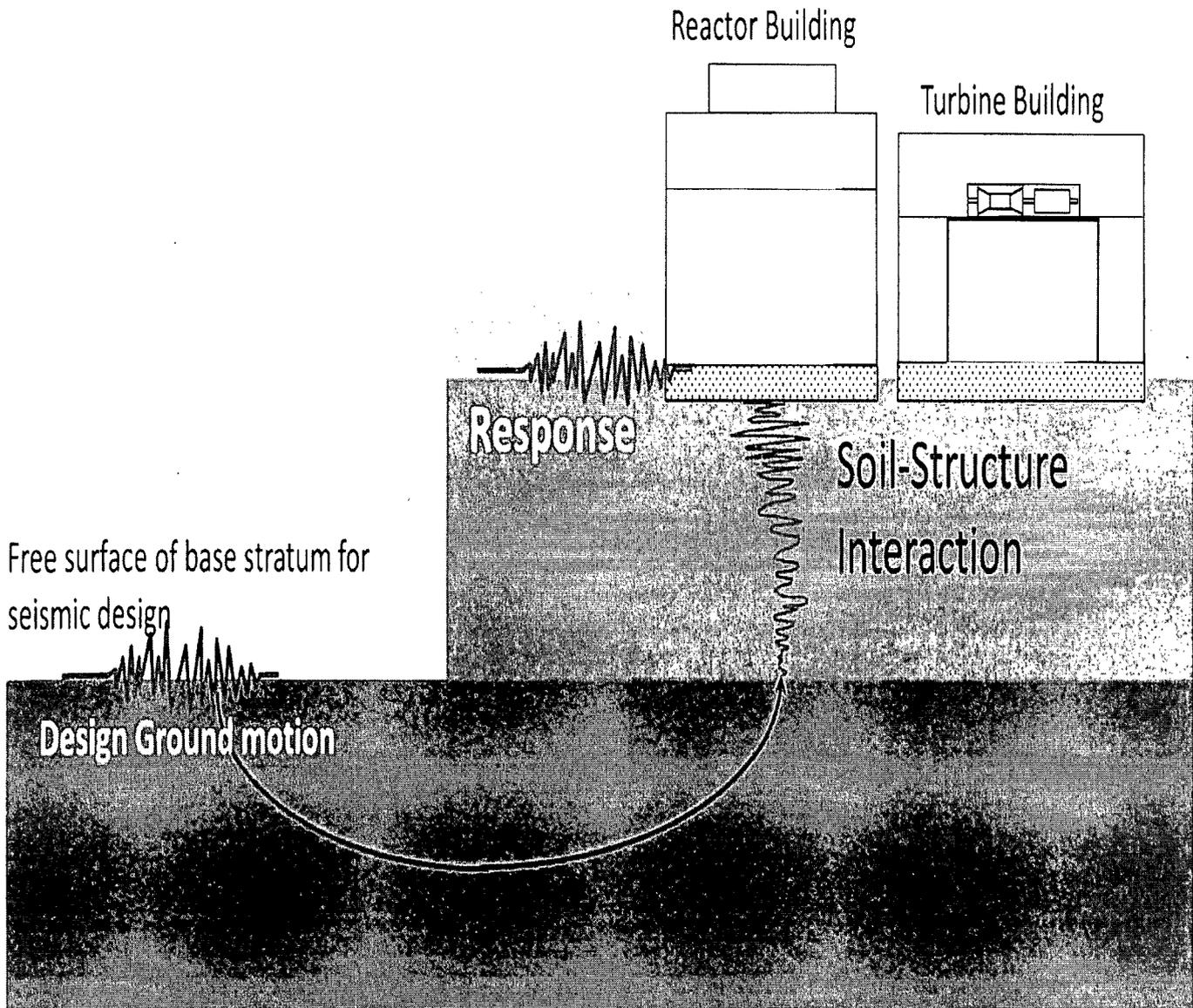
22/38

T.M.S.L. = Tokyo-bay Mean Sea Level



Depth of each unit's embedded R/B basement and the base stratum(input motion level)

Design Ground Motion and In-Structure Response



Bensi, Michelle

From: GIP Resource [GIP.Resource@nrc.gov]
Sent: Thursday, March 24, 2011 6:32 PM
To: Kauffman, John; Reisifard, Mehdi; Lane, John; Perkins, Richard; Killian, Lauren; Beasley, Benjamin; Smith, April; Bensi, Michelle; Ibarra, Jose
Subject: FW: Response from "Contact a GIP Representative"

From: (b)(6)
Sent: Thursday, March 24, 2011 6:32:25 PM
To: GIP Resource
Subject: Response from "Contact a GIP Representative"
Auto forwarded by a Rule

Below is the result of your feedback form. It was submitted by

(b)(6) on Thursday, March 24, 2011 at 18:32:25

comments: Regarding the cooling of ponds holding spent fuel rods: The problem in Japan is that the circulating system was interrupted by the lack of power for pumps leading to the boil-off of containment pond water.

Why can't the heat generated by the fuel rods be used to generate enough power to operate the pumps that service the containment ponds? Even without pumps heat exchange coils in the pond could be used to dump excess heat to a cooler environment.

name: Daniel Studelska

organization:

address1: (b)(6)

address2:

city: (b)(6)

state: (b)(6)

zip: (b)(6)

country: (b)(6)

phone: (b)(6)

22/39

From: Kammerer, Annie
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle; "rmtbactsu_einrc@otda.gov"
Subject: Seismic Q&As March 28th 10pm update
Date: Monday, March 28, 2011 10:33:28 PM
Attachments: Seismic Questions for Incident Response 3-28-11 9am.pdf

All,

It seems that some people actually missed getting the Q&As since I'm starting to get emails asking if I can do an update. Sorry it's been a while, for some reason my workload seems to have exploded...LOL. (*Actually I really have no excuse as Shelby has been a compiling machine!*). We've added several new sections including **ACRONYMS**, located near the back. (*Thanks to Stephanie Devlin for pulling the acronyms together*)

Now that the agency is moving out of the heart of the emergency response phase, and looking towards short, medium and long term actions and goals, our little seismic group has been discussing what to do with this document; and specifically how to make it useful beyond this event. We've discussed the fact that ever since the Kashiwazaki earthquake, we have recognized the need to develop a "generic" seismic Q&A document so that the agency can hit the ground running in cases such as this. It is obvious to us that we now have the guts of the document we've envisaged for years in one 140 page compilation; and it's time to make it happen!

So the next time you see this document (which won't be for a while), it will be radically transformed. We'll be putting all the "static" information in the front, and will be pulling the japan earthquake-specific information into a separate section. It will be more user friendly and will be easier to find any new information. It's unclear to us how long these updates will be useful, but we suspect, not much longer. So, now's the time to start wrapping it up and putting a bow on it...

We hope the new document will be worth the wait...

Dr. Annie Kammerer, P.E.

US NRC/RES/DE

(301) 251-7695 Office

(b)(6)

Mobile

-----Original Message-----

From: Kammerer, Annie

Sent: Wednesday, March 23, 2011 3:15 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Gitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 22th 10pm update

22/40

All,

Attached please find an updated set of Q&As. I also included some new Q&As for SONGS and Diablo Canyon, just in case anyone is interested.

This version has an expanded set of definitions and new sections on station blackout, spent fuel, flooding and some other topics. It also has fewer duplicate questions.

Let me also pass on a tidbit of info: According to TEPCO (via an NEI press release), the tsunami at Fukushima was 14 meters and the design tsunami level was 5.7 meters. The reactors and backup power sources were at 10 meters and at 13 meters. Ouch.

Cheers,

Annie

From: Kammerer, Annie

Sent: Sunday, March 20, 2011 11:00 PM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Glitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle

Subject: Seismic Q&As March 20th 8pm update

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie

Sent: Saturday, March 19, 2011 9:00 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Glitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara;

Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov

Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,

Annie

From: Kammerer, Annie

Sent: Friday, March 18, 2011 6:51 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean

Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

- *We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)
- *The "additional information" section has been split into tables, plots, and fact sheets
- *A high-level draft fact sheet on NRC's seismic regulations has been added
- *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,

Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,

Annie

Dr. Annie Kammerer, PE

Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile
BB

Ex. 6

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Niles; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

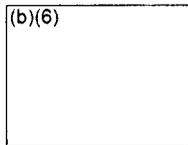
This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE

Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)



mobile

BB

EX 6

Bensi, Michelle

From: Bensi, Michelle
Sent: Monday, March 28, 2011 5:40 PM
To: Kammerer, Annie
Subject: FW: Seismic Q&As: latest version?

See my reply to Chris below. He wants to give something to his branch tomorrow. If you are able to go through the document and re-issue it this evening, that might be best since he is going to distribute it.
Shelby

-----Original Message-----
From: Bensi, Michelle
Sent: Monday, March 28, 2011 5:38 PM
To: Cook, Christopher
Subject: RE: Seismic Q&As: latest version?

UPDATE.
You may want to hold-off until tomorrow morning on printing anything. Annie may issue one last "un-reformatted" version of the document this evening.
-Shelby

-----Original Message-----
From: Cook, Christopher
Sent: Monday, March 28, 2011 5:35 PM
To: Bensi, Michelle
Subject: RE: Seismic Q&As: latest version?

I'm going to distribute the latest version at my branch meeting tomorrow and was just looking for the latest version. Thanks for your prompt response and good luck on the reformat!

Chris

-----Original Message-----
From: Bensi, Michelle
Sent: Monday, March 28, 2011 5:09 PM
To: Cook, Christopher
Cc: Kammerer, Annie
Subject: RE: Seismic Q&As: latest version?

Hi Chris,

The March 22 revision is the most recent version of the document that has been issued. Annie and I are currently working on a reformat of the entire document to make it more organized and user-friendly (which is why Annie has not sent out any emails with new versions of the document). We will hopefully be able to send out a new document soon.

Is there any specific information you are looking for?

-Shelby

-----Original Message-----
From: Cook, Christopher
Sent: Monday, March 28, 2011 5:01 PM

22/41

To: Bensi, Michelle
Cc: Kammerer, Annie
Subject: Seismic Q&As: latest version?

Hi Michelle,

The latest version I have of this document is from March 22, which appears to be later than the 'latest' version I could find on the SharePt site. Is there a newer release or better site to be looking in than:

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

Thanks,
Chris

Christopher B. Cook, Ph.D.
Chief, Geoscience and Geotechnical Engineering Branch 2 US NRC, Office of New Reactors
(301) 415-6397
Christopher.Cook@nrc.gov

-----Original Message-----

From: Kammerer, Annie
Sent: Wednesday, March 23, 2011 3:15 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 22th 10pm update

All,

Attached please find an updated set of Q&As. I also included some new Q&As for SONGS and Diablo Canyon, just in case anyone is interested.

This version has an expanded set of definitions and new sections on station blackout, spent fuel, flooding and some other topics. It also has fewer duplicate questions.

Let me also pass on a tidbit of info. According to TEPCO (via an NEI press release), the tsunami at Fukushima was 14 meters and the design tsunami level was 5.7 meters. The reactors and backup power sources were at 10 meters and at 13 meters. Ouch.

Cheers,
Annie

From: Kammerer, Annie
Sent: Sunday, March 20, 2011 11:00 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie

Sent: Saturday, March 19, 2011 9:00 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean;

FOIAResource.hoc@nrc.gov

Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie

Sent: Friday, March 18, 2011 6:51 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

*We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little) *The "additional information" section has been split into tables, plots, and fact sheets *A high-level draft fact sheet on NRC's seismic regulations has been added *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas
Subject: Seismic Q&As March 17th 2am update All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of Nuclear
Regulatory Research Washington DC 20555

(b)(6)

mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of Nuclear
Regulatory Research Washington DC 20555

(b)(6)

mobile
BB

Lee, Richard

From: Lee, Richard
Sent: Tuesday, March 29, 2011 6:45 PM
To: 'Michael Salay'
Cc: Esmaili, Hossein
Subject: RE: plots

Thanks, Mike:

So far I have not heard whether you will be going. Your name has been submitted.

Richard

From: Michael Salay (b)(6)
Sent: Tuesday, March 29, 2011 6:43 PM
To: Lee, Richard
Cc: Esmaili, Hossein
Subject: plots

Someone has reconstructed plots from publicly available data

<http://www.ic.unicamp.br/~stolfi/EXPORT/projects/fukushima/plots/v6/Main.html>

They explain data sources and issues and provide their typed-in text data files.

-Mike

Michael Salay
(b)(6)
(b)(6) (cell)

22/42

Lee, Richard

From: Lee, Richard
Sent: Wednesday, March 30, 2011 9:16 AM
To: 'Gauntt, Randall O'
Subject: RE: Request for Ops Center RTS support

Mike is still in the Netherlands. Have not heard from our Executive team yet on approving the list of staff to go! They will be up at Congress today for more testimonies. Have a safe trip.

From: Gauntt, Randall O [mailto:rogaunt@sandia.gov]
Sent: Wednesday, March 30, 2011 8:37 AM
To: Lee, Richard
Subject: RE: Request for Ops Center RTS support

Where is Mike Salay? Is he going to Japan?
I am on plane now.
Just curious if Mike will be there.

Randy

From: Lee, Richard [Richard.Lee@nrc.gov]
Sent: Wednesday, March 30, 2011 6:28 AM
To: Esmaili, Hossein; Gauntt, Randy (home); Gauntt, Randall O; Salay, Michael
Subject: FW: Request for Ops Center RTS support

fyi

From: Gibson, Kathy
Sent: Wednesday, March 30, 2011 7:37 AM
To: Lee, Richard
Subject: Fw: Request for Ops Center RTS support

From: Arndt, Steven
To: Skeen, David; RST06 Hoc; Cheok, Michael; Gibson, Kathy
Cc: Ruland, William; Dudes, Laura; Uhle, Jennifer; Hiland, Patrick; Hackett, Edwin; RST01 Hoc; Hoc, PMT12; McDermott, Brian; Coe, Doug; Scott, Michael
Sent: Wed Mar 30 07:33:07 2011
Subject: Re: Request for Ops Center RTS support

I agree with Dave, this should be done out side of the Op Center. A group of RES folks are already doing some analysis in this area (DRA and DSA) to support the PMT. We should task them to do this and provide them with additional resources if needed.

Sent from a NRC blackberry
Steven Arndt

(b)(6)

From: Skeen, David
To: RST06 Hoc; Cheok, Michael; Gibson, Kathy
Cc: Ruland, William; Dudes, Laura; Uhle, Jennifer; Hiland, Patrick; Hackett, Edwin; RST01 Hoc; Hoc, PMT12; McDermott,

Brian; Coe, Doug; Scott, Michael; Arndt, Steven
Sent: Tue Mar 29 23:43:46 2011
Subject: Re: Request for Ops Center RTS support

Good thought, Fred.

I think this would be a worthwhile task, and I think we need a small group of severe accident experts to discuss the potential worst case outcomes for each scenario.

I believe this effort should be conducted outside of the RST, on the normal day shift, with either NRR or RES taking the lead to put a team together to develop the potential outcomes.

Please let me know if you need any support from NRR/DE. We could potentially offer Steve Arndt to support.

From: RST06 Hoc
To: Cheok, Michael; Gibson, Kathy
Cc: Ruland, William; Dudes, Laura; Uhle, Jennifer; Hiland, Patrick; Hackett, Edwin; Skeen, David; RST01 Hoc; Hoc, PMT12; McDermott, Brian; Coe, Doug; Scott, Michael; RST01 Hoc
Sent: Tue Mar 29 23:01:43 2011
Subject: RE: Request for Ops Center RTS support

Please see below.

From: Brown, Frederick
Sent: Tuesday, March 29, 2011 10:56 PM
To: Cheok, Michael; Gibson, Kathy
Cc: Ruland, William; Dudes, Laura; Uhle, Jennifer; Hiland, Patrick; Hackett, Edwin; Skeen, David; RST01 Hoc; Hoc, PMT12; McDermott, Brian; Coe, Doug; Scott, Michael; Brown, Frederick; RST01 Hoc
Subject: Request for Ops Center RTS support
Importance: High

Mike, Kathy

First, I'm not sure that you two are the right folks to ask, but I know that you'll know where this should go.

I'd like to have folks with the right skill set look at two issues (the two are inter-related, but the first may be easier to give a quick answer to without the work that the second will take):

- 1) Given the known, or assumed, status of the three units and four pools, what realistic scenarios exist for energetic dispersion of high quantities of radioactive material that would result in mobile plumes? The point of this question is that there are many clear scenarios that present significant near-area radiological challenges, but given the time since shutdown (for the operating units) and age of much of the fuel (in the SFPs) what are the remaining scenarios of concern with respect to more distant locations (Tokyo with a large concentration of US citizens, Alaska, Hawaii, etc).
- 2) Given the assumed condition of the three units and four pools, can we generate basic event trees for the coming weeks/months? The point would be to identify key success criteria and to help identify key decision points/risk factors to be balanced (qualitative not quantitative analysis). For instance, take two units, each with significant core damage and prior release of volatile fission products, each with primary and secondary containment failure, but one with an intact RPV and the other with a breach of RPV - would there be a difference in potential releases that would lead to different strategies for flooding the primary containment of these two units? This question will make more sense if you look at the assumed conditions below and the attached assessment document where we recommend that TEPCO utilize the SAMG recommendation to flood all 3 units' containments.

Note that the intent is to limit this activity to hours and days, not weeks or years. Once we validate the concept of this evaluation, we can turn it over to US industry for further action/development.

Assumed status (slightly different than the status in the attached assessment):

Unit 1 Rx: Shutdown 3/11. 70% core damage. Cooling with 30 gpm. Significant salt deposits in vessel, core spay plugged. Primary pressure 65 psig. Drywell pressure 25 psig. Secondary containment destroyed. Containment has been vented at least once since fuel damage occurred. Attempting to establish Nitrogen purge prior to resuming venting.

Unit 2 Rx: Shutdown 3/11. 30% core damage. Significant salt deposits in vessel/drywell. Assumed RPV breach, with at least some core ex-vessel that occurred approximately 3/15. Primary containment breached in the torus. Secondary containment breached. Significant release of volatile fission products has occurred through both airborne release and also via water drainage out of the Rx building.

Unit 3 Rx: same assumptions as Unit 2, but do not assume RPV failure and location of primary containment breach may be the drywell.

SFP 1: 292 bundles. Pool intact. All fuel at least 12 years old. No secondary containment. Rubble on top of pool. Water can be added through external spray. Now at saturation temperature.

SFP 2: 587 bundles. Pool intact. Water added to the point of pool over-flow. Pool had reached saturation temperature at one time.

SFP 3: 548 bundles. $\frac{1}{4}$ core offload previous refueling. No checker boarding of hotter fuel. Structural damage to pool area suspected. Pool leakage possible. External addition of water has been made repeatedly, but flooding of pool may not be possible due to damage.

SFP 4: 1331 bundles. Full core offload about 120 days ago. No checker boarding of hotter fuel. Structural damage to pool area is known to exist, and structure may not support a full pool weight load. Pool leakage likely, requiring addition of water periodically. Pool was likely dry enough to have cladding/water reaction which produced enough hydrogen to lead to catastrophic explosion that destroyed secondary containment.

Bensi, Michelle

From: Bensi, Michelle
Sent: Wednesday, March 30, 2011 8:34 AM
To: Boska, John
Cc: Kammerer, Annie
Subject: RE: Seismic Q&As March 28th 10pm update

Hi John,
Thanks for catching the problem. You are correct, the columns/rows are misaligned. It appears that something happened when the table was initially copied from another document.
Thanks again,
Shelby

From: Kammerer, Annie
Sent: Tuesday, March 29, 2011 12:25 PM
To: Bensi, Michelle
Subject: FW: Seismic Q&As March 28th 10pm update

Can you take a look?

Dr. Annie Kammerer, P.E.
US NRC/RES/DE
(301) 251-7695 Office
(b)(6) Mobile

From: Boska, John
Sent: Tuesday, March 29, 2011 8:22 AM
To: Kammerer, Annie
Subject: FW: Seismic Q&As March 28th 10pm update

Actually, I think several of the columns are out of sequence and don't match with the plants. I thought Indian Point 3 should be 1E-4 CDF.

John Boska
Indian Point Project Manager, NRR/DORL
U.S. Nuclear Regulatory Commission
301-415-2901
email: john.boska@nrc.gov

From: Boska, John
Sent: Tuesday, March 29, 2011 8:21 AM
To: Kammerer, Annie
Subject: RE: Seismic Q&As March 28th 10pm update

Annie, on p.71, the table from GI-199, the docket numbers are out of sequence and no longer match with the plants. For example, Indian Point 2 should be 05000247, Indian Point 3 should be 05000286.

John Boska
Indian Point Project Manager, NRR/DORL
U.S. Nuclear Regulatory Commission
301-415-2901
email: john.boska@nrc.gov

From: Kammerer, Annie
Sent: Monday, March 28, 2011 10:32 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle; 'rmtpactsu_elnrc@ofda.gov'
Subject: Seismic Q&As March 28th 10pm update

All,

It seems that some people actually missed getting the Q&As since I'm starting to get emails asking if I can do an update. Sorry it's been a while, for some reason my workload seems to have exploded...LOL. (*Actually I really have no excuse as Shelby has been a compiling machine!*). We've added several new sections including **ACRONYMS**, located near the back. (*Thanks to Stephanie Devlin for pulling the acronyms together*)

Now that the agency is moving out of the heart of the emergency response phase, and looking towards short, medium and long term actions and goals, our little seismic group has been discussing what to do with this document; and specifically how to make it useful beyond this event. We've discussed the fact that ever since the Kashiwazaki earthquake, we have recognized the need to develop a "generic" seismic Q&A document so that the agency can hit the ground running in cases such as this. It is obvious to us that we now have the guts of the document we've envisaged for years in one 140 page compilation; and it's time to make it happen!

So the next time you see this document (which won't be for a while), it will be radically transformed. We'll be putting all the "static" information in the front, and will be pulling the japan earthquake-specific information into a separate section. It will be more user friendly and will be easier to find any new information. It's unclear to us how long these updates will be useful, but we suspect, not much longer. So, now's the time to start wrapping it up and putting a bow on it...

We hope the new document will be worth the wait...

<< File: Seismic Questions for Incident Response 3-28-11 9pm.pdf >>

Dr. Annie Kammerer, P.E.

US NRC/RES/DE

(301) 251-7695 Office

(b)(6)

Mobile

Ex 6

-----Original Message-----

From: Kammerer, Annie

Sent: Wednesday, March 23, 2011 3:15 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 22th 10pm update

All,

Attached please find an updated set of Q&As. I also included some new Q&As for SONGS and Diablo Canyon, just in case anyone is interested.

This version has an expanded set of definitions and new sections on station blackout, spent fuel, flooding and some other topics. It also has fewer duplicate questions.

Let me also pass on a tidbit of info. According to TEPCO (via an NEI press release), the tsunami at Fukushima was 14 meters and the design tsunami level was 5.7 meters. The reactors and backup power sources were at 10 meters and at 13 meters. Ouch.

Cheers,
Annie

From: Kammerer, Annie
Sent: Sunday, March 20, 2011 11:00 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie
Sent: Saturday, March 19, 2011 9:00 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

*We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little) *The "additional information" section has been split into tables, plots, and fact sheets *A high-level draft fact sheet on NRC's seismic regulations has been added *We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week! We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE

Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile
BB

Ex 2,6

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE

Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Ex 2, 4

4
Dunham, Katrina

From: Krafty, James
Sent: Thursday, March 31, 2011 3:07 PM
To: Dunham, Katrina
Subject: FOIA - 2011-0147 - FW: Seismic Q&As March 20th 8pm update (FOUO)
Attachments: → Seismic Questions for Incident Response 3-20-11 8pm.pdf

FOIA

From: Guzman, Richard
Sent: Monday, March 21, 2011 9:11 AM
To: Jackson, Donald
Cc: Kim, James; Sanders, Carleen; Dunham, Katrina; Setzer, Thomas; Dodson, Douglas; Keighley, Elizabeth; Spindler, David; Rich, Sarah; Shaffer, Steve; Krafty, James; Haagensen, Brian; Schneider, Max; Smith, Brian
Subject: FW: Seismic Q&As March 20th 8pm update (FOUO)

Don – see updated Q&A and fact sheet. Should be useful in support of the upcoming annual assessment meetings.

Regards,
Rich

Rich Guzman
Sr. Project Manager
NRR/DORL
US NRC
301-415-1030
Richard.Guzman@nrc.gov

From: Kammerer, Annie
Sent: Sunday, March 20, 2011 11:00 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the

compilation of this document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie

Sent: Saturday, March 19, 2011 9:00 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov

Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie

Sent: Friday, March 18, 2011 6:51 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean

Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

*We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little)

*The "additional information" section has been split into tables, plots, and fact sheets

*A high-level draft fact sheet on NRC's seismic regulations has been added

*We added a section to track outstanding questions that have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffrey; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update

All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile
BB

From: Kammerer, Annie
Sent: Tuesday, March 15, 2011 3:41 AM
To: Hiland, Patrick; Skeen, David
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael
Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE
Senior Seismologist and Earthquake Engineer
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6)

mobile
BB

Bano, Mahmooda

From: Scott, Michael
Sent: Tuesday, April 05, 2011 11:13 PM
To: Collins, Elmo; Blamey, Alan; Taylor, Robert; Giessner, John; Salay, Michael; Bernhard, Rudolph; Hay, Michael; Call, Michel
Subject: Points to ponder

1. I recommended to Laura Dudes last night that she ask the consortium to ponder where its role goes now that inpo industry embedment in effect. Duplication in membership is confusing when work is tasked. Maybe should shift focus and membership, with clear mission statement for both groups.

2. If consortium changes position 180 degrees on hydrogen flammability and goes to tepco position, consortium may lose face with Japanese. If it's the right answer, need to make the change. But we should understand why we got way overconservative answer when such probably inappropriate for this situation. Such understanding would minimize "wrong" answers in future. I say this not to denigrate what has been done but to focus on how to enhance contribution going forward.

Sent from my NRC blackberry
Michael Scott

(b)(6)

2/21/46

Bensi, Michelle

From: Bensi, Michelle
Sent: Wednesday, April 13, 2011 4:10 PM
To: Beasley, Benjamin
Subject: FW: Seismic Q&As March 28th 10pm update

FYI.

From: Kammerer, Annie
Sent: Monday, March 28, 2011 10:32 PM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle; 'rmtpactsu_elnrc@ofda.gov'
Subject: Seismic Q&As March 28th 10pm update

All,

It seems that some people actually missed getting the Q&As since I'm starting to get emails asking if I can do an update. Sorry it's been a while, for some reason my workload seems to have exploded...LOL. (*Actually I really have no excuse as Shelby has been a compiling machine!*). We've added several new sections including **ACRONYMS**, located near the back. (*Thanks to Stephanie Devlin for pulling the acronyms together*)

Now that the agency is moving out of the heart of the emergency response phase, and looking towards short, medium and long term actions and goals, our little seismic group has been discussing what to do with this document; and specifically how to make it useful beyond this event. We've discussed the fact that ever since the Kashiwazaki earthquake, we have recognized the need to develop a "generic" seismic Q&A document so that the agency can hit the ground running in cases such as this. It is obvious to us that we now have the guts of the document we've envisaged for years in one 140 page compilation; and it's time to make it happen!

So the next time you see this document (which won't be for a while), it will be radically transformed. We'll be putting all the "static" information in the front, and will be pulling the japan earthquake-specific information into a separate section. It will be more user friendly and will be easier to find any new information. It's unclear to us how long these updates will be useful, but we suspect, not much longer. So, now's the time to start wrapping it up and putting a bow on it...

We hope the new document will be worth the wait...



Seismic Questions
for Incident...

Dr. Annie Kammerer, P.E.
US NRC/RES/DE

22/47

(301) 251-7695 Office

(b)(6) Mobile

-----Original Message-----

From: Kammerer, Annie

Sent: Wednesday, March 23, 2011 3:15 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 22th 10pm update

All,

Attached please find an updated set of Q&As. I also included some new Q&As for SONGS and Diablo Canyon, just in case anyone is interested.

This version has an expanded set of definitions and new sections on station blackout, spent fuel, flooding and some other topics. It also has fewer duplicate questions.

Let me also pass on a tidbit of info. According to TEPCO (via an NEI press release), the tsunami at Fukushima was 14 meters and the design tsunami level was 5.7 meters. The reactors and backup power sources were at 10 meters and at 13 meters. Ouch.

Cheers,
Annie

From: Kammerer, Annie

Sent: Sunday, March 20, 2011 11:00 PM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIA Response.hoc Resource; Bensi, Michelle
Subject: Seismic Q&As March 20th 8pm update

All,

Here's today's version. It includes updates on related topics for tomorrow's briefing. Also, some of the sections have been streamlined and some (though not all) of the answers have been updated.

The biggest news from the seismic team's perspective is that starting tomorrow a very bright young risk analyst (Michelle Bensi) who recently joined us from UC Berkeley (my beloved alma mater) will be helping with the compilation of this

document. That will allow our team to spend more time cleaning and streamlining it; which inevitably will make it more user friendly...and shorter! Starting with tomorrow's version her name will start to show up on the front.

Best of luck to everyone with the briefing tomorrow!

Annie

From: Kammerer, Annie
Sent: Saturday, March 19, 2011 9:00 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean; FOIAResource.hoc@nrc.gov
Subject: Seismic Q&As March 19th 8am update

All,

Here is today's updated version. Lot of new fact sheets have been prepared for various briefings and for Monday's public meeting!

However, the big news of the day is that we just sent off a 6 page, 22 question, much better edited version for a public Q&A set. It's all in OPA's capable hands now. I think it's pretty good...but then I'm biased.

Cheers,
Annie

From: Kammerer, Annie
Sent: Friday, March 18, 2011 6:51 AM
To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc
Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas; Webb, Michael; Manoly, Kamal; Khanna, Meena; Screnci, Diane; Thomas, Eric; Nguyen, Quynh; Meighan, Sean
Subject: RE: Seismic Q&As March 18th 5am update

All,

Please see the updated version of the Seismic Q&As.

Among today's highlights:

*We added a Terms and Definitions section at the end of the document. (We know that an acronyms list would be helpful too, but it will have to wait a little) *The "additional information" section has been split into tables, plots, and fact sheets *A high-level draft fact sheet on NRC's seismic regulations has been added *We added a section to track outstanding questions that

have come in from congress. This will support those who get the tickets in the short terms (most likely NRR). The questions will be moved to the appropriate sections long term (as long as they are not duplicates.)

I'm sure we all agree this has been a crazy week!. We're hoping that the weekend workload is lighter (if only because we won't get as many email from in house) and we can clean up this document and fill in some of the missing answers in preparation for the news story changing. We're trying hard to get out in front of the next wave.

Cheers,
Annie

From: Kammerer, Annie

Sent: Thursday, March 17, 2011 2:36 AM

To: Kammerer, Annie; Hiland, Patrick; Skeen, David; Case, Michael; RST01 Hoc

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael; Orders, William; Santiago, Patricia; Snodderly, Michael; Baggett, Steven; Sosa, Belkys; Davis, Roger; Franovich, Mike; Castleman, Patrick; Sharkey, Jeffry; Boska, John; Ma, John; Tegeler, Bret; Patel, Pravin; Shams, Mohamed; Morris, Scott; Brenner, Eliot; Harrington, Holly; Seber, Dogan; Ledford, Joey; Johnson, Michael; Virgilio, Martin; Holahan, Vincent; Bergman, Thomas

Subject: Seismic Q&As March 17th 2am update All,

As promised, a sharepoint site has been set up where our friends in NRR will be posting the latest version of the Seismic Q&A document on an ongoing basis. If someone would prefer to use the sharepoint site, instead of being on this distribution list, please let me know...

<http://portal.nrc.gov/edo/nrr/NRR%20TA/FAQ%20Related%20to%20Events%20Occuring%20in%20Japan/Forms/AllItems.aspx>

This latest update has a number of new questions (not many with answers today, but we are working hard). A high priority question we are working on is "how many plants are near a mapped active fault". We're focusing on anything within 50 miles. We're also pulling relevant questions from the congressional inquiries we just received; and will also give these high priority to support any needs by NRR.

Many new figures and some draft fact sheets have added to the "additional information" section. These include the NRO half of a tsunami fact sheet...a description of the tsunami research is still to come from RES.

Some good news: Yesterday's version seems to have been widely forwarded around the agency. So, we are also starting to get some excellent questions from staff looking forward. This is allowing us to feel that we are finally getting out in front of things to a small degree. Also, our team has grown and we now have someone acting as source of seismic expertise for the 11pm to 7 am shift. This means that we now have seismic experts available to the RST and OPA at the Op Center 24 hours, with 2 people during the day. That extra support is allowing us to get this out at least an hour earlier today ☺

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Happy St. Paddy's Day. May the world (especially our friends in Japan) have the luck of the Irish today.

Cheers,
Annie

Dr. Annie Kammerer, PE

Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

From: Kammerer, Annie

Sent: Tuesday, March 15, 2011 3:41 AM

To: Hiland, Patrick; Skeen, David

Cc: Howe, Allen; Nelson, Robert; Stutzke, Martin; Giitter, Joseph; Rihm, Roger; McDermott, Brian; Hasselberg, Rick; Kammerer, Annie; Chokshi, Nilesh; Munson, Clifford; Cook, Christopher; Flanders, Scott; Ross-Lee, MaryJane; Brown, Frederick; Giitter, Joseph; Howe, Allen; Case, Michael; Ruland, William; Dudes, Laura; Karas, Rebecca; Ake, Jon; Munson, Clifford; Hogan, Rosemary; Uhle, Jennifer; Marshall, Michael; Uselding, Lara; Randall, John; Allen, Don; Burnell, Scott; Hayden, Elizabeth; Pires, Jose; Graves, Herman; Candra, Hernando; Murphy, Andrew; Murphy, Andrew; Pires, Jose; Hogan, Rosemary; Sheron, Brian; Dricks, Victor; Warnick, Greg; Reynoso, John; Lantz, Ryan; Markley, Michael

Subject: latest version of Q&As

All,

This is the first draft of the seismic-specific Q&As. It is pretty rough and there are many answers still missing, but people have contributed a lot and we thought it may be useful for many people trying to answer questions coming in.

We are continuing to compile the questions that come in and update the seismic Q&A document. If you have suggested changes, or want to provide missing answers, please forward them to me for compilation.

This is a living document and will be updated daily in the foreseeable future.

Annie

Dr. Annie Kammerer, PE

Senior Seismologist and Earthquake Engineer US Nuclear Regulatory Commission Office of Nuclear Regulatory Research
Washington DC 20555

(b)(6) mobile
BB

Wagner, Katie

From: Wagner, Katie
Sent: Thursday, March 17, 2011 5:36 PM
To: Lee, Richard
Subject: RE: Fukushima

Good Afternoon Richard,

Pat asked if this is security-related: Are you asking Charlie to release this? What is the task to be completed?

Thanks
Katie

From: Lee, Richard
Sent: Thursday, March 17, 2011 12:10 PM
To: Wagner, Katie
Subject: Fw: Fukushima

Sent from nrc blackberry
(b)(6)
Richard Lee

From: Lee, Richard
To: 'kathy.wagner@nrc.' <kathy.wagner@nrc.>
Sent: Thu Mar 17 12:07:37 2011
Subject: Fw: Fukushima

Katie:
Pls forward to Charlie Tinkler.
Thx

Sent from nrc blackberry
(b)(6)
Richard Lee

From: Gauntt, Randall O <rogaunt@sandia.gov>
To: 'CLEMENT Bernard' <bernard.clement@irsn.fr>; Lee, Richard; Tinkler, Charles
Cc: 'VOLA Didier' <didier.vola@irsn.fr>; 'BONNET Jean-Michel' <jean-michel.bonnet@irsn.fr>
Sent: Thu Mar 17 12:02:44 2011
Subject: RE: Fukushima

From: CLEMENT Bernard [mailto:bernard.clement@irsn.fr]
Sent: Thursday, March 17, 2011 5:47 AM
To: Gauntt, Randall O
Cc: VOLA Didier; BONNET Jean-Michel
Subject: Fukushima

22/48

Dear Randy,

As you may imagine, we are looking at the possible accident progression in Fukushima power plant. At the time being we are looking at the problem of the spent fuel storage pool of reactor #4.

We will make evaluations of the consequences of the loss of water for different scenarios of emptying, calculate heat-up and associated source term.

You certainly have made such evaluations in the past using MELCOR calculations. So i have the following question: would it be possible for you to send us some results so as we can make cross-comparisons with our results.

You can certainly understand that this is an urgent request.

Bernard

B. Clément

IRSN/DPAM/SEMIC Bt 702

BP3 13115 Saint-Paul-lez-Durance

Tel + 33 4 42 19 94 70

Fax + 33 4 42 19 91 67

B. Clément

IRSN/DPAM/SEMIC Bt 702

BP3 13115 Saint-Paul-lez-Durance

Tel + 33 4 42 19 94 70

Fax + 33 4 42 19 91 67

Greenwood, Carol

From: Gibson, Kathy
Sent: Thursday, March 17, 2011 6:40 PM
To: Lee, Richard
Subject: RE: Sandia reports requested for Fuku recovery
Attachments: Kathy Halvey Gibson.vcf

Can you stop by my office before you leave?

-----Original Message-----

From: Lee, Richard
Sent: Thursday, March 17, 2011 6:39 PM
To: Gibson, Kathy; Scott, Michael
Cc: Wagner, Katie
Subject: FW: Sandia reports requested for Fuku recovery
Importance: High

Fyi. I just came back with Brian from meeting with Secretary Chu, Dr. Holdren, Director of the Office of Science and Technology Policy of the White House, and others.

-----Original Message-----

From: Lee, Richard
Sent: Thursday, March 17, 2011 6:35 PM
To: Holzle, Catherine
Subject: FW: Sandia reports requested for Fuku recovery
Importance: High

Hi, Cathy:

Please help us on this. This is related to the Fukushima crisis in Japan, and we need to act on this fast.

Thanks, Richard

-----Original Message-----

From: Gibson, Kathy
Sent: Thursday, March 17, 2011 5:53 PM
To: Lee, Richard
Cc: Tinkler, Charles; Wagner, Katie
Subject: FW: Sandia reports requested for Fuku recovery
Importance: High

Richard,
This is high priority. Please find out how we can send OOU reports to GE.

Thanks,
Kathy

-----Original Message-----

2/24/11

From: Wagner, Katie
Sent: Thursday, March 17, 2011 5:42 PM
To: wayne.marquino@ge.com
Cc: Gibson, Kathy
Subject: RE: Sandia reports requested for Fuku recovery

Dear Mr. Marquino,

I am the POC for your request for reports. We are following up on your request and will get back to you.

Thanks,

Katie Wagner
General Engineer
U.S. Nuclear Regulatory Commission
(301) 251.7917
Katie.Wagner@nrc.gov

-----Original Message-----

From: Marquino, Wayne (GE Power & Water) [mailto:wayne.marquino@ge.com]
Sent: Thursday, March 17, 2011 4:35 PM
To: Tinkler, Charles
Cc: Kingston, Rick E. (GE Power & Water); Head, Jerald G (GE Power & Water); Quintana, Louis M (GE Power & Water); Gauntt, Randall O
Subject: Sandia reports requested for Fuku recovery

Charles -

We request the reports in the attached .pdf file to assist in recovery efforts at the Fukushima 1 units. We've screened the list of reports provided by Randy Gauntt, to those which seem relevant to our present efforts.

If you can send them to me encrypted via email, I will follow GEH Safe Guards Information while handling them. Please advise what encryption SW I need if it's special so I can install it on our SGI computer.

If via FedEx, please send to

Jerald Head
3901 Castle Hayne Road M/C A18
Wilmington, NC 28402

Thanks,

Wayne

Wayne Marquino P.E.
System Integration Engineering Manager, ESBWR GE Hitachi Nuclear Energy
Voice- (910) 819-6444 (dial comm 819-6444) Cell (b)(6)
FAX- (910) 362-6444
Conferencing passcode (b)(6) toll free: (b)(6) International (b)(6) Sweden
(b)(6) Spain (b)(6) Japan (b)(6), Mexico (b)(6), DialComm (b)(6)

email:wayne.marquino@ge.com

3901 Castle Hayne Road M/C A75
ATC2 4319
Wilmington, NC 28402
www.ge-energy.com/nuclear
http://www.ge-energy.com/prod_serv/products/nuclear_energy/en/passive_safety_system.htm
http://adamswebsearch2.nrc.gov/idmws/ViewDocByAccession.asp?AccessionNumber=ML103440266

-----Original Message-----

From: Gauntt, Randall O [mailto:rogaunt@sandia.gov]
Sent: Wednesday, March 16, 2011 5:09 PM
To: Marquino, Wayne (GE Power & Water); Head, Jerald G (GE Power & Water)
Cc: Loewen, Eric (GE Power & Water); Ginsberg, Robert (GE Power & Water); Klapproth, James F (GE Power & Water); Quintana, Louis M (GE Power & Water)
Subject: RE: Can we call you about spent fuel?

Wayne
List of relevant reports.

Randy

-----Original Message-----

From: Marquino, Wayne (GE Power & Water) [mailto:wayne.marquino@ge.com]
Sent: Wednesday, March 16, 2011 11:49 AM
To: Gauntt, Randall O; Head, Jerald G (GE Power & Water)
Cc: Loewen, Eric (GE Power & Water); Ginsberg, Robert (GE Power & Water); Klapproth, James F (GE Power & Water); Quintana, Louis M (GE Power & Water)
Subject: Re: Can we call you about spent fuel?

Jerry-

Jim asked me to request the reports via you when Randy sends the reports numbers.

Wayne
Wayne Marquino P.E.
System Integration Engineering Manager, ESBWR GE Hitachi Nuclear Energy

Voice- (910) 819-6444 (dial comm 292-6444) Cell (b)(6)
FAX- (910) 362-6444
Conferencing passcode (b)(6) toll free: (b)(6) International 01
(b)(6) Spain access (b)(6)

email:wayne.marquino@ge.com

3901 Castle Hayne Road M/C A75
ATC2 4319
Wilmington, NC 28402

----- Original Message -----

From: Marquino, Wayne (GE Power & Water)
To: Gauntt, Randall O <rogaunt@sandia.gov>

Cc: Loewen, Eric (GE Power & Water); Ginsberg, Robert (GE Power & Water); Klapproth, James F (GE Power & Water)
Sent: Wed Mar 16 12:09:07 2011
Subject: RE: Can we call you about spent fuel?

Randy -

GEH would like to obtain the Sandia reports you described on spent fuel response to loss of cooling which includes BWR fuel and different discharge times. Can you provide the report numbers?

I understand that these have a security classification (one of the lower ones) and therefore will have to request reports from the NRC, and the knowledgeable NRC contacts are:

Jennifer Uhle 301 251 7499

Hinkler 251 7496

Brain Sheron

Thanks for the information,

Wayne

Greenwood, Carol

From: Gibson, Kathy
Sent: Friday, March 18, 2011 10:03 AM
To: Santiago, Patricia
Subject: Re: Fukushima
Attachments: image001.jpg

I asked Charlie to do it, not Jason. I want Jason in the Ops Center. Charlie just told me again they need Jason in OC because of his Source term expertise.

From: Santiago, Patricia
To: Gibson, Kathy
Sent: Fri Mar 18 09:59:57 2011
Subject: Re: Fukushima

They said u met yesterday and u said work calc .

Sent from an NRC BlackBerry
Patricia Santiago

(b)(6)

From: Gibson, Kathy
To: Santiago, Patricia
Sent: Fri Mar 18 09:47:11 2011
Subject: Re: Fukushima

Have we resolved the Jason and Ops Center question? This looks like the duplication of effort I spoke of. Also Charlie mentioned to me yesterday it would be good to have Jason's expertise in the Ops Center.

From: Lee, Richard
To: Gibson, Kathy; Dehn, Jeff; Wagner, Katie
Cc: Sangimino, Donna-Marie; Santiago, Patricia
Sent: Fri Mar 18 09:39:28 2011
Subject: RE: Fukushima

Charlie and Jason said the documents requested by GE is NOT SAFEGUARDS and only OOU. I have not heard back from OGC. Will call her now.

From: Gibson, Kathy
Sent: Friday, March 18, 2011 9:33 AM
To: Lee, Richard; Dehn, Jeff; Wagner, Katie
Cc: Sangimino, Donna-Marie; Santiago, Patricia
Subject: Re: Fukushima

No, Jeff can go ahead and provide it.

The more important question is whether/how we can provide the requested documents to GE-Wilmington. Have you heard fro OGC? Are all those documents OOU-Security Related Information?

Thx

uu/50

From: Lee, Richard
To: Gibson, Kathy; Dehn, Jeff; Wagner, Katie
Cc: Sangimino, Donna-Marie; Santiago, Patricia
Sent: Fri Mar 18 09:27:31 2011
Subject: RE: Fukushima

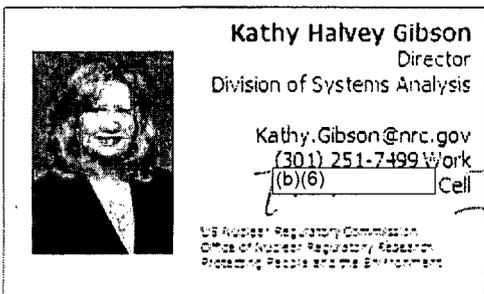
I spoke to Jason and Charlie this morning. Jason had previously gone and consulted with NSIR, and determined that it is NOT SAFEGUARD material.

My suggestion is to proceed to provide it to IRSN. Do we need to inform Op. Center first?

From: Gibson, Kathy
Sent: Thursday, March 17, 2011 7:42 PM
To: Dehn, Jeff; Wagner, Katie
Cc: Lee, Richard; Sangimino, Donna-Marie
Subject: RE: Fukushima

The document requested is attached to the original email from Sandia and is marked "Official Use Only – Security Related Information". Do you still need us to verify there is no safeguards information?

This document and some others were also requested by GE-Wilmington and Richard is contacting OGC to see whether we can release them to a private company.



Kathy Halvey Gibson
Director
Division of Systems Analysis

Kathy.Gibson@nrc.gov
(301) 251-7499 Work
(b)(6) Cell

US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Protecting People and the Environment

From: Dehn, Jeff
Sent: Thursday, March 17, 2011 7:25 PM
To: Gibson, Kathy; Wagner, Katie
Cc: Lee, Richard; Sangimino, Donna-Marie
Subject: RE: Fukushima

All,

I just spoke with OIP/Ops Center about this. The information may be OK to send to IRSN. The central question is what their classifications are. Those marked as "Official Use Only – Security Related Information" aren't necessarily Safeguards, and if they're not we can send them to IRSN. If any of them are SGI, we will need to work further with OIP to possibly get Commission approval for their dissemination.

So – who is able to identify these documents' classification? With that answered, I can take the next step. Another question they asked is whether we were going to ask IRSN to supply the results of their analysis to us. Do we plan to?

They agree with me that it isn't necessary to coordinate further within the Ops Center on this.

Thanks,
Jeff

From: Gibson, Kathy
Sent: Thursday, March 17, 2011 6:02 PM
To: Wagner, Katie; Dehn, Jeff
Cc: Lee, Richard
Subject: RE: Fukushima
Importance: High

Jeff Dehn should handle it. Note that the report is OUO- Safeguards information. We need to know whether/how we can provide this to the requester.

Jeff – the announcement from the ops center said:
It is possible that some of us will be requested by colleagues in another country to provide technical advice and assistance during this emergency. It is essential that all such communications be handled through the NRC Operations Center. Any assistance to a foreign government or entity must be coordinated through the NRC Operations Center and the U.S. Department of State (DOS). If you receive such a request, contact the NRC Operations Officer (301-816-5100 or via the NRC Operator) immediately.

Are you coordinating with the Ops Center? (regarding this request and the info to GRS and any others we get) or is OIP doing that?

	Kathy Halvey Gibson Director Division of Systems Analysis
	Kathy.Gibson@nrc.gov (301) 251-7499 Work (b)(6) Cell
<small>U.S. Nuclear Regulatory Commission Office of Nuclear Regulatory Research Protecting People and the Environment</small>	

From: Wagner, Katie
Sent: Thursday, March 17, 2011 4:40 PM
To: Gibson, Kathy
Subject: FW: Fukushima

Kathy,

Pat and I are asking for your guidance on priority for responding to this.

Thanks,
Pat and Katie

From: Wagner, Katie
Sent: Thursday, March 17, 2011 3:38 PM
To: Dehn, Jeff
Subject: FW: Fukushima

Good Afternoon Jeff,

I have already forwarded this to Charlie Tinkler as Richard instructed, but realized this also needs to go through you since you are the designated international contact.

Thanks,
Katie

From: Wagner, Katie
Sent: Thursday, March 17, 2011 1:05 PM
To: Tinkler, Charles
Subject: FW: Fukushima

From: Lee, Richard
Sent: Thursday, March 17, 2011 12:10 PM
To: Wagner, Katie
Subject: Fw: Fukushima

Sent from nrc blackberry

(b)(6)

Richard Lee

From: Lee, Richard
To: 'kathy.wagner@nrc.' <kathy.wagner@nrc.>
Sent: Thu Mar 17 12:07:37 2011
Subject: Fw: Fukushima

Katie:
Pls forward to Charlie Tinkler.
Thx

Sent from nrc blackberry

(b)(6)

Richard Lee

From: Gauntt, Randall O <rogaunt@sandia.gov>
To: 'CLEMENT Bernard' <bernard.clement@irsn.fr>; Lee, Richard; Tinkler, Charles
Cc: 'VOLA Didier' <didier.vola@irsn.fr>; 'BONNET Jean-Michel' <jean-michel.bonnet@irsn.fr>
Sent: Thu Mar 17 12:02:44 2011
Subject: RE: Fukushima

From: CLEMENT Bernard [mailto:bernard.clement@irsn.fr]
Sent: Thursday, March 17, 2011 5:47 AM
To: Gauntt, Randall O
Cc: VOLA Didier; BONNET Jean-Michel
Subject: Fukushima

Dear Randy,

As you may imagine, we are looking at the possible accident progression in Fukushima power plant. At the time being we are looking at the problem of the spent fuel storage pool of reactor #4.

We will make evaluations of the consequences of the loss of water for different scenarios of emptying, calculate heat-up and associated source term.

You certainly have made such evaluations in the past using MELCOR calculations. So i have the following question: would it be possible for you to send us some results so as we can make cross-comparisons with our results.

You can certainly understand that this is an urgent request.

Bernard

B. Clément

IRSN/DPAM/SEMIC Bt 702

BP3 13115 Saint-Paul-lez-Durance

Tel + 33 4 42 19 94 70

Fax + 33 4 42 19 91 67

B. Clément

IRSN/DPAM/SEMIC Bt 702

BP3 13115 Saint-Paul-lez-Durance

Tel + 33 4 42 19 94 70

Fax + 33 4 42 19 91 67

Lee, Richard

From: Santiago, Patricia
Sent: Wednesday, March 23, 2011 9:52 AM
To: Dacus, Eugene
Cc: Uhle, Jennifer; Sheron, Brian; Lee, Richard; Bowman, Gregory; Wagner, Katie; Gibson, Kathy; Lee, Richard; Elkins, Scott
Subject: RE: House E&C request
Attachments: image001.jpg

Eugene

I am sending you a password for the zip file that contains the SOARCA App A for Peach Bottom. The document is marked predecisional – not for public release. Since the file is so large, I am not sending it to all recipients of this request.

The password is soarcaappav3. If you have any difficulties opening the file, please let me know or Richard Chang.

Thanks,

Pat

Patricia A. Santiago
Chief, Special Projects Branch
Division of Systems Analysis
Office of Nuclear Regulatory Research
Phone- 301-251-7982
Fax- 301-251-7426
Patricia.Santiago@nrc.gov

From: Dacus, Eugene
Sent: Tuesday, March 22, 2011 6:38 PM
To: Santiago, Patricia; Gibson, Kathy
Cc: Uhle, Jennifer; Weber, Michael; Sheron, Brian; Lee, Richard
Subject: RE: House E&C request

Thanks Patricia.

From: Santiago, Patricia
Sent: Tuesday, March 22, 2011 6:36 PM
To: Gibson, Kathy; Dacus, Eugene
Cc: Uhle, Jennifer; Weber, Michael; Sheron, Brian; Lee, Richard
Subject: Re: House E&C request

Yes we have it marked and may need to zip the file. We will send it first thing tomorrow morning.

Sent from an NRC BlackBerry
Patricia Santiago

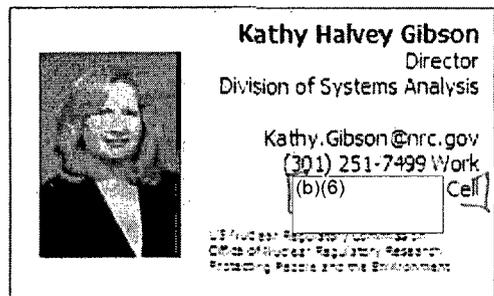
(b)(6)

From: Gibson, Kathy
To: Dacus, Eugene

Cc: Uhle, Jennifer; Weber, Michael; Sheron, Brian; Santiago, Patricia; Lee, Richard
Sent: Tue Mar 22 15:41:19 2011
Subject: RE: House E&C request

I have forwarded the request to the staff.

Richard/Pat: Please coordinate with Eugene on this request.



From: Dacus, Eugene
Sent: Tuesday, March 22, 2011 3:33 PM
To: Sheron, Brian
Cc: Gibson, Kathy; Uhle, Jennifer; Weber, Michael
Subject: RE: House E&C request

Thanks Brian

From: Sheron, Brian
Sent: Tuesday, March 22, 2011 3:17 PM
To: Dacus, Eugene
Cc: Gibson, Kathy; Uhle, Jennifer; Weber, Michael
Subject: RE: House E&C request

Probably not. We need to mark it "DRAFT." Call Kathy Gibson. Her staff can get it to you.

From: Dacus, Eugene
Sent: Tuesday, March 22, 2011 3:09 PM
To: Sheron, Brian
Cc: Powell, Amy; Lund, Louise
Subject: RE: House E&C request

Thanks Brian. Is there a reason we cannot provide the information to Congress?

From: Sheron, Brian
Sent: Tuesday, March 22, 2011 2:58 PM
To: Dacus, Eugene
Cc: Powell, Amy; Lund, Louise
Subject: RE: House E&C request

During the briefing I gave to House staffers last week, I referred to the SOARCA analysis of Peach Bottom. I did not mention relicensing or license renewal.

The SOARCA results are not yet publicly available.

From: Dacus, Eugene
Sent: Tuesday, March 22, 2011 2:48 PM
To: Sheron, Brian
Cc: Powell, Amy; Lund, Louise
Subject: FW: House E&C request

Brian,

Help. One of the staffers you briefed last week has asked for some documentation. See trail below.

Grnr

From: Lund, Louise
Sent: Tuesday, March 22, 2011 10:14 AM
To: Dacus, Eugene
Cc: Galloway, Melanie; Holian, Brian
Subject: RE: House E&C request

Gene,

Brian H. brings up a good point. You may want to close the loop with Brian Sheron to see if he was referring to the SAMA reviews or the SORCA.

Louise

From: Holian, Brian
Sent: Tuesday, March 22, 2011 9:59 AM
To: Dacus, Eugene; Lund, Louise
Cc: Galloway, Melanie
Subject: Re: House E&C request

I believe sheron is talking about SORCA reviews. These were done independent of license renewal. PB was one plant looked at in depth

From: Dacus, Eugene
To: Lund, Louise
Cc: Holian, Brian
Sent: Mon Mar 21 16:49:47 2011
Subject: RE: House E&C request

Thanks Louise. Really appreciate your help on this. You always come through for us.

From: Lund, Louise
Sent: Monday, March 21, 2011 4:47 PM
To: Dacus, Eugene
Cc: Holian, Brian
Subject: RE: House E&C request

Gene,

I talked with Sam Lee (DRA), and we both think Brian was referring to the SAMA (Severe Accident Mitigation Alternatives) analysis in the plant-specific supplement to the Environmental Impact Statement that DLR issues as part of the license renewal process. It is publicly available, and contained in Section 5 of the following link on our web page to the Supplemental EIS:

<http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/supplement10/>

Louise

From: Dacus, Eugene
Sent: Monday, March 21, 2011 4:17 PM
To: Lund, Louise
Subject: FW: House E&C request

Louise,

I hate to bug you, but I don't have a contact for PB. The e-mail below is from a staffer on the House Energy and Commerce Committee. He's asking for data relating to the Peach Bottom relicensing.

From: Baran, Jeff [mailto:Jeff.Baran@mail.house.gov]
Sent: Friday, March 18, 2011 4:56 PM
To: Powell, Amy
Cc: Dotson, Greg; Cassady, Alison
Subject: Follow-up

Hi Amy,

We had a very informative discussion with Brian Sheron earlier. Thanks for helping to set that up. He mentioned that, for the Peach Bottom license renewals, NRC ran several scenarios as part of a risk assessment to calculate the consequences of certain severe events. We're interested in reviewing the documentation regarding these scenarios. If the document(s) is/are on ADAMS and you can point me in the right direction, that'd be great. If it's not publicly available, we'd still be very interested in getting copies of the documents next week.

Feel free to call if you have any questions.

Thanks,

Jeff