Expanded NRC Questions and Answers related to the March 11, 2011 Japanese Earthquake and Tsunami (May 20, 2011)

Table of Contents

Fukushima Daiichi Earthquake

Q: *Did the Japanese underestimate the size of the maximum credible earthquake and tsunami that could affect the plants?* ***UPDATED***

A: 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. Although the NRC does not regularly have access to design information on foreign nuclear power plants, information regarding the maximum tsunami height that was expected at the sites is available at the following links:

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/

http://www.tepco.co.jp/en/press/corp-com/release/11040910-e.html

Q: *Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?*

A: 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.

Fukushima Daiichi Emergency Preparedness

Q: *A chart titled "NRC Dose Estimates" was posted on March 17, 2011, to the Yahoo Group "Know_Nukes," which plots total dose (Rem) vs. distance (miles) for a one reactor site and a four reactor site. Was this document released by the NRC?*

A: No, this document was not released by the NRC. The chart appears to plot the dose information that was included as attachments to the NRC press release of March 16, 2011. This press release provided NRC protective action recommendations for U.S. citizens residing within 50 miles of the Fukushima reactors. The NRC press release had two attachments that gave the results of dose assessments performed for the Fukushima Daiichi facility.

Japanese Plants

Q: *What is the basis for the dose analyses attached to the March 16, 2011, NRC press release?*

A: The basis for the dose assessment was the limited and unverifiable information on the plant conditions at the Fukushima facility. The facility was modeled in a computer-based dose assessment code as a hypothetical, four reactor site. The dose assessment results are conservative predictions only and may not be representative of any actual radiation releases. The computer-based dose assessment model also utilized predicted meteorological conditions following the events at the Fukushima facility and, therefore, may not be representative of the actual meteorological conditions that occurred for this area. The NRC press release of March 16, 2011, and the predicted dose estimates are available on the NRC's public website and may be accessed at the following link:

http://www.nrc.gov/reading-rm/doc-collections/news/2011/11-050.pdf.

The assumptions on plant conditions used as the basis for the analyses were indicative of the uncertain and unstable nature of the conditions on Fukushima Daiichi site at the time the analyses were done, and accounted for uncertainty in the future progression of events. Since that time, actions to mitigate the events at facility and to stabilize the reactors and spent fuel at the plant have continued. Therefore, the assumptions used in for the dose assessment may continue to overestimate the actual radiation releases. The NRC continues to support the protective action recommendations provided in the March 16, 2011, press release because conditions at the plant continue to change. The NRC continues to monitor the situation at the Fukushima facility and may reassess its protective action recommendations as additional detailed and verifiable information about actual conditions becomes available.

Q: *How did the NRC develop its computer-based projections that supported the evacuation decision?*

A: The NRC uses the RASCAL computer code to perform offsite radiation dose projections. The RASCAL computer program contains information about U.S. nuclear reactor design types, radiation release pathways from the nuclear power plant to the environment, radionuclide source terms and meteorology. However, RASCAL is not capable of evaluating concurrent and multiple nuclear plant failures. So, to approximate the events unfolding at the Fukushima Daiichi facility, the NRC developed a model that aggregated information from the three operating reactors and the spent fuel pool. This aggregate model was then evaluated using the RASCAL computer code. The radiation doses calculated by the RASCAL code were predicted to exceed the protective action guidelines (PAGs) established by the U.S. Environmental Protection Agency (EPA) well beyond the 10-mile exposure pathway EPZ and beyond the 30 kilometer sheltering zone recommended by the Japanese authorities. Subsequent aerial monitoring by the U.S. Department of Energy (DOE) fixed-wing aircraft monitoring showed elevated radiation dose rates that were in excess of the EPA relocation PAGs to a distance beyond 25 miles from the facility.

Japanese Plants

Q: *Why did the NRC decide to recommend evacuation out to 50 miles from the Fukushima Daiichi facility for U.S. citizens in Japan?*

A: The decision to expand evacuation of U.S. citizens out to 50 miles from the Fukushima Daiichi facility was a conservative decision that was made out of consideration of several factors including an abundance of caution resulting from limited and unverifiable information concerning event progression at several units at the Fukushima Daiichi facility. The NRC based its assessment on information available at the time regarding the condition of the units conditions at Fukushima Daiichi that included significant damage to Units 1, 2, and 3 that appeared to been a result of hydrogen explosions. Prior to the earthquake and tsunami, Unit 4 was in a refueling outage and its entire core had been transferred to the spent fuel pool only 3 months earlier so the fuel was quite fresh. Radiation monitors showed significantly elevated readings in some areas of the plant site which would challenge plant crews attempting to stabilize the plant. Based on analysis results, there were indications from some offsite contamination sampling smears that fuel damage had occurred. There was a level of uncertainty about whether or not efforts to stabilize the plant in the very near term were going to be successful. Changing meteorological conditions resulted in the winds shifting rapidly from blowing out to sea to blowing back onto land.

Fukushima Daiichi Event Progression

Q: *Could an accident sequence like the one at Japan's Fukushima Daiichi nuclear plants happen in the US?*

A: 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.

Q: *As time goes on, does the chance for a meltdown increase?*

A: Not necessarily. Each passing hour the fuel rods will become cooler. If adequate cooling can be established and maintained, the risk of a meltdown will be mitigated.

Japanese Plants

Q: *If Chernobyl was a 7 and Three Mile Island was a 5, when does this event move from the 4 level?* ***UPDATED***

A: The International Atomic Energy Agency (IAEA) rates nuclear events in accordance with its International Nuclear and Radiological Event Scale (INES). IAEA initially assigned the events in Japan an INES rating of 4, "Accident with Local Consequences." This rating is subject to change as events unfold and additional information becomes available. INES classifies nuclear accidents based on the radiological effects on people and the environment and the status of barriers to the release of radiation. IAEA determinations regarding the INES rating of events are made independently.

Three Mile Island was assigned an INES rating of 5, "Accident with Wider Consequences," due to the severed damage to the reactor core.

On April 12, 2011, the Japanese Nuclear and Industrial Safety Agency (NISA) government raised the rating for the events at the Fukushima Daiichi site on the International Nuclear and Radiological Event Scale (INES) from 5, "Accident with Wider Consequences," to 7, "Major Accident," citing calculations by both NISA and the Nuclear Safety Commission of Japan (NSC) of radioactive materials released from the Fukushima Daiichi reactors. This new provisional rating considers the accidents that occurred at Units 1, 2, and 3 as a single event on INES. NISA notes that while an INES rating of 7 is the same as that of the Chernobyl accident, their current estimated amount of radioactive materials released is approximately 10% of the amount from the Chernobyl accident.

Q: *Compare this incident to the Three Mile Island. What are the similarities?*

A: The events at Three Mile Island in 1979 were the result of an equipment malfunction that resulted in the loss of cooling water to the reactor fuel. Subsequent operator actions compounded the malfunction ultimately resulting in the partial core meltdown. While details are still developing, the events in Japan appear to be the result of an earthquake and subsequent tsunami that knocked out electrical power to emergency safety systems designed to cool the reactor fuel. In both events the final safety barrier, the containment building, contained the majority of the radioactivity preventing its release to the environment.

Q: *What's going to happen following the hydrogen explosions everyone's seen from the video footage?*

A: The NRC is aware of the Japanese efforts to stabilize conditions at the affected reactors, and those actions are in line with what would be done in the United States. The NRC continues to monitor information on the status of the reactor core, the reactor vessel and the containment structure – all three areas are important to controlling the situation and protecting the public.

Q: *What is the sequence of events at the Japanese reactors?*

A: It is too early to determine the sequence of events and the impacts that may have been realized from the earthquake as compared to the tsunami. Likewise, it is too early to assess the implications of nuclear plant system response or human actions. The NRC has sent staff to assist and advise officials in Japan regarding the response and mitigation of the current reactor and spent fuel pool events. The NRC is working through the U.S. ambassador to Japan regarding these activities. Since the beginning of the event, the NRC has continuously manned its Headquarters Operations Center in Rockville, MD, in order to gather and examine all available information as part of the effort to analyze the event and understand its implications both for Japan and the United States.

Q: *What else can go wrong?*

A: The NRC is continuously monitoring the developments at the nuclear power plants in Japan. Circumstances are constantly evolving and it would be inappropriate to speculate on how this situation might develop over the coming days.

Japanese Plants

Q: *What is the worst-case scenario?*

A: In a nuclear emergency, the most important action is to ensure the core is covered with water to provide cooling to remove any heat from the fuel rods. Without adequate cooling, the fuel rods will melt. Should the final containment structure fail, radiation from these melting fuel rods would be released to the atmosphere and additional protective measures may be necessary depending on factors such as prevailing wind patterns.

Fukushima Daiichi Hydrogen Explosion

Q: *What's going to happen following the hydrogen explosions everyone's seen from the video footage?*

A: The NRC is aware of the Japanese efforts to stabilize conditions at the affected reactors, and those actions are in line with what would be done in the United States. The NRC continues to monitor information on the status of the reactor core, the reactor vessel and the containment structure – all three areas are important to controlling the situation and protecting the public.

Q: *Could explosions like those that occurred in Japan happen at a U.S facility?*

A: The NRC is aware of the Japanese efforts to stabilize the plants. It may be some time before the cause and full extent of the explosions at the facilities in Japan can be determined. It is suspected that hydrogen buildup may have caused explosions in the secondary containment buildings located around the primary containment structures that house the reactor vessels and spent fuel pools. U.S. facilities of similar design have venting capabilities that would allow operators to release hydrogen or other combustible gases to prevent a concentrated buildup that could exceed the flammability limit.

Fukushima Daiichi Lessons Learned

Q: *Have events in Japan changed our perception of earthquake risk to the nuclear plants in the US?*

A: 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.

Q: *Have any lessons for US nuclear plants been identified?*

A: 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.

Q: *How will the U.S. learn from the failures at the Japanese reactors?*

A: The NRC staff will analyze the events in Japan and develop lessons learned and recommendations to improve plant safety, as appropriate. The review may involve other Federal departments and agencies. Lessons learned will be used to develop longer-term agency actions. The NRC has already issued an information notice to inform licensees about the effects of the earthquake on nuclear power plants in Japan. The NRC is considering enhanced inspection activities targeted at facility response to beyond design-basis events. The staff will also assess whether any additional licensing actions are necessary. Actions may also include Orders, information requests in accordance with Section 50.54(f) of Title 10 (10 CFR) of the Code of Federal Regulations, license amendments, rulemaking, etc.

Fukushima Daiichi Radiation

Q: *A chart titled "NRC Dose Estimates" was posted on March 17, 2011, to the Yahoo Group "Know_Nukes," which plots total dose (Rem) vs. distance (miles) for a one reactor site and a four reactor site. Was this document released by the NRC?*

A: No, this document was not released by the NRC. The chart appears to plot the dose information that was included as attachments to the NRC press release of March 16, 2011. This press release provided NRC protective action recommendations for U.S. citizens residing within 50 miles of the Fukushima reactors. The NRC press release had two attachments that gave the results of dose assessments performed for the Fukushima Daiichi facility.

Q: *Is the U.S. government tracking the radiation released from the Japanese plants?*

A: Yes, a number of U.S. agencies are involved in monitoring and assessing radiation including EPA, DOE, and NRC. The best source of additional information is the Environmental Protection Agency.

Q: *Is there a danger of radiation making it to the United States?*

A: In response to nuclear emergencies, the NRC works with other U.S. agencies to monitor radioactive releases and predict their path. The NRC continues to monitor information regarding wind patterns near the Japanese nuclear power plants. Nevertheless, given the thousands of miles between the two countries, Hawaii, Alaska, the U.S. Territories and the U.S. West Coast are not expected to experience any harmful levels of radioactivity.

Q: *What is the magnitude of the radiation release from the Japanese facility at Fukushima?* ***UPDATED***

A: It is too early to determine the magnitude of the release in Japan. The NRC has sent staff to assist and advise officials in Japan regarding the response and mitigation of the current reactor and spent fuel pool events. The NRC is working through the U.S. ambassador to Japan regarding these activities. The U.S. Department of Energy (DOE) is providing aerial monitoring in Japan. DOE is also developing dose predictions for areas outside the 50-mile radius in Japan and can also support measurement of radiation that reaches the U.S. and its territories.

If an event occurred at a nuclear plant in the U.S., the NRC would model radiation releases using a sophisticated computer modeling called RASCAL (Radiological Assessment System for Consequence Analysis). Individual states are responsible for deciding when their citizens might need to evacuate or take shelter in response to such an event. There are two Emergency Planning Zones (EPZs) around each nuclear plant; a 10-mile EPZ for plume exposure and a 50-mile EPZ for food exposure. The 10-mile EPZ is the area established as a basis for planning because, at that distance, the projected doses from most accidents would not exceed the Environmental Protective Agency's protective action dose guidelines (1-5 rem). However, the 10-mile EPZ was always considered a basis for emergency planning that could be expanded if the situation warranted. The situation in Japan, with three reactors and two fuel pools experiencing exceptional difficulties simultaneously, along with uncertainty regarding conditions at the plant, led to the decision to recommend evacuation of U.S. citizens out to 50 miles from Fukushima.

Q: *The radiation "plume" seems to be going out to sea -- what is the danger of it reaching Alaska? Hawaii? The west coast?*

A: In response to nuclear emergencies, the NRC works with other U.S. agencies to monitor radioactive releases and predict their path. The NRC continues to monitor information regarding wind patterns near the Japanese nuclear power plants. Nevertheless, given the thousands of miles between the two countries, Hawaii, Alaska, the U.S. Territories and the U.S. West Coast are not expected to experience any harmful levels of radioactivity.

Japanese Plants

Q: *I live in the Western United States – should I be taking potassium iodide (KI)?*

A: At this time, the NRC does not believe that protective measures are necessary in the United States. We do not expect any U.S. states or territories to experience harmful levels of radioactivity. In the unlikely event that circumstances change, U.S. residents should listen to the protective action decisions of their states and counties. These protective action decisions could include actions such as sheltering, evacuation, or taking potassium iodide. The NRC will provide technical assistance to the states should they request it.

Q: *Has the government set up radiation monitoring stations to track the release?*

A: The NRC understands that EPA is utilizing its existing nationwide radiation monitoring system, RadNet, to monitor continuously the nation's air and regularly monitors drinking water, milk and precipitation for environmental radiation. EPA has publicly stated its agreement with the NRC's assessment that we do not expect to see radiation at harmful levels reaching the U.S. from damaged Japanese nuclear power plants. Nevertheless, EPA has stated that it plans to work with its federal partners to deploy additional monitoring capabilities to parts of the western U.S. and U.S. territories.

Q: *Are there other protective measures I should be taking?*

A: At this time, the NRC does not believe that protective measures are necessary in the United States. We do not expect any U.S. states or territories to experience harmful levels of radioactivity. In the unlikely event that circumstances change, U.S. residents should listen to the protective action decisions of their states and counties. These protective action decisions could include actions such as sheltering, evacuation, or taking potassium iodide. The NRC will provide technical assistance to the states should they request it. United States citizens in Japan are encouraged to follow the protective measures recommended by the Japanese government. These measures appear to be consistent with steps the United States would take.

Q: *What should be done to protect people in Alaska, Hawaii and the West Coast from radioactive fallout?*

A: The NRC continues to believe that the type and design of the Japanese reactors, combined with how events have unfolded, will prevent radiation at harmful levels from reaching U.S. territory.

Japanese Plants

Q: *What is the basis for the dose analyses attached to the March 16, 2011, NRC press release?*

A: The basis for the dose assessment was the limited and unverifiable information on the plant conditions at the Fukushima facility. The facility was modeled in a computer-based dose assessment code as a hypothetical, four reactor site. The dose assessment results are conservative predictions only and may not be representative of any actual radiation releases. The computer-based dose assessment model also utilized predicted meteorological conditions following the events at the Fukushima facility and, therefore, may not be representative of the actual meteorological conditions that occurred for this area. The NRC press release of March 16, 2011, and the predicted dose estimates are available on the NRC's public website and may be accessed at the following link:

http://www.nrc.gov/reading-rm/doc-collections/news/2011/11-050.pdf.

The assumptions on plant conditions used as the basis for the analyses were indicative of the uncertain and unstable nature of the conditions on Fukushima Daiichi site at the time the analyses were done, and accounted for uncertainty in the future progression of events. Since that time, actions to mitigate the events at facility and to stabilize the reactors and spent fuel at the plant have continued. Therefore, the assumptions used in for the dose assessment may continue to overestimate the actual radiation releases. The NRC continues to support the protective action recommendations provided in the March 16, 2011, press release because conditions at the plant continue to change. The NRC continues to monitor the situation at the Fukushima facility and may reassess its protective action recommendations as additional detailed and verifiable information about actual conditions becomes available.

Q: *What is the official agency to report radiation numbers and what is the public contact?*

A: NRC regulations require nuclear power plants to report any radiation doses detected at the plant that could be harmful to the public. This would include doses that are generated by the plant or by an external source. During an event in the U.S., it is the state's responsibility to provide protective action decisions for public health and safety. For this incident, the Japanese are responsible for reporting the public dose; nevertheless, should radiation doses be detected within the U.S., it would still be the state's responsibility to provide protective action decisions for public health and safety.

Q: *What are the short-term and long-term effects of exposure to radiation?*

A: The NRC does not expect that residents of the United States or its territories are at any risk of exposure to harmful levels of radiation resulting from the events in Japan.

On a daily basis, people are exposed to naturally occurring sources of radiation, such as from the sun or medical X-rays. The resulting effects are dependent on the strength and type of radiation as well as the duration of exposure.

Q: *My family has planned a vacation to Hawaii/Alaska/Seattle next week – is it safe to go, or should we cancel our plans?*

A: The NRC does not expect that residents of the United States or its territories are at any risk of exposure to harmful levels of radiation resulting from the events in Japan. Any changes to travel are a personal decision. The NRC is unaware of any travel restrictions within the United States or its territories.

Japanese Plants

Q: *What are the risks to my children?*

A: At this time, the NRC does not believe that protective measures are necessary in the United States. We do not expect any U.S. states or territories to experience harmful levels of radioactivity. In the unlikely event that circumstances change, U.S. residents should listen to the protective action decisions of their states and counties. These protective action decisions could include actions such as sheltering, evacuation, or taking potassium iodide. The NRC will provide technical assistance to the states should they request it. United States citizens in Japan are encouraged to follow the protective measures recommended by the Japanese government. These measures appear to be consistent with steps the United States would take.

Fukushima Daiichi Reactor Design

Q: *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?*

A: 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.

Japanese Plants

Q: *How many U.S. plants have designs similar to the affected Japanese reactors (and which ones)?* ***UPDATED***

A: Thirty-five of the 104 operating nuclear power plants in the U.S. are boiling water reactors (BWRs), as are the reactors at Fukushima. Twenty-three of the U.S. BWRs have the same Mark I containment as the Fukushima reactors.

Two of the U.S. BWRs with a Mark I containment have an early nuclear steam supply system (NSSS) design designated as BWR-2. Six of the U.S. BWRs with Mark I containments have another early design, designated BWR-3, which are similar to Fukushima Unit 1. The remaining fifteen of the Mark I BWRs have the BWR-4 NSSS, similar to Fukushima Units 2, 3, and 4. The following table lists the operating BWRs in the United States.

Plant Name	NSSS Type	Containment Design	Location
Browns Ferry 1	BWR-4	Mark I	AL
Browns Ferry 2	BWR-4	Mark I	AL
Browns Ferry 3	BWR-4	Mark I	AL
Brunswick 1	BWR-4	Mark I	NC
Brunswick 2	BWR-4	Mark I	NC
Clinton	BWR-6	Mark III	IL
Columbia Generating Station	BWR-5	Mark II	WA
Cooper	BWR-4	Mark I	NE
Dresden 2	BWR-3	Mark I	IL
Dresden 3	BWR-3	Mark I	IL
Duane Arnold	BWR-4	Mark I	IA
Fermi 2	BWR-4	Mark I	OH
FitzPatrick	BWR-4	Mark I	NY
Grand Gulf 1	BWR-6	Mark III	MS
Hatch 1	BWR-4	Mark I	GA
Hatch 2	BWR-4	Mark I	GA
Hope Creek 1*	BWR-4	Mark I	NJ
La Salle 1	BWR-5	Mark II	IL
La Salle 2	BWR-5	Mark II	IL
Limerick 1	BWR-4	Mark II	PA
Limerick 2	BWR-4	Mark II	PA
Monticello	BWR-3	Mark I	MN
Nine Mile Point 1	BWR-2	Mark I	NY
Nine Mile Point 2	BWR-5	Mark II	NY
Oyster Creek	BWR-2	Mark I	NJ
Peach Bottom 2	BWR-4	Mark I	PA
Peach Bottom 3	BWR-4	Mark I	PA
Perry 1	BWR-6	Mark III	OH
Pilgrim 1	BWR-3	Mark I	MA
Quad Cities 1	BWR-3	Mark I	IL
Quad Cities 2	BWR-3	Mark I	IL
River Bend 1	BWR-6	Mark III	LA
Susquehanna 1	BWR-4	Mark II	PA
Susquehanna 2	BWR-4	Mark II	PA
Vermont Yankee	BWR-4	Mark I	VT

*has concrete secondary containment unlike other BWRs of this type

Japanese Plants

Q: *How do the Japanese reactor designs compare to the US reactor designs of similar vintage?*

A: The NRC is not aware of all of the differences that may exist between the Japanese reactors that are of similar design and vintage as those operated in the U.S. Many improvements have been made to U.S boiling water reactors (BWRs). For example, NRC Generic Letter 89-16, "Installation of a Hardened Wetwell Vent," conveyed the importance of having a robust pathway for venting primary containment, which contains the suppression pool, in certain severe accident scenarios. In response, all BWRs with Mark I containments that didn't have an existing strengthened or "hardened" pathway for venting directly from primary containment to the outside, made modifications to the plant consistent with the intent of the Generic Letter. This design feature permits a controlled depressurization of primary containment as well as a controlled release of radioactive materials and combustible hydrogen generated by damaged fuel, as may occur during severe accidents. Additional enhancements include:

- Emergency diesel generator (EDG) fuel oil tanks required by NRC regulations are sheltered in safety-related structures or underground in order to withstand an earthquake as well as flooding events. These tanks provide a reliable fuel supply to safety related AC and DC power systems for several days.

- The regulations in 10 CFR 50.63 require all U.S. nuclear power plants to cope with a loss of all AC power (i.e., station blackout) in the event of a loss of station on-site and normal off-site power sources. In addition, nuclear plants are required to have alternate AC sources from separate grid systems separate from the normal off-site power supply.

- A portable emergency diesel-driven water pump for emergency fuel pool cooling is available at all US nuclear sites.

- Emergency operating procedures as well as severe accident management guidelines ensure that the containment structure integrity takes priority in an accident situation. Therefore, in a beyond-design-basis event, such as the one at Fukushima Dai'ichi, U.S. BWR operators are trained to reduce the buildup of explosive concentrations of hydrogen and to preserve primary and secondary containment by venting.

- In parallel with the above, a U.S. facility's emergency operating procedures would prioritize the restoration of offsite power in order to restore vital power needs following a severe event.

Fukushima Daiichi Recovery Efforts

Q: *What is the longer term prognosis for keeping the reactors cooled at the Japanese facilities?*

A: It is difficult to tell the long-term prognosis for the Japanese plants until the full extent of the damage is known. The NRC is coordinating with the Japanese government, private industry, other Federal Agencies, and the military to mitigate the cooling challenges and bring the events to a stable state of operation.

Q: *What should the American public know about the incident in Japan?*

A: The events unfolding in Japan are the result of a catastrophic series of natural disasters. These include the fifth largest earthquake in recorded history and the resulting devastating tsunami. Despite these unique circumstances, the Japanese appear to have taken reasonable actions to mitigate the event and protect the surrounding population. Since the beginning of the event, the NRC has continuously manned its Operations Center in Rockville, MD in order to gather and examine all available information as part of the effort to analyze the event and understand its implications both for Japan and the United States.

Japanese Plants

Q: *What happens next in Japan? How long will it take to assess the damage to the reactors?*

A: The current focus is ensuring that adequate cooling of the reactor fuel at each of the affected Japanese reactors is established and maintained. In the days, weeks, and months that follow, there will be adequate time to assess the damage and determine next steps.

Q: *Why did the seawater fail to cool the reactor?*

A: Based on information available to the NRC, it appears that the seawater has been effective at providing some cooling for the reactor. While it appears that some fuel damage has occurred, there will be plenty of time once this crisis is resolved to determine the effectiveness of the measures taken in response to this event.

Fukushima Daiichi Tsunami

Q: *Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?*

A: 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.

Q: *Did the Japanese underestimate the size of the maximum credible earthquake and tsunami that could affect the plants?* ***UPDATED***

A: 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. Although the NRC does not regularly have access to design information on foreign nuclear power plants, information regarding the maximum tsunami height that was expected at the sites is available at the following links:

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/

http://www.tepco.co.jp/en/press/corp-com/release/11040910-e.html

Q: *How high was the tsunami at the Fukushima nuclear plants?* ***UPDATED***

A: 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. The NRC does not normally have access to operating data for foreign nuclear power plants, however, information regarding the tsunami height may be accessed at the following links:

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/

http://www.tepco.co.jp/en/press/corp-com/release/11040910-e.html

Fukushima Daiichi U.S. Assistance

Q: *What is the NRC doing in response to the situation in Japan?*

A: The NRC has taken a number of actions:

1. Since the beginning of the event, the NRC has continuously manned its Operations Center in Rockville, MD in order to gather and examine all available information as part of the effort to analyze the event and understand its implications both for Japan and the United States.

2. A team of 11 officials from the NRC with expertise in boiling water nuclear reactors have deployed to Japan as part of a U.S. International Agency for International Development (USAID) team.

3. The NRC has spoken with its counterpart agency in Japan, offering the assistance of U.S. technical experts.

4. The NRC is coordinating its actions with other Federal agencies as part of the U.S. government response.

Q: *What other U.S. agencies are involved, and what are they doing?*

A: The entire federal family is responding to this event. The NRC is closely coordinating its efforts with the White House, DOE, DOD, USAID, and others. The U.S. government is providing whatever support requested by the Japanese government.

Q: *What is the NRC doing to ensure this (Japan event) doesn't happen at US plants?*

A: The NRC has sent staff to assist and advise officials in Japan regarding the response and mitigation of the current reactor and spent fuel pool events. The NRC is working through the U.S. ambassador to Japan regarding these activities. Since the beginning of the event, the NRC has continuously manned its Headquarters Operations Center in Rockville, MD, in order to gather and examine all available information as part of the effort to analyze the event and understand its implications both for Japan and the United States.

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

A: We are closely following events in Japan, working with other agencies of the federal government, and have been in direct contact with our counterparts in that country. We have sent a total of 11 staff to Tokyo in response to the Japanese government's request for assistance. Two of those NRC staff members, knowledgeable about boiling water reactors, are already in Japan participating in the USAID team.

Q: *A chart titled "NRC Dose Estimates" was posted on March 17, 2011, to the Yahoo Group "Know_Nukes," which plots total dose (Rem) vs. distance (miles) for a one reactor site and a four reactor site. Was this document released by the NRC?*

A: No, this document was not released by the NRC. The chart appears to plot the dose information that was included as attachments to the NRC press release of March 16, 2011. This press release provided NRC protective action recommendations for U.S. citizens residing within 50 miles of the Fukushima reactors. The NRC press release had two attachments that gave the results of dose assessments performed for the Fukushima Daiichi facility.

Q: *Did the NRC consult the Department of Energy (DOE) or the Nuclear Energy Institute (NEI) for assistance in developing the protective action recommendation?*

A: Although the DOE assisted in providing radiation dose rate information to support the analysis performed by the NRC, the protective action recommendation was made by the NRC.

Japanese Plants

Q: *How did the NRC develop its computer-based projections that supported the evacuation decision?*

A: The NRC uses the RASCAL computer code to perform offsite radiation dose projections. The RASCAL computer program contains information about U.S. nuclear reactor design types, radiation release pathways from the nuclear power plant to the environment, radionuclide source terms and meteorology. However, RASCAL is not capable of evaluating concurrent and multiple nuclear plant failures. So, to approximate the events unfolding at the Fukushima Daiichi facility, the NRC developed a model that aggregated information from the three operating reactors and the spent fuel pool. This aggregate model was then evaluated using the RASCAL computer code. The radiation doses calculated by the RASCAL code were predicted to exceed the protective action guidelines (PAGs) established by the U.S. Environmental Protection Agency (EPA) well beyond the 10-mile exposure pathway EPZ and beyond the 30 kilometer sheltering zone recommended by the Japanese authorities. Subsequent aerial monitoring by the U.S. Department of Energy (DOE) fixed-wing aircraft monitoring showed elevated radiation dose rates that were in excess of the EPA relocation PAGs to a distance beyond 25 miles from the facility.

Q: *Why did the NRC decide to recommend evacuation out to 50 miles from the Fukushima Daiichi facility for U.S. citizens in Japan?*

A: The decision to expand evacuation of U.S. citizens out to 50 miles from the Fukushima Daiichi facility was a conservative decision that was made out of consideration of several factors including an abundance of caution resulting from limited and unverifiable information concerning event progression at several units at the Fukushima Daiichi facility. The NRC based its assessment on information available at the time regarding the condition of the units conditions at Fukushima Daiichi that included significant damage to Units 1, 2, and 3 that appeared to been a result of hydrogen explosions. Prior to the earthquake and tsunami, Unit 4 was in a refueling outage and its entire core had been transferred to the spent fuel pool only 3 months earlier so the fuel was quite fresh. Radiation monitors showed significantly elevated readings in some areas of the plant site which would challenge plant crews attempting to stabilize the plant. Based on analysis results, there were indications from some offsite contamination sampling smears that fuel damage had occurred. There was a level of uncertainty about whether or not efforts to stabilize the plant in the very near term were going to be successful. Changing meteorological conditions resulted in the winds shifting rapidly from blowing out to sea to blowing back onto land.

Q: *What resources are the Japanese asking for?*

A: The Japanese have formally requested equipment needed to cool the reactor fuel. This includes such things as pumps, fire hoses, portable generators, and diesel fuel. The NRC is coordinating with General Electric, which has plant design specifications, to ensure any equipment provided will be capable of meeting the needs of the Japanese.

Q: *The United States has troops in Japan and has sent ships to help the relief effort – are they in danger from the radiation?*

A: The NRC is not the appropriate federal agency to answer this question. DOD is better suited to provide information regarding its personnel.

Japanese Plants

Q: *What is the basis for the dose analyses attached to the March 16, 2011, NRC press release?*

A: The basis for the dose assessment was the limited and unverifiable information on the plant conditions at the Fukushima facility. The facility was modeled in a computer-based dose assessment code as a hypothetical, four reactor site. The dose assessment results are conservative predictions only and may not be representative of any actual radiation releases. The computer-based dose assessment model also utilized predicted meteorological conditions following the events at the Fukushima facility and, therefore, may not be representative of the actual meteorological conditions that occurred for this area. The NRC press release of March 16, 2011, and the predicted dose estimates are available on the NRC's public website and may be accessed at the following link:

http://www.nrc.gov/reading-rm/doc-collections/news/2011/11-050.pdf.

The assumptions on plant conditions used as the basis for the analyses were indicative of the uncertain and unstable nature of the conditions on Fukushima Daiichi site at the time the analyses were done, and accounted for uncertainty in the future progression of events. Since that time, actions to mitigate the events at facility and to stabilize the reactors and spent fuel at the plant have continued. Therefore, the assumptions used in for the dose assessment may continue to overestimate the actual radiation releases. The NRC continues to support the protective action recommendations provided in the March 16, 2011, press release because conditions at the plant continue to change. The NRC continues to monitor the situation at the Fukushima facility and may reassess its protective action recommendations as additional detailed and verifiable information about actual conditions becomes available.

Fukushima Daini Earthquake

Q: *Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?*

A: 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.

Q: *Did the Japanese underestimate the size of the maximum credible earthquake and tsunami that could affect the plants?* ***UPDATED***

A: 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. Although the NRC does not regularly have access to design information on foreign nuclear power plants, information regarding the maximum tsunami height that was expected at the sites is available at the following links:

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/

http://www.tepco.co.jp/en/press/corp-com/release/11040910-e.html

Japanese Plants

Fukushima Daini Lessons Learned

Q: *Have events in Japan changed our perception of earthquake risk to the nuclear plants in the US?*

A: 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.

Q: *Have any lessons for US nuclear plants been identified?*

A: 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.

Fukushima Daini Reactor Design

Q: *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?*

A: 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.

Fukushima Daini Tsunami

Q: *Did the Japanese underestimate the size of the maximum credible earthquake and tsunami that could affect the plants?* ***UPDATED***

A: 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. Although the NRC does not regularly have access to design information on foreign nuclear power plants, information regarding the maximum tsunami height that was expected at the sites is available at the following links:

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/

http://www.tepco.co.jp/en/press/corp-com/release/11040910-e.html

Japanese Plants

Q: *How high was the tsunami at the Fukushima nuclear plants?* ***UPDATED***

A: 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. The NRC does not normally have access to operating data for foreign nuclear power plants, however, information regarding the tsunami height may be accessed at the following links:

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/

http://www.tepco.co.jp/en/press/corp-com/release/11040910-e.html

Q: *Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?*

A: 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.

Plant-specific

Chernobyl

Q: *If Chernobyl was a 7 and Three Mile Island was a 5, when does this event move from the 4 level?* ***UPDATED***

A: The International Atomic Energy Agency (IAEA) rates nuclear events in accordance with its International Nuclear and Radiological Event Scale (INES). IAEA initially assigned the events in Japan an INES rating of 4, "Accident with Local Consequences." This rating is subject to change as events unfold and additional information becomes available. INES classifies nuclear accidents based on the radiological effects on people and the environment and the status of barriers to the release of radiation. IAEA determinations regarding the INES rating of events are made independently.

Three Mile Island was assigned an INES rating of 5, "Accident with Wider Consequences," due to the severed damage to the reactor core.

On April 12, 2011, the Japanese Nuclear and Industrial Safety Agency (NISA) government raised the rating for the events at the Fukushima Daiichi site on the International Nuclear and Radiological Event Scale (INES) from 5, "Accident with Wider Consequences," to 7, "Major Accident," citing calculations by both NISA and the Nuclear Safety Commission of Japan (NSC) of radioactive materials released from the Fukushima Daiichi reactors. This new provisional rating considers the accidents that occurred at Units 1, 2, and 3 as a single event on INES. NISA notes that while an INES rating of 7 is the same as that of the Chernobyl accident, their current estimated amount of radioactive materials released is approximately 10% of the amount from the Chernobyl accident.

Q: *Is the event in Japan worse than TMI and Chernobyl?* ***UPDATED***

A: Initially, the events in Japan were classified as Level 3, "Serious Incidents," and were reclassified as Level 5, "Accidents with Wider Consequences," on the International Nuclear Events Scale (INES). In comparison, TMI was a Level 5 event and Chernobyl was a Level 7 event.

On April 12, 2011, the Japanese Nuclear and Industrial Safety Agency (NISA) government raised the rating for the events at the Fukushima Daiichi site on the International Nuclear and Radiological Event Scale (INES) from 5, "Accident with Wider Consequences," to 7, "Major Accident," citing calculations by both NISA and the Nuclear Safety Commission of Japan (NSC) of radioactive materials released from the Fukushima Daiichi reactors. This new provisional rating considers the accidents that occurred at Units 1, 2, and 3 as a single event on INES. NISA notes that while an INES rating of 7 is the same as that of the Chernobyl accident, their current estimated amount of radioactive materials released is approximately 10% of the amount from the Chernobyl accident.

Diablo Canyon

Q: *Why should the NRC not require the more sophisticated (3D) seismic studies being voluntarily conducted by licensees in California?* ***NEW!***

A: Current NRC and American Nuclear Society (ANS) documentation provides guidance related to site investigations undertaken for the purpose of characterizing seismic sources and dynamic site properties. A variety of geophysical and geotechnical tools are available that can be used to investigate the earth from both a site-specific and a regional level. Each of these methods provides specific information by probing the earth in a different way. While some tools are universally useful, others are better suited to certain types of sub-surface materials and tectonic situations. While 3D seismic studies, such as those being performed in California, are sophisticated, they are not useful for all situations and the very large expense of the study could preclude broader application of techniques better suited to a specific site. The NRC would suggest the use of 3D seismic studies only in cases where it could be useful. The NRC attempts to provide regulations that call for techniques that would be the most suitable given the specific conditions of a plant and requested licensing actions.

Plant-specific

<u>Indian Point</u>

Q: *Why is Indian Point safe if there is a fault line underneath it?*

A: 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. U.S. 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 geologic record near the site.

<u>Pilgrim</u>

Q: *If the same tragedy hit Pilgrim Station, Seabrook Station and Vermont Yankee would we be having the same major issues that the Japanese plants have? Please explain yes or no.*

A: As noted in Question 1 above, the circumstances related to the events in Japan are highly unlikely in that the plant-specific external hazards profile is substantially different. All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. Even those plants that are located in 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 very rare and extreme seismic and tsunami events. Pilgrim, Seabrook, and Vermont Yankee stations are designed to withstand the maximum credible natural events predicted for their specific sites. In addition to the design of the plants, significant effort goes into emergency response planning, preparation, and training. The NRC has also completed substantial research and analysis that resulted in the development and use of severe accident management guidelines. These insights have informed our decision making and review of licensed activities.

Q: *For Pilgrim Station and Seabrook Station, what design and safety precautions have been installed at your plant to sustain a devastating tsunami that would hit as did the tragedy at the Japanese plants?*

A: All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. Even those plants that are located in 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 very rare and extreme seismic and tsunami events. The Pilgrim and Seabrook Stations are designed to withstand the maximum credible natural events predicted for their specific sites. In addition to the design of the plants, significant effort goes into emergency response planning, preparation, and training. The NRC has also completed substantial research and analysis that resulted in the development and use of severe accident management guidelines. These insights have informed our decision making and review of licensed activities.

Plant-specific

Q: *What is the seismic limit that Pilgrim Station, Seabrook Station and Vermont Yankee have been built to withstand?*

A: Each 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. Ground shaking is a function of both the magnitude of the earthquake and the distance from the fault plane to the site. The seismic responses of the structures, systems, and components associated with these facilities are dependent on several factors, as mentioned above; therefore, the responses may be different for the same magnitude earthquake. As a result, the NRC regulatory requirements focus on seismic limits based on ground shaking rather than limits defined by earthquake magnitude.

The ground motions associated with seismic events are determined for two categories of earthquakes: the Safe Shutdown Earthquake (SSE) which is generally defined as the maximum ground motion seismic response that the plant must be able to withstand and safely shut down and be maintained in a safely shut down condition, and; the Operating Basis Earthquake (OBE) which is defined as the ground motion seismic response that the plant must be able to withstand and to continue operating normally following such an event. The SSE and OBE reflect the horizontal acceleration of the ground in units of the earth's gravity, 'g'. The ground motions to which the Pilgrim, Seabrook, and Vermont Yankee plants are designed are: Pilgrim SSE of 0.150g and OBE of 0.080g; Seabrook SSE of 0.250g and OBE of 0.125g, and Vermont Yankee SSE of 0.140g and OBE of 0.070g.

Q: *Please explain that outcome at each plant (Pilgrim Station, Seabrook Station and Vermont Yankee) if it was hit with a 8.9 earthquake the same as what hit Japan?*

A: Each 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. Ground shaking is a function of both the magnitude of the earthquake and the distance from the fault plane to the site. The seismic hazards associated with the earthquake in Japan cannot be duplicated by the geology of New England, where the Pilgrim, Seabrook, and Vermont Yankee facilities are located, so this makes a postulated comparison of facility responses to the same seismic event even less likely.

<u>Seabrook</u>

Q: *What is the seismic limit that Pilgrim Station, Seabrook Station and Vermont Yankee have been built to withstand?*

A: Each 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. Ground shaking is a function of both the magnitude of the earthquake and the distance from the fault plane to the site. The seismic responses of the structures, systems, and components associated with these facilities are dependent on several factors, as mentioned above; therefore, the responses may be different for the same magnitude earthquake. As a result, the NRC regulatory requirements focus on seismic limits based on ground shaking rather than limits defined by earthquake magnitude.

The ground motions associated with seismic events are determined for two categories of earthquakes: the Safe Shutdown Earthquake (SSE) which is generally defined as the maximum ground motion seismic response that the plant must be able to withstand and safely shut down and be maintained in a safely shut down condition, and; the Operating Basis Earthquake (OBE) which is defined as the ground motion seismic response that the plant must be able to withstand and to continue operating normally following such an event. The SSE and OBE reflect the horizontal acceleration of the ground in units of the earth's gravity, 'g'. The ground motions to which the Pilgrim, Seabrook, and Vermont Yankee plants are designed are: Pilgrim SSE of 0.150g and OBE of 0.080g; Seabrook SSE of 0.250g and OBE of 0.125g, and Vermont Yankee SSE of 0.140g and OBE of 0.070g.

Plant-specific

Q: *Please explain that outcome at each plant (Pilgrim Station, Seabrook Station and Vermont Yankee) if it was hit with a 8.9 earthquake the same as what hit Japan?*

A: Each 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. Ground shaking is a function of both the magnitude of the earthquake and the distance from the fault plane to the site. The seismic hazards associated with the earthquake in Japan cannot be duplicated by the geology of New England, where the Pilgrim, Seabrook, and Vermont Yankee facilities are located, so this makes a postulated comparison of facility responses to the same seismic event even less likely.

Q: *If the same tragedy hit Pilgrim Station, Seabrook Station and Vermont Yankee would we be having the same major issues that the Japanese plants have? Please explain yes or no.*

A: As noted in Question 1 above, the circumstances related to the events in Japan are highly unlikely in that the plant-specific external hazards profile is substantially different. All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. Even those plants that are located in 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 very rare and extreme seismic and tsunami events. Pilgrim, Seabrook, and Vermont Yankee stations are designed to withstand the maximum credible natural events predicted for their specific sites. In addition to the design of the plants, significant effort goes into emergency response planning, preparation, and training. The NRC has also completed substantial research and analysis that resulted in the development and use of severe accident management guidelines. These insights have informed our decision making and review of licensed activities.

Q: *For Pilgrim Station and Seabrook Station, what design and safety precautions have been installed at your plant to sustain a devastating tsunami that would hit as did the tragedy at the Japanese plants?*

A: All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. Even those plants that are located in 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 very rare and extreme seismic and tsunami events. The Pilgrim and Seabrook Stations are designed to withstand the maximum credible natural events predicted for their specific sites. In addition to the design of the plants, significant effort goes into emergency response planning, preparation, and training. The NRC has also completed substantial research and analysis that resulted in the development and use of severe accident management guidelines. These insights have informed our decision making and review of licensed activities.

<u>Three Mile Island</u>

Q: *Compare this incident to the Three Mile Island. What are the similarities?*

A: The events at Three Mile Island in 1979 were the result of an equipment malfunction that resulted in the loss of cooling water to the reactor fuel. Subsequent operator actions compounded the malfunction ultimately resulting in the partial core meltdown. While details are still developing, the events in Japan appear to be the result of an earthquake and subsequent tsunami that knocked out electrical power to emergency safety systems designed to cool the reactor fuel. In both events the final safety barrier, the containment building, contained the majority of the radioactivity preventing its release to the environment.

Plant-specific

Q: *If Chernobyl was a 7 and Three Mile Island was a 5, when does this event move from the 4 level?* ***UPDATED***

A: The International Atomic Energy Agency (IAEA) rates nuclear events in accordance with its International Nuclear and Radiological Event Scale (INES). IAEA initially assigned the events in Japan an INES rating of 4, "Accident with Local Consequences." This rating is subject to change as events unfold and additional information becomes available. INES classifies nuclear accidents based on the radiological effects on people and the environment and the status of barriers to the release of radiation. IAEA determinations regarding the INES rating of events are made independently.

Three Mile Island was assigned an INES rating of 5, "Accident with Wider Consequences," due to the severed damage to the reactor core.

On April 12, 2011, the Japanese Nuclear and Industrial Safety Agency (NISA) government raised the rating for the events at the Fukushima Daiichi site on the International Nuclear and Radiological Event Scale (INES) from 5, "Accident with Wider Consequences," to 7, "Major Accident," citing calculations by both NISA and the Nuclear Safety Commission of Japan (NSC) of radioactive materials released from the Fukushima Daiichi reactors. This new provisional rating considers the accidents that occurred at Units 1, 2, and 3 as a single event on INES. NISA notes that while an INES rating of 7 is the same as that of the Chernobyl accident, their current estimated amount of radioactive materials released is approximately 10% of the amount from the Chernobyl accident.

Q: *Is the event in Japan worse than TMI and Chernobyl?* ***UPDATED***

A: Initially, the events in Japan were classified as Level 3, "Serious Incidents," and were reclassified as Level 5, "Accidents with Wider Consequences," on the International Nuclear Events Scale (INES). In comparison, TMI was a Level 5 event and Chernobyl was a Level 7 event.

On April 12, 2011, the Japanese Nuclear and Industrial Safety Agency (NISA) government raised the rating for the events at the Fukushima Daiichi site on the International Nuclear and Radiological Event Scale (INES) from 5, "Accident with Wider Consequences," to 7, "Major Accident," citing calculations by both NISA and the Nuclear Safety Commission of Japan (NSC) of radioactive materials released from the Fukushima Daiichi reactors. This new provisional rating considers the accidents that occurred at Units 1, 2, and 3 as a single event on INES. NISA notes that while an INES rating of 7 is the same as that of the Chernobyl accident, their current estimated amount of radioactive materials released is approximately 10% of the amount from the Chernobyl accident.

Plant-specific

U.S. BWR Mark I Plants

Q: *Some in the media and in Hill briefings are suggesting that Mark I containment is flawed. What are the concerns about this type of containment? Are the US plants with this safe?* ***UPDATED***

A: BWR Mark I containments have relatively small volumes in comparison with pressureized water reactor (PWR) containments. This makes the BWR Mark I containment relatively more susceptible to containment failure given a core meltdown severe enough to (1) fail the reactor vessel and also (2) severe enough so that the core melt reaches the containment boundary. On the positive side, BWRs have more ways of adding water to the core than PWRs to prevent core meltdown. The following improvements have been made to U.S. Mark I containment reactors:

Station Blackout (SBO) Rule: Required the ability to cope with SBO for specified time and recover the plant

Anticipated Transient Without Scram (ATWS) Rule: Required vendor specific improvements to enhance scram reliability

Hydrogen Control Rule: Required modifications to reduce impact of hydrogen generated from beyond design basis events (DBEs)

Equipment Qualification Rule: Required environmental qualification of electrical system equipment used for design basis accidents (DBAs)

Mark I Containment Improvement Program: (i) Added hardened vent system for containment cooling and fission product scrubbing for beyond DBAs, and (ii) Enhanced reliability of automatic depressurization system (ADS) and added an additional water injection capability independent of normal AC and emergency diesel power

Symptom-based Emergency Procedure Guides (EPGs): Provides emergency procedures that direct operator actions on the basis of critical safety parameter status rather than knowledge of the event initiator – applicable to any initiating event (DBA or beyond DBA)

Severe Accident Management Guidelines (SAMGs): Guidelines for minimizing radiological consequences of a damaged core event. Focuses on maintaining containment integrity, controlling releases, and emergency planning interface

Aircraft Impact Requirements: Requires procedures to use all available equipment for core cooling, containment protection, and spent fuel pool cooling assuming a significant damage to the facility from an airplane crash

Mark I Containment Hydrodynamic Load Issue Resolution: Resulted in structural strengthening of Mark I containments to better handle reactor system depressurization forces

Emergency Core Cooling System (ECCS) Pump Suction Strainer Improvements: Larger surface area strainers installed with higher debris loading tolerance to ensure ECCS pump operation

Hydrogen explosions have been a major aspect of the Fukushima accident. In the U.S., NRC Generic Letter 89-16, "Installation of a Hardened Wetwell Vent," conveyed the importance of having a robust pathway for venting primary containment, which contains the suppression pool, in certain severe accident scenarios. In response, all BWRs with Mark I containments that didn't have an existing strengthened or "hardened" pathway for venting directly from primary containment to the outside, made modifications to the plant consistent with the intent of the Generic Letter. This design feature permits a controlled depressurization of primary containment as well as a controlled release of radioactive materials and combustible hydrogen generated by damaged fuel, as may occur during severe accidents.

Plant-specific

U.S. Coastal Plants

Q: *How many reactors are along coastal areas that could be affected by a tsunami? Is plant X designed to withstand a tsunami (for each coastal plant)?*

A: All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. 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.

Q: *Are U.S. nuclear power plants designed to withstand tsunamis? What would the effect be on [plant X] if a subsequent tsunami hit?*

A: All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. 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.

Q: *Why should the NRC not require the more sophisticated (3D) seismic studies being voluntarily conducted by licensees in California?* ***NEW!***

A: Current NRC and American Nuclear Society (ANS) documentation provides guidance related to site investigations undertaken for the purpose of characterizing seismic sources and dynamic site properties. A variety of geophysical and geotechnical tools are available that can be used to investigate the earth from both a site-specific and a regional level. Each of these methods provides specific information by probing the earth in a different way. While some tools are universally useful, others are better suited to certain types of sub-surface materials and tectonic situations. While 3D seismic studies, such as those being performed in California, are sophisticated, they are not useful for all situations and the very large expense of the study could preclude broader application of techniques better suited to a specific site. The NRC would suggest the use of 3D seismic studies only in cases where it could be useful. The NRC attempts to provide regulations that call for techniques that would be the most suitable given the specific conditions of a plant and requested licensing actions.

Vermont Yankee

Q: *Please explain that outcome at each plant (Pilgrim Station, Seabrook Station and Vermont Yankee) if it was hit with a 8.9 earthquake the same as what hit Japan?*

A: Each 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. Ground shaking is a function of both the magnitude of the earthquake and the distance from the fault plane to the site. The seismic hazards associated with the earthquake in Japan cannot be duplicated by the geology of New England, where the Pilgrim, Seabrook, and Vermont Yankee facilities are located, so this makes a postulated comparison of facility responses to the same seismic event even less likely.

Plant-specific

Q: *If the same tragedy hit Pilgrim Station, Seabrook Station and Vermont Yankee would we be having the same major issues that the Japanese plants have? Please explain yes or no.*

A: As noted in Question 1 above, the circumstances related to the events in Japan are highly unlikely in that the plant-specific external hazards profile is substantially different. All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. Even those plants that are located in 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 very rare and extreme seismic and tsunami events. Pilgrim, Seabrook, and Vermont Yankee stations are designed to withstand the maximum credible natural events predicted for their specific sites. In addition to the design of the plants, significant effort goes into emergency response planning, preparation, and training. The NRC has also completed substantial research and analysis that resulted in the development and use of severe accident management guidelines. These insights have informed our decision making and review of licensed activities.

Q: *What is the seismic limit that Pilgrim Station, Seabrook Station and Vermont Yankee have been built to withstand?*

A: Each 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. Ground shaking is a function of both the magnitude of the earthquake and the distance from the fault plane to the site. The seismic responses of the structures, systems, and components associated with these facilities are dependent on several factors, as mentioned above; therefore, the responses may be different for the same magnitude earthquake. As a result, the NRC regulatory requirements focus on seismic limits based on ground shaking rather than limits defined by earthquake magnitude.

The ground motions associated with seismic events are determined for two categories of earthquakes: the Safe Shutdown Earthquake (SSE) which is generally defined as the maximum ground motion seismic response that the plant must be able to withstand and safely shut down and be maintained in a safely shut down condition, and; the Operating Basis Earthquake (OBE) which is defined as the ground motion seismic response that the plant must be able to withstand and to continue operating normally following such an event. The SSE and OBE reflect the horizontal acceleration of the ground in units of the earth's gravity, 'g'. The ground motions to which the Pilgrim, Seabrook, and Vermont Yankee plants are designed are: Pilgrim SSE of 0.150g and OBE of 0.080g; Seabrook SSE of 0.250g and OBE of 0.125g, and Vermont Yankee SSE of 0.140g and OBE of 0.070g.

BWR Mark I Design

Q: *How many U.S. plants have designs similar to the affected Japanese reactors (and which ones)?* ***UPDATED***

A: Thirty-five of the 104 operating nuclear power plants in the U.S. are boiling water reactors (BWRs), as are the reactors at Fukushima. Twenty-three of the U.S. BWRs have the same Mark I containment as the Fukushima reactors.

Two of the U.S. BWRs with a Mark I containment have an early nuclear steam supply system (NSSS) design designated as BWR-2. Six of the U.S. BWRs with Mark I containments have another early design, designated BWR-3, which are similar to Fukushima Unit 1. The remaining fifteen of the Mark I BWRs have the BWR-4 NSSS, similar to Fukushima Units 2, 3, and 4. The following table lists the operating BWRs in the United States.

Plant Name	NSSS Type	Containment Design	Location
Browns Ferry 1	BWR-4	Mark I	AL
Browns Ferry 2	BWR-4	Mark I	AL
Browns Ferry 3	BWR-4	Mark I	AL
Brunswick 1	BWR-4	Mark I	NC
Brunswick 2	BWR-4	Mark I	NC
Clinton	BWR-6	Mark III	IL
Columbia Generating Station	BWR-5	Mark II	WA
Cooper	BWR-4	Mark I	NE
Dresden 2	BWR-3	Mark I	IL
Dresden 3	BWR-3	Mark I	IL
Duane Arnold	BWR-4	Mark I	IA
Fermi 2	BWR-4	Mark I	OH
FitzPatrick	BWR-4	Mark I	NY
Grand Gulf 1	BWR-6	Mark III	MS
Hatch 1	BWR-4	Mark I	GA
Hatch 2	BWR-4	Mark I	GA
Hope Creek 1*	BWR-4	Mark I	NJ
La Salle 1	BWR-5	Mark II	IL
La Salle 2	BWR-5	Mark II	IL
Limerick 1	BWR-4	Mark II	PA
Limerick 2	BWR-4	Mark II	PA
Monticello	BWR-3	Mark I	MN
Nine Mile Point 1	BWR-2	Mark I	NY
Nine Mile Point 2	BWR-5	Mark II	NY
Oyster Creek	BWR-2	Mark I	NJ
Peach Bottom 2	BWR-4	Mark I	PA
Peach Bottom 3	BWR-4	Mark I	PA
Perry 1	BWR-6	Mark III	OH
Pilgrim 1	BWR-3	Mark I	MA
Quad Cities 1	BWR-3	Mark I	IL
Quad Cities 2	BWR-3	Mark I	IL
River Bend 1	BWR-6	Mark III	LA
Susquehanna 1	BWR-4	Mark II	PA
Susquehanna 2	BWR-4	Mark II	PA
Vermont Yankee	BWR-4	Mark I	VT

*has concrete secondary containment unlike other BWRs of this type

U.S. Plants

Q: *How are US BWRs similar and/or different from the plants experience problems in Japan?* ***UPDATED***

A: Thirty-five of the 104 operating nuclear power plants in the U.S. are boiling water reactors (BWRs), as are the reactors at Fukushima. Twenty-three of the U.S. BWRs have the same Mark I containment as the Fukushima reactors.

Two of the U.S. BWRs with a Mark I containment have an early nuclear steam supply system (NSSS) design designated as BWR-2. Six of the U.S. BWRs with Mark I containments have another early design, designated BWR-3, which are similar to Fukushima Unit 1. The remaining fifteen of the Mark I BWRs have the BWR-4 NSSS, similar to Fukushima Units 2, 3, and 4. The following table lists the operating BWRs in the United States.

The NRC is not aware of all differences that may exist between the Fukushima reactors and those of similar design and vintage operated in the U.S., neither do we have specific knowledge of implementation at Fukushima of the following improvements made to U.S. reactors:

Station Blackout (SBO) Rule - required the ability to cope with SBO for specified time and recover the plant

Anticipated Transient Without Scram (ATWS) Rule - required vendor specific improvements to enhance scram reliability

Hydrogen Control Rule - required modifications to reduce impact of hydrogen generated from beyond design basis events (DBEs)

Equipment Qualification Rule - required environmental qualification of electrical system equipment used for design basis accidents (DBAs)

Mark I Containment Improvement Program - (i) added hardened vent system for containment cooling and fission product scrubbing for beyond DBEs, and (ii) enhanced reliability of automatic depressurization system (ADS) and added an additional water injection capability independent of normal AC and emergency diesel power

Symptom- based Emergency Procedure Guides (EPGs) -provides emergency procedures that direct operator actions on the basis of critical safety parameter status rather than knowledge of the event initiator – applicable to any initiating event (DBA or beyond DBA).

Severe Accident Management Guidelines (SAMGs) - guidelines for minimizing radiological consequences of a damaged core event. Focuses on maintaining containment integrity, controlling releases, and emergency planning interface

Aircraft Impact Requirements - requires procedures to use all available equipment for core cooling, containment protection, and spent fuel pool cooling assuming a significant damage to the facility from an airplane crash

Mark I Containment Hydrodynamic Load Issue Resolution -resulted in structural strengthening of Mark I containments to better handle reactor system depressurization forces

Emergency Core Cooling System (ECCS) Pump Suction Strainer Improvements - larger surface area strainers installed with higher debris loading tolerance to ensure ECCS pump operation

Hydrogen explosions have been a major aspect of the Fukushima accident. In the U.S., NRC Generic Letter 89-16, “Installation of a Hardened Wetwell Vent,” conveyed the importance of having a robust pathway for venting primary containment, which contains the suppression pool, in certain severe accident scenarios. In response, all BWRs with Mark I containments that didn’t have an existing strengthened or “hardened” pathway for venting directly from primary containment to the outside, made modifications to the plant consistent with the intent of the Generic Letter. This design feature permits a controlled depressurization of primary containment as well as a controlled release of radioactive materials and combustible hydrogen generated by damaged fuel, as may occur during severe accidents.

U.S. Plants

Q: *Some in the media and in Hill briefings are suggesting that Mark I containment is flawed. What are the concerns about this type of containment? Are the US plants with this safe?* ***UPDATED***

A: BWR Mark I containments have relatively small volumes in comparison with pressureized water reactor (PWR) containments. This makes the BWR Mark I containment relatively more susceptible to containment failure given a core meltdown severe enough to (1) fail the reactor vessel and also (2) severe enough so that the core melt reaches the containment boundary. On the positive side, BWRs have more ways of adding water to the core than PWRs to prevent core meltdown. The following improvements have been made to U.S. Mark I containment reactors:

Station Blackout (SBO) Rule: Required the ability to cope with SBO for specified time and recover the plant

Anticipated Transient Without Scram (ATWS) Rule: Required vendor specific improvements to enhance scram reliability

Hydrogen Control Rule: Required modifications to reduce impact of hydrogen generated from beyond design basis events (DBEs)

Equipment Qualification Rule: Required environmental qualification of electrical system equipment used for design basis accidents (DBAs)

Mark I Containment Improvement Program: (i) Added hardened vent system for containment cooling and fission product scrubbing for beyond DBAs, and (ii) Enhanced reliability of automatic depressurization system (ADS) and added an additional water injection capability independent of normal AC and emergency diesel power

Symptom-based Emergency Procedure Guides (EPGs): Provides emergency procedures that direct operator actions on the basis of critical safety parameter status rather than knowledge of the event initiator – applicable to any initiating event (DBA or beyond DBA)

Severe Accident Management Guidelines (SAMGs): Guidelines for minimizing radiological consequences of a damaged core event. Focuses on maintaining containment integrity, controlling releases, and emergency planning interface

Aircraft Impact Requirements: Requires procedures to use all available equipment for core cooling, containment protection, and spent fuel pool cooling assuming a significant damage to the facility from an airplane crash

Mark I Containment Hydrodynamic Load Issue Resolution: Resulted in structural strengthening of Mark I containments to better handle reactor system depressurization forces

Emergency Core Cooling System (ECCS) Pump Suction Strainer Improvements: Larger surface area strainers installed with higher debris loading tolerance to ensure ECCS pump operation

Hydrogen explosions have been a major aspect of the Fukushima accident. In the U.S., NRC Generic Letter 89-16, "Installation of a Hardened Wetwell Vent," conveyed the importance of having a robust pathway for venting primary containment, which contains the suppression pool, in certain severe accident scenarios. In response, all BWRs with Mark I containments that didn't have an existing strengthened or "hardened" pathway for venting directly from primary containment to the outside, made modifications to the plant consistent with the intent of the Generic Letter. This design feature permits a controlled depressurization of primary containment as well as a controlled release of radioactive materials and combustible hydrogen generated by damaged fuel, as may occur during severe accidents.

U.S. Plants

Continued Plant Safety

Q: *What could you say about the dangers to the American public from our nuclear plants?*

A: As the events in Japan continue to unfold, the NRC is focused on supporting the Japanese government and people in bringing this crisis to closure in the safest manner possible. The NRC remains convinced that U.S. nuclear power plants are designed and operated in a manner that protects public health and safety. The time will come, after this crisis is behind us, to evaluate what, if any, changes are needed at U.S. nuclear power plants. We will assess all the available information and evaluate whether enhancements to U.S. nuclear power plants are warranted, as we have done with previous natural disasters, such as the 2007 earthquake in the Sea of Japan and the 2004 tsunami in the Indian Ocean.

Q: *The German government ordered some of its nuclear power plants to shut down in response to the events in Japan. Why is it safe to continue to operate the nuclear power reactors in the U.S. that are similar to the Japanese reactors at Fukushima Dai-ichi?*

A: Every regulatory body around the world that deals with nuclear reactors has considered many factors in determining the appropriate response to events in Japan. The NRC is not privy to all the factors influencing the decision by the German government. The Chairman of the NRC and the Executive Director for Operations at the NRC have briefed the White House and members of Congress on the situation in Japan and the impacts on the U.S.

The NRC continues to closely monitor the activities in Japan and is reviewing all available information; the agency continues to conclude that U.S. plants are operating safely. The NRC continues its licensing and oversight functions for all NRC licensees, including nuclear power plants. Information in a number of areas, including the principle of defense in depth, leads to the conclusion that the current fleet of reactors and materials licensees continue to protect the public health and safety.

Every reactor in the country is designed for severe natural events at its site. Every reactor has a wide range of diverse and redundant safety features as well as multiple physical barriers to contain radioactive material, in order to provide that public health and safety assurance. The NRC has a long regulatory history of conservative decision making. The NRC has been intelligently using risk insights to help inform the regulatory process and has required improvements to the plant designs as we learn from operating experience. Some of these include severe accident management guidelines, revisions to the emergency operating procedures, procedures and processes for dealing with large fires and explosions regardless of the cause, and requirements for coping with station blackout.

Q: *Is our battery backup power less effective than the Japanese?* ***UPDATED***

A: US regulations do not specify the length of time that you need to have the batteries operate following a loss of offsite power. Instead, the amount of time is dependent on the site recovery strategy and is based on providing sufficient capacity to assure that the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

With respect to a comparison of battery backup power effectiveness, we currently do not have sufficient information to compare the differences in design requirements and performance characteristics of nuclear-grade batteries in the U.S. and Japanese nulcear power plants. However, in the U.S., nuclear power plants utilize redundant nuclear-grade (i.e., Class 1E, safety-related) batteries that are designed and constructed using rigorous standards and are routinely tested in accordance with plant technical specifications to ensure adequate capacity and capability exists to perform their intended safety functions. These batteries are located in structures that can withstand external environmental events such as earthquakes, tornadoes, tsunamis, and floods in accordance with NRC regulations. For U.S. nuclear power plants, the typical desig duty cycles for safety grade batteries range from 1 - 8 hours (i.e., 1-2 hours for accident; 4 hours for station blackout; and 1-8 hours for a fire).

U.S. Plants

Q: *Has this incident changed the NRC perception about earthquake risk?*

A: There has been no change in the NRC's perception of earthquake hazard (i.e. ground shaking levels) for US nuclear plants. As is prudent, the NRC will certainly be looking closely at this incident and the effects on the Japanese nuclear power plant in the future to see if any changes are necessary to NRC regulations.

Q: *Has this crisis changed your opinion about the safety of U.S. nuclear power plants?*

A: No. The NRC remains confident that the design of U.S. nuclear power plants ensures the continued protection of public health and safety and the environment.

Q: *I live near a nuclear power plant similar to the ones having trouble in Japan. How can we now be confident that this plant won't experience a similar problem?*

A: U.S. nuclear power plants are built to withstand environmental hazards, including earthquakes and tsunamis. Even those plants that are located outside of areas with extensive 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 the most severe natural phenomena historically reported for the site and surrounding area. The NRC is confident that the robust design of these plants makes it highly unlikely that a similar event could occur in the United States.

Q: *Could an accident sequence like the one at Japan's Fukushima Daiichi nuclear plants happen in the US?*

A: 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.

U.S. Plants

Q: *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?*

A: 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.

U.S. Plants

Q: *Some in the media and in Hill briefings are suggesting that Mark I containment is flawed. What are the concerns about this type of containment? Are the US plants with this safe?* ***UPDATED***

A: BWR Mark I containments have relatively small volumes in comparison with pressureized water reactor (PWR) containments. This makes the BWR Mark I containment relatively more susceptible to containment failure given a core meltdown severe enough to (1) fail the reactor vessel and also (2) severe enough so that the core melt reaches the containment boundary. On the positive side, BWRs have more ways of adding water to the core than PWRs to prevent core meltdown. The following improvements have been made to U.S. Mark I containment reactors:

Station Blackout (SBO) Rule: Required the ability to cope with SBO for specified time and recover the plant

Anticipated Transient Without Scram (ATWS) Rule: Required vendor specific improvements to enhance scram reliability

Hydrogen Control Rule: Required modifications to reduce impact of hydrogen generated from beyond design basis events (DBEs)

Equipment Qualification Rule: Required environmental qualification of electrical system equipment used for design basis accidents (DBAs)

Mark I Containment Improvement Program: (i) Added hardened vent system for containment cooling and fission product scrubbing for beyond DBAs, and (ii) Enhanced reliability of automatic depressurization system (ADS) and added an additional water injection capability independent of normal AC and emergency diesel power

Symptom-based Emergency Procedure Guides (EPGs): Provides emergency procedures that direct operator actions on the basis of critical safety parameter status rather than knowledge of the event initiator – applicable to any initiating event (DBA or beyond DBA)

Severe Accident Management Guidelines (SAMGs): Guidelines for minimizing radiological consequences of a damaged core event. Focuses on maintaining containment integrity, controlling releases, and emergency planning interface

Aircraft Impact Requirements: Requires procedures to use all available equipment for core cooling, containment protection, and spent fuel pool cooling assuming a significant damage to the facility from an airplane crash

Mark I Containment Hydrodynamic Load Issue Resolution: Resulted in structural strengthening of Mark I containments to better handle reactor system depressurization forces

Emergency Core Cooling System (ECCS) Pump Suction Strainer Improvements: Larger surface area strainers installed with higher debris loading tolerance to ensure ECCS pump operation

Hydrogen explosions have been a major aspect of the Fukushima accident. In the U.S., NRC Generic Letter 89-16, "Installation of a Hardened Wetwell Vent," conveyed the importance of having a robust pathway for venting primary containment, which contains the suppression pool, in certain severe accident scenarios. In response, all BWRs with Mark I containments that didn't have an existing strengthened or "hardened" pathway for venting directly from primary containment to the outside, made modifications to the plant consistent with the intent of the Generic Letter. This design feature permits a controlled depressurization of primary containment as well as a controlled release of radioactive materials and combustible hydrogen generated by damaged fuel, as may occur during severe accidents.

U.S. Plants

Coordination Efforts

Q: *Did the NRC consult the Department of Energy (DOE) or the Nuclear Energy Institute (NEI) for assistance in developing the protective action recommendation?*

A: Although the DOE assisted in providing radiation dose rate information to support the analysis performed by the NRC, the protective action recommendation was made by the NRC.

Q: *What resources are the Japanese asking for?*

A: The Japanese have formally requested equipment needed to cool the reactor fuel. This includes such things as pumps, fire hoses, portable generators, and diesel fuel. The NRC is coordinating with General Electric, which has plant design specifications, to ensure any equipment provided will be capable of meeting the needs of the Japanese.

Q: *What is the official agency to report radiation numbers and what is the public contact?*

A: NRC regulations require nuclear power plants to report any radiation doses detected at the plant that could be harmful to the public. This would include doses that are generated by the plant or by an external source. During an event in the U.S., it is the state's responsibility to provide protective action decisions for public health and safety. For this incident, the Japanese are responsible for reporting the public dose; nevertheless, should radiation doses be detected within the U.S., it would still be the state's responsibility to provide protective action decisions for public health and safety.

Q: *Where would I get IOSAT Potassium Iodide if my city should experience fallout from the Japanese nuclear disaster? Is this the right precaution or is there anything else that can be done to protect myself?*

A: We do not expect any U.S. states or territories to experience harmful levels of radioactivity. As such, we do not believe that there is any need for residents of the United States to take potassium iodide. U.S. residents should listen to the protective action decisions by their states and counties. As necessary, protective action decisions could include actions such as sheltering, evacuating, or taking potassium iodide.

Additional information regarding the use of potassium iodide can be found on NRC's webpage at the following link: http://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/potassium-iodide-use.html.

Since Potassium Iodide is classified as a drug. Additional information is on the Food and Drug Administration's web site: www.fda.gov.

Q: *My loved one is overseas, how do I find out if they are ok?*

A: We are directing public inquiries with regard to concern for loved ones overseas to the State Department, Consular Services at 202-647-7004.

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

A: We are closely following events in Japan, working with other agencies of the federal government, and have been in direct contact with our counterparts in that country. We have sent a total of 11 staff to Tokyo in response to the Japanese government's request for assistance. Two of those NRC staff members, knowledgeable about boiling water reactors, are already in Japan participating in the USAID team.

U.S. Plants

Q: *What should the American public know about the incident in Japan?*

A: The events unfolding in Japan are the result of a catastrophic series of natural disasters. These include the fifth largest earthquake in recorded history and the resulting devastating tsunami. Despite these unique circumstances, the Japanese appear to have taken reasonable actions to mitigate the event and protect the surrounding population. Since the beginning of the event, the NRC has continuously manned its Operations Center in Rockville, MD in order to gather and examine all available information as part of the effort to analyze the event and understand its implications both for Japan and the United States.

Q: *What is the NRC doing to ensure this (Japan event) doesn't happen at US plants?*

A: The NRC has sent staff to assist and advise officials in Japan regarding the response and mitigation of the current reactor and spent fuel pool events. The NRC is working through the U.S. ambassador to Japan regarding these activities. Since the beginning of the event, the NRC has continuously manned its Headquarters Operations Center in Rockville, MD, in order to gather and examine all available information as part of the effort to analyze the event and understand its implications both for Japan and the United States.

Q: *Are any Americans in danger – armed forces, citizens in Tokyo?*

A: The NRC, in consultation with the White House and U.S. Embassy, has advised United States citizens in Japan to follow the protective measures recommended by the Japanese government. These measures appear to be consistent with steps the United States would take. The Department of Defense has personnel trained in radiation protective measures and is responsible for providing guidance to U.S. armed forces. Inquiries regarding U.S. citizens in Japan should be directed to the State Department, Consular Services at 202-647-7004.

Q: *I am traveling to Asia (not Japan). Should I adjust my travel plans to avoid flying through plume or being contaminated once on the ground?*

A: The NRC is not the responsible federal agency to advise U.S. citizens on foreign travel restrictions. That responsibility belongs to the Department of State.

Q: *How did the NRC develop its computer-based projections that supported the evacuation decision?*

A: The NRC uses the RASCAL computer code to perform offsite radiation dose projections. The RASCAL computer program contains information about U.S. nuclear reactor design types, radiation release pathways from the nuclear power plant to the environment, radionuclide source terms and meteorology. However, RASCAL is not capable of evaluating concurrent and multiple nuclear plant failures. So, to approximate the events unfolding at the Fukushima Daiichi facility, the NRC developed a model that aggregated information from the three operating reactors and the spent fuel pool. This aggregate model was then evaluated using the RASCAL computer code. The radiation doses calculated by the RASCAL code were predicted to exceed the protective action guidelines (PAGs) established by the U.S. Environmental Protection Agency (EPA) well beyond the 10-mile exposure pathway EPZ and beyond the 30 kilometer sheltering zone recommended by the Japanese authorities. Subsequent aerial monitoring by the U.S. Department of Energy (DOE) fixed-wing aircraft monitoring showed elevated radiation dose rates that were in excess of the EPA relocation PAGs to a distance beyond 25 miles from the facility.

U.S. Plants

Q: *How is EPA monitoring, collecting and posting information related to the impacts in the U.S. of the accident in Japan?* ***NEW!***

A: The EPA monitors, collects, and posts information related to the impacts of the Japanese events on the U.S. using their RadNet system. They have 100 fixed radiation monitoring sites in 48 states plus 40 additional deployable monitors that may be sent where needed. The fixed monitors provide information on beta and gamma radiation levels. The deployable monitors measure the external exposure rate and provide weather information. The data from these monitors is sent to a computer, where it is continually reviewed and is usually posted on the EPA's Central Data Exchange website (http://epa.gov/cdx) within 2 hours. However, if the computer picks up an abnormality in the radiation level, then the EPA laboratory staff is alerted and reviews the information prior to it being posted. In response to the events in Japan, EPA has sent additional monitors to Guam, Hawaii, and Alaska.

The EPA also monitors contamination in rainwater and drinking water as well as the level of iodine in milk. The EPA provides updates on these testing efforts and a summary of the air radiation monitoring results on its webpage, http://www.epa.gov/japan2011/. This webpage contains a link to Frequently Asked Questions, which was the source of information for this response. Additional information may be found there.

Q: *Are we providing additional KI to the Japanese?*

A: We have not been asked to provide KI.

Q: *Who are the Federal Contacts (for the state) to get information on what DOE & EPA are doing?*

A: States have an ongoing dialogue with the NRC and routinely ask questions through the NRC Regional State Liaison Officer. States also can ask questions through the NRC Headquarters Operations Center at 301-816-5100. Information regarding the following Federal departments and agencies can be obtained through their internet websites and through the NRC's public website:

- Department of State:http://www.state.gov/

- Federal Emergency Management Agency:http://www.fema.gov/

- Environmental Protection Agency:http://www.epa.gov/japan2011/rert/radnet-data.html

- Department of Energy:http://blog.energy.gov/content/situation-japan

Q: *Has the government set up radiation monitoring stations to track the release?*

A: The NRC understands that EPA is utilizing its existing nationwide radiation monitoring system, RadNet, to monitor continuously the nation's air and regularly monitors drinking water, milk and precipitation for environmental radiation. EPA has publicly stated its agreement with the NRC's assessment that we do not expect to see radiation at harmful levels reaching the U.S. from damaged Japanese nuclear power plants. Nevertheless, EPA has stated that it plans to work with its federal partners to deploy additional monitoring capabilities to parts of the western U.S. and U.S. territories.

U.S. Plants

Q: *How does the NRC ensure people can escape if an accident occurs from a natural disaster when the infrastructure is also affected or destroyed in an area around a plant?* ***UPDATED***

A: Each US nuclear power plant has an Emergency Plan for ensuring the health and safety of people who live within the emergency planning zone. Emergency plans contain contingencies for alternate evacuation routes, alternate means of notification, and other backup plans in the event of a natural disaster that damages the surrounding infrastructure. Licensees exercise these plans on a regular basis. The NRC performs oversight to verify the acceptable performance of the licensee's response during exercises, drills, and actual incidents and events. The Federal Emergency Managment Agency (FEMA) provides oversight for offsite response.

For Incidents of National Significance where the critical infrastructure is severely damaged, the Department of Homeland Security (DHS) has a lead role as a coordinating agency to orchestrate Federal, State, and local assets. The Nuclear/Radiological Incident Annex to the National Response Framework provides for the NRC to be a coordinating agency for incidents involving NRC licensed materials.

Q: *When the states receive questions from the public / media that the NRC would be better to answer, where should they direct these calls?*

A: Members of state governments should first consult the NRC public website link for information. Some answers may already be provided. Press releases, information about boiling water reactor technology, and frequently asked questions are already provided on the website at the following link: http://www.nrc.gov/japan/japan-info.html. If sufficient information is not available to address your inquiry, please call the NRC Headquarters Operations Center at (301) 816-5100.

Q: *Why are US plants safe to operate considering the events in Japan?*

A: The NRC has been very closely monitoring the activities in Japan and reviewing all available information to allow us to conclude that the U.S. plants continue to operate safely. There has been no reduction in the licensing or oversight function of the NRC as it relates to any of the NRC licensees. Contributors to the conclusion that the current fleet of reactors and materials licensees continue to protect the public health and safety are based on a number of principles, including defense in depth.

The fact that every reactor in the country is designed for natural events, based on the specific site where the reactor is located, that there are multiple fission product barriers, and that there are a wide range of diverse and redundant safety features in order to provide that public health and safety assurance. The NRC has a long regulatory history of conservative decision making. The NRC has been intelligently using risk insights to help inform the regulatory process and has required improvements to the plant designs as we learn from operating experience. Some of these include severe accident management guidelines, revisions to the emergency operating procedures, procedures and proceses for dealing with large fires and explosions regardless of the cause, and requirements for coping with station blackout.

Q: *Does the NRC participate in inspection of the Japanese facilities?* ***UPDATED***

A: Unless the inspection is sponsored by the International Atomic Energy Agency (IAEA), the NRC does not normally participate in inspections of Japanese facilities.

U.S. Plants

Q: *Did the NRC share the post 9/11 enhancements to the U.S. facilities with the Japanese?* ***UPDATED***

A: Following the events of September 11, 2001, the NRC issued Orders requiring licensees to develop specific guidance and strategies to maintain or restore cooling of the core, containment, and spent fuel using existing or readily available resources (equipment and personnel). These strategies have to be implemented effectively even if large areas of the plant were lost due to explosions or fire, including those that an aircraft impact might create. Although it was recognized prior to September 11, 2001, that nuclear reactors already had significant capabilities to withstand a broad range of attacks, implementing these types of mitigation strategies would significantly enhance the plants' capabilities to withstand a broad range of threats. NRC's Japanese counterpart, the Japan Nuclear and Industrial Safety Agency (NISA), visited NRC in 2008. During that visit, NRC staff shared information contained in the NRC-issued Orders as referenced above. This cooperative exchange occurred under the authority of an international agreement between NRC and NISA for technical exchange.

Q: *What is the NRC doing in response to the situation in Japan?*

A: The NRC has taken a number of actions:

1. Since the beginning of the event, the NRC has continuously manned its Operations Center in Rockville, MD in order to gather and examine all available information as part of the effort to analyze the event and understand its implications both for Japan and the United States.

2. A team of 11 officials from the NRC with expertise in boiling water nuclear reactors have deployed to Japan as part of a U.S. International Agency for International Development (USAID) team.

3. The NRC has spoken with its counterpart agency in Japan, offering the assistance of U.S. technical experts.

4. The NRC is coordinating its actions with other Federal agencies as part of the U.S. government response.

Q: *What other U.S. agencies are involved, and what are they doing?*

A: The entire federal family is responding to this event. The NRC is closely coordinating its efforts with the White House, DOE, DOD, USAID, and others. The U.S. government is providing whatever support requested by the Japanese government.

Q: *The United States has troops in Japan and has sent ships to help the relief effort – are they in danger from the radiation?*

A: The NRC is not the appropriate federal agency to answer this question. DOD is better suited to provide information regarding its personnel.

Q: *Is there a danger of radiation making it to the United States?*

A: In response to nuclear emergencies, the NRC works with other U.S. agencies to monitor radioactive releases and predict their path. The NRC continues to monitor information regarding wind patterns near the Japanese nuclear power plants. Nevertheless, given the thousands of miles between the two countries, Hawaii, Alaska, the U.S. Territories and the U.S. West Coast are not expected to experience any harmful levels of radioactivity.

Q: *Is the U.S. government tracking the radiation released from the Japanese plants?*

A: Yes, a number of U.S. agencies are involved in monitoring and assessing radiation including EPA, DOE, and NRC. The best source of additional information is the Environmental Protection Agency.

U.S. Plants

Q: *Are air and sea shipments from Japan being checked for radiation contamination?* ***UPDATED***

A: U.S. Customs and Border Protection (CBP), a part of the Department of Homeland Security, is responsible for monitoring food and cargo at U.S. ports of entry. In accordance with established protocols, CBP uses radiation detection equipment at both air and sea ports, and uses this equipment, along with specific operational protocols, to resolve any security or safety risks that are identified with inbound travelers and cargo. CBP has issued field guidance reiterating its operational protocols and directing field personnel to specifically monitor maritime and air traffic from Japan. CBP will continue to evaluate the potential risks posed by radiation contamination on inbound travelers and cargo and will adjust its detection and response protocols, in coordination with its interagency partners, as developments warrant. The NRC works closely with CBP and the U.S. Environmental Protection Agency when CBP identifies radioactive materials that may involve licensed materials or radioactive materials shipped from other countries inadvertently.

<u>Design: Risk-informed</u>

Q: *Could there be core damage and radiation release at a U.S. plant if a natural disaster exceeding the plant design were to occur?* ***UPDATED***

A: U.S. nuclear power plants are built to withstand external hazards, including earthquakes, tsunamis, and flooding, as appropriate. The NRC has made substantial effort over time to ensure that vulnerabilities to both internal and external hazards were considered and mitigated in the plant current design and licensing basis of its regulated facilities. In 1988, the NRC's Generic Letter (GL) No. 88-20, "Individual Plant Examination [IPE] for Severe Accident Vulnerabilities," requested plant owners to perform a systematic evaluation of plant-specific vulnerabilities and report the results to the Commission. For many plants, the IPEs became the basis for the plant's initial Probabilistic Risk Assessment (PRA). Later the NRC issued Supplement 4 to GL 88-20, that requested licensees to evaluate vulnerabilities to external events (IPEEE). Most licensees made improvements to their facilities to reduce vulnerabilities identified in their IPEs and IPEEEs.

The ground motions that are used as seismic design bases at US nuclear plants are called the Safe Shutdown Earthquake (SSE) ground motions. In the 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 a generic review (i.e., GI-199) to again assess the resistance of US nuclear plants to earthquakes. Based on NRC's preliminary analyses to date, the average 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.

U.S. Plants

Q: *Given low probability events do occur, how does the U.S . ensure that U.S. plant designs are not significantly degraded by risk-informed changes?*

A: The NRC has established a policy for using risk information in its regulatory decision making. The NRC's policy statement on probabilistic risk assessment (PRA) encourages greater use of this analysis technique to improve safety decisionmaking and improve regulatory efficiency. The use of PRA technology should be increased in all regulatory matters to the extent supported by the state of the art in PRA methods and data and in a manner that complements the NRC's deterministic approach and supports the NRC's traditional defense-in-depth philosophy. In implementing risk-informed decisionmaking, licensing basis changes are expected to meet a set of key principles. Some of these principles are written in terms typically used in traditional engineering decisions (e.g., defense in depth). While written in these terms, it should be understood that risk analysis techniques can be, and are encouraged to be, used to help ensure and show that these principles are met. These principles are:

1. The proposed change meets the current regulations unless it is explicitly related to a requested exemption or rule change, i.e., a"specific exemption" under 10 CFR 50.12 or a "petition for rulemaking" under 10 CFR 2.802.

2. The proposed change is consistent with the defense-in-depth philosophy.

3. The proposed change maintains sufficient safety margins.

4. When proposed changes result in an increase in core damage frequency or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.

5. The impact of the proposed change should be monitored using performance measurement strategies.

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

A: 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.

Q: *Does GI-199 provide rankings of US nuclear plants in terms of safety?* ***UPDATED***

A: 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 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.

U.S. Plants

Q: *What do you mean by "increased estimates of seismic hazards" at nuclear plant sites?*

A: 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).

Q: *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)?*

A: 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.

<u>Design: Defense-in-Depth</u>

Q: *How would the U.S. have responded to the events of March 11?* ***UPDATED***

A: The NRC requires plant designs to include multiple and diverse safety systems, and plants must test their emergency response capabilities on a regular basis. Plant operators are very capable of responding to significant events. U.S. nuclear power plants have emergency operating procedures as well as severe accident management guidelines that ensure that the containment structure integrity takes priority in an accident situation. Therefore, in an event that goes beyond those analyzed in the original plant design (i.e., beyond design basis event), such as the one at Fukushima Daiichi, U.S. BWR operators are trained to preserve primary and secondary containment by venting to provide the greatest assurance of public protection during a severe accident. Each U.S. plant has an emergency plan that is coordinated with local, State and Federal departments and agencies to ensure the safety of the public within the Emergency Planning Zone. In addition, NRC regulations require plants to have plans in place that would allow them to mitigate even worst-case scenarios. Since 9/11, we have implemented requirements for licensees to have additional response capabilities for extreme situations.

Q: *Why are US plants safe to operate considering the events in Japan?*

A: The NRC has been very closely monitoring the activities in Japan and reviewing all available information to allow us to conclude that the U.S. plants continue to operate safely. There has been no reduction in the licensing or oversight function of the NRC as it relates to any of the NRC licensees. Contributors to the conclusion that the current fleet of reactors and materials licensees continue to protect the public health and safety are based on a number of principles, including defense in depth.

The fact that every reactor in the country is designed for natural events, based on the specific site where the reactor is located, that there are multiple fission product barriers, and that there are a wide range of diverse and redundant safety features in order to provide that public health and safety assurance. The NRC has a long regulatory history of conservative decision making. The NRC has been intelligently using risk insights to help inform the regulatory process and has required improvements to the plant designs as we learn from operating experience. Some of these include severe accident management guidelines, revisions to the emergency operating procedures, procedures and proceses for dealing with large fires and explosions regardless of the cause, and requirements for coping with station blackout.

Design: External Events: Others (e.g., hurricanes, tornadoes, snow, ice, etc.)

Q: *Any quick-hit info about how the Southeast Reactors performed during Katrina? What damage did the flood water do? Any power loss?*

A: The reactors performed as designed. Waterford was the most affected while River Bend also experienced some effects.

Waterford 3 (near New Orleans, LA) did not have damage to any safety equipment during, or shortly after Katrina. They shut down on August 28, 2005, in advance of the hurricane strike. The flooding did affect local infrastructure, including communications and power distribution. However, the plant successfully used their emergency diesel generators to furnish plant power. Access was maintained to the plant throughout the event. On September 9, 2005, after a comprehensive review by FEMA and the NRC, the plant was authorized to restart.

River Bend Station (30 miles north of Baton Rouge, LA) did not experience damage to any safety relate equipment and only minimal damage to emergency planning equipment (one siren) during and after Hurricane Katrina. The station reduced power to 70 percent core thermal power on August 28, 2005, due to reduced electrical grid loads. Access was maintained to the plant throughout the event. On September 2, 2005, the plant returned to 100% power.

Also, in 1992 the eye of Hurricane Andrew, a category 5 hurricane, passed directly over the Turkey Point nuclear plant. The plant was shut down prior to the hurricane making landfall and an assessment of the plant following the hurricane demonstrated that the plant sustained very little damage and all of the safety equipment was intact.

Design: External Events: Seismic

Q: *Why should the NRC not require the more sophisticated (3D) seismic studies being voluntarily conducted by licensees in California?* ***NEW!***

A: Current NRC and American Nuclear Society (ANS) documentation provides guidance related to site investigations undertaken for the purpose of characterizing seismic sources and dynamic site properties. A variety of geophysical and geotechnical tools are available that can be used to investigate the earth from both a site-specific and a regional level. Each of these methods provides specific information by probing the earth in a different way. While some tools are universally useful, others are better suited to certain types of sub-surface materials and tectonic situations. While 3D seismic studies, such as those being performed in California, are sophisticated, they are not useful for all situations and the very large expense of the study could preclude broader application of techniques better suited to a specific site. The NRC would suggest the use of 3D seismic studies only in cases where it could be useful. The NRC attempts to provide regulations that call for techniques that would be the most suitable given the specific conditions of a plant and requested licensing actions.

U.S. Plants

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

A: 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.

Q: *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?*

A: 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.

Q: *Have events in Japan changed our perception of earthquake risk to the nuclear plants in the US?*

A: 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.

Q: *What magnitude earthquake are currently operating US nuclear plants designed to?*

A: 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.

U.S. Plants

Q: *What level of earthquake hazard are the US reactors designed for?*

A: 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 1x10-4/year, but this can be thought of as the ground motion that occurs every 10,000 years on average. One important aspect is that probabilistic 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.

Q: *How many US reactors are located in active earthquake zones?*

A: 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.

Q: *How big an earthquake is plant X designed to handle (for each plant)?*

A: All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. Even those plants that are located in areas with low and moderate seismic activity are designed for safety in the event of such a natural disaster. Each 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. Ground shaking is a function of both the magnitude of the earthquake and the distance from the fault plane to the specific site. The seismic responses of the structures, systems, and components associated with these facilities are site specific. The plants are analyzed for certain identified faults and tectonic capabilities in the area while others are analyzed for seismic zones.

U.S. Plants

Q: *Could there be core damage and radiation release at a U.S. plant if a natural disaster exceeding the plant design were to occur?* ***UPDATED***

A: U.S. nuclear power plants are built to withstand external hazards, including earthquakes, tsunamis, and flooding, as appropriate. The NRC has made substantial effort over time to ensure that vulnerabilities to both internal and external hazards were considered and mitigated in the plant current design and licensing basis of its regulated facilities. In 1988, the NRC's Generic Letter (GL) No. 88-20, "Individual Plant Examination [IPE] for Severe Accident Vulnerabilities," requested plant owners to perform a systematic evaluation of plant-specific vulnerabilities and report the results to the Commission. For many plants, the IPEs became the basis for the plant's initial Probabilistic Risk Assessment (PRA). Later the NRC issued Supplement 4 to GL 88-20, that requested licensees to evaluate vulnerabilities to external events (IPEEE). Most licensees made improvements to their facilities to reduce vulnerabilities identified in their IPEs and IPEEEs.

The ground motions that are used as seismic design bases at US nuclear plants are called the Safe Shutdown Earthquake (SSE) ground motions. In the 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 a generic review (i.e., GI-199) to again assess the resistance of US nuclear plants to earthquakes. Based on NRC's preliminary analyses to date, the average 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.

Q: *What is magnitude anyway? What is the Richter Scale? What is intensity?*

A: 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.

U.S. Plants

Q: *Do U.S. nuclear plants have better capabilities to respond to natural disasters than the plants in Japan?*

A: The NRC is not yet aware of all of the differences that may exist between the reactors that are of similar design and vintage as those operated in the U.S. Many improvements have been made to U.S boiling water reactors (BWRs). For example, NRC Generic Letter 89-16, "Installation of a Hardened Wetwell Vent," conveyed the importance of having a robust pathway for venting primary containment, which contains the suppression pool, in certain severe accident scenarios. In response, all BWRs with Mark I containments that didn't have an existing strengthened or "hardened" pathway for venting directly from primary containment to the outside, made modifications to the plant consistent with the intent of the Generic Letter. This design feature permits a controlled depressurization of primary containment as well as a controlled release of radioactive materials and combustible hydrogen that could be generated by damaged fuel, as may occur during severe accidents. U.S. nuclear power plants are built to withstand external hazards, including earthquakes tsunamis, and flooding, as appropriate. In addition to the design of the plants, significant effort goes into emergency response planning, preparation, and training. The NRC has also completed substantial research and analysis that resulted in the development and use of severe accident management guidelines. These insights have informed our decision making and review of licensed activities.

Q: *Are U.S. nuclear power plants designed to withstand earthquakes? What would the effect be on [plant X] if a 9.0 earthquake hit?*

A: All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. Even those plants that are located in areas with low and moderate seismic activity are designed for safety in the event of such a natural disaster. Each 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. Ground shaking is a function of both the magnitude of the earthquake and the distance from the fault plane to the specific site. The seismic responses of the structures, systems, and components associated with these facilities are site specific. The plants are analyzed for certain identified faults and tectonic capabilities in the area while others are analyzed for seismic zones.

Q: *What is the seismic limit that Pilgrim Station, Seabrook Station and Vermont Yankee have been built to withstand?*

A: Each 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. Ground shaking is a function of both the magnitude of the earthquake and the distance from the fault plane to the site. The seismic responses of the structures, systems, and components associated with these facilities are dependent on several factors, as mentioned above; therefore, the responses may be different for the same magnitude earthquake. As a result, the NRC regulatory requirements focus on seismic limits based on ground shaking rather than limits defined by earthquake magnitude.

The ground motions associated with seismic events are determined for two categories of earthquakes: the Safe Shutdown Earthquake (SSE) which is generally defined as the maximum ground motion seismic response that the plant must be able to withstand and safely shut down and be maintained in a safely shut down condition, and; the Operating Basis Earthquake (OBE) which is defined as the ground motion seismic response that the plant must be able to withstand and to continue operating normally following such an event. The SSE and OBE reflect the horizontal acceleration of the ground in units of the earth's gravity, 'g'. The ground motions to which the Pilgrim, Seabrook, and Vermont Yankee plants are designed are: Pilgrim SSE of 0.150g and OBE of 0.080g; Seabrook SSE of 0.250g and OBE of 0.125g, and Vermont Yankee SSE of 0.140g and OBE of 0.070g.

U.S. Plants

Q: *If the same tragedy hit Pilgrim Station, Seabrook Station and Vermont Yankee would we be having the same major issues that the Japanese plants have? Please explain yes or no.*

A: As noted in Question 1 above, the circumstances related to the events in Japan are highly unlikely in that the plant-specific external hazards profile is substantially different. All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. Even those plants that are located in 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 very rare and extreme seismic and tsunami events. Pilgrim, Seabrook, and Vermont Yankee stations are designed to withstand the maximum credible natural events predicted for their specific sites. In addition to the design of the plants, significant effort goes into emergency response planning, preparation, and training. The NRC has also completed substantial research and analysis that resulted in the development and use of severe accident management guidelines. These insights have informed our decision making and review of licensed activities.

Q: *Could this happen at [any U.S. plant]?*

A: The events that have occurred in Japan are the result of a combination of highly unlikely natural disasters. These include the fifth largest earthquake in recorded history and the resulting devastating tsunami. 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 32 times larger than a magnitude 8 earthquake.

The NRC believes that it is highly unlikely that a similar combination of events could occur in the United States. NRC and industry practices of defense in depth, conservative decision making, use of risk insights, and industry actions and coordination through the Institute of Nuclear Power Operations provides for further assurance that the facilities are safe.

Q: *Is the NRC relooking at seismic analysis for US plants?* ***UPDATED***

A: 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 a generic review referred to as GI-199, “Implications of Updated Probabilistic Seismic Estimates in Central and Eastern United States on Existing Plants,” to again assess the resistance of US nuclear plants to earthquakes. In addition, the NRC has been reviewing new seismic information regarding the plants in California for many years.

U.S. Plants

Q: *Does GI-199 provide rankings of US nuclear plants in terms of safety?* ***UPDATED***

A: 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 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.

Q: *What are the current findings of GI-199?*

A: 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.

Q: *What do you mean by "increased estimates of seismic hazards" at nuclear plant sites?*

A: 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).

Q: *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)?*

A: 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.

U.S. Plants

Q: *Could an accident sequence like the one at Japan's Fukushima Daiichi nuclear plants happen in the US?*

A: 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.

Q: *How many plants are located in seismic areas?*

A: 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 plant be designed for site-specific ground motions that are appropriate for their location. In addition, the NRC has specified a minimum ground shaking level to which the plants must be designed.

Q: *Has this incident changed the NRC perception about earthquake risk?*

A: There has been no change in the NRC's perception of earthquake hazard (i.e. ground shaking levels) for US nuclear plants. As is prudent, the NRC will certainly be looking closely at this incident and the effects on the Japanese nuclear power plant in the future to see if any changes are necessary to NRC regulations.

Q: *How many US reactors are located in active earthquake zones (and which reactors)?*

A: 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 plant is designed for site-specific ground motions that are appropriate for their location. In addition, the NRC has specified a minimum ground shaking level to which the plants must be designed.

Q: *What could you say about the dangers to the American public from our nuclear plants?*

A: As the events in Japan continue to unfold, the NRC is focused on supporting the Japanese government and people in bringing this crisis to closure in the safest manner possible. The NRC remains convinced that U.S. nuclear power plants are designed and operated in a manner that protects public health and safety. The time will come, after this crisis is behind us, to evaluate what, if any, changes are needed at U.S. nuclear power plants. We will assess all the available information and evaluate whether enhancements to U.S. nuclear power plants are warranted, as we have done with previous natural disasters, such as the 2007 earthquake in the Sea of Japan and the 2004 tsunami in the Indian Ocean.

U.S. Plants

Q: *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?*

A: The regulations related to seismic requirements are contained in General Design Criterion 2 in Appendix A to Title 10 of the *Code of Federal Regulations*, Part 50.

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 1x10-4 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.

Q: *How do magnitude and ground motion relate to each other?*

A: 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.

Design: External Events: Tsunami

Q: *What could you say about the dangers to the American public from our nuclear plants?*

A: As the events in Japan continue to unfold, the NRC is focused on supporting the Japanese government and people in bringing this crisis to closure in the safest manner possible. The NRC remains convinced that U.S. nuclear power plants are designed and operated in a manner that protects public health and safety. The time will come, after this crisis is behind us, to evaluate what, if any, changes are needed at U.S. nuclear power plants. We will assess all the available information and evaluate whether enhancements to U.S. nuclear power plants are warranted, as we have done with previous natural disasters, such as the 2007 earthquake in the Sea of Japan and the 2004 tsunami in the Indian Ocean.

U.S. Plants

Q: *If the same tragedy hit Pilgrim Station, Seabrook Station and Vermont Yankee would we be having the same major issues that the Japanese plants have? Please explain yes or no.*

A: As noted in Question 1 above, the circumstances related to the events in Japan are highly unlikely in that the plant-specific external hazards profile is substantially different. All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. Even those plants that are located in 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 very rare and extreme seismic and tsunami events. Pilgrim, Seabrook, and Vermont Yankee stations are designed to withstand the maximum credible natural events predicted for their specific sites. In addition to the design of the plants, significant effort goes into emergency response planning, preparation, and training. The NRC has also completed substantial research and analysis that resulted in the development and use of severe accident management guidelines. These insights have informed our decision making and review of licensed activities.

Q: *Are U.S. nuclear plants on the East Coast designed to withstand mega-tsunami waves 60–90 feet high that might be caused by a massive landslide into the Atlantic Ocean from eruption of a large volcano in the Canary Islands off northwest Africa?* ***NEW!***

A: The NRC is aware of a study performed ten years ago which theorized that such a mega-tsunami could be generated by a massive landslide of one side of the Cumbre Vieja volcano on the Canary Island of La Palma. While this type of failure does occur to volcanoes in the Canary and Hawaiian Islands, significant problems with the original study have been identified by a number of subsequent studies performed in response to this study's theory. For example, studies performed since that time have refuted the highly conservative assumption that the landslide would hit the water in one coherent mass, but rather would do so in multiple landslides. In addition, improper modeling techniques and assumptions were used to assess how the resulting tsunami wave would propagate through the Atlantic Ocean. A recent report on tsunamis developed for the NRC by the US Geological Survey asserted that the tsunami generated by an eruption of this volcano would be, in fact, a small fraction of that size (i.e., no more than 3 feet). Nuclear stations on the East Coast of the United States are principally designed to deal with hurricane induced storm surges far higher than 3 feet. Thus based on the best, most reliable scientific studies currently available, the NRC has concluded that the existing flood protection measures of East Coast nuclear plants provide adequate margin against a tsunami induced by a flank landslide of this volcano.

Q: *Are U.S. nuclear power plants designed to withstand tsunamis? What would the effect be on [plant X] if a subsequent tsunami hit?*

A: All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. 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.

U.S. Plants

Q: *How many reactors are along coastal areas that could be affected by a tsunami? Is plant X designed to withstand a tsunami (for each coastal plant)?*

A: All U.S. nuclear power plants are built to withstand external hazards, including earthquakes, flooding, and tsunamis, as appropriate. 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.

Q: *Do U.S. nuclear plants have better capabilities to respond to natural disasters than the plants in Japan?*

A: The NRC is not yet aware of all of the differences that may exist between the reactors that are of similar design and vintage as those operated in the U.S. Many improvements have been made to U.S boiling water reactors (BWRs). For example, NRC Generic Letter 89-16, "Installation of a Hardened Wetwell Vent," conveyed the importance of having a robust pathway for venting primary containment, which contains the suppression pool, in certain severe accident scenarios. In response, all BWRs with Mark I containments that didn't have an existing strengthened or "hardened" pathway for venting directly from primary containment to the outside, made modifications to the plant consistent with the intent of the Generic Letter. This design feature permits a controlled depressurization of primary containment as well as a controlled release of radioactive materials and combustible hydrogen that could be generated by damaged fuel, as may occur during severe accidents. U.S. nuclear power plants are built to withstand external hazards, including earthquakes tsunamis, and flooding, as appropriate. In addition to the design of the plants, significant effort goes into emergency response planning, preparation, and training. The NRC has also completed substantial research and analysis that resulted in the development and use of severe accident management guidelines. These insights have informed our decision making and review of licensed activities.

Q: *Could an accident sequence like the one at Japan's Fukushima Daiichi nuclear plants happen in the US?*

A: 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.

U.S. Plants

Emergency Preparedness

Q: *Is there a 50-mile emergency planning zone (EPZ) around U.S. reactors?*

A: There are two emergency planning zones (EPZ) established around a nuclear power plant. The first zone, the 10-mile EPZ, is where exposure from a radiological release event would likely be from the radioactive plume and it is in this EPZ where protective actions such as sheltering and/or evacuation would be appropriate. Beyond the 10-mile EPZ and out to the 50-mile EPZ is the ingestion exposure pathway where exposure to radionuclides would likely be from ingestion of contaminated food/milk and surface water. These zones are not limits but rather provide for a comprehensive emergency planning framework that would allow expansion of the response efforts beyond the zones should radiological conditions warrant such expansion.

Q: *How is EPA monitoring, collecting and posting information related to the impacts in the U.S. of the accident in Japan?* ***NEW!***

A: The EPA monitors, collects, and posts information related to the impacts of the Japanese events on the U.S. using their RadNet system. They have 100 fixed radiation monitoring sites in 48 states plus 40 additional deployable monitors that may be sent where needed. The fixed monitors provide information on beta and gamma radiation levels. The deployable monitors measure the external exposure rate and provide weather information. The data from these monitors is sent to a computer, where it is continually reviewed and is usually posted on the EPA's Central Data Exchange website (http://epa.gov/cdx) within 2 hours. However, if the computer picks up an abnormality in the radiation level, then the EPA laboratory staff is alerted and reviews the information prior to it being posted. In response to the events in Japan, EPA has sent additional monitors to Guam, Hawaii, and Alaska.

The EPA also monitors contamination in rainwater and drinking water as well as the level of iodine in milk. The EPA provides updates on these testing efforts and a summary of the air radiation monitoring results on its webpage, http://www.epa.gov/japan2011/. This webpage contains a link to Frequently Asked Questions, which was the source of information for this response. Additional information may be found there.

Q: *What is the basis for the dose analyses attached to the March 16, 2011, NRC press release?*

A: The basis for the dose assessment was the limited and unverifiable information on the plant conditions at the Fukushima facility. The facility was modeled in a computer-based dose assessment code as a hypothetical, four reactor site. The dose assessment results are conservative predictions only and may not be representative of any actual radiation releases. The computer-based dose assessment model also utilized predicted meteorological conditions following the events at the Fukushima facility and, therefore, may not be representative of the actual meteorological conditions that occurred for this area. The NRC press release of March 16, 2011, and the predicted dose estimates are available on the NRC's public website and may be accessed at the following link:

http://www.nrc.gov/reading-rm/doc-collections/news/2011/11-050.pdf.

The assumptions on plant conditions used as the basis for the analyses were indicative of the uncertain and unstable nature of the conditions on Fukushima Daiichi site at the time the analyses were done, and accounted for uncertainty in the future progression of events. Since that time, actions to mitigate the events at facility and to stabilize the reactors and spent fuel at the plant have continued. Therefore, the assumptions used in for the dose assessment may continue to overestimate the actual radiation releases. The NRC continues to support the protective action recommendations provided in the March 16, 2011, press release because conditions at the plant continue to change. The NRC continues to monitor the situation at the Fukushima facility and may reassess its protective action recommendations as additional detailed and verifiable information about actual conditions becomes available.

U.S. Plants

Q: *Do U.S. nuclear plants have better capabilities to respond to natural disasters than the plants in Japan?*

A: The NRC is not yet aware of all of the differences that may exist between the reactors that are of similar design and vintage as those operated in the U.S. Many improvements have been made to U.S boiling water reactors (BWRs). For example, NRC Generic Letter 89-16, “Installation of a Hardened Wetwell Vent,” conveyed the importance of having a robust pathway for venting primary containment, which contains the suppression pool, in certain severe accident scenarios. In response, all BWRs with Mark I containments that didn’t have an existing strengthened or “hardened” pathway for venting directly from primary containment to the outside, made modifications to the plant consistent with the intent of the Generic Letter. This design feature permits a controlled depressurization of primary containment as well as a controlled release of radioactive materials and combustible hydrogen that could be generated by damaged fuel, as may occur during severe accidents. U.S. nuclear power plants are built to withstand external hazards, including earthquakes tsunamis, and flooding, as appropriate. In addition to the design of the plants, significant effort goes into emergency response planning, preparation, and training. The NRC has also completed substantial research and analysis that resulted in the development and use of severe accident management guidelines. These insights have informed our decision making and review of licensed activities.

Q: *Why did the NRC decide to recommend evacuation out to 50 miles from the Fukushima Daiichi facility for U.S. citizens in Japan?*

A: The decision to expand evacuation of U.S. citizens out to 50 miles from the Fukushima Daiichi facility was a conservative decision that was made out of consideration of several factors including an abundance of caution resulting from limited and unverifiable information concerning event progression at several units at the Fukushima Daiichi facility. The NRC based its assessment on information available at the time regarding the condition of the units conditions at Fukushima Daiichi that included significant damage to Units 1, 2, and 3 that appeared to been a result of hydrogen explosions. Prior to the earthquake and tsunami, Unit 4 was in a refueling outage and its entire core had been transferred to the spent fuel pool only 3 months earlier so the fuel was quite fresh. Radiation monitors showed significantly elevated readings in some areas of the plant site which would challenge plant crews attempting to stabilize the plant. Based on analysis results, there were indications from some offsite contamination sampling smears that fuel damage had occurred. There was a level of uncertainty about whether or not efforts to stabilize the plant in the very near term were going to be successful. Changing meteorological conditions resulted in the winds shifting rapidly from blowing out to sea to blowing back onto land.

Q: *Did the NRC share the post 9/11 enhancements to the U.S. facilities with the Japanese?* ***UPDATED***

A: Following the events of September 11, 2001, the NRC issued Orders requiring licensees to develop specific guidance and strategies to maintain or restore cooling of the core, containment, and spent fuel using existing or readily available resources (equipment and personnel). These strategies have to be implemented effectively even if large areas of the plant were lost due to explosions or fire, including those that an aircraft impact might create. Although it was recognized prior to September 11, 2001, that nuclear reactors already had significant capabilities to withstand a broad range of attacks, implementing these types of mitigation strategies would significantly enhance the plants' capabilities to withstand a broad range of threats. NRC’s Japanese counterpart, the Japan Nuclear and Industrial Safety Agency (NISA), visited NRC in 2008. During that visit, NRC staff shared information contained in the NRC-issued Orders as referenced above. This cooperative exchange occurred under the authority of an international agreement between NRC and NISA for technical exchange.

U.S. Plants

Q: *How does the NRC ensure people can escape if an accident occurs from a natural disaster when the infrastructure is also affected or destroyed in an area around a plant?* ***UPDATED***

A: Each US nuclear power plant has an Emergency Plan for ensuring the health and safety of people who live within the emergency planning zone. Emergency plans contain contingencies for alternate evacuation routes, alternate means of notification, and other backup plans in the event of a natural disaster that damages the surrounding infrastructure. Licensees exercise these plans on a regular basis. The NRC performs oversight to verify the acceptable performance of the licensee's response during exercises, drills, and actual incidents and events. The Federal Emergency Managment Agency (FEMA) provides oversight for offsite response.

For Incidents of National Significance where the critical infrastructure is severely damaged, the Department of Homeland Security (DHS) has a lead role as a coordinating agency to orchestrate Federal, State, and local assets. The Nuclear/Radiological Incident Annex to the National Response Framework provides for the NRC to be a coordinating agency for incidents involving NRC licensed materials.

Q: *Why are US plants safe to operate considering the events in Japan?*

A: The NRC has been very closely monitoring the activities in Japan and reviewing all available information to allow us to conclude that the U.S. plants continue to operate safely. There has been no reduction in the licensing or oversight function of the NRC as it relates to any of the NRC licensees. Contributors to the conclusion that the current fleet of reactors and materials licensees continue to protect the public health and safety are based on a number of principles, including defense in depth.

The fact that every reactor in the country is designed for natural events, based on the specific site where the reactor is located, that there are multiple fission product barriers, and that there are a wide range of diverse and redundant safety features in order to provide that public health and safety assurance. The NRC has a long regulatory history of conservative decision making. The NRC has been intelligently using risk insights to help inform the regulatory process and has required improvements to the plant designs as we learn from operating experience. Some of these include severe accident management guidelines, revisions to the emergency operating procedures, procedures and proceses for dealing with large fires and explosions regardless of the cause, and requirements for coping with station blackout.

Q: *How would the U.S. have responded to the events of March 11?* ***UPDATED***

A: The NRC requires plant designs to include multiple and diverse safety systems, and plants must test their emergency response capabilities on a regular basis. Plant operators are very capable of responding to significant events. U.S. nuclear power plants have emergency operating procedures as well as severe accident management guidelines that ensure that the containment structure integrity takes priority in an accident situation. Therefore, in an event that goes beyond those analyzed in the original plant design (i.e., beyond design basis event), such as the one at Fukushima Daiichi, U.S. BWR operators are trained to preserve primary and secondary containment by venting to provide the greatest assurance of public protection during a severe accident. Each U.S. plant has an emergency plan that is coordinated with local, State and Federal departments and agencies to ensure the safety of the public within the Emergency Planning Zone. In addition, NRC regulations require plants to have plans in place that would allow them to mitigate even worst-case scenarios. Since 9/11, we have implemented requirements for licensees to have additional response capabilities for extreme situations.

U.S. Plants

Q: *How did the NRC develop its computer-based projections that supported the evacuation decision?*

A: The NRC uses the RASCAL computer code to perform offsite radiation dose projections. The RASCAL computer program contains information about U.S. nuclear reactor design types, radiation release pathways from the nuclear power plant to the environment, radionuclide source terms and meteorology. However, RASCAL is not capable of evaluating concurrent and multiple nuclear plant failures. So, to approximate the events unfolding at the Fukushima Daiichi facility, the NRC developed a model that aggregated information from the three operating reactors and the spent fuel pool. This aggregate model was then evaluated using the RASCAL computer code. The radiation doses calculated by the RASCAL code were predicted to exceed the protective action guidelines (PAGs) established by the U.S. Environmental Protection Agency (EPA) well beyond the 10-mile exposure pathway EPZ and beyond the 30 kilometer sheltering zone recommended by the Japanese authorities. Subsequent aerial monitoring by the U.S. Department of Energy (DOE) fixed-wing aircraft monitoring showed elevated radiation dose rates that were in excess of the EPA relocation PAGs to a distance beyond 25 miles from the facility.

Generic Issues Program

Q: *Is the NRC relooking at seismic analysis for US plants?* ***UPDATED***

A: 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 a generic review referred to as GI-199, "Implications of Updated Probabilistic Seismic Estimates in Central and Eastern United States on Existing Plants," to again assess the resistance of US nuclear plants to earthquakes. In addition, the NRC has been reviewing new seismic information regarding the plants in California for many years.

Q: *Where can I get current information about Generic Issue 199?*

A: 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/.

GI-199

Q: *Where can I get current information about Generic Issue 199?*

A: 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/.

Q: *What is Generic Issue 199 about?* ***UPDATED***

A: 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 shaking above the seismic design basis for some nuclear power plants in the Central and Eastern United States is still low, but larger than previous estimates.

U.S. Plants

Q: *What level of earthquake hazard are the US reactors designed for?*

A: 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 1x10-4/year, but this can be thought of as the ground motion that occurs every 10,000 years on average. One important aspect is that probabilistic 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.

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

A: 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.

Q: *Does GI-199 provide rankings of US nuclear plants in terms of safety?* ***UPDATED***

A: 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 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.

Q: *What are the current findings of GI-199?*

A: 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.

License Renewal

Q: *How will the events in Japan affect license renewal for U.S. plants?*

A: The NRC's recently initiated review of U.S. plants will examine current practice at operating reactors to ensure proper actions will be taken if a severe event occurs – this covers plants regardless of where they are in their license lifetime. The events in Japan, based on what's known at this time, appear to be unrelated to issues examined in license renewal. The NRC's long-term review of its regulations will determine whether any revisions to license renewal reviews are necessary.

Q: *Why do license renewal reviews not include a review of the plant's response to external events?* ***NEW!***

A: The regulations stipulating the requirements associated with license renewal were issued via rulemaking in 1991 (54 FR 64943). As described in the Statement of Considerations (SOC) for this license renewal rule, the Commission determined that, with the exception of age-related degradation unique to license renewal, the NRC's existing regulatory process is adequate to ensure that the licensing bases of all currently operating plants provide and maintain an acceptable level of safety for operation. The Commission considered whether or not to include plant responses to external events that may be outside the licensing basis but reasoned that the existing regulatory process was sufficient to address those instances while at the same time avoiding duplicative and, perhaps, less efficient assessments. With this understanding, the Commission maintained that the focus of license application renewals should be limited to the age-related degradation management for systems, structures and components (SSCs) that are included in the scope of license renewal (e.g., important to safety, or whose failure could impact safety equipment). As a consequence, license renewal reviews consider applicant activities to detect, manage, and correct the effects of age-related materials degradation on SSCs to ensure that the functionality of safety equipment is not adversely impacted during the renewed license operating period.

Recent proceedings associated with Oyster Creek license renewal have reiterated the Commission's position that the NRC's comprehensive and ongoing oversight of licensed facilities will assure that useful data, operating experience, lessons learned, etc. will be absorbed by changes in NRC rules, orders, and license amendments, as needed, accompanied by the public participation required by statute and regulation. Therefore, plant response to external events will be reviewed when the need is identified, irrespective of the plant's status regarding license renewal (e.g., post-Fukushima review is being done for all plants, and actions will be taken and applied based on plant designs). The NRC is currently reviewing the lessons learned from the events at the Fukushima Daiichi facility in Japan to determine if additional requirements are needed. If changes are recommended for any identified issues, they will be applied to plants irrespective of whether a plant has a renewed license or not.

MOX Fuel

Q: *Where in the U.S. are commercial nuclear power reactors currently licensed to use MOX fuel. Where is MOX fuel currently in use?*

A: There are currently no nuclear power plants in the U.S. that are utilizing mixed-oxide (MOX) fuel. In response to a license amendment request from Duke Energy Carolinas, LLC, the NRC authorized the use of four MOX fuel lead test assemblies (LTAs) in one of the two units at the Catawba Nuclear Station. The MOX LTAs were loaded into the reactor in the spring of 2005. The LTAs were irradiated for two operating cycles and were removed in the spring of 2008. Testing and evaluation of the MOX fuel lead test assemblies at Catawba is no longer ongoing and there are no plans for its resumption.

The four LTAs are currently in the spent fuel pool at Catawba Nuclear Station. Five pins from these assemblies were sent to Oak Ridge National Laboratory in January 2009 and are currently undergoing analysis.

Additional information on MOX fuel and its use in power reactors are available at the following links:

http://www.nrc.gov/materials/fuel-cycle-fac/mox/reactors.html and http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/mox-bg.html.

Q: *Are there any active license applications for MOX fuel use or production?*

A: There are currently no active license applications for use of MOX fuel in nuclear power reactors in the U.S. Shaw AREVA MOX Services (MOX Services), under contract to the U.S. Department of Energy (DOE) applied to the NRC for approval to construct a Mixed Oxide Fuel Fabrication Facility (MFFF) at the Savannah River site in Aiken, South Carolina. The NRC issued a construction authorization in March 2005 for this facility. In September 2006, MOX Services submitted a License Application (LA) to possess and use radioactive material. The NRC reviewed the LA and published its Final Safety Evaluation Report (SER) in December 2010.

Upon verification of construction of the principal structures, systems and components (PSSCs) of the MFFF, the NRC may issue a license to possess and use radioactive material at the facility. The NRC understands that the schedule for completion of construction of the PSSCs is expected to be in the 2014/2015 timeframe to allow operations to begin by 2016. The NRC also understands that the DOE has solicited the commercial nuclear power industry to assess interest in future use of MOX fuel that will be produced at this facility.

New Nuclear Power Plants

Q: *With all this happening, how can the NRC continue to approve new nuclear power plants?*

A: It is premature to speculate what, if any, effect the events in Japan will have on the licensing of new nuclear power plants.

Q: *Will this incident affect new reactor licensing?*

A: It is not appropriate to hypothesize on such a future scenario at this point.

U.S. Plants

Q: *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?*

A: The regulations related to seismic requirements are contained in General Design Criterion 2 in Appendix A to Title 10 of the *Code of Federal Regulations*, Part 50.

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 1x10-4 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.

<u>Potential Consequences</u>

Q: *Why is KI administered during nuclear emergencies?*

A: KI – potassium iodide – is one of the protective measures that might be taken in a radiological emergency in this country. A KI tablet will saturate the thyroid with non radioactive iodine and prevent the absorption of radioactive iodine that could be part of the radioactive material mix of radionuclides in a release. KI does not prevent exposure from these other radionuclides.

Q: *What should be done to protect people in Alaska, Hawaii and the West Coast from radioactive fallout?*

A: The NRC continues to believe that the type and design of the Japanese reactors, combined with how events have unfolded, will prevent radiation at harmful levels from reaching U.S. territory.

Q: *What are the short-term and long-term effects of exposure to radiation?*

A: The NRC does not expect that residents of the United States or its territories are at any risk of exposure to harmful levels of radiation resulting from the events in Japan.

On a daily basis, people are exposed to naturally occurring sources of radiation, such as from the sun or medical X-rays. The resulting effects are dependent on the strength and type of radiation as well as the duration of exposure.

Q: *My family has planned a vacation to Hawaii/Alaska/Seattle next week – is it safe to go, or should we cancel our plans?*

A: The NRC does not expect that residents of the United States or its territories are at any risk of exposure to harmful levels of radiation resulting from the events in Japan. Any changes to travel are a personal decision. The NRC is unaware of any travel restrictions within the United States or its territories.

U.S. Plants

Q: *What are the risks to my children?*

A: At this time, the NRC does not believe that protective measures are necessary in the United States. We do not expect any U.S. states or territories to experience harmful levels of radioactivity. In the unlikely event that circumstances change, U.S. residents should listen to the protective action decisions of their states and counties. These protective action decisions could include actions such as sheltering, evacuation, or taking potassium iodide. The NRC will provide technical assistance to the states should they request it. United States citizens in Japan are encouraged to follow the protective measures recommended by the Japanese government. These measures appear to be consistent with steps the United States would take.

Q: *The radiation "plume" seems to be going out to sea -- what is the danger of it reaching Alaska? Hawaii? The west coast?*

A: In response to nuclear emergencies, the NRC works with other U.S. agencies to monitor radioactive releases and predict their path. The NRC continues to monitor information regarding wind patterns near the Japanese nuclear power plants. Nevertheless, given the thousands of miles between the two countries, Hawaii, Alaska, the U.S. Territories and the U.S. West Coast are not expected to experience any harmful levels of radioactivity.

Q: *Has the government set up radiation monitoring stations to track the release?*

A: The NRC understands that EPA is utilizing its existing nationwide radiation monitoring system, RadNet, to monitor continuously the nation's air and regularly monitors drinking water, milk and precipitation for environmental radiation. EPA has publicly stated its agreement with the NRC's assessment that we do not expect to see radiation at harmful levels reaching the U.S. from damaged Japanese nuclear power plants. Nevertheless, EPA has stated that it plans to work with its federal partners to deploy additional monitoring capabilities to parts of the western U.S. and U.S. territories.

Q: *Is the U.S. government tracking the radiation released from the Japanese plants?*

A: Yes, a number of U.S. agencies are involved in monitoring and assessing radiation including EPA, DOE, and NRC. The best source of additional information is the Environmental Protection Agency.

Q: *Is there a danger of radiation making it to the United States?*

A: In response to nuclear emergencies, the NRC works with other U.S. agencies to monitor radioactive releases and predict their path. The NRC continues to monitor information regarding wind patterns near the Japanese nuclear power plants. Nevertheless, given the thousands of miles between the two countries, Hawaii, Alaska, the U.S. Territories and the U.S. West Coast are not expected to experience any harmful levels of radioactivity.

Q: *Was there any damage to US reactors from either the earthquake or the resulting tsunami?*

A: No.

U.S. Plants

Q: *Are air and sea shipments from Japan being checked for radiation contamination?* ***UPDATED***

A: U.S. Customs and Border Protection (CBP), a part of the Department of Homeland Security, is responsible for monitoring food and cargo at U.S. ports of entry. In accordance with established protocols, CBP uses radiation detection equipment at both air and sea ports, and uses this equipment, along with specific operational protocols, to resolve any security or safety risks that are identified with inbound travelers and cargo. CBP has issued field guidance reiterating its operational protocols and directing field personnel to specifically monitor maritime and air traffic from Japan. CBP will continue to evaluate the potential risks posed by radiation contamination on inbound travelers and cargo and will adjust its detection and response protocols, in coordination with its interagency partners, as developments warrant. The NRC works closely with CBP and the U.S. Environmental Protection Agency when CBP identifies radioactive materials that may involve licensed materials or radioactive materials shipped from other countries inadvertently.

Q: *Are there other protective measures I should be taking?*

A: At this time, the NRC does not believe that protective measures are necessary in the United States. We do not expect any U.S. states or territories to experience harmful levels of radioactivity. In the unlikely event that circumstances change, U.S. residents should listen to the protective action decisions of their states and counties. These protective action decisions could include actions such as sheltering, evacuation, or taking potassium iodide. The NRC will provide technical assistance to the states should they request it. United States citizens in Japan are encouraged to follow the protective measures recommended by the Japanese government. These measures appear to be consistent with steps the United States would take.

Q: *I live in the Western United States – should I be taking potassium iodide (KI)?*

A: At this time, the NRC does not believe that protective measures are necessary in the United States. We do not expect any U.S. states or territories to experience harmful levels of radioactivity. In the unlikely event that circumstances change, U.S. residents should listen to the protective action decisions of their states and counties. These protective action decisions could include actions such as sheltering, evacuation, or taking potassium iodide. The NRC will provide technical assistance to the states should they request it.

Power Supplies

Q: *What are US plants required to have for backup power?*

A: U.S. plants are required to meet General Design Criterion 17 in Appendix A to Title 10 of the *Code of Federal Regulations*, Part 50. Reactor units must have 2 independent power supplies. All U.S. plants, except one (i.e., Oconee), have diesel generators and battery backup systems. The remaining plant has a hydroelectric power facility for backup. Most of the U.S. plants with diesels have two diesels per unit and those that have only one dedicated diesel have a swing diesel available. The regulations do not specify the length of time that the diesels and batteries must operate following a loss of offsite power (most sites plan to run the diesels for multiple days and have battery backup capability for 8 hours). Instead the amount of time is dependent on the site recovery strategy and is based on providing sufficient capacity to assure that the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

U.S. Plants

Q: *Are U.S. nuclear power plants designed for scenarios similar to what happened in Japan where all power to the reactors (i.e., both the power grid and emergency onsite power) was lost as a result of the earthquake and resultant tsunami?*

A: The NRC requires that all nuclear power plants are able to withstand a station blackout (SBO) - a complete loss of AC electric power to the station. These requirements are specified in 10 CFR 50.63, Loss of all alternating current power, and a more detailed definition is provided in 10 CFR 50.2, Definitions. The definition of coping is the time it takes until off site power is restored (i.e., the grid) or an emergency diesel generator, located either onsite or offsite, is restored to service. To meet this requirement, all nuclear power plants performed an SBO coping analysis that determined how long the plant could cope without AC power. The NRC has provided guidance for determining a plant specific SBO duration in Regulatory Guide 1.155, "Station Blaskout," (August 1988). In general, SBO durations range from 2 to 16 hours, though licensees may propose alternate durations based on specific factors relating to the offsite and onsite power characteristics. There are two methods of coping with an SBO event. They are either: (i) AC independent (i.e., relying on battery power), or; (ii) alternate AC (AAC).

AC independent plants had to satisfy all the requirements for maintaining a plant in a safe condition for maximum duration of 4 hours.

If the configuration of offsite power (i.e., the grid system), onsite power (i.e., emergency diesel generators) and reliability of these sources could be affected by weather related events, and if restoration of these sources was not possible within 4 hours, then plants had to use an alternate AC source (i.e, AAC). Some plants decided to comply with the SBO rule by using the AAC as they alreay that capability on their sites. Plants using an AAC source had a variable coping duration between 2 hours and 16 hours. This duration was subject to factors affecting the restoration of onsite or offsite power sources. The capablity for coping with an SBO of specified duration must be determined by a coping analysis for plants with an AC independent method (i.e., batteries) and for plants with an AAC if that source is not available within 10 minutes of the initiating event.

Q: *Is our battery backup power less effective than the Japanese?* ***UPDATED***

A: US regulations do not specify the length of time that you need to have the batteries operate following a loss of offsite power. Instead, the amount of time is dependent on the site recovery strategy and is based on providing sufficient capacity to assure that the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

With respect to a comparison of battery backup power effectiveness, we currently do not have sufficient information to compare the differences in design requirements and performance characteristics of nuclear-grade batteries in the U.S. and Japanese nulcear power plants. However, in the U.S., nuclear power plants utilize redundant nuclear-grade (i.e., Class 1E, safety-related) batteries that are designed and constructed using rigorous standards and are routinely tested in accordance with plant technical specifications to ensure adequate capacity and capability exists to perform their intended safety functions. These batteries are located in structures that can withstand external environmental events such as earthquakes, tornadoes, tsunamis, and floods in accordance with NRC regulations. For U.S. nuclear power plants, the typical desig duty cycles for safety grade batteries range from 1 - 8 hours (i.e., 1-2 hours for accident; 4 hours for station blackout; and 1-8 hours for a fire).

U.S. Plants

Q: *A recent newswire article claimed that 93 of the U.S. nuclear power plants only had a 4-hour coping capacity for SBO. The rest of the plants could cope for 8 hours. Is that information correct?*

A: That information is not correct. First to clarify SBO coping capacity, the definition of coping is the time required to restore off site (i.e., the grid) or onsite power (i.e., emergency diesel generator). There are two different methods for coping with an SBO event:

- Relying only on battery power (AC-independent)

- Relying on an Alternate AC power source (i.e., an emergency diesel generator, hydro-powered generator, or a gas turbine)

The NRC only allows up to a 4-hour SBO coping analysis with batteries, anything longer requires an alternate AC source. The SBO coping time for an alternate AC source ranges from 2 hours to a maximum of 16 hours. For the 104 operating plants in the U.S., the basic breakdown with respect to power source is that 44 plants are "battery coping plants" and 60 plants are "alternate AC source" plants.

With respect to SBO coping times, a further breakdown includes 44 plants that have adopted the AC-independent method and have battery power for 4 hours. Another 43 plants use the AAC methodology and can restore AC power (i.e., offsite power or emergency diesel generator) within 4 hours. Hence a total of 87 plants have 4-hour SBO coping duration.

For the remainder of U.S. plants, 14 plants use the AAC methodology and can restore AC power (i.e., offsite power or emergency diesel generator) within 8 hours; hence these 14 plants have an 8-hour SBO coping duration. There are 3 plants that use the AAC methodology and have 16-hour duration for restoration of AC power; hence the remaining 3 plants have a 16-hour SBO coping duration.

<u>Price-Anderson Act</u>

Q: *When does the Price-Anderson Act expire?*

A: In 2005, the Price-Anderson Act was extended through December 31, 2025.

Q: *Has Price-Anderson ever been used?*

A: Only once. During the 1979 accident at the Three Mile Island Nuclear Power Plant, the Price-Anderson Act provided liability insurance to the public. The day after the accident, insurance company representatives established a local claims office in Pennsylvania. Advertisements were placed in local newspapers to inform residents of claims procedures. The insurance paid for the living expenses of families who decided to evacuate, although evacuation was not immediately ordered. When Pennsylvania's governor recommended the evacuation of pregnant women and families with young children who lived near the plant, the insurance paid for those evacuation expenses, too. In 1979, more than 3,000 people received nearly $1.2 million in evacuation claims. More than 600 people were also reimbursed for lost wages as a result of the accident. In the months after the accident, numerous lawsuits were filed alleging various injuries and property damages. To date, the Price-Anderson insurance has paid about $71 million in claims and litigation costs associated with the Three Mile Island accident. All payments were made from the primary insurance coverage. Money from the secondary layer of insurance was not needed.

Q: *The Price-Anderson Act is a federal law? Why does the government spend my tax dollars on providing nuclear insurance to big energy companies?*

A: The Price-Anderson Act is a federal law, but your tax dollars do not pay for the insurance it requires owners of nuclear power plants to purchase. The extra insurance protection required for large commercial nuclear power companies is purchased at no cost to the public or the federal government.

U.S. Plants

Q: *I'll have to find another place to stay if I have to evacuate my home during a nuclear accident. I can't afford to pay for a hotel or apartment for several months while the government tries to clean things up. How am I supposed to pay for that?*

A: Insurance under the Price-Anderson Act covers bodily injury, sickness, disease or resulting death, property damage and loss, and reasonable living expenses for people who are evacuated from a nuclear accident. The Stafford Act is another federal law that provides disaster relief to state and local governments. If a nuclear accident is declared an emergency or major disaster by the President, the Stafford Act will also be available to provide assistance to accident victims. The Stafford Act allows the federal and state governments to share costs of temporary housing for up to 18 months. It also provides additional money for home repair and temporary mortgage or rental payments. Distribution of Stafford Act funding is done through the Federal Emergency Management Agency. Together, the Price-Anderson and Stafford Acts provide money for a variety of expenses following a nuclear accident.

Q: *The accidents in Japan affected the reactors and the spent fuel pools. Does the Price-Anderson Act cover all nuclear plant accidents or just some of them?*

A: The Price-Anderson Act covers all property and liability claims resulting from nuclear accidents at commercial nuclear power plants. This includes any incident related to the reactor or the spent fuel pool. Price-Andersen also covers claims related to transporting nuclear fuel and nuclear waste in and out of the plant.

Q: *My insurance company is a nationally known, reputable business that I trust. What insurance company does the nuclear plant use – a good one or the cheapest one they can find?*

A: All U.S. nuclear power plant owners purchase their Price-Anderson insurance from American Nuclear Insurers (ANI), which is made of several large and reputable insurance companies. About half of the ANI companies are foreign insurance businesses. On average, a nuclear power plant owner pays about $400,000 per year for Price-Anderson insurance at a single-unit reactor site. For power plants with more than one reactor, the total annual insurance cost is typically discounted, similar to automobile insurance for households with more than one car.

Q: *My insurance agent said that my homeowner's insurance does not cover nuclear accidents. Does Price-Anderson protect me?*

A: Your homeowner's insurance policy does not cover nuclear accidents because Price-Anderson covers claims related to nuclear accidents. By law, owners of nuclear power plants are required to purchase $375 million of offsite liability insurance for each reactor at the plant. If a nuclear accident causes damages of more than $375 million, the insurance is supplemented by additional coverage that is shared by every nuclear power plant in the country. There are currently 104 reactors licensed to operate in the United States, so this secondary pool of money contains about $12.6 billion. If all of this secondary money is used, Congress would determine whether to provide additional disaster relief.

Q: *What is the Price-Anderson Act?*

A: In 1957, a federal law called the Price-Anderson Act was established to ensure that adequate money would be available to pay insurance claims following an accident at a commercial nuclear power plant. That law is still in place to protect those that live around nuclear power plants.

U.S. Plants

Q: *Why does the NRC let a private insurance company determine the amount of insurance coverage? Why does this private company control public protection?*

A: The intent of the Price-Anderson Act was to allow the government to regulate the safety of nuclear power while allowing the private insurance industry to provide financial protection. The NRC is the government agency that is responsible for ensuring that nuclear power plants are designed and operated in a way that protects public health and safety. The NRC is confident that the amount of insurance coverage determined by the private insurance company is adequate to provide financial compensation in the event of a nuclear accident.

Q: *More than a million people live within 50 miles of Plant X. How is a $375 million insurance policy supposed to cover all of us?*

A: The Price-Anderson Act is a federal law that requires owners of nuclear power plants to purchase $375 million of offsite liability insurance for each reactor at the plant. If a nuclear accident causes damages of more than $375 million, the insurance is supplemented by additional coverage that is shared by every nuclear power plant in the country. There are currently 104 reactors licensed to operate in the United States, so this secondary pool of money contains about $12.6 billion ... all of this secondary money is used, Congress would determine whether to provide additional disaster relief.

Radiation Protection

Q: *I live in the Western United States – should I be taking potassium iodide (KI)?*

A: At this time, the NRC does not believe that protective measures are necessary in the United States. We do not expect any U.S. states or territories to experience harmful levels of radioactivity. In the unlikely event that circumstances change, U.S. residents should listen to the protective action decisions of their states and counties. These protective action decisions could include actions such as sheltering, evacuation, or taking potassium iodide. The NRC will provide technical assistance to the states should they request it.

Q: *What is the official agency to report radiation numbers and what is the public contact?*

A: NRC regulations require nuclear power plants to report any radiation doses detected at the plant that could be harmful to the public. This would include doses that are generated by the plant or by an external source. During an event in the U.S., it is the state's responsibility to provide protective action decisions for public health and safety. For this incident, the Japanese are responsible for reporting the public dose; nevertheless, should radiation doses be detected within the U.S., it would still be the state's responsibility to provide protective action decisions for public health and safety.

Q: *Where would I get IOSAT Potassium Iodide if my city should experience fallout from the Japanese nuclear disaster? Is this the right precaution or is there anything else that can be done to protect myself?*

A: We do not expect any U.S. states or territories to experience harmful levels of radioactivity. As such, we do not believe that there is any need for residents of the United States to take potassium iodide. U.S. residents should listen to the protective action decisions by their states and counties. As necessary, protective action decisions could include actions such as sheltering, evacuating, or taking potassium iodide.

Additional information regarding the use of potassium iodide can be found on NRC's webpage at the following link: http://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/potassium-iodide-use.html.

Since Potassium Iodide is classified as a drug. Additional information is on the Food and Drug Administration's web site: www.fda.gov.

U.S. Plants

Q: *What should be done to protect people in Alaska, Hawaii and the West Coast from radioactive fallout?*

A: The NRC continues to believe that the type and design of the Japanese reactors, combined with how events have unfolded, will prevent radiation at harmful levels from reaching U.S. territory.

Q: *Why is KI administered during nuclear emergencies?*

A: KI – potassium iodide – is one of the protective measures that might be taken in a radiological emergency in this country. A KI tablet will saturate the thyroid with non radioactive iodine and prevent the absorption of radioactive iodine that could be part of the radioactive material mix of radionuclides in a release. KI does not prevent exposure from these other radionuclides.

Q: *How is EPA monitoring, collecting and posting information related to the impacts in the U.S. of the accident in Japan?* ***NEW!***

A: The EPA monitors, collects, and posts information related to the impacts of the Japanese events on the U.S. using their RadNet system. They have 100 fixed radiation monitoring sites in 48 states plus 40 additional deployable monitors that may be sent where needed. The fixed monitors provide information on beta and gamma radiation levels. The deployable monitors measure the external exposure rate and provide weather information. The data from these monitors is sent to a computer, where it is continually reviewed and is usually posted on the EPA's Central Data Exchange website (http://epa.gov/cdx) within 2 hours. However, if the computer picks up an abnormality in the radiation level, then the EPA laboratory staff is alerted and reviews the information prior to it being posted. In response to the events in Japan, EPA has sent additional monitors to Guam, Hawaii, and Alaska.

The EPA also monitors contamination in rainwater and drinking water as well as the level of iodine in milk. The EPA provides updates on these testing efforts and a summary of the air radiation monitoring results on its webpage, http://www.epa.gov/japan2011/. This webpage contains a link to Frequently Asked Questions, which was the source of information for this response. Additional information may be found there.

Reactor Oversight

Q: *Why do license renewal reviews not include a review of the plant's response to external events?* ***NEW!***

A: The regulations stipulating the requirements associated with license renewal were issued via rulemaking in 1991 (54 FR 64943). As described in the Statement of Considerations (SOC) for this license renewal rule, the Commission determined that, with the exception of age-related degradation unique to license renewal, the NRC's existing regulatory process is adequate to ensure that the licensing bases of all currently operating plants provide and maintain an acceptable level of safety for operation. The Commission considered whether or not to include plant responses to external events that may be outside the licensing basis but reasoned that the existing regulatory process was sufficient to address those instances while at the same time avoiding duplicative and, perhaps, less efficient assessments. With this understanding, the Commission maintained that the focus of license application renewals should be limited to the age-related degradation management for systems, structures and components (SSCs) that are included in the scope of license renewal (e.g., important to safety, or whose failure could impact safety equipment). As a consequence, license renewal reviews consider applicant activities to detect, manage, and correct the effects of age-related materials degradation on SSCs to ensure that the functionality of safety equipment is not adversely impacted during the renewed license operating period.

Recent proceedings associated with Oyster Creek license renewal have reiterated the Commission's position that the NRC's comprehensive and ongoing oversight of licensed facilities will assure that useful data, operating experience, lessons learned, etc. will be absorbed by changes in NRC rules, orders, and license amendments, as needed, accompanied by the public participation required by statute and regulation. Therefore, plant response to external events will be reviewed when the need is identified, irrespective of the plant's status regarding license renewal (e.g., post-Fukushima review is being done for all plants, and actions will be taken and applied based on plant designs). The NRC is currently reviewing the lessons learned from the events at the Fukushima Daiichi facility in Japan to determine if additional requirements are needed. If changes are recommended for any identified issues, they will be applied to plants irrespective of whether a plant has a renewed license or not.

Severe Accidents

Q: *What is the worst-case scenario?*

A: In a nuclear emergency, the most important action is to ensure the core is covered with water to provide cooling to remove any heat from the fuel rods. Without adequate cooling, the fuel rods will melt. Should the final containment structure fail, radiation from these melting fuel rods would be released to the atmosphere and additional protective measures may be necessary depending on factors such as prevailing wind patterns.

Q: *How would the U.S. have responded to the events of March 11?* ***UPDATED***

A: The NRC requires plant designs to include multiple and diverse safety systems, and plants must test their emergency response capabilities on a regular basis. Plant operators are very capable of responding to significant events. U.S. nuclear power plants have emergency operating procedures as well as severe accident management guidelines that ensure that the containment structure integrity takes priority in an accident situation. Therefore, in an event that goes beyond those analyzed in the original plant design (i.e., beyond design basis event), such as the one at Fukushima Daiichi, U.S. BWR operators are trained to preserve primary and secondary containment by venting to provide the greatest assurance of public protection during a severe accident. Each U.S. plant has an emergency plan that is coordinated with local, State and Federal departments and agencies to ensure the safety of the public within the Emergency Planning Zone. In addition, NRC regulations require plants to have plans in place that would allow them to mitigate even worst-case scenarios. Since 9/11, we have implemented requirements for licensees to have additional response capabilities for extreme situations.

U.S. Plants

Q: *Do U.S. nuclear plants have better capabilities to respond to natural disasters than the plants in Japan?*

A: The NRC is not yet aware of all of the differences that may exist between the reactors that are of similar design and vintage as those operated in the U.S. Many improvements have been made to U.S boiling water reactors (BWRs). For example, NRC Generic Letter 89-16, "Installation of a Hardened Wetwell Vent," conveyed the importance of having a robust pathway for venting primary containment, which contains the suppression pool, in certain severe accident scenarios. In response, all BWRs with Mark I containments that didn't have an existing strengthened or "hardened" pathway for venting directly from primary containment to the outside, made modifications to the plant consistent with the intent of the Generic Letter. This design feature permits a controlled depressurization of primary containment as well as a controlled release of radioactive materials and combustible hydrogen that could be generated by damaged fuel, as may occur during severe accidents. U.S. nuclear power plants are built to withstand external hazards, including earthquakes tsunamis, and flooding, as appropriate. In addition to the design of the plants, significant effort goes into emergency response planning, preparation, and training. The NRC has also completed substantial research and analysis that resulted in the development and use of severe accident management guidelines. These insights have informed our decision making and review of licensed activities.

Q: *What happens when/if a plant "melts down"?*

A: In short, nuclear power plants in the United States are designed to be safe. To prevent the release of radioactive material, there are multiple barriers between the radioactive material and the environment, including the fuel cladding, the heavy steel reactor vessel itself and the containment building, usually a heavily reinforced structure of concrete and steel several feet thick.

Q: *Could there be core damage and radiation release at a U.S. plant if a natural disaster exceeding the plant design were to occur?* ***UPDATED***

A: U.S. nuclear power plants are built to withstand external hazards, including earthquakes, tsunamis, and flooding, as appropriate. The NRC has made substantial effort over time to ensure that vulnerabilities to both internal and external hazards were considered and mitigated in the plant current design and licensing basis of its regulated facilities. In 1988, the NRC's Generic Letter (GL) No. 88-20, "Individual Plant Examination [IPE] for Severe Accident Vulnerabilities," requested plant owners to perform a systematic evaluation of plant-specific vulnerabilities and report the results to the Commission. For many plants, the IPEs became the basis for the plant's initial Probabilistic Risk Assessment (PRA). Later the NRC issued Supplement 4 to GL 88-20, that requested licensees to evaluate vulnerabilities to external events (IPEEE). Most licensees made improvements to their facilities to reduce vulnerabilities identified in their IPEs and IPEEEs.

The ground motions that are used as seismic design bases at US nuclear plants are called the Safe Shutdown Earthquake (SSE) ground motions. In the 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 a generic review (i.e., GI-199) to again assess the resistance of US nuclear plants to earthquakes. Based on NRC's preliminary analyses to date, the average 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.

<u>Spent Fuel</u>

Q: *Do U.S. nuclear power plants store their fuel above grade? Why is this considered safe?* ***NEW!***

A: For boiling water reactor (BWR) Mark I and II designs, the spent fuel pool structures are located in the reactor building at an elevation several stories above the ground (about 50 to 60 feet above ground for the Mark I reactors). The spent fuel pools at other operating reactors in the U.S. are typically located with the bottom of the pool at or below plant grade level. Regardless of the location of the pool, its robust construction provides the potential for the structure to withstand events well beyond those considered in the original design. In addition, there are multiple means of restoring water to the spent fuel pools in the unlikely event that any is lost.

Q: *How do you know the fuel pools are safe? Does the NRC inspect these facilities, or just the reactor itself?* ***NEW!***

A: NRC inspectors are responsible for verifying that spent fuel pools and related operations are consistent with a plant's license. For example, our staff inspects spent fuel pool operations during each refueling outage. We also performed specialized inspections to verify that new spent fuel cooling capabilities and operating practices were being implemented properly.

Q: *What would happen to a spent fuel pool during an earthquake? How can I be sure the pool wouldn't be damaged?* ***NEW!***

A: All spent fuel pools are designed to seismic standards consistent with other important safety-related structures on the site. The pool and its supporting systems are located within structures that protect against natural phenomena and flying debris. The pools' thick walls and floors provide structural integrity and further protection of the fuel from natural phenomena and debris. In addition, the deep water above the stored fuel (typically more than 20 feet above the top of the spent fuel rods) would absorb the energy of debris that could fall into the pool. Finally, the racks that support the fuel are designed to keep the fuel in its designed configuration after a seismic event.

Q: *Can spent fuel pools leak?* ***NEW!***

A: Spent fuel pools lined with stainless steel are designed to protect against a substantial loss of the water that cools the fuel. Pipes typically enter the pool above the level of the stored fuel, so that the fuel would stay covered even if there were a problem with one of the pipes. The only exceptions are small leakage-detection lines and, at two pressurized water reactor (PWR) sites, robust fuel transfer tubes that enter the spent fuel pool directly. The liner normally prevents water from being lost through the leak detection lines, and isolation valves or plugs are available if the liner experiences a large leak or tear.

Q: *How would you know about a leak in such a large pool of water?* ***NEW!***

A: The spent fuel pools associated with all but one operating reactor have liner leakage collection to allow detection of very small leaks. In addition, the spent fuel pool and fuel storage area have diverse instruments to alert operators to possible large losses of water, which could be indicated by low water level, high water temperature, or high radiation levels.

U.S. Plants

Q: *How can operators get water back in the pool if there is a leak or a failure?* ***NEW!***

A: All plants have systems available to replace water that could evaporate or leak from a spent fuel pool. Most plants have at least one system designed to be available following a design basis earthquake. In addition, the industry's experience indicates that systems not specifically designed to meet seismic criteria are likely to survive a design basis earthquake and be available to replenish water to the spent fuel pools. Furthermore, plant operators can use emergency and accident procedures that identify temporary systems to provide water to the spent fuel pool if normal systems are unavailable. In some cases, operators would need to connect hoses or install short pipes between systems. The fuel is unlikely to become uncovered rapidly because of the large water volume in the pool, the robust design of the pool structure, and the limited paths for loss of water from the pool.

Q: *How are spent fuel pools kept cool? What happens if the cooling system fails?* ***NEW!***

A: The spent fuel pool is cooled by an attached cooling system. The system keeps fuel temperatures low enough that, even if cooling were lost, operators would have substantial time to recover cooling before boiling could occur in the spent fuel pool. Licensees also have backup means to cool the spent fuel pool, using temporary equipment that would be available even after fires, explosions, or other unlikely events that could damage large portions of the facility and prevent operation of normal cooling systems. Operators have been trained to use this backup equipment, and it has been evaluated to provide adequate cooling even if the pool structure loses its water-tight integrity.

Q: *What keeps spent fuel from re-starting a nuclear chain reaction in the pool?* ***NEW!***

A: Spent fuel pools are designed with appropriate space between fuel assemblies and neutron-absorbing plates attached to the storage rack between each fuel assembly. Under normal conditions, these design features mean that there is substantial margin to prevent criticality (i.e., a condition where nuclear fission would become self-sustaining). Calculations demonstrate that some margin to criticality is maintained for a variety of abnormal conditions, including fuel handling accidents involving a dropped fuel assembly.

Q: *How long is spent fuel allowed to be stored in a pool or cask?* ***NEW!***

A: NRC regulations do not specify a maximum time for storing spent fuel in pool or cask. The agency's "waste confidence decision" expresses the Commission's confidence that the fuel can be stored safely in either pool or cask for at least 60 years beyond the licensed life of any reactor without significant environmental effects. At current licensing terms (40 years of initial reactor operation plus 20 of extended operation), that would amount to at least 120 years of safe storage. However, it is important to note that this does not mean NRC "allows" or "permits" storage for that period. Dry casks are licensed or certified for 20 years, with possible renewals of up to 40 years. This shorter licensing term means the casks are reviewed and inspected, and the NRC ensures the licensee has an adequate aging management program to maintain the facility.

U.S. Plants

Q: *The recent waste confidence findings say that fuel can be stored safely for 60 years beyond the reactor's licensed life. Does this mean fuel will be unsafe after 60 years? What if the spent fuel pool runs out of room before the end of a license?* ***NEW!***

A: The NRC staff is currently developing an extended storage and transportation (EST) regulatory program. One aspect of this program is a safety and environmental analysis to support long-term (up to 300 years) storage and handling of spent fuel, as well as associated updates to the "waste confidence" rulemaking. This analysis will include an Environmental Impact Statement (EIS) on the environmental impacts of extended storage of fuel. The 300-year timeframe is appropriate for characterizing and predicting aging effects and aging management issues for EST. The staff plans to consider a variety of cask technologies, storage scenarios, handling activities, site characteristics, and aging phenomena—a complex assessment that relies on multiple supporting technical analyses. Any revisions to the waste confidence rulemaking, however, would not be an "approval" for waste to be stored longer than before—we do that through the licensing and certification of ISFSIs and casks. More information on the staff's plan can be found in SECY-11-0029

Q: *Does the waste confidence decision mean that a particular cask is safe?* ***NEW!***

A: Not specifically. When the NRC issues certificates and licenses for specific dry cask storage systems, the staff makes a determination that the designs provide reasonable assurance that the waste will be stored safely for the term of the license or certificate. The Commission's Waste Confidence Decision is a generic action where the Commission found reasonable assurance that the waste from the nation's nuclear facilities can be stored safely and with minimal environmental impacts until a repository becomes available.

Q: *The waste-confidence revision seems like a long-term effort. What is the NRC doing to improve safety of spent fuel storage now?* ***NEW!***

A: The NRC staff is currently reviewing its processes to identify near-term ways to improve efficiency and effectiveness in licensing, inspection, and enforcement. We expect to identify enhancements to the certification and licensing of storage casks, to the integration of inspection and licensing, and to our internal procedures and guidance. More information on the staff's plans can be found in COMSECY-10-0007.

Q: *What do you look at when you license a fuel storage facility? How do I know it can withstand a natural disaster?* ***NEW!***

A: The NRC's requirements for both wet and dry storage can be found in Title 10 of the Code of Federal Regulations (10 CFR), including the general design criteria in Appendix A to Part 50 and the spent-fuel storage requirements in Part 72. The staff uses these rules to determine that the fuel will remain safe under anticipated operating and accident conditions. There are requirements on topics such as radiation shielding, heat removal, and criticality. In addition, the staff reviews fuel storage designs for protection against external environmental such as seismic events, tornados, and flooding, dynamic effects such as flying debris or drops from fuel handling equipment and drops of fuel storage and handling equipment, and hazards to the storage site from nearby activities.

U.S. Plants

Q: *What about security? How do you know terrorists won't use all of this waste against us?* ***NEW!***

A: For spent fuel, as with reactors, the NRC sets security requirements and licensees are responsible for providing the protection. We constantly remain aware of the capabilities of potential adversaries and threats to facilities, material, and activities, and we focus on physically protecting and controlling spent fuel to prevent sabotage, theft, and diversion. Some key features of these protection programs include intrusion detection, assessment of alarms, response to intrusions, and offsite assistance when necessary. Over the last 20 years, there have been no radiation releases that have affected the public. There have also been no known or suspected attempts to sabotage spent fuel casks or storage facilities. The NRC responded to the terrorist attacks on September 11, 2001, by promptly requiring security enhancements for spent fuel storage, both in spent fuel pools and dry casks.

Q: *What is dry cask storage?* ***NEW!***

A: Dry cask storage allows spent fuel that has already been cooled in the spent fuel pool for several years to be surrounded by inert gas inside a container called a cask. The casks are typically steel cylinders that are either welded or bolted closed. The steel cylinder provides containment of the spent fuel. Each cylinder is surrounded by additional steel, concrete, or other material to provide radiation shielding to workers and members of the public.

Q: *The NRC is reviewing applications for new nuclear power plants. What is the environmental impact of all that extra fuel?* ***NEW!***

A: Continued use and potential growth of nuclear power is expected to increase the amount of waste in storage. This increased amount of spent fuel affects the environmental impacts to be assessed by the NRC staff, such as the need for larger storage capacities. In the staff's plan to develop an environmental impact statement for longer-term spent fuel storage, a preliminary scoping assumption is that nuclear power grows at a "medium" rate (as defined by the Department of Energy), in which nuclear power continues to supply about 20 percent of U.S. electricity production.

Q: *If the SFPs at U.S. plants are not in hardened structures (i.e., concrete containments) as has shown to be the case at Fukushima, why is this acceptable given the risks?*

A: The specific sequence of events regarding the Fukushima plants remains to be determined. However, it appears that the design of the building housing the spent fuel pools at Fukushima did not create or initiate the problems experienced by the fuel pools that have been observed. The NRC's regulatory focus is to ensure that cooling capability is maintained in order to prevent fuel damage. This has been accomplished at U.S. plants by redundant and/or diverse capabilities to provide forced cooling and water addition. As the sequence of events at Fukushima become better understood, we will continue to critically assess the safety of the U.S. plants in the area of spent fuel storage.

Q: *How much fuel is in the spent fuel pool(s) at [Plant XYZ]?*

A: The NRC does not disclose the exact amount of fuel currently stored at a plant's spent fuel storage pool. The Technical Specifications for each plant specify the maximum amount of assemblies that may be stored in the spent fuel pool. The design of the spent fuel pool is specifically reviewed by the NRC to ensure that the spent fuel can be safely stored under normal and accident conditions. Changes to the number of spent fuel assemblies that can be stored in the spent fuel pool must receive prior NRC review and approval.

U.S. Plants

Q: *What kind of license is required for an ISFSI?* ***NEW!***

A: NRC authorizes storage of spent nuclear fuel at an ISFSI in two ways: site-specific or general license. For site-specific applications, the NRC reviews the safety, environmental, physical security and financial aspects of the licensee and proposed ISFSI and, if we conclude it can operate safely, we issue a valid license. This license contains requirements on topics such as leak testing and monitoring and specifies the quantity and type of material the licensee is authorized to store at the site. A general license authorizes storage of spent fuel in casks previously approved by the NRC at a site already licensed to possess fuel or operate a nuclear power plant. Licensees must show the NRC that it is safe to store spent fuel in dry casks at their site, including analysis of earthquake intensity and tornado missiles. Licensees also review their programs (such as security or emergency planning) and make any changes needed to incorporate an ISFSI at their site. Of the currently licensed ISFSIs, 48 are operating under general licenses and 15 have specific licenses.

Q: *How long are ISFSIs at U.S. plants good for (or "designed for")? What kind of analysis does NRC do to support extending their licenses?*

A: Utilities can apply for a site specific license under 10 CFR 72.42 or a general license under 10 CFR 72.212. The general license limits storage of spent fuel in casks that have been pre-approved for use by the NRC. In both cases the NRC's regulations provide for an initial 20-year license term for ISFSI licenses. License renewals are submitted with information consistent with the original license and the NRC staff reviews this information for continued acceptability. Site specific renewals can be requested for a time period chosen and justified by the licensee. License renewals under the general license are limited to 20 years for each renewal application.

BACKGROUND:

[The NRC issued a renewed license in December 2004 for the Surry ISFSI for a 40-year renewal term, through an exemption (ML043430234). In March 2005, NRC also granted a 40-year renewal period for the H.B. Robinson ISFSI (ML050890357).]

Q: *What keeps fuel cool in dry casks?* ***NEW!***

A: Fuel is often moved to dry cask storage after several years in spent fuel pools, so the residual heat given off by the fuel has significantly decreased. These casks are typically thick, leak-tight steel containers inside a robust steel or concrete overpack. The fuel is cooled by natural airflow around the cask.

Q: *Are the spent fuel pools at U.S. plants cooled by safety-related cooling systems at [Plant XYZ]?*

A: Whether the spent fuel pool cooling system is "safety-related" at a particular plant depends on the plants specific accident analysis. Each plant's spent fuel pool cooling system is designed to provide cooling for both normal and accident conditions.

U.S. Plants

Q: *What amount of fuel was originally intended for spent fuel pool storage when the plants in the U.S. were initially licensed (and for how long)?*

A: The amount of fuel that can be stored in a spent fuel pool is governed by each plants' Technical Specifications. The original limit, as well as any increases to the limit are reviewed by the NRC on a plant-specific basis. The spent fuel may be stored in the pool for the duration of the license, including the time taken to decommission the plant.

BACKGROUND:

[Most spent fuel pools at U.S. nuclear power plants were not originally designed to have a storage capacity for all the spent fuel generated by their reactors. Depending upon when a plant was licensed, long-term planning for the spent fuel considered either reprocessing or shipment to a geologic repository. Since reprocessing or storage in a geologic repository are not currently an available option, nuclear power plant licensees have had to employ other options such as increasing the capacity of the spent fuel pool or an independent spent fuel storage installation. Either of these options would receive NRC review and approval prior to use.]

Q: *Is the NRC going to make changes to spent fuel storage/safety requirements in light of the Japanese events (including possibly requiring spent fuel to be transferred to dry cask storage after a certain period of time)?*

A: The NRC continues to believe that U.S. nuclear power plants, including their spent fuel storage facilities, can and do operate safely. Following the events in Japan, the Commission directed the staff to establish a senior level task to conduct a methodical and systematic review of NRC processes and regulations to determine whether the agency should make additional improvements to its regulatory system and make recommendations to the Commission for its policy direction.

BACKGROUND:

[In Staff Requirements Memorandum (SRM-SECY 09-0090) issued in September 2010, the Commission approved revisions to the draft final rule on nuclear waste confidence and directed the staff to initiate a long-term rulemaking to address impacts of storage of spent fuel at onsite storage facilities, offsite storage facilities or both for extended periods. The Commission affirmed its confidence that spent nuclear fuel can be stored safely and securely without significant environmental impacts for at least 60 years after operation at any nuclear power plant either in the SFP or either onsite or offsite ISFSIs. Prior to the events in Japan, the staff provided a proposed plan for the long-term update to the Waste Confidence Rule (10 CFR 51.23) to the Commission in SECY-11-0029 which may be accessed at the following link: http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2011/2011-0029scy.pdf

Following the events in Japan, the Commission directed the staff to establish a senior level task to conduct a methodical and systematic review of NRC processes and regulations to determine whether the agency should make additional improvements to its regulatory system and make recommendations to the Commission for its policy direction. This direction is provided in tasking memorandum (COMSECY-COMGBJ-11-0002 which may be accessed at the following link: http://www.nrc.gov/reading-rm/doc-collections/commission/comm-secy/2011/2011-0002comgbj-srm.pdf. The task force will provide briefings to the Commission on a 30-day quick look report, a 60-day status of the ongoing near term review, and a 90-day completion of near term review.]

Q: *What is spent nuclear fuel?* ***NEW!***

A: "Spent nuclear fuel" refers to fuel elements that have been used at commercial nuclear reactors, but that are no longer capable of economically sustaining a nuclear reaction. Periodically, about one-third of the nuclear fuel in an operating reactor needs to be unloaded and replaced with fresh fuel.

U.S. Plants

Q: *Why is spent fuel hot?* ***NEW!***

A: Spent fuel generates what is called “residual heat” because of radioactive decay of the elements inside the fuel. After the fission reaction is stopped and the reactor is shut down, the products left over from the fuel’s time in the reactor are still radioactive and emit heat as they decay into more stable elements. Although the heat production drops rapidly at first, heat is still generated many years after shutdown. Therefore, the NRC sets requirements on the handling and storage of this fuel to ensure protection of the public and the environment.

Q: *Why doesn’t the NRC have up-to-date figures on how much spent fuel is stored at U.S. nuclear plants? Doesn’t the regulator have a clue about how much of this stuff is out there?* ***NEW!***

A: The NRC and Department of Energy (NNSA) operate the Nuclear Material Management and Safeguards System (NMMSS), a database that tracks Special Nuclear Material (enriched uranium and plutonium). This database does not distinguish between fresh and irradiated material, and the information is withheld from the public for security reasons. That’s why figures on spent fuel inventory come from the industry.

Q: *How much fuel is currently in dry cask storage?* ***NEW!***

A: As of November 2010, there were 63 “independent spent fuel storage installations” (or ISFSIs) licensed to operate at 57 sites in 33 states. These locations are shown on a map on the NRC website at: http://www.nrc.gov/waste/spent-fuel-storage/locations.pdf. Over 1400 casks are stored in these independent facilities.

Q: *How much fuel is stored at decommissioned reactors? Is it in pools or casks?* ***NEW!***

A: There are currently 10 decommissioned nuclear power reactors at 9 sites with no other nuclear operations. According to a 2008 Department of Energy report to Congress, approximately 2800 metric tons of spent fuel is stored at these nine sites. As of the writing of that report, seven of the sites had independent spent fuel storage installations, or ISFSIs. Two additional sites had approximately 1000 metric tons of spent fuel remaining in pool storage.

Q: *What is an “ISFSI”?* ***NEW!***

A: An independent spent fuel storage installation, or ISFSI, is a facility that is designed and constructed for the interim storage of spent nuclear fuel. These facilities are licensed separately from a nuclear power plant and are considered independent even though they may be located on the site of another NRC-licensed facility.

Q: *How do you know the dry casks are safe? Does the NRC inspect these facilities, or just the reactor and spent fuel pool?* ***NEW!***

A: Designs for dry casks are reviewed by the NRC to ensure compliance with regulatory requirements for protection of the public and the environment. If the NRC determines that a storage cask meets the necessary requirements, the NRC will certify that storage cask for use. The NRC is also responsible for inspection of dry cask storage. Before casks are loaded, inspectors with specific knowledge of ISFSI operations assess the adequacy of a “dry run” by the licensee; they then observe all initial cask loadings. The on-site resident inspectors or region-based inspectors may observe later cask loadings, and the regional offices also perform periodic inspections of routine ISFSI operations.

U.S. Plants

Q: *A recent report from the California Coastal Commission, dated March 24, 2011, identified the Humboldt Bay Power Plant as being susceptible to the same type of "megathrust earthquake" and resultant tsunami that occurred in Japan. Is that plant safe?*

A: The nuclear power reactor at the Humboldt Bay Power Plant is located near Eureka, California, and ceased operation in 1976. The plant is currently being decommissioned. All fuel, which was stored in the spent fuel pool since operations ceased, has been moved from the spent fuel pool into an onsite independent spent fuel storage installation (ISFSI) that was reviewed and approved by the NRC. The ISFSI provides an adequate means for safely storing the plant's spent fuel, which has been cooling for several decades, in dry cask/storage containers.

Q: *What is the corresponding radiological risk to that amount of fuel, should there be a fuel pool event. Is that factored into the licensee's emergency planning?*

A: The Final Safety Analysis Report (FSAR) for each plant analyzes a spectrum of accidents, including those that could occur in the spent fuel pool. These analyses are reviewed by the NRC to ensure that they demonstrate that any postulated radiological release would be below regulatory limits. These limits are selected to protect the public health and safety.

A licensee's emergency plan is symptom based to deal with any radiological hazard that could occur onsite. Regardless of the source, it is designed to ensure that appropriate protective actions are taken onsite and appropriate protective actions are recommended offsite.

<u>Station Blackout</u>

Q: *Are U.S. nuclear power plants designed for scenarios similar to what happened in Japan where all power to the reactors (i.e., both the power grid and emergency onsite power) was lost as a result of the earthquake and resultant tsunami?*

A: The NRC requires that all nuclear power plants are able to withstand a station blackout (SBO) - a complete loss of AC electric power to the station. These requirements are specified in 10 CFR 50.63, Loss of all alternating current power, and a more detailed definition is provided in 10 CFR 50.2, Definitions. The definition of coping is the time it takes until off site power is restored (i.e., the grid) or an emergency diesel generator, located either onsite or offsite, is restored to service. To meet this requirement, all nuclear power plants performed an SBO coping analysis that determined how long the plant could cope without AC power. The NRC has provided guidance for determining a plant specific SBO duration in Regulatory Guide 1.155, "Station Blaskout," (August 1988). In general, SBO durations range from 2 to 16 hours, though licensees may propose alternate durations based on specific factors relating to the offsite and onsite power characteristics. There are two methods of coping with an SBO event. They are either: (i) AC independent (i.e., relying on battery power), or; (ii) alternate AC (AAC).

AC independent plants had to satisfy all the requirements for maintaining a plant in a safe condition for maximum duration of 4 hours.

If the configuration of offsite power (i.e., the grid system), onsite power (i.e., emergency diesel generators) and reliability of these sources could be affected by weather related events, and if restoration of these sources was not possible within 4 hours, then plants had to use an alternate AC source (i.e, AAC). Some plants decided to comply with the SBO rule by using the AAC as they alreay that capability on their sites. Plants using an AAC source had a variable coping duration between 2 hours and 16 hours. This duration was subject to factors affecting the restoration of onsite or offsite power sources. The capablity for coping with an SBO of specified duration must be determined by a coping analysis for plants with an AC independent method (i.e., batteries) and for plants with an AAC if that source is not available within 10 minutes of the initiating event.

U.S. Plants

Q: *A recent newswire article claimed that 93 of the U.S. nuclear power plants only had a 4-hour coping capacity for SBO. The rest of the plants could cope for 8 hours. Is that information correct?*

A: That information is not correct. First to clarify SBO coping capacity, the definition of coping is the time required to restore off site (i.e., the grid) or onsite power (i.e., emergency diesel generator). There are two different methods for coping with an SBO event:

- Relying only on battery power (AC-independent)

- Relying on an Alternate AC power source (i.e., an emergency diesel generator, hydro-powered generator, or a gas turbine)

The NRC only allows up to a 4-hour SBO coping analysis with batteries, anything longer requires an alternate AC source. The SBO coping time for an alternate AC source ranges from 2 hours to a maximum of 16 hours. For the 104 operating plants in the U.S., the basic breakdown with respect to power source is that 44 plants are "battery coping plants" and 60 plants are "alternate AC source" plants.

With respect to SBO coping times, a further breakdown includes 44 plants that have adopted the AC-independent method and have battery power for 4 hours. Another 43 plants use the AAC methodology and can restore AC power (i.e., offsite power or emergency diesel generator) within 4 hours. Hence a total of 87 plants have 4-hour SBO coping duration.

For the remainder of U.S. plants, 14 plants use the AAC methodology and can restore AC power (i.e., offsite power or emergency diesel generator) within 8 hours; hence these 14 plants have an 8-hour SBO coping duration. There are 3 plants that use the AAC methodology and have 16-hour duration for restoration of AC power; hence the remaining 3 plants have a 16-hour SBO coping duration.

Q: *Does the SBO coping capacity take into consideration the B5b mitigating measures that were issued with NRC security orders following the events of 9/11?*

A: No. The Station Blackout (SBO) rule (10 CFR 50.63, Loss of all alternating current power) was issued as a final rule on June 21, 1988. The SBO requirements were in place well before the B5b mitigating measures in response to the 9/11 event were established so the determination of SBO coping capacity did not take the B5b measures into consideration.

<u>U.S. Response (Immediate actions at U.S. reactors)</u>

Q: *What is the NRC doing to correct misinformation in the public/media?*

A: The NRC Office of Public Affairs is working closely with stakeholders to disseminate information via press releases to keep the public informed. The NRC and Regional Offices are also working closely with State and Local officials to maintain an open dialogue on the events and safety of the NRC licensed facilities. The NRC has recently established a link on its public internet website http://www.nrc.gov/japan/japan-info.html that provides information and links to other sources of related information.

U.S. Plants

Q: *How will the U.S. learn from the failures at the Japanese reactors?*

A: The NRC staff will analyze the events in Japan and develop lessons learned and recommendations to improve plant safety, as appropriate. The review may involve other Federal departments and agencies. Lessons learned will be used to develop longer-term agency actions. The NRC has already issued an information notice to inform licensees about the effects of the earthquake on nuclear power plants in Japan. The NRC is considering enhanced inspection activities targeted at facility response to beyond design-basis events. The staff will also assess whether any additional licensing actions are necessary. Actions may also include Orders, information requests in accordance with Section 50.54(f) of Title 10 (10 CFR) of the Code of Federal Regulations, license amendments, rulemaking, etc.

Q: *What action is the NRC taking regarding licensee plans to walk down their plants to confirm systems, procedures, etc., are in place to deal with natural phenomena? Are the resident inspectors going to accompany the licensees during the walkdowns?*

A: The NRC issued Information Notice 2011-05, “Tohoku-Taiheiyou-Oki Earthquake Effects on Japanese Nuclear Power Plants”, on March 18, 2011, to all holders of or applicants for operating licenses for nuclear power plants. The issuance of Information Notice (IN 2011-05) was also the subject of an NRC Press Release on March 18, 2011. Both documents are available on the NRC’s public webpage at the following link: http://www.nrc.gov/reading-rm/doc-collections/news/2011/11-052.pdf. The IN provided a summary discussion of actions that the U.S. nuclear power industry has begun taking at each licensed reactor site to confirm systems, procedures, staged equipment, etc. are in place to deal with natural phenomena. On March 23, 2011, the NRC issued Temporary Instruction 2515/183, “Followup to the Fukushima Daiichi Nuclear Station Fuel Damage Event”, which instructs NRC inspectors to independently assess the adequacy of the actions taken by licensees in response to the Fukushima Daiichi event and to coordinate their inspection efforts with the licensees schedule for verification of plant capabilities. TI 2515/183 is available on the NRC’s public webpage at the following link: http://pbadupws.nrc.gov/docs/ML1107/ML11077A007.pdf.

U.S. Plants

Q: *What short-term and long-term actions to ensure the safety of the U.S. operating nuclear power plants is the NRC taking in response to the events at the Japanese nuclear power plants at Fukushima Dai-Ichi.*

A: The NRC is launching a two-pronged review of U.S. nuclear power plant safety in the aftermath of the March 11 earthquake and tsunami and the resulting crisis at the Japanese Fukushima Dai-Ichi nuclear power plant. The NRC is creating an agency task force, made up of current senior managers and former NRC experts with relevant experience, to conduct both short- and long-term analysis of the lessons that can be learned from the situation in Japan, and the results of their work will be made public. The NRC will perform a systematic and methodical review, examining all available information from Japan, to see if there are changes that should be made to programs and regulations to ensure continued protection of public health and safety. The NRC has established an aggressive schedule for the task force to provide formal updates to the Commission on the short-term effort in 30, 60 and 90 days. As a first step for this effort, the NRC senior technical staff provided the Commission with a 90-minute briefing on March 21, 2011.

NRC inspectors who are posted at every U.S. nuclear power plant will also support the task force's short-term effort, supplemented as necessary by experts from the agency's regional and headquarters offices. The task force will help determine if any additional NRC responses, such as Orders requiring immediate action by U.S. plants, are called for, prior to completing an in-depth investigation of the information from events in Japan.

The longer-term review will inform any permanent NRC regulation changes determined to be necessary. The NRC anticipates the task force will begin the long-term evaluation in no later than 90 days and added that a report with recommended actions will be provided to the Commission within six months of the start of that effort. The Commission plans to hold monthly public meetings on the status of the NRC response to the Japan earthquake and will post the meeting schedule in the NRC's public webpage.

Q: *The German government ordered some of its nuclear power plants to shut down in response to the events in Japan. Why is it safe to continue to operate the nuclear power reactors in the U.S. that are similar to the Japanese reactors at Fukushima Dai-ichi?*

A: Every regulatory body around the world that deals with nuclear reactors has considered many factors in determining the appropriate response to events in Japan. The NRC is not privy to all the factors influencing the decision by the German government. The Chairman of the NRC and the Executive Director for Operations at the NRC have briefed the White House and members of Congress on the situation in Japan and the impacts on the U.S.

The NRC continues to closely monitor the activities in Japan and is reviewing all available information; the agency continues to conclude that U.S. plants are operating safely. The NRC continues its licensing and oversight functions for all NRC licensees, including nuclear power plants. Information in a number of areas, including the principle of defense in depth, leads to the conclusion that the current fleet of reactors and materials licensees continue to protect the public health and safety.

Every reactor in the country is designed for severe natural events at its site. Every reactor has a wide range of diverse and redundant safety features as well as multiple physical barriers to contain radioactive material, in order to provide that public health and safety assurance. The NRC has a long regulatory history of conservative decision making. The NRC has been intelligently using risk insights to help inform the regulatory process and has required improvements to the plant designs as we learn from operating experience. Some of these include severe accident management guidelines, revisions to the emergency operating procedures, procedures and processes for dealing with large fires and explosions regardless of the cause, and requirements for coping with station blackout.

U.S. Response (Long-term actions at U.S. reactors)

Q: *How will the U.S. learn from the failures at the Japanese reactors?*

A: The NRC staff will analyze the events in Japan and develop lessons learned and recommendations to improve plant safety, as appropriate. The review may involve other Federal departments and agencies. Lessons learned will be used to develop longer-term agency actions. The NRC has already issued an information notice to inform licensees about the effects of the earthquake on nuclear power plants in Japan. The NRC is considering enhanced inspection activities targeted at facility response to beyond design-basis events. The staff will also assess whether any additional licensing actions are necessary. Actions may also include Orders, information requests in accordance with Section 50.54(f) of Title 10 (10 CFR) of the Code of Federal Regulations, license amendments, rulemaking, etc.

Q: *What short-term and long-term actions to ensure the safety of the U.S. operating nuclear power plants is the NRC taking in response to the events at the Japanese nuclear power plants at Fukushima Dai-Ichi.*

A: The NRC is launching a two-pronged review of U.S. nuclear power plant safety in the aftermath of the March 11 earthquake and tsunami and the resulting crisis at the Japanese Fukushima Dai-Ichi nuclear power plant. The NRC is creating an agency task force, made up of current senior managers and former NRC experts with relevant experience, to conduct both short- and long-term analysis of the lessons that can be learned from the situation in Japan, and the results of their work will be made public. The NRC will perform a systematic and methodical review, examining all available information from Japan, to see if there are changes that should be made to programs and regulations to ensure continued protection of public health and safety. The NRC has established an aggressive schedule for the task force to provide formal updates to the Commission on the short-term effort in 30, 60 and 90 days. As a first step for this effort, the NRC senior technical staff provided the Commission with a 90-minute briefing on March 21, 2011.

NRC inspectors who are posted at every U.S. nuclear power plant will also support the task force's short-term effort, supplemented as necessary by experts from the agency's regional and headquarters offices. The task force will help determine if any additional NRC responses, such as Orders requiring immediate action by U.S. plants, are called for, prior to completing an in-depth investigation of the information from events in Japan.

The longer-term review will inform any permanent NRC regulation changes determined to be necessary. The NRC anticipates the task force will begin the long-term evaluation in no later than 90 days and added that a report with recommended actions will be provided to the Commission within six months of the start of that effort. The Commission plans to hold monthly public meetings on the status of the NRC response to the Japan earthquake and will post the meeting schedule in the NRC's public webpage.