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NUCLEAR POWER PLANT TRAGEDY IN JAPAN

BRIEFING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

TO

PROVIDE AN UPDATE FOR COMMITTEE MEMBERS AND THEIR STAFF ON THE RECENT EVENTS AT THE TOKYO ELECTRIC POWER COMPANY'S FUKUSHIMA DAIICHI REACTOR COMPLEX DUE TO THE EARTHQUAKE AND TSUNAMI THAT OCCURRED ON MARCH 11, 2011

MARCH 29, 2011

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NUCLEAR POWER PLANT TRAGEDY IN JAPAN

TUESDAY, MARCH 29, 2011

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The committee met, pursuant to notice, at 10:01 a.m. in room SD–366, Dirksen Senate Office Building, Hon. Jeff Bingaman, chairman, presiding.

OPENING STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

The CHAIRMAN. OK, why don't we get started?

Thank you all for being here. This is a briefing. This is not a hearing as such. I think the reason we tried to do it as a briefing is so that people wouldn't have to file written testimony 72 hours ahead of time and all of that. Things are changing very quickly with regard to the evolving situation at the Fukushima Daiichi nuclear power plant.

While this committee does not have direct oversight on the safety of U.S. nuclear plants, we do have to consider how events such as those at Fukushima affect the ability of our nation's nuclear fleet of 104 reactors to supply electricity. This, of course, these 104 reactors currently account for about 20 percent of the electricity that we use. What the future of nuclear energy will be as part of our nation's energy mix.

The events at Fukushima are changing by the hour. They're serious. We are watching those events unfold on the other side of the world.

Our knowledge at best is incomplete. As we look forward to these experts informing the committee on what they see occurring at the plant. How it impacts on our nation's existing fleet of reactors and answer questions that the Committee members might have.

Before I introduce our first panel, we've got 4 witnesses, 2 on this first panel and then 2 on the second panel. Before I introduce the first panel let me call on Senator Murkowski for her comments.

STATEMENT OF HON. LISA MURKOWSKI, U.S. SENATOR FROM ALASKA

Senator MURKOWSKI. Thank you, Mr. Chairman. Good morning and welcome to those who will be presenting today. I do appreciate the timeliness of this hearing this morning or this oversight this morning as we try to better understand what is unfolding at the Fukushima Daiichi power plant in Japan.

As you have pointed out, Mr. Chairman, it's probably too early for us to say that this situation is under control. I think it is important to recognize though that the workers who are there on a daily basis. The progress that they—are being made, hopefully positive steps being achieved there.

But I think it is important to recognize. To really praise the very courageous efforts of those workers that are on the ground trying to stabilize the situation. They have been going round the clock for over 2 weeks now.

Probably no doubt exhausted at the same time they're dealing with personal stress issues brought about by loss of loved ones, loss of their homes. It's perhaps easy for us in this country to be sitting back looking at the situation, picking at the issue. But we do need to keep in mind the very selfless acts that these individuals are embarking on everyday as they work to prevent further damage and to protect their fellow countrymen.

Mr. Chairman, I do hope that this is an opportunity for us as a committee as well as other committees here in the Congress to really take away some lessons learned here. So I'll be listening with great interest this morning. As we continue in the weeks ahead to understand more of what has happened with this disaster in Japan.

With that, I look forward to the testimony.

The CHAIRMAN. Thank you very much.

Our first panel is Dr. Peter Lyons, who, of course, is the Acting Assistant Secretary. We hope soon to be the Assistant Secretary of the Office of Nuclear Energy in the Department of Energy.

Mr. Bill Borchardt, who is the Executive Director for Operations at the Nuclear Regulatory Commission.

So why don't we go in that order unless you have a reason to go in a different order?

Dr. Lyons, why don't you go right ahead and give us your perspective? Then Mr. Borchardt. Then we'll undoubtedly have some questions.

STATEMENT OF PETER LYONS, ACTING ASSISTANT SECRETARY, OFFICE OF NUCLEAR ENERGY, DEPARTMENT OF ENERGY

Mr. LYONS. Thank you.

Chairman Bingaman, Ranking Member Murkowski and members of the committee, thank you for the opportunity to appear before you today to discuss the nuclear accident situation in Japan.

The Department of Energy's response to that situation.

Relevant research development and deployment programs within my office of Nuclear Energy.

Let me briefly recap our current understanding of the still evolving events at the Fukushima Daiichi nuclear power plant with its 6 nuclear reactors, albeit with many gaps in our knowledge. When the earthquake on March 11 struck, the 3 operating reactors shut down in accordance with operating procedures. Back up diesel generators started but were damaged by the tsunami. The operating units used battery power to continue to run their cooling pumps until the batteries were drained or the pumps failed.

As the reactor cores heated from radioactive decay steam was produced. The pressure build up from that steam required venting which released some radioactive materials. It also lowered the water level in the three reactor pressure vessels, reducing the cooling of the core. It appears that all three reactor cores are damaged to unknown extents.

Additionally as the fuel temperature increased, a reaction took place between the zirconium fuel cladding and the steam or water in the pressure vessel producing hydrogen. This hydrogen was vented along with the steam and may have ignited at all three reactors. Vision products have been released through these processes.

Once pumper units were brought in sea water cooling was used for many days until fresh water supplies were available. Water levels at the spent fuel pools also have concern with some reports that at least one of them was empty for some time. Sea water is being used to cool those spent fuel pools until fresh water supplies are obtained.

Current information suggests that the plants are in a slow recovery from the accident. However, long term cooling of the reactors and pools is essential during this period and has not been adequately restored to date to the best of my knowledge. A massive cleanup operation obviously remains for the future.

To assist in our country's response the Nuclear Incident Team Operations Center at the Department of Energy was promptly activated and has been continuously staffed by NNSA and Office of Nuclear Energy personnel since the accident. The focus of all DOE activities led by the Operations Center has been to understand the accident progression and offer advice and assistance to the Japanese officials, who have the direct responsibility to manage the accident recovery. The Department of Energy has deployed about 40 people and more than 17,000 pounds of equipment including NNSA's aerial measurement system and several so called Consequence Management Response Teams.

The National Atmospheric Release Advisory Capability at the Livermore Laboratory has been modeling transport, potential transport of radioactive materials. The Office of Nuclear Energy has established a Nuclear Energy Response Team that is utilizing our national lab capabilities to analyze the situation and suggest approaches and industry teams providing important support both in Japan and here. In addition Secretary Chu and White House Science and Tech Advisor John Holdren have reached out to Laboratory Directors and other imminent scientists for technical advice.

Beyond our response to the accident the research development and deployment programs of the Office of Nuclear Energy are highly relevant to future decisions about the potential options for nuclear power in the United States. As examples, our proposed small modular reactor program will explore designs that offer safety advantages through extensive use of passive systems. We're also conducting research and development at a high temperature gas reactor designs that offer inherent safety features. Our light water reactor sustainability program is exploring whether the lifetime of our operating reactors can be extended with no compromise in safety.

Research in fuel cycles is also within the Office of Nuclear Energy. While we await guidance from the Blue Ribbon Commission on America's Nuclear Future, we're conducting research and development into a broad range of options for the nation's fuel cycle with careful attention to safety, environmental protection and non-proliferation. Safety of future systems is key to all of the DOE programs.

Selected research areas like work on fuel claddings that cannot generate hydrogen in an accident or fuels that are virtually impossible to melt have various, obvious relevance. The new modeling and simulation hub based at Oak Ridge National Laboratory will be providing important new capabilities to the nuclear industry, capabilities that can be used to assess and improve the safety of existing and future reactors.

I fully concur with the recent statement made by Deputy Secretary Dan Poneman. That we view nuclear energy as a very important component for the overall portfolio we are trying to build for a clean energy future. The programs of the Office of Nuclear Energy are focused on assuring that the option for safe nuclear power remains open to the nation.

By way of concluding these brief comments the earthquake and the resulting tsunami brought tremendous devastation on Japan. At the Department of Energy and indeed throughout the Administration, we are making every effort to assist the Japanese people in their time of need. Thank you. I'll try to answer your questions.

The CHAIRMAN. Thank you very much.

Mr. Borchardt, go right ahead.

STATEMENT OF R. WILLIAM BORCHARDT, EXECUTIVE DIRECTOR FOR OPERATIONS, NUCLEAR REGULATORY COMMISSION

Mr. BORCHARDT. Chairman Bingaman, Senator Murkowski, members of the committee, good morning. The staff of the NRC is deeply saddened by the tragedy in Japan. I and many of my colleagues on the NRC staff have had many years of very close professional and personal interaction with our regulatory counterparts in Japan. We would like to extend our condolences to them.

The NRC is mindful that our primary responsibility is to ensure the adequate protection of the public health and safety of the American people. We have been very closely monitoring the activities in Japan and reviewing all available information. Review of this information combined with our ongoing inspection and licensing oversight allow us to say with confidence 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 U.S. licensees. Notwithstanding the very high level of support being provided as a result of the events in Japan, we continue to maintain our focus on our domestic responsibilities.

On Friday, March 11, an earthquake hit Japan resulting in the shutdown of more than ten reactors. From what we know now it appears that the reactor's response to the earthquake went according to design. The ensuing tsunami, however, appears to have caused the loss of normal and emergency alternating current power

to 6 units at the Fukushima Daiichi site. It is those 6 units that have received the majority of our attention since that time.

It's our assessment at this time that units 1, 2 and 3 have experienced some degree of core damage, but that they are currently stable and being cooled with fresh water. Units 2 and 3 appear to have some primary containment damage. There have been releases of radioactivity that are a continuing significant concern, including significant contamination in the lower levels of the unit 2 and unit 3 turbine buildings.

The spent fuel pools on units one through four have experienced varying water levels, but also have been receiving sea water from helicopter and spray systems. The unit 2 spent fuel pool has now started receiving fresh water. They are trying to change all of the units from fire trucks to normal pumping in the next few days. Tokyo Electric Power Company has restored electric power to the site and to the 6 reactor control rooms. The situation in general continues to further stabilize although there are many hurdles that remain.

Shortly after four o'clock in the morning on Friday, March 11, the NRC Emergency Operations Center made the first call to inform NRC management of the earthquake. We went into the monitoring mode at the Op Center as the first concern was for possible tsunami impacts on U.S. plants and radioactive materials on the West Coast and in Hawaii, Alaska and the U.S. territories in the Pacific. On that same day we began interactions with our Japanese regulatory counterparts and dispatched 2 experts to Japan to help at the U.S. Embassy. By Monday, March 14, we dispatched a total of 11 staff to Japan. We subsequently rotated in additional staff to continue our on the ground activities.

The areas of focus for the NRC team in Japan are to assist the Japanese government with technical support as part of the USAID response and to support the U.S. Ambassador.

While our focus now is on helping Japan in any way we can, the experience will also help us to assess the implications for U.S. citizens and the U.S. reactor fleet in as timely a manner as possible. Let me also just note here in concluding this section of my remarks that the U.S. Government has an extensive network of radiation monitors across the country. We feel confident, based on the current data for monitoring at nuclear power plants and through the Environmental Protection Agency's system, that there is no reason for concern in the U.S. regarding radioactive releases from Japan.

I'll now turn to the factors that assure us of ongoing domestic reactor safety. We have since the beginning of the regulatory program in the United States, used the philosophy of defense-in-depth, which recognizes that nuclear reactors require the highest standards of design, construction, oversight and operation, and safety does not rely on any single level in order to protect the public health and safety. There are multiple physical barriers to fission product release at every reactor design. Beyond that, there are both diverse and redundant systems that are required to be maintained and in operable condition. They are frequently tested to ensure that the plant is in a high condition of readiness to respond to any scenario.

Beyond this we've taken advantages of lessons learned from previous operating experience to implement a program of continuous improvement. We've learned from the experiences across a wide range of situations including the Three Mile Island accident in 1979. As a result of those lessons learned we significantly revised emergency planning requirements and emergency operating procedures.

We've addressed many human factor issues regarding how control room employees operate the plant. We've added new requirements for hydrogen control to prevent explosions inside containment. We've also created requirements for enhanced control room displays showing the status of pumps and valves. We have a post accident sampling system that enables the monitoring of radioactive material release and possible fuel degradation. One of the most significant changes we made after Three Mile Island was the expansion of the Resident Inspector Program, which has at least 2 full time NRC employees on each and every site with unfettered access to all licensee activities, 24 hours a day, 7 days a week.

As a result of the operating experience and ongoing research programs, we've developed requirements for severe accident management guidelines. Our program of continuous improvement based on this operating experience will now include evaluation of the significant events in Japan. We've already begun enhancing inspection activities through temporary instructions to our inspection staff to look at the licensee's readiness to deal with both design basis accidents and beyond design basis accidents. We've also issued an information notice to licensees to make them aware of events in Japan and advising them to verify their capabilities to mitigate the conditions that result from severe accidents.

Over the past 20 years there have been a number of new rulemakings that have enhanced the domestic fleet's preparedness against some of the problems we're seeing in Japan. For example, the station blackout rule requires every plant in the country to have analyzed what the plant response would be if it were to lose all alternating current so that it could respond using batteries for a period of time. Then have procedures in place to restore alternating current to the site.

The hydrogen rule requires modifications to reduce the impact of hydrogen generated for beyond design basis events.

Regarding the type of containment design used by most of the heavily damaged plants in Japan, we've had a boiling water reactor, Mark 1, containment improvement program since the late 1980s. This has required the installation of hardened vent systems for containment pressure relief, as well as enhanced reliability of the automatic depressurization system.

Beyond the initial steps to address the experience from Japan, the Chairman of the NRC with the full support of the Commission has directed the NRC staff to establish a Senior Level Agency Task Force to conduct a methodical and systematic review of our processes and regulations to determine whether the agency should make additional improvements to our regulatory system and make recommendations to the Commission for its policy direction. This activity will have both near term and longer term objectives.

For the near term we're beginning a 90-day review. This review will evaluate all of the currently available information from the Japanese event to identify immediate or near term operational or regulatory issues potentially affecting any of the 104 operating reactors including the spent fuel pools. Areas of investigation will include the ability to protect against natural disasters, response to station blackouts, severe accidents, spent fuel accident progression, radiological consequence analysis, and severe accident management. Over this 90-day period we will develop recommendations, as appropriate, for changes to the inspection procedures and licensing guidance, and recommend whether generic communications, orders, or other regulatory requirements are needed.

The Task Force's longer term review will begin as soon as the NRC has sufficient information from the events in Japan. The Task Force will evaluate all the technical and policy issues related to the event to identify additional potential research, generic issues, changes to the reactor oversight program, rulemakings, or adjustments to the regulatory framework. A report with the appropriate recommendations will be provided to the Commission within 6 months of the start of this evaluation. Both the 90-day report and the final report will be made publicly available in accordance with normal Commission procedures.

In conclusion I want to reiterate that we continue to make our domestic responsibilities for licensing and oversight of the U.S. fleet our top priority and that the U.S. plants continue to operate safely. At the same time, we are undertaking a thorough look at the events in Japan and their lessons for us. Based on these efforts we will take all appropriate actions necessary to ensure the continuing safety of U.S. nuclear power plants.

Thank you.

[The prepared statement of Mr. Borchardt follows:]

PREPARED STATEMENT OF R. WILLIAM BORCHARDT, EXECUTIVE DIRECTOR FOR OPERATIONS, NUCLEAR REGULATORY COMMISSION

The staff of the U.S. Nuclear Regulatory Commission is deeply saddened by the tragedy in Japan. I and many of my colleagues on the NRC staff have had many years of very close and personal interaction with our regulatory counterparts and we would like to extend our condolences to them.

INTRODUCTION

The NRC is mindful that our primary responsibility is to ensure the adequate protection of the public health and safety of the American people. We have been very closely monitoring the activities in Japan and reviewing all currently available information. Review of this information, combined with our ongoing inspection and licensing oversight, allows us to say with confidence 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 U.S. licensees.

We have a long history of conservative regulatory decision-making. We have been using risk insights to help inform our regulatory process, and, over more than 35 years of civilian nuclear power in this country, we have never stopped making improvements to our regulatory framework as we learn from operating experience.

Notwithstanding the very high level of support being provided to respond to events in Japan, we continue to maintain our focus on our domestic responsibilities.

I'd like to begin with a brief overview of our immediate and continuing response. I then want to spend the bulk of my time discussing the reasons for our confidence in the safety of the U. S. commercial nuclear reactor fleet, and the path forward that we will take to ensure we learn any lessons we need to from events in Japan.

THE NRC'S IMMEDIATE AND CONTINUING RESPONSE TO EVENTS IN JAPAN

On Friday, March 11th an earthquake hit Japan, resulting in the shutdown of more than 10 reactors. From what we know now, it appears possible that the reactors' response to the earthquake went according to design. The ensuing tsunami, however, appears to have caused the loss of normal and emergency AC power to the six units at the Fukushima Daiichi site; it is those six units that have received the majority of our attention since that time. Units One, Two, and Three at the site were in operation at the time of the earthquake. Units Four, Five, and Six were in previously scheduled outages.

Shortly after 4:00 AM EDT on Friday, March 11th, the NRC Emergency Operations Center made the first call, informing NRC management of the earthquake and the potential impact on U.S. plants. We went into the monitoring mode at the Emergency Operations Center and the first concern for the NRC was possible impacts of the tsunami on U.S. plants and radioactive materials on the West Coast, and in Hawaii, Alaska, and U.S. Territories in the Pacific.

On that same day, we began interactions with our Japanese regulatory counterparts and dispatched two experts to help at the U.S. embassy in Japan. By Monday, we had dispatched a total of 11 staff to Japan. We have subsequently rotated in additional staff to continue our on-the-ground assistance in Japan. The areas of focus for this team are: 1) to assist the Japanese government with technical support as part of the USAID response; and 2) to support the U.S. ambassador. While our focus now is on helping Japan in any way that we can, the experience will also help us assess the implications for U.S. citizens and the U.S. reactor fleet in as timely a manner as possible.

We have an extensive range of stakeholders with whom we have ongoing interaction, including the White House, Congressional staff, our state regulatory counterparts, a number of other federal agencies, and international regulatory bodies around the world.

The NRC response in Japan and our Emergency Operations Center continue with the dedicated efforts of over 250 NRC staff on a rotating basis. The entire agency is coordinating and pulling together in response to this event so that we can provide assistance to Japan while continuing the normal activities necessary to fulfill our domestic responsibilities.

Let me also just note here in concluding this section of my remarks that the U.S. government has an extensive network of radiation monitors across this country. Monitoring equipment at nuclear power plants and in the U. S. Environmental Protection Agency's (EPA) system has not identified any radiation levels of concern in this country. In fact, natural background radiation from sources such as rocks, the sun, and buildings, is 100,000 times more than doses attributed to any level of the radiation from this event that has been detected in the U.S. to date. Therefore, we feel confident, based on current data, that there is no reason for concern in the United States regarding radioactive releases from Japan.

CONTINUING CONFIDENCE IN THE SAFETY OF U.S. NUCLEAR POWER PLANTS

I will now turn to the factors that assure us of ongoing domestic reactor safety. We have, since the beginning of the regulatory program in the United States, used a philosophy of Defense-in-Depth, which recognizes that nuclear reactors require the highest standards of design, construction, oversight, and operation, and does not rely on any single layer for protection of public health and safety. We begin with designs for every individual reactor in this country that take into account site-specific factors and include a detailed evaluation for any natural event, such as earthquakes, tornadoes, hurricanes, floods, and tsunamis, as they relate to that site.

There are multiple physical barriers to radiation in every reactor design. Additionally, there are both diverse and redundant safety systems that are required to be maintained in operable condition and frequently tested to ensure that the plant is in a high condition of readiness to respond to any scenario.

We have taken advantage of the lessons learned from previous operating experience to implement a program of continuous improvement for the U.S. reactor fleet. We have learned from experience across a wide range of situations, including most significantly, the Three Mile Island accident in 1979. As a result of those lessons learned, we have significantly revised emergency planning requirements and emergency operating procedures. We have addressed many human factors issues regarding how control room employees operate the plant, added new requirements for hydrogen control to help prevent explosions inside of containment, and created requirements for enhanced control room displays of the status of pumps and valves.

The NRC has a post-accident sampling system that enables the monitoring of radioactive material release and possible fuel degradation. One of the most significant

changes after Three Mile Island was expansion of the Resident Inspector Program, which has at least two full-time NRC inspectors on site at each nuclear power plant. These inspectors have unfettered access to all licensees' activities.

As a result of operating experience and ongoing research programs, we have developed requirements for severe accident management guidelines. These are components and procedures developed to ensure that, in the event all of the above precautions failed and a severe accident occurred, the plant would still protect public health and safety. The requirements for severe accident management have been in effect for many years and are frequently evaluated by the NRC inspection program.

As a result of the events of September 11, 2001, we identified important pieces of equipment that, regardless of the cause of a significant fire or explosion at a plant, we want licensees to have available and staged in advance, as well as new procedures, training requirements, and policies that would help deal with a severe situation.

Our program of continuous improvement based on operating experience will now include evaluation of the significant events in Japan as well as what we can learn from them. We already have begun enhancing inspection activities through temporary instructions to our inspection staff, including the resident inspectors and the region-based inspectors in our four Regional offices, to look at licensees' readiness to deal with both the design basis accidents and the beyond-design basis accidents. The information that we gather will be used to evaluate the industry's readiness for similar events, and will aid in our understanding of whether additional regulatory actions need to be taken in the immediate term.

We have also issued an information notice to the licensees to make them aware of the events in Japan, and the kinds of activities we believe they should be engaged in to verify their readiness. Specifically, we have requested them to verify that their capabilities to mitigate conditions that result from severe accidents, including the loss of significant operational and safety systems, are in effect and operational. Licensees are verifying the capability to mitigate a total loss of electric power to the nuclear plant. They also are verifying the capability to mitigate problems associated with flooding and the resulting impact on systems both inside and outside of the plant. Also, licensees are confirming the equipment that is needed is in place for the potential loss of equipment due to seismic events appropriate for the site, because each site has its own unique seismic profiles.

During the past 20 years, there have been a number of new rulemakings that have enhanced the domestic fleet's preparedness against some of the problems we are seeing in Japan. The "station blackout" rule requires every plant in this country to analyze what the plant response would be if it were to lose all alternating current so that it could respond using batteries for a period of time, and then have procedures in place to restore alternating current to the site and provide cooling to the core.

The hydrogen rule requires modifications to reduce the impacts of hydrogen generated for beyond-design basis events and core damage. There are equipment qualification rules that require equipment, including pumps and valves, to remain operable under the kinds of environmental temperature and radiation conditions that you would see under a design basis accident. With regard to the type of containment design used by the most heavily damaged plants in Japan, the NRC has had a Boiling Water Reactor Mark I Containment Improvement Program since the late 1980s, which has required installation of hardened vent systems for containment pressure relief, as well as enhanced reliability of the automatic depressurization system.

The final factor I want to mention with regard to our belief in the ongoing safety of the U.S. fleet is the emergency preparedness and planning requirements in place that provide ongoing training, testing, and evaluations of licensees' emergency preparedness programs. In coordination with our federal partner, the Federal Emergency Management Administration (FEMA), these activities include extensive interaction with state and local governments, as those programs are evaluated and tested on a periodic basis.

THE PATH AHEAD

Beyond the initial steps to address the experience from the events in Japan, the Chairman, with the full support of the Commission, directed the NRC staff to establish a senior level agency task force to conduct a methodical and systematic review of our processes and regulations to determine whether the agency should make additional improvements to our regulatory system and make recommendations to the Commission for its policy direction. This activity will have both near-term and longer-term objectives.

For the near term effort, we are beginning a 90-day review. This review will evaluate all of the currently available information from the Japanese events to identify immediate or near-term operational or regulatory issues potentially affecting the 104 operating reactors in the U.S., including their spent fuel pools. Areas of investigation will include the ability to protect against natural disasters, response to station blackouts, severe accidents and spent fuel accident progression, radiological consequence analysis, and severe accident management issues regarding equipment. Over this 90-day period, we will develop recommendations, as appropriate, for changes to inspection procedures and licensing review guidance, and recommend whether generic communications, orders, or other regulatory requirements are needed.

This 90-day effort will include a 30-day "Quick Look Report" to the Commission to provide a snapshot of the regulatory response and the condition of the U.S. fleet based on information we have available at that time. Preparing a "Quick Look Report" will also ensure that the Commission is both kept informed of ongoing efforts and prepared to resolve any policy recommendations that surface. I believe we will have limited stakeholder involvement in the first 30 days to accomplish this. However over the 90-day and longer-term efforts we will seek additional stakeholder input. At the end of the 90-day period, a report will be provided to the Commission and to the public. The task force's longer-term review will begin as soon as the NRC has sufficient technical information from the events in Japan.

The task force will evaluate all technical and policy issues related to the event to identify additional potential research, generic issues, changes to the reactor oversight process, rulemakings, and adjustments to the regulatory framework that should be pursued by the NRC. We also expect to evaluate potential interagency issues, such as emergency preparedness, and examine the applicability of any lessons learned to non-operating reactors and materials licensees. We expect to seek input from stakeholders during this process. A report with appropriate recommendations will be provided to the Commission within 6 months of the start of this evaluation. Both the 90-day and final reports will be made publicly available in accordance with normal Commission processes.

CONCLUSION

In conclusion, I want to reiterate that we continue to make our domestic responsibilities for licensing and oversight of the U.S. licensees our top priority and that the U.S. plants continue to operate safely. In light of the events in Japan, there is a near-term evaluation of their relevance to the U.S. fleet underway, and we are continuing to gather the information necessary for us to take a longer, more thorough look at the events in Japan and their lessons for us. Based on these efforts, we will take all appropriate actions necessary to ensure the continuing safety of the U.S. fleet.

The CHAIRMAN. Thanks to both of you for that testimony. Let me start with questions. We'll have 5 minute round of questions.

On the Fukushima Daiichi plant let me ask if there have been reports about high levels of radioactive water, radioactivity in the water that is found in the turbine building's basements. Do we know what the source of that radioactive water is? Do we know the extent of the problem that that could create going forward?

Either of you?

Mr. BORCHARDT. Yes. We have very limited information on this as with many other aspects. But we believe that the water is the result of the bleed and feed process that they have been using to keep water in the reactor cores and in the containment of the units.

It is leaking out. The exact flow path of that leakage has not been determined. But it is a result of the water that they've been injected since shortly after the onset of the event.

Mr. LYONS. I can add to that, Senator.

The CHAIRMAN. Yes, go ahead.

Mr. LYONS. About complications. As I noted, it is essential that they restore dependable, long term cooling to those systems. The

existence of the high backgrounds from that leak water, whatever the source, are certainly complicating those efforts.

The CHAIRMAN. OK.

Let me ask about the thrust to use passive safety features and passive designs and get to a point where if power fails you don't have this kind of potential for crisis that we've seen occur in Japan. To what extent are we trying to ensure that those passive type designs and systems and safety features be put in place in our nuclear power plants?

Mr. BORCHARDT. In the United States there are 2 principle reactor designs that are called passive reactor designs. The reason they're called passive is because, as you mentioned, they don't rely on alternating current in order to respond to an event of this magnitude. There are no pumps that need to start and run off of alternating current. Any valves that need to change position change because of stored air, a pneumatic system or off of a DC battery power supply.

Then once they're running, they rely on natural processes like gravity in order to create a water flow to keep the core cool. These are designs that have undergone extensive NRC review. They are receiving approval.

In fact, there are designs that are being planned for construction in the United States that utilize this design concept.

The CHAIRMAN. But I'm right in thinking that none of the 104 currently operating plants have these design features in them at the current time. Is that right?

Mr. BORCHARDT. That's correct.

The CHAIRMAN. Yes, Dr. Lyons.

Mr. LYONS. Senator Bingaman, just a comment that the small modular reactors that are of great interest looking into the future in our program, each of the light water, small modular systems that has been proposed is a highly passive system. That's certainly one of the aspects that we look toward in terms of the potential for the future of the small modular systems as well.

The CHAIRMAN. OK.

Mr. Borchardt, let me ask you on re-licensing. I gather that there are quite a few nuclear power plants in this country that are scheduled for re-licensing or at least are going to be applying for re-licensing sometime in the next few years. To what extent do you think this development in Japan will impact on the actions of the Nuclear Regulatory Commission on those re-licensing applications? Is there any way to judge that at this point?

Mr. BORCHARDT. Senator, as you mentioned, over half of the 104 operating reactors in the United States have already received a license renewal for an additional 20 years of operation. We expect that the other half will continue with either an in-process license renewal review or they will apply for a license renewal in the future. It is our intent through the lessons learned programs and our continuous operational oversight of the operating fleet that if there was a design change necessary in order to adapt the plants to what we're learning from Japan, that we would take that action absent or outside of the license renewal review process. We would take that without hesitation.

So there's no technical reason that I'm aware of that this would impact the license renewal process for the remaining plants in the U.S.

The CHAIRMAN. Thank you very much.

Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman. Gentlemen, thank you.

Mr. Borchardt, you mentioned the task force and the 90-day review that you will be undertaking here. So much of what we need to learn, of course, we're not able to know at this point in time because we cannot safely go into the facility. Do we have any idea how long we are looking at to get these units cooled down so that in fact we can enter the area, examine the reactors, look at the spent fuel? What do you anticipate?

Mr. BORCHARDT. I really can't even hazard a guess on how long that will be. But the reason that we're approaching with a 90-day lessons learned immediately is because we didn't want to wait for whenever that time period is. We think that there are things we can evaluate, should evaluate, immediately. That's why we're beginning that review.

Senator MURKOWSKI. Dr. Lyons.

Mr. LYONS. Senator Murkowski, just as a possible addition to that. The Department has provided information to the government of Japan on radiation hardened robotic capabilities available within the country. A shipment is being readied. I don't know if it has left yet.

But there will be radiation hardened robotics available soon. I can't say exactly when, in Japan, which could provide some of the information that you're asking about. Certainly not all we need, but some.

Senator MURKOWSKI. Do I understand correctly that Japan did not have any of the robotics that we are making available to them at this time?

Mr. LYONS. I can't speak to whether such capabilities are available in Japan. I can only speak that the government of Japan has been very, very interested in understanding the capabilities that can be brought to bear from this country and we have provided that information. They have identified needs. We're moving expeditiously to ship, not only the robots, but also operators who perhaps will be used to train Japanese operators. We don't know yet how close it will be necessary for the operators to be to the site.

Senator MURKOWSKI. Let me ask a question about the decision-making process at the NRC to evacuate U.S. residents. The decision was made for evacuation with a 50-mile radius within the reactor itself. Of course, initially the determination from the Japanese was that it was 12 and a half miles. Then they bumped that to 19 miles.

Can you tell me how this decision was reached? Who made it? Was it a vote of all the Commissioners? How did you conclude that 50 miles was the appropriate evacuation range?

Mr. BORCHARDT. The factors that were taken into consideration include all the indications that we had a strong belief that there was likely fuel damage in three reactors. There were degraded

water level conditions in at least 2 of the spent fuel pools at the time. There were elevated radiation releases from those plants.

Given those realities and then given the uncertainty of the progression at that time, we ran some models to see what kind of releases would be possible under those scenarios. Made the conservative decision that although the conditions did not exist at that instant to require an evacuation, we thought that it was a conservative and prudent recommendation to make.

Senator MURKOWSKI. You mentioned the radiation monitoring units that we have in place. Alaska received 3 that we understand are up. I hope that all three are up now.

But there's a lot of concern about what may end up in our oceans, impact to the fisheries. Do we have radiation monitors off of Honshu that are measuring anything in the ocean or is it just monitors that are evaluating the air?

Mr. LYONS. The Department of Energy systems are, as I mentioned, the airborne system that is monitoring ground contamination, but not out over the ocean. It's the EPA, through their RadNet has made the monitors that you mentioned in Alaska. Guam, Hawaii has added several additional monitors. I am not aware of monitoring capability within the ocean that we have. That certainly could be added if it was deemed necessary.

I should add that the Department of Energy through the calculational capabilities at Livermore using the source terms developed by the Nuclear Regulatory Commission as being the worse cases. We do not anticipate a significant health effect in any of the United States areas.

Senator MURKOWSKI. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Udall.

Senator UDALL. Thank you, Mr. Chairman. Good morning to the panelists. Thank you for being here.

I think we begin to learn that just because an event is improbable, doesn't mean that it's impossible. In that spirit, let me turn to the design of the spent fuel pools. It seems like, based on what you've told us this morning, that's a key part of the ongoing crisis there at Daiichi.

I understand that the same design is employed at almost a quarter of our plants here in the U.S. It seems like this is a design flaw. I'm surprised we hadn't addressed it previously. But what are we doing now and what can we do to address it in the months and the years ahead?

Mr. BORCHARDT. Even after the events of 9/11 the NRC took a concerted review effort to look at risks to the plants regardless of the cause. One of the issues that we looked at is optimizing the ways that you can fill the spent fuel pool and keep water injected into the reactor vessel to keep the core cool. So there are a number of both procedures and pieces of equipment that can be put into place in order to keep the spent fuel pool full.

So that has been greatly enhanced, as well as having a backup system and power supplies to do the same thing.

Senator UDALL. Dr. Lyons, do you have thoughts both from the point of view of the Department of Energy but I would certainly welcome your personal opinions on ways in which we can make spent fuel broad storage systems safer and moving forward?

Mr. LYONS. Senator Udall, I was on the NRC as we conducted many of those evaluations, extremely careful evaluations of the safety of the existing spent fuel pools and dry casks. Using the best information available at the time those both storage systems were deemed to be safe. I look forward to the review that will be conducted by the NRC, as Bill said, the pools will certainly be part of that review. Whether that will lead to any suggestions for changes, I await their review.

I do not have concerns today based on the NRC studies to date.

Senator UDALL. I know you have an official point of view, but personally do you have any other thoughts about how we might make spent fuel rod storage safer in the future, just thinking creatively, thinking as the engineer that I know you are?

Dr. LYONS. Senator Udall, I think my comments should say that we should await the review of the NRC. We certainly include within our program's research on the longevity of dry cask storage that may prove to be relevant in these discussions. But that would be the main area that I can think of offhand that would be applicable to your question.

Senator UDALL. I believe there is a design where the spent fuel rods are stored in the basement or the lower level.

Mr. LYONS. Yes, that will be the case on the—I'm sorry.

Senator UDALL. Yes, and I was just going to talk about the engineering challenges to do so. I have to believe that it's easiest to bring the fuel rods out of the reactor at the top. Then you move them at that same level into these spent fuel rods. But they're 5 or 6 stories up in the air. Gravity works against us in that kind of situation.

Mr. LYONS. Bill can help me on this. But I believe all of the PWR pressurized water reactors in this country utilize ground level or near ground level storage of the spent fuel poles. Knowing of your interest in the small modular reactors with their underground siting, the intent there is that spent fuel pools would be sited well underground in those designs.

Senator UDALL. I appreciate your mentioning of that new technology, that new engineering approach.

Mr. Borchardt, did you want to comment?

Mr. BORCHARDT. Yes, Senator, I'll just mention that it was really the difference between the boiling water reactors that are above grade and the pressurized water reactors that are near ground level is really just one of the original design philosophy during the early development of those designs, probably in the 1950s and 1960s. So there isn't really a technical barrier that would prevent changing that configuration for a new design.

Senator UDALL. Thank you, gentlemen. My time is about to expire. But again this is obviously a very timely topic.

I look forward to working with you as we move forward to understanding what's happened. I think we're all frustrated with the various kinds of information, that's often contradictory, coming out of Japan. For the record I will ask you both to comment on how we could do a better job given a situation developing in our own country. I think that's added to the sense that this is out of control and the improbable has become actually the possible. So thank you for being here today.

Mr. LYONS. Certainly.

Mr. BORCHARDT. Thank you.

The CHAIRMAN. Senator Corker.

Senator CORKER. Thank you, Mr. Chairman. Thank you for having this briefing and the 2 of you for being here. Obviously working together to try to deal with this issue in the best way that we can.

Senator Udall actually went down a line of questioning that is similar to mine. On the quarter of the reactors that we have that are boiling water reactors here in our country. Is it your sense that over the course of time we've done things to alleviate the same type of risk in our own country?

Mr. BORCHARDT. Yes, sir. As I mentioned we've done a number of improvements to the design. Some were not specific to the boiling water reactors, but included both pressurized and boiling water reactors like the station blackout rule, which looks at the loss of alternating current, complete loss at a site.

There are things that are specific to boiling water reactors, which is the hardened vent that's the way to relieve pressure from inside the containment. That is a design improvement. We've required the inerting inside the containment that's to prevent the possibility of an explosion by having the containment inerted with nitrogen.

Again, generically for all reactor designs, we've looked at severe accident mitigation guidelines. These are programs and procedures, pieces of equipment that exist in the plants. That say even with all the careful design, all the design requirements we've imposed, what if the unthinkable still happens? We should have systems in place to adapt to that. So we've done those at all of the plants in the country.

Senator CORKER. So I'll knock on wood as I ask this question. I mean, your sense is that you've seen nothing that's occurred in Japan thus far that you haven't already tried to engineer or change in our own existing facilities of that nature?

Mr. BORCHARDT. I would say that's true. But that's why we're doing this extensive, both short term and longer term review. So that we can do a thorough analysis and make sure that we're not missing something.

Senator CORKER. You know, Senator Udall asked a little bit about the storage situations. I know we've had a debate in this country that is sort of stalled out at present. But we've looked at a national repository. I mean one of the reasons we have these spent fuel rods onsite as we do in this country is we never came to an agreement about what we might do with them over the long haul.

Are there any editorial comments you all might make about regional or national repositories or?

Mr. LYONS. Senator Corker, I think the main comment I'd make is that the Secretary created the Blue Ribbon Commission to look at the back end of the fuel cycle to include repository, possible reprocessing issues. That Commission which certainly includes a number of technical and other leaders from around the country is fairly close to their interim report anticipated in July. Personally I'm very hopeful that that report will provide some important suggestions and perhaps guidelines as the Nation moves forward with this challenge.

Senator CORKER. But you don't want to state what you hope those guidelines say, I guess. You'll wait.

It will be interesting to see. It certainly at some point would love to hear comments about a catastrophe of this nature happening and how that might have affected things if they had had a different type of storage mechanism.

Back to the SMUs, the small modular reactors. They utilize a more of a natural cooling process. I too am very interested in that technology. I'm hoping we're getting ready to move ahead. You know, these are reactors where U.S. you know, U.S. engineering can be more greatly deployed and certainly at lesser capital up front.

That more natural cooling process that occurs, is there anything about this recent disaster that makes you feel those are going to be even more useful to us or more safe or less safe? Have you learned anything from the Japanese incident regarding them?

Mr. LYONS. Senator Corker, I don't know specific from the Japanese incident but in general as we discussed earlier those small modular reactors that we're interested in would have highly passive systems. They would rely as Bill Borchardt already noted, on natural forces, on gravity, on convection. They would not require pumps.

At least one obvious concern in Japan has been the loss of AC power, the loss of the pumping capability. That would not be an issue for a highly passive system such as we're exploring for the SMRs.

Senator CORKER. I assume what you're saying is that some of the failures that have occurred recently in Japan likely would not occur with these SMUs.

Mr. LYONS. At least the small modular reactors would not depend on the use of pumps in an accident situation. So that is one very, very major difference. The designs in Japan are very much dependent on such pumping capability.

Senator CORKER. Now I know my time is up. This is a yes/no. I'll move quickly.

The Japanese Ministry of Economy and Trade sort of does what—they sort of do both sides of the equation. They promote nuclear, Japanese nuclear products. They also regulate them.

Have you seen any issue there as it relates to lack of oversight because of that dual mandate?

Mr. BORCHARDT. Senator, no, we're not aware of any interference. There is a very strong focus internationally about independence of the regulator. There has recently been an IAEA review done of the Japanese regulator and they did not identify any of that kind of interference concern that I think you're referring to.

Senator CORKER. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Franken.

Senator FRANKEN. Thank you, Mr. Chairman. Thank you, Gentlemen for your testimony.

In the 2006 report published by the National Academies, they recommended that the spent fuel rods stored in pools onsite should be arranged to place old, cool fuel rods next to newer hotter rods to prevent hot spots and fires in the event that the pools lost enough water to cover the rods. In an editorial in the Washington

Post on March 24, Matthew Bunn wrote that despite these recommendations "no such action has been taken either in the United States or in Japan." Mr. Borchardt, does the National Regulatory Commission have plans to review these recommendations and possibly implement them?

Mr. BORCHARDT. Senator I believe, and you can ask perhaps the next panel, but I believe it's a common practice to do such a thing at the plants in the United States that there is a movement of fuel in order to optimize the storage conditions in the spent fuel pool. But we would certainly——

Senator FRANKEN. That's at odds with what was written in the Post. But we'll ask the next panel.

Mr. BORCHARDT. Sir.

Senator FRANKEN. We have a nuclear plant in Monticello, Minnesota that basically is the same design as the Fukushima reactors. You know, we're not going to have, probably an earthquake in Minnesota and we're probably if we have a tsunami there we probably got bigger problems.

[Laughter.]

Senator FRANKEN. But we do have floods. Is there any chance that the backup generation of places like Prairie Island in Minnesota or Monticello could be overwhelmed by unforeseen levels of flooding?

Mr. BORCHARDT. Monticello and every other plant in the country has an extensive review done before original licensing that looks at that specific site and looks at the historical record for things like flooding, tornados, hurricanes, tsunamis, earthquakes, and does a review using that historical record to make sure that that plant can respond to all of the kinds of natural events that happen.

Senator FRANKEN. Do they do those kinds of reviews in Japan?

Mr. BORCHARDT. I can't really speak to that. I know they do——

Senator FRANKEN. Wouldn't that be——

Mr. BORCHARDT. Some part of design basis—they consider some of those factors, but the specifics of how Japan did their licensing site reviews, I don't know.

Senator FRANKEN. Wouldn't that be a good thing to know?

Mr. BORCHARDT. Certainly. Yes, sir.

Senator FRANKEN. OK. I would suggest hopping right on that.

On terms of the cost of nuclear power has the events in Fukushima changed any sense of what the costs of nuclear power is vis-à-vis other sources of electricity? Either of you?

Mr. LYONS. At least the way I would respond, Senator, would be that that remains for the results of the NRC evaluation.

Senator FRANKEN. OK.

Mr. LYONS. To the extent that they identify needed changes then that might change the cost equation. But I couldn't speculate for now.

Senator FRANKEN. OK. Fine.

Let's say that we have a few reactors—what happened here is we had a very large earthquake and then a tsunami. Are there any reactors in the United States, say in California, that are built near faults and oceans or just one ocean?

[Laughter.]

Mr. BORCHARDT. Of course there are and, as I mentioned in my previous answer, what we do is we look at the earthquake history for the plants in California, for example, and do an evaluation of the distance and the conditions that would be felt on the site. So you have to consider what kind of soil and formations exist between the fault line and the plant. That distills down to how much motion you will see at the plant.

The systems have to be designed to withstand that motion plus a little bit more. There's always margins that are built into the reviews. The same is done looking at flooding or tsunamis and other natural events.

So that's part of the design basis. Every plant therefore has its own design basis and will have its own requirements based upon its specific geographic location.

Senator FRANKEN. I see. Again, your testimony is you're not aware of whether or not they did that same kind of analysis in Japan?

Mr. BORCHARDT. That's right. I can't speak to the Japanese design criteria.

Senator FRANKEN. OK. Because my feeling is they didn't expect this. Thank you.

The CHAIRMAN. Senator Barrasso.

Senator BARRASSO. Thank you, Mr. Chairman. Thank you both for being here today.

There are going to be ongoing lessons learned from this tragedy. That's going to continue the situation on the ground actually, still is evolving. Our focus is clearly helping the Japanese people get through this disaster. I was happy to see Secretary Chu publicly assuring Americans that the people in the United States are in no danger from the tragedy in Japan. He's also indicated that the Administration supports building additional nuclear power plants.

Senator Corker talked about needs to finalize a long term solution for storage of nuclear waste. The Administration has stopped the long term nuclear storage facility and has created the Blue Ribbon Commission to look at the problem. As you discussed, you said we'd have a report possibly in July.

Fundamentally is it safer to store nuclear waste in temporary storage facilities around the country or at a permanent disposal site?

Dr. Lyons.

Mr. LYONS. Senator Barrasso, the way I would respond is that the NRC would evaluate both. Both can be made safe and their requirements would assure that safety.

Senator BARRASSO. Mr. Borchardt.

Mr. BORCHARDT. I agree with Dr. Lyons.

Senator BARRASSO. When you talk about the report and I think you said, hopefully soon, perhaps July. You think that that Commission will have an opportunity then to really learn the lessons of what we've seen happening in Japan to apply those or will we have a report they've been working on and they're kind of ready to put out from preparation prior to the current disaster that we're studying?

Mr. LYONS. Senator Barrasso, I don't have any detailed information of what they will have in that report. That should be left up

to them. But the report in July is their so-called interim report. It is due July 29.

The plan after that interim was to allow 6 months for public comment, further refinement and the final report in January of next year. In response then to your question I think there's very adequate time for the BRC to take whatever lessons may be necessary from Japan and at least incorporate it in the final, if not the interim.

Senator BARRASSO. The more recent news, Reuters reported this morning that plutonium has been found in the soil at the nuclear complex. I mean, it was the reactor No. 3 was the only one to use plutonium in the fuel mix, may indicate a breach in the containment mechanism. Could you speak to that?

Mr. LYONS. At least the reports that I saw were reporting trace levels of plutonium. The report I saw was that it was still debatable exactly what those levels were derived from. All operating reactors whether they start with any plutonium in the fuel or not, build up plutonium in the course of operation.

So finding plutonium, it was derived from either the operating reactors or the spent fuel pools, would not be regarded as a major surprise. Certainly it would be a concern if it were in significant levels. At least anything I've seen was it's not significant at this point.

Senator BARRASSO. Then the New York Times today reported that highly contaminated water, I think Senator Bingaman commented on this, could actually leak into the ocean. What are the implications of that?

Mr. LYONS. Certainly that has to be monitored from the standpoint of fisheries from food products. There are other agencies in our government that would be tracking whether there were any concerns from a U.S. perspective on that. Certainly the Japanese have adequate resources to be verifying that from their own standpoint.

I think it's fair, certainly from the Department of Energy's standpoint and I would guess from the NRC's standpoint, our focus now very, very much is on controlling the accident, stabilizing the accident and trying to move toward a situation where we can see a long term path toward eventual resolution, whatever that may be. So our focus now has not been on that particular issue, but that may well be for other agencies and the Japanese government.

Senator BARRASSO. Thank you. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Coats.

Senator COATS. Mr. Chairman, thank you. Thanks for the testimony.

Help me out a little bit here because I'm somewhat new to all of this. I don't tend to begin to be an expert in any sense of the word. But we see these news reports that keep coming out. The public reacts in a way that, potentially I think, could undermine any kind of consensus building for the place of nuclear energy in addressing energy needs in the future whether it's here in the United States or elsewhere in the world.

Obviously the carbon footprint of a nuclear plant is extraordinarily less if virtually nothing compared to other sources of energy. So a wrong perception or a wrong conclusion in terms of how

we should go forward with nuclear energy possibilities for our country and others could lead to some very significant consequences in a whole number of ways. So I'm trying to get my head around a little bit about what we see in the paper everyday or see on TV every day.

Every time a plume of steam escapes it's immediately on the networks. The headlines talk about and things that have just been mentioned here, plutonium potentially leaking into the seawater and so forth and so on. Then we read about news that has come out about babies should not be drinking milk in Tokyo. Vegetables may be contaminated.

Give me some perspective in terms of levels of radiation where we need to be concerned as opposed to those where it's something that is not at such a serious nature. For instance in your testimony, Dr. Lyons I believe it was, basically stated that some of the levels of detection here in the United States emanating from the Japanese coast line. We get 100,000 more radiation, units of radiation or however measures you do, just simply from natural causes, rocks, sun, buildings, etcetera, etcetera.

So I'm trying to put all this in perspective because when you look at the paper the average person doesn't pay any attention to this 100,000 times more. That was what was recorded in Tokyo relative to vegetables or so forth. I mean, is this something that should cause us the kind of concern that we're having or—I'm just trying to put it in better perspective.

Mr. LYONS. There have been several press releases from the Department of Energy trying to assist with the general point that you're making, Senator. You're indeed right that we essentially live in a sea of radiation. We all have natural exposures of the order of 300 milligram to natural causes in a year. A milligram happens to be a convenient unit.

To put that somewhat into perspective a flight across the country, you pick up about three millirem simply from that flight. Cosmic rays as you went up in altitude. But radiation is everywhere. It's important. We have certainly tried and we will continue to try to put in perspective the radiation levels that are measured.

I don't mean to suggest that there are not harmful levels where the EPA and others have defined so called protection action guidelines. We pay careful attention to those guidelines to assure that levels are far below. Levels in the United States are many, many orders of magnitude below anything close to a protective action guideline.

Senator COATS. What I'm——

Mr. LYONS. In some areas in Japan they are going to have to be much more careful with attention to at least their version of protection action guidelines.

Mr. BORCHARDT. Senator, if I could just add. The EPA monitoring sites and all of the operating reactors in the country are continuing to take samples and readings. We haven't seen any readings that would be of any concern whatsoever to public health and safety.

Mr. LYONS. To quantify that slightly more, we have the aerial monitoring system which is taking countless measurements around the site. Just to give you one figure, the highest within two and a

half miles of the site. They haven't gone any closer. Within two and a half miles of the site there has been no level detected greater than 30 millirem back to that unit per hour.

As the flights have continued those levels have gone down. But they are seeing—they are measuring levels of radiation well above background. That information is available on DOE's website, available to the Japanese. We're trying to share that information as much as possible.

Senator COATS. Yes. I don't think that really has been understood or maybe even shared. So 30 millirem within what circumference?

Mr. LYONS. That was the highest level observed for flights that came within two and a half miles of the site. There certainly are higher levels closer than that.

Senator COATS. Right.

Mr. LYONS. But our crews and our planes are not going any closer—30 millirem per hour.

Senator COATS. Put that 30 millirem in perspective to the danger level of that.

Mr. LYONS. The level to which the NRC, the EPA recommend the public stay below in a year is 100 millirem. So that would be, if it was 30 millirem per hour that would be of the order of 3 hours would be the maximum you should spend at that. Again, that is the highest dose observed. It's gone down every day that they've flown since.

Senator COATS. Within two and a half miles?

Mr. LYONS. Within two and a half miles.

Senator COATS. OK.

Mr. LYONS. But levels on the site are much higher.

Senator COATS. Of course, but I think the perspective is is that these types of levels are floating across the Nation of Japan, hanging over Tokyo, reaching the West Coast and so forth. So I think it's important that you put that in that perspective.

Thank you, Mr. Chairman.

The CHAIRMAN. Senator Coons.

Senator COONS. Thank you, Chairman Bingaman. Thank you to the panel for your informative and helpful testimony today.

I'll simply reaffirm what Senator Coats was just asking about. I do think there is broad concern in the general public about radiation and dosages. As I'm sure you're both far more familiar even than I am, general confusion about orders of magnitude, about consequence and about possible impact on the public health. I happen to represent a state that has no nuclear facilities within it but is within 50 miles of four others that are currently operating, one of which is of the design of the reactors of question.

As I understand the incident and reading and listening to your testimony today, one of the core areas of concern and potential future action has to do with backup power with spent fuel rod pools and in particular with battery power. The unique circumstances that occurred in Japan may not occur in the United States. But there are other circumstances that might give rise to the need for a more than four or 8 hour backup power scenario.

What are you doing to look at safety training and backup power generation and in particular battery capacity to focus on the issue

of the spent fuel rod pools. Particularly given the lack of a clear path forward for the long term for managing spent fuel rods in the United States?

Mr. BORCHARDT. Senator, the types of issues that you raise are exactly why we're putting together this lessons learned. We're going to look at both the station blackout rule that required a review of the coping capability of all the U.S. reactors to deal with the loss of all alternating current, and then look at what conditions, capabilities exist at all of the 104 reactors to see if we need to strengthen regulatory requirements.

I mean one of the obvious questions we'll be asking ourselves is do we need an enhanced battery supply, a battery supply that can last longer? We already have safety related, well protected, constantly tested diesel generators that are onsite. There is a day tank that provides fuel oil to those diesel generators that's also protected. So there is a robust capability that exists already.

But given what we've learned in Japan, it's obvious the question that we need to ask ourselves. Do we need to make it even more robust and stronger? So that will be part of the review we'll be doing.

Senator COONS. Thank you. I'm glad to hear that is a part of the review. I was pleased to see that there was a prompt move toward a top to bottom review nationally.

My closing concern would be to simply urge you to then implement whatever the outcome is of that review. I understand this is an industry that already is subject to stringent, regulatory review to significant safety and backup procedures. But I think this particular incidence in order to address legitimate concerns of the broad American public we need to focus on the specific failure mechanisms here. On making sure, particularly for the longer term, that we've dealt with spent fuel and exactly how it's being stored and maintained in ways that couldn't lead to a reoccurrence of this sort of an accident in the United States, so.

Mr. BORCHARDT. On the subject of spent fuel I mean, let me just say, that we've done a thorough evaluation of that storage, in either the wet spent fuel pool or in dry cask storage; which many of the plants in the country are currently using, and both provide adequate protection and safety.

Senator COONS. Are spent fuel pools subject to also in the event of the loss of power they have lower backup power standards currently is that accurate?

Mr. BORCHARDT. They require, over the long term, to have a circulating pump if you will, that provides cooling to the pool. But it would be many days as long as that there's no damage to the spent fuel pool and no leakage of water out. It would take many days for it to heat up to a point where it began to boil off and you would lose water level.

What the industry has done in coordination with some of the regulatory requirements we imposed after 9/11 was came up with other backup ways to put water into the pool. I mean, using fire hoses and other things that aren't even hard height to the spent fuel pool because it's really a simple issue. All you need to do is keep the pool full and you protect the integrity of that fuel.

Senator COONS. Thank you both. We look forward to the outcome of the 90-day review.

The CHAIRMAN. Senator Lee.

Senator LEE. I thank you both for your testimony. Dr. Lyons I wanted to start out with a question to you. I know much of your career has been devoted to nuclear safety issues. I suspect you would agree that the people in Japan are doing everything they can, doing the best job they can to deal with the situation.

But I was wondering as you look at it, if you had been in charge of this from the outset, knowing what you know now, is there anything different that you might have done than was done in Japan to deal with this disaster?

Mr. LYONS. Senator Lee, as part of the standard procedures that the NRC would go through to say nothing of the special review, it would be a very careful lessons learned study of any event whether it's Three Mile Island, whether it's 9/11, whether it's the Davis-Besse events recently. There's always lessons learned and careful study of what transpired.

That needs to be done in this case as well. As was stated earlier we do not have enough detail now to really do that. But as that detail becomes available it will be very important, as I think you're suggesting, to understand in detail the steps that were taken and to understand whether an alternative sequence of steps, different timing of steps, could have been more effective.

But for now, that's a little premature. We're very much focused on trying to help them with restoring the cooling which almost independent of the accident sequence that got us here. They need to restore that cooling.

Senator LEE. OK. Are you fairly confident that once we've reviewed all of that and had the opportunity to conduct the post mortem of what happened that you'll be in a position to be able to evaluate whether if the same thing, the exact same set of environmental conditions that occurred there, if those were presented here in the United States, whether or not we'd be able to withstand them without a meltdown or without the release of radiation that occurred there?

Mr. LYONS. I guess I'd perhaps word it just—I mean, in general, yes, sir. But slightly differently because as Bill indicated for each of our plants there is an assessment of what can happen from a natural disaster perspective. Depending on the location of the plant one will evaluate different natural phenomenon.

But as part of the review that the NRC must undertake there has to be another check of whether there has been a sufficiently robust estimate of what those maximum cases could be.

Senator LEE. OK. Then I've got a couple of questions for either or both of you just dealing with spent fuel following up on what some of my colleagues have asked.

First of all, can either of you tell me what's the biggest single impediment to our using spent fuel reprocessing in the United States as one approach to take with spent fuel rods?

Mr. LYONS. Senator, reprocessing certainly is one of the issues that the Blue Ribbon Commission will be studying. I'm sure it will be part of their recommendations. It's not particularly obvious to

me how reprocessing or not would have dramatically changed at least what we've seen to date.

But again, from the U.S. perspective we need to await the Blue Ribbon Commission and within my office we have a range of research programs looking at different potential options or solutions for the back end of the fuel cycle. Those, that research, guided by the BRC, I hope will allow us to suggest options that Congress may want to consider for the future for used fuel management.

Senator LEE. But in the meantime you consider indefinite onsite storage, sustainable practice between now and whenever we get that figured out?

Mr. LYONS. I was at the NRC when we did—when they did a number of evaluations of the safety and integrity of spent fuel casks. I have to admit that I have never seen a spent fuel cask until I was at the NRC and had many opportunities to see them. These are rather impressive structures.

Yes, I have great confidence in the safety of dry cask storage. You know, I mentioned that we do have research programs within my office as does the NRC at trying to understand how long a duration one should consider for the use of dry casks. I don't think we know what that upper ground is. We need research to establish that. But these are very impressive structures.

Senator LEE. OK. Thank you very much.

The CHAIRMAN. Senator Murkowski, did you have other questions of this panel or should we go to the second panel?

Senator MURKOWSKI. I think in the interest of time, Mr. Chairman, we should go to the second panel. Thank you.

The CHAIRMAN. We thank both of you for your excellent testimony. We will go ahead and dismiss you and allow the second panel to come forward.

Our second panel is Mr. David Lochbaum, who is the Director of Nuclear Power Project with the Union of Concerned Scientists.

Also Mr. Anthony Pietrangelo, I think I've got that pronunciation correct, Senior Vice President and Chief Nuclear Officer with the Nuclear Energy Institute.

Mr. Pietrangelo, did I correctly pronounce your name?

Mr. PIETRANGELO. Yes.

The CHAIRMAN. Thank you.

Why don't we go ahead? Mr. Lochbaum, if you'd like to proceed with your testimony and then we'll hear Mr. Pietrangelo and then we'll have a few questions.

STATEMENT OF DAVID LOCHBAUM, DIRECTOR, NUCLEAR SAFETY PROJECT, UNION OF CONCERNED SCIENTISTS

Mr. LOCHBAUM. Sorry. The Fukushima Daiichi nuclear plant in Japan experienced a station blackout. A station blackout occurs when a nuclear power plant loses electrical power from all sources except that by onsite batteries. The normal power supply energizes all the equipment needed to operate the plant on a daily basis as well as the emergency equipment needed during an accident.

When a normal power supply is lost, backup power is supplied from onsite emergency diesel generators that provide electricity only to the smaller set of equipment needed to cool the reactor cores and maintain the containment's integrity. At Fukushima the

earthquake caused the normal power supply to be lost while the tsunami caused the backup power supply to be lost. This placed the plant into a station blackout.

Batteries provided sufficient power for the steam driven systems to cool the reactor cores on units one, 2 and 3. When those batteries were exhausted there were no cooling systems for the reactor cores or the spent fuel pools. Fuel in the reactor cores and some spent fuel pools has been damaged by overheating.

Had either normal or backup power been restored before the batteries were depleted we would not be here today. There are lessons that can and should be applied to lessen the vulnerabilities at U.S. reactors. I cannot emphasize enough that the lessons from Japan apply to all U.S. reactors not just the boiling water reactors like those affected at Fukushima. None are immune to station blackout problems. All must be made less vulnerable to those problems.

As at Fukushima, U.S. reactors are designed for a station blackout of only a short duration. Eleven U.S. reactors are designed to cope for a station blackout lasting 8 hours as were the reactors in Japan. Ninety-three of our reactors are designed to cope for only 4 hours. One lesson from Fukushima is the need to provide workers with options for dealing with a prolonged station blackout.

In other words the moment that any U.S. reactor enters a station blackout condition response efforts should proceed along three parallel paths.

First, restoration of the electrical grid as soon as possible.

Second, recovery of one or more emergency diesel generators as soon as possible.

Third, acquisition of additional batteries and/or temporary battery generators as soon as possible.

If either of the first 2 paths leads to success, the station blackout ends and the re-energized safety systems can cool the reactor core and spent fuel pool.

If the first 2 paths lead to failure, success on the third path provides enough time for the first 2 paths to achieve belated success.

The timeline associated with the third path should determine whether additional batteries are required at existing facilities. For example, the existing battery life may be sufficient when a reactor is located near a facility where temporary generators are readily available. Such as the San Onofre Nuclear plant in California which is right next door to the U.S. Marine Base at Camp Pendleton.

When a reactor is more remotely located it may be necessary to add onsite batteries to increase the chance that the third path leads to success when the first 2 paths do not.

A reminder from Fukushima involves vulnerability at spent fuel pools. All U.S. reactors have more irradiated fuel in the spent fuel pool than exists in the reactor core. All U.S. reactors have the spent fuel pool cool by fewer and less reliable systems than are provided for the reactor core. At all U.S. reactors the spent fuel pool is housed in less robust containment than surrounds the reactor core.

More irradiated fuel that is less well protected and less well defended is an undo hazard. There are 2 simple measures that can be taken to better manage this risk.

Accelerate the transfer of spent fuel from the spent fuel pools to dry cask storage.

Second, upgrade the guidelines for how to address an emergency and provide operator training for spent fuel pool problems.

Currently the U.S. spent fuel storage strategy is to nearly fill the spent fuel pools to capacity and then transfer fuel into dry cask storage. This keeps the spent fuel pools filled nearly to capacity, thus maintaining the risk as high as possibly achievable. A better strategy would be to reduce the inventory of irradiated fuels in the pool to only the fuel discharged from the reactor in the last 5 years.

Less irradiated fuel in the pools generates lower heat load. The lower heat load gives workers more time to restore cooling or the water inventory in the spent fuel pool. If irradiated fuel in the spent fuel pool did become damaged, having fewer assemblies in the spent fuel pool means the radioactive cloud is much smaller.

Following the accident at Three Mile Island reactor owners significantly upgraded emergency procedures and training that the operators relied upon. Prior to that accident the procedures relied on the operators diagnosing what happened and taking steps to fix that problem. If they misdiagnosed the accident the guidelines could lead them to taking the wrong steps for the actual accident that they faced.

Today's procedures guide the operator's response to abnormally high pressure or unusually low water level without undo regard for what caused that condition. These revamped emergency procedures represent significant improvements over the pre-TMI days. But they only apply to reactor core accidents. No comparable procedures would help the operators respond to a spent fuel pool accident. It's imperative that the comparable emergency procedures be provided for spent fuel pool accidents as they've helped protect us against reactor pool accidents.

Thank you.

[The prepared statement of Mr. Lochbaum follows:]

PREPARED STATEMENT OF DAVID LOCHBAUM, DIRECTOR, NUCLEAR SAFETY PROJECT, UNION OF CONCERNED SCIENTISTS

The Fukushima Dai-Ichi nuclear plant in Japan experienced a station blackout. A station blackout occurs when a nuclear power plant loses electrical power from all sources except that provided by onsite banks of batteries. The normal power supply comes from the plant's own main generator or from the electrical grid when the reactor is shut down. All the equipment needed to operate the plant on a daily basis as well as the emergency equipment needed during an accident can be energized by the normal power supply. When the normal power supply is lost, backup power is supplied from onsite emergency diesel generators. These generators provide electricity only to the smaller set of equipment needed to cool the reactor cores and maintain the containments' integrity during an accident.

At Fukushima, the earthquake caused the normal power supply to be lost. Within an hour, the tsunami caused the backup power supply to be lost. This placed the plant into a station blackout where the only source of power came from batteries. These batteries provided sufficient power for the valves and controls of the steam-driven system—called the reactor core isolation cooling system—that provided cooling water for the reactor cores on Units 1, 2, and 3. When those batteries were exhausted, there were no cooling systems for the reactor cores or the spent fuel pools. There are clear indications that the fuel in the reactor cores of units 1, 2, and 3 and some spent fuel pools has been damaged due to overheating.

Had either normal or backup power been restored before the batteries were depleted, we would not be here today discussing this matter. The prolonged station blackout resulted in the inability to cool the reactor cores in Units 1, 2, and 3, the spent fuel pools for all six units, and the consolidated spent fuel pool. There are les-

sons, learned at high cost in Japan, that can and should be applied to lessen the vulnerabilities at US reactors. And I cannot emphasis enough that the lessons from Japan apply to all US reactors, not just the boiling water reactors like those affected at Fukushima. None are immune to station blackout problems. All must be made less vulnerable to those problems.

As at Fukushima, US reactors are designed to cool the reactor core during a station blackout of only a fairly short duration. It is assumed that either the connection to an energized electrical grid or the repair of an emergency diesel generator will occur before the batteries are depleted. Eleven US reactors are designed to cope with a station blackout lasting eight hours, as were the reactors in Japan. Ninety-three of our reactors are designed to cope for only four hours. But unless the life of the on-site batteries is long enough to eliminate virtually any chance that the batteries would be depleted before power from another source is restored, one lesson from Fukushima is the need to provide workers with options for dealing with a station blackout lasting longer than the life of the on-site batteries. In other words, the moment that any US reactor enters a station blackout, response efforts should proceed along three parallel paths: (1) restoration of the electrical grid as soon as possible, (2) recovery of one or more emergency diesel generators as soon as possible, and (3) acquisition of additional batteries and/or temporary generators as soon as possible. If either of the first two paths leads to success, the station blackout ends and the reenergized safety systems can cool the reactor core and spent fuel pool. If the first two paths lead to failure, success on the third path will hopefully provide enough time for the first two paths to achieve belated success.

The timeline associated with the third path should determine whether the life of the on-site batteries is adequate or whether additional batteries should be required.. For example, the existing battery life may be sufficient when a reactor is located near a facility where temporary generators are readily available, such as the San Onofre nuclear plant in California, which is next to the US Marine base at Camp Pendleton. When a reactor is more remotely located, it may be necessary to add on-site batteries to increase the chance that the third path leads to success if the first two paths do not.

The second lesson from Fukushima is the need to address the vulnerability of spent fuel pools. At many US reactors, there is far more irradiated fuel in the spent fuel pool than in the reactor core. At all US reactors, the spent fuel pool is cooled by fewer and less reliable systems than are provided for the reactor core. At all US reactors, the spent fuel pool is housed in far less robust structures than surround the reactor core. This means that any release of radiation from the pool will not be as well contained as radiation released from the reactor core. It also means that spent fuel pools are more vulnerable to terrorist attack than is the reactor itself. More irradiated fuel that is less well protected and less well defended is an undue hazard. There are two measures to better manage this risk: (1) accelerate the transfer of spent fuel from spent fuel pools to dry cask storage, and (2) upgrade the guidelines for how to address an emergency and the operator training for spent fuel pool problems.

Currently, the US spent fuel storage strategy is to nearly fill the spent fuel pools to capacity and then to transfer fuel into dry cask storage to provide space for the new fuel discharged from the reactor core. This keeps the spent fuel pools nearly filled with irradiated fuel, thus maintaining the risk level about as high as possible. Added to that risk is the risk from dry casks stored onsite, which is less than that from the spent fuel pools but not zero.

A better strategy would be to reduce the inventory of irradiated fuel in the pools to the minimum amount, which would be only the fuel discharged from the reactor core within the past five years. Reducing the spent fuel stored in the pools would lower the risk in two ways. First, less irradiated fuel in the pools would generate a lower heat load. If cooling of the spent fuel pool was interrupted or water inventory was lost from the pool, the lower heat load would give workers more time to recover cooling and/or water inventory before overheating caused fuel damage. And second, if irradiated fuel in a spent fuel pool did become damaged, the amount of radioactivity released from the smaller amount of spent fuel would be significantly less than that released from a nearly full pool. Reducing the amount of irradiated fuel in spent fuel pools would significantly reduce the safety and security risks from a nuclear power plant.

Following the 1979 accident at Three Mile Island, reactor owners significantly upgraded emergency procedures and operator training.. Prior to that accident, procedures and training relied on the operators quickly and correctly diagnosing what had happened and taking steps to mitigate the consequences. If the operators misdiagnosed the accident they faced, the guidelines could lead them to take the wrong steps for the actual accident in progress. The revamped emergency procedures and

training would guide the operators' response to an abnormally high pressure or an unusually low water level without undue regard for what caused the abnormalities. The revamped emergency procedures and training represent significant improvements over the pre-TMI days. But they apply only to reactor core accidents. No comparable procedures and training would help the operators respond to a spent fuel pool accident. It is imperative that comparable emergency procedures and training be provided for spent fuel pool accidents to supplement the significant gains in addressing reactor core accidents that were made following the TMI accident.

The Nuclear Regulatory Commission has announced a two-phase response plan to Fukushima; a 90-day quick look followed by a more in-depth review. If the past three decades have demonstrated anything, it's that the NRC will likely come up with a solid action plan to address problems revealed at Fukushima, but will be glacially slow in implementing those identified safety upgrades. A comprehensive action plan does little to protect Americans until its goals are achieved. We urge the US Congress to force the NRC to not merely chart a course to a safer place, but actually reach that destination as soon as possible.

The CHAIRMAN. Mr. Pietrangelo, go right ahead.

STATEMENT OF ANTHONY R. PIETRANGELO, SENIOR VICE PRESIDENT AND CHIEF NUCLEAR OFFICER, NUCLEAR ENERGY INSTITUTE

Mr. PIETRANGELO. Thank you, Senator. Good morning, all.

First, on behalf of NEI and our members our thoughts are with the Japanese, our friends and colleagues in the industry there and in particular those workers on the ground who have been struggling with trying to bring this plant to a safe condition over the last couple weeks. So Senator Murkowski, I echo your empathy for them. I can't pretend to understand what it's like to get hit by a massive earthquake, followed by a tsunami, followed by additional aftershocks of a very significant magnitude. So they are doing a heroic job there to bring that plant to a safe condition.

There have been a lot of questions thus far this morning about could it happen here? What are the events that could bring us to this similar condition in Japan? What I like to say is that and Bill Borchardt and Pete went over the provisions that go into the licensing of our plants.

But I think for the people at the stations it almost doesn't matter what gets you in the condition, whether it's an earthquake, tsunami, flood, hurricane, tornado, equipment failure, operator error, manufacturing defect, all those areas are exhaustively reviewed by the NRC before you can get a license. If you did get some rare combination of those that puts you in a station blackout or any other concern where you can't get cooling to the core, that's why we prepare the way we do at our plants. We're ready for those kinds of measures.

I want to start with the proactive steps we've taken as an industry. Basically looking at severe accidents and what goes into, what we prepare for in terms of beyond design basis events. When the NRC licenses to plants originally the demonstration had to be that you could place the plant in a safe condition given the extreme design basis events, earthquake, loss of offsite power, etcetera.

Since that time through both NRC regulation and other measures we put in place we've gone beyond the design basis.

We've used probalistic risk assessment to look at combinations of initiating events and equipment failures and human actions that could damage the core and what we could do to respond to those.

So we've identified vulnerabilities in the designs that we've addressed.

We've identified accident management insights for the operators.

I agree with David's suggestion about looking at severe accident management for fuel pools.

We have some numbers in place, some measures in place, but not to the extent we do for the reactors.

Also I think the President got it right on March 17. Again, these designs have been exhaustively reviewed. But it's incumbent upon us as an industry and NRC as a regulator and the International Atomic Energy Agency and operators all over the world to fully understand the lessons learned that come out of Fukushima and apply them.

I do want to talk a little bit more about the improvements we've put in place since the plants were licensed. I mentioned the PRA improvements. Also after September 11, 2001, we did a lot of work on fires and explosions related to aircraft impact. Wiping out quadrants of the plant and seeing what contingency measures could be put in place to deal with the loss of key safety functions.

This even goes beyond some of the station blackout measures that David talked about. The ability to get water into steam generators and PWRs or water into the primary containment and BWRs to look at backup pooling measures. We put a lot of those measures in place. Those measures included contingency measures for spent fuel pools including getting sprays to the pools and connections to stand pipes or existing equipment to keep the fuel covered.

Bill mentioned that the analysis of the spent fuel pools. It's not quite as complicated, thankfully, as the reactors are. Basically you have to keep water in the pool. It's a great radiation shield and a great coolant. You can go to any spent fuel pool in the country and look over the handrail right down at the used fuel without any protective clothing on whatsoever.

You know, Bill mentioned that depending on the age of the fuel and how long it's been in there it will take days, more likely weeks before you would boil off the inventory. Typically there's 20 to 30 feet of water above the top of those used fuel rods. So that's a long time to be able to deal with the event if it occurs.

One thing I can say going forward is that our industry, our hallmark is learning from operating experience. We learned a lot from TMI in terms of operator training as well as design enhancements. We will enhance safety as a result of Fukushima. We will get these lessons learned.

We started that already. But it's going to take a long time to get a full understanding of what transpired there. But when we do I can assure you that we will enhance safety margins across the industry.

Thank you.

The CHAIRMAN. Thank you both for your testimony.

Let me ask first, Mr. Lochbaum, what are your thoughts this—we had testimony in the first panel about the station blackout rule that the NRC has put in place that presumably would build in some safety precautions against the kind of loss of power that we've experienced or at least the consequences from loss of power

that we've seen in the case of the Japanese plant. Could you give us your views as to the adequacy of that station blackout rule? Whether it does what it should do or whether there are other things it should have done that it didn't accomplish?

Mr. LOCHBAUM. I think the station blackout rule was to the NRC and the industry's credit. It did significantly reduce or improve safety. Put it more positively.

I think what Japan showed us is that when the event lasts longer that our assumptions either four or 8 hours, we shouldn't leave the operators with no choices. When the station blackout in Japan lasted longer than their assumed duration of 8 hours, they were left with no options. As a result the reactor cores and the spent fuel pools were overheated and damaged.

We need to do a better job of increasing the reliability that either we restore AC power from the grid or restore AC power from the diesel generators within the 4 to 8 hours that we assume, and also provide the operators with something else should those very dedicated and intense efforts fail so they're not left without any options other than a miracle. Miracles are great, but you can't rely on them.

So I think we need to look at that to increase the odds that things are corrected before the station blackout duration ends. Be prepared should that duration end without success on the restoration of power. I think we can do that. I don't think it's difficult.

I think Japan showed the price of not doing that. So I think it's cheap insurance for the reactors in the United States to go ahead and do that.

The CHAIRMAN. Mr. Pietrangelo, did you have a thought on any of those comments?

Mr. PIETRANGELO. Yes. I think that's one of the obvious places that we'll have to look. But just looking at the event in Japan with the earthquake and then the tsunami, destroying all the infrastructure around that plant. What is was was a massive common mode failure of all those backup emergency diesel generators.

It's hard to postulate that here. It's very, very unlikely to occur. Also destroy the entire infrastructure around the plant such that you can't get help there soon.

We're already looking at trying to stage equipment regionally. We've done it locally at the sites in response to 9/11 such that we can go beyond the station blackout duration and still provide cooling. But to get the 48 hours or 72 hours, pick a number. We're going to take a hard look at that and see what resources would be necessary to extend the capability that long.

But again, it's pretty remote that you'd get that kind of common mode failure across all your systems. Really the station blackout was predicated on giving sufficient time to either restore AC power from the grid or get one of the emergency diesel generators started.

The CHAIRMAN. Mr. Pietrangelo, let me ask your comment on another statement that Mr. Lochbaum makes in his testimony. He says a better strategy would be to reduce the inventory of irradiated fuel in the pools to the minimum amount which would be only the fuel discharge from the reactor core within the past 5 years. Reducing the spent fuel stored in the pools would lower the risk in a couple of ways. He goes into that.

Mr. PIETRANGELO. Right.

The CHAIRMAN. Have you looked at that recommendation and do you have a thought about it?

Mr. PIETRANGELO. Yes. First of all it's not a new recommendation. It's been out there for quite some time. I think as a result of Fukushima we need to take a real hard look at how we manage used fuel in our country. Hopefully while it's not a crisis situation, get some momentum behind a national policy to deal with used fuel.

The issue is with the spent fuel pools. I think, you know, that with a lot of analyses done of what happens to used fuel if it gets uncovered and some kind of worse case scenarios. We don't know exactly what happened in those used fuel pools yet. I think part of those lessons learned is going to be specifically focused on the risk from uncovering that fuel and what happens when it gets uncovered.

Nevertheless, while there would be some risk reduction in unloading the pools of the fuel rods after 5 or 6 years. The freshest old fuel is where the most heat load is and where the most radio toxicity is. So you would still have some risk going forward even if you unloaded all of the older old used fuel.

So the problem doesn't go away. It's really a marginal reduction in risk when you do that.

The CHAIRMAN. Alright.

Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman. Just to follow up on that then.

So the decay radiation in this spent fuel that we're moving and saying OK, after 5 years we're going to move this. You're still going to have a level of radiation there. Do we know what kind of decay radiation we have?

Then understanding that, do we have to design some type of a new dry cask to contain that radiation? How do we deal with it? Either one of you.

Mr. LOCHBAUM. The reason we said 5 is that the casks that are being used today, there are hundreds of casks at U.S. plants around the country, are designed for fuel that's been out of the reactor for 5 years or more. So we don't have to go to new casks. We can use the ones that are currently certified by the NRC and being used by the industry.

We would just like to accelerate the transfer from the pools into those already certified casks and available casks.

Senator MURKOWSKI. OK. So really we don't have to do that much in terms of any new technologies. We just move it quicker.

Mr. LOCHBAUM. That's correct.

Senator MURKOWSKI. Let me ask a question about the use of the sea water to act as a coolant. I understand that we are now in the process, the United States is now in the process of helping ship in some fresh water. But in the meantime, the sea water has been used. There's been some question about the corrosive nature of the salt.

I don't know, maybe this was a question that was best asked of either the 2 gentlemen before you, but can either one of you speak to this as an issue whether or not the salt in the sea water is per-

haps having an impact on our ability or on the Japanese ability to get the reactors under control?

Mr. PIETRANGELO. Yes. I think the concern was as you boil off the sea water you're left with the salt that could get crusted in the fuel and thereby preclude the cooling of it. So that's why as soon as they had fresh water available they've started injection to the reactor vessels with fresh water.

Those barges from the U.S. Navy, I believe have arrived now so they've got about a half a million gallons of fresh water available to continue that exercise.

Senator MURKOWSKI. But given that we've already used some pretty substantial amounts of sea water.

Mr. PIETRANGELO. Right.

Senator MURKOWSKI. Do we know whether or not that has proven to be an impediment or caused a delay or further complications in getting this under control?

Mr. PIETRANGELO. I don't know, Senator.

Mr. LOCHBAUM. I think just the opposite. It helped. They were facing very dire situations. So the sea water helped stop whatever fuel damage was ongoing.

So they dealt with their most immediate problem with the use of sea water as they should have. Now as they're probably doing. They're diluting that sea water with fresh water. So it looks like they took the right steps for the right reasons.

Mr. PIETRANGELO. Senator, even in our plants in this country there are provisions when you lose your available inventory of fresh water in a tank, provisions to use river water or sea water in existing systems. So, it's not exactly what the situation you want to get to.

Senator MURKOWSKI. Yes.

Mr. PIETRANGELO. But it's there if you need it.

Senator MURKOWSKI. Does it, does the salt have any impact, do we know on the spent fuel pools?

Mr. PIETRANGELO. I think it's the same concern that it would be in the reactor.

Senator MURKOWSKI. Yes.

Mr. PIETRANGELO. It could impede the cooling.

Senator MURKOWSKI. But again, the concern about any corrosive effect?

Mr. LOCHBAUM. There are stainless steel liners that help retard more resistant to corrosion than other forms of steel. I think the problem for the pools would be the instrumentation and the other controls over the water flow through the reactor. But we heard in the last couple days they've restored fresh water supplies to the pools.

So they'll be diluting the salinity of the water in those pools. So whatever damage has been done is getting better from now on as long as they're able to sustain that progress.

Senator MURKOWSKI. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Franken.

Senator FRANKEN. Yes. I have couple areas I want to get into. I'm getting some idea about how we approach assessing all the safety factors of a nuclear plant when we site it.

Mr. Pietrangelo, you spoke in some good detail about that. But when I asked Mr. Borchardt of the Nuclear Regulatory Commission how the Japanese system compared to ours, he said he didn't know. Now I think that if Americans are going to get some kind of, take some kind of comfort that our system when everything you describe actually works. It would be nice to know how our system compare with the Japanese system.

Because what we're seeing in Japan didn't work. So Mr. Lochbaum, I find this disturbing that this far into this crisis that the Nuclear Regulatory Commission doesn't know how to compare the Japanese system of siting and looking into the safety verses ours. Do you have any thoughts on that?

Mr. LOCHBAUM. I'm in an unusual role of defending the NRC, that's typically not my role. But I think the NRC has 4,000 people. They have an International Programs Unit that probably knows those answers, but to Mr. Borchardt's defense, he doesn't know the combined knowledge of those 4,000 people.

I would be willing to bet this week's paycheck that the NRC has that answer and could get it fairly quickly. So the situation is not quite as bad as it may look on the surface.

Senator FRANKEN. OK——

Mr. LOCHBAUM. By the way, it wasn't my paycheck. It was somebody else's 1 week paycheck I'm betting.

[Laughter.]

Mr. PIETRANGELO. Senator, I think going forward you're absolutely right. We have to understand not only the differences in the regulatory systems. But from an industry perspective understand what design mods were made to those plants.

What operational practices they put in place? Their emergency planning they've done for events like this and compare it to what we have in place. Then assess the gaps, if you will, to see whether we would have been able to better deal with it or that we still need to do additional things.

Senator FRANKEN. Yes, because, you know, it's hard to take a lot of comfort from what we do if you can't compare it to what they do because obviously what they did wasn't sufficient, right?

OK. Now, I quoted a Washington Post editorial by Matthew Bunn. Did you read that?

Mr. PIETRANGELO. I did, sir.

Senator FRANKEN. Did you read that, Mr. Lochbaum?

Mr. LOCHBAUM. Yes.

Senator FRANKEN. OK. In it he wrote that despite the recommendations by the National Academies that spent fuel rods be stored in pools onsite that they should be arranged place old, cool fuel rods next to newer, hotter fuel rods to prevent hot spots and fires in the event that the pools lost enough water to uncover—to cover the rods. That despite that recommendation in 2006 there is no such action. This is a quote.

"No such action had been taken either in the U.S. or Japan."

Mr. Borchardt said they had been. So now I ask 2 questions.

One, Dr. Bunn is an expert at Harvard. Is he wrong? Is Mr. Borchardt wrong?

Is this a good recommendation?

Mr. PIETRANGELO. Mr. Bunn is wrong. There was a correction. It was hard to see. So about 2 or 3 days later in the editorial section in the Post from Mr. Bunn saying that there had been measures taken to address some of the concerns he raised in his op ed.

We refer to it as a checkerboard pattern of the fuel, precisely what he was talking about.

Secondly, as part of the post 9/11 measures to get additional capability to refill the pools in the event of fires, explosions or any other event that could lose inventory in the pools.

Senator FRANKEN. OK. That answers that.

Mr. PIETRANGELO. Yes.

Senator FRANKEN. One last thing. I have 20 seconds left, so but I can the question and then you can take whatever time you want to answer it.

Evacuation. We kind are seeing, kind of, a lot of controversy about how much area around the reactor in Fukushima is a safe area. We see that there—if you take a 50-mile radius from some of our reactors you have 10 and 10 of millions of people around them. Do we have adequate evacuation plans in case something like this would happen in the United States?

Mr. PIETRANGELO. Yes. Our evacuation plans are based on studies done in 1970s by both the NRC and other agencies. The ten mile emergency planning zone or EPZ, as we refer to it, was determined to be sufficient to protect public health and safety.

There's also a 50-mile zone that looks at the ingestion path, any contamination of food products or dairy products and so forth that can be sampled.

I'd also note there's provisions to increase the evacuation or protective action recommendations be it evacuation or sheltering beyond the ten mile EPZ. Every 2 years each plant conducts an emergency planning exercise that's overseen by both the Nuclear Regulatory Commission and FEMA. In addition we practice those drills quarterly onsite.

So we think we've got the gold standard of emergency planning. It was a difficult situation for the NRC 2 weeks ago when we were in the middle of this event when they were looking at 3 cores and 4 spent fuel pools and limited and conflicting information. I think they do what they always do is think of, when there's a lot of uncertainty on the ground, they make a very conservative decision.

I think we've seen that over the years with how the agency regulates. That's what happened here.

Senator FRANKEN. Mr. Lochbaum, do you have any opinion about the state of our evacuation plans?

Mr. LOCHBAUM. I think our plans are as good as those in Japan on March 10.

Senator FRANKEN. I don't know what that means.

Mr. LOCHBAUM. It means we would be equally in dire straits if we were faced with that kind of disaster. We have great plans on paper. If we put them to practice I think that we're going to show that we're going to come up short.

Mr. PIETRANGELO. But I would also add, Senator, that the Japanese, I think responded exactly as we would with our emergency plan. They evacuated within their, I think it's 12 ½ miles or 20 kilometer radius. They put sheltering in place later.

So they did precisely the kinds of actions and protective action recommendations we would take to protect public health and safety. In our country it's the state and local officials acting on recommendations from the plant operator in the event and overseen by the NRC, who makes that decision.

Senator FRANKEN. But this Fukushima is not as dense an area.

Mr. PIETRANGELO. Certainly not.

Senator FRANKEN. As many of——

Mr. PIETRANGELO. Certainly not.

Senator FRANKEN. I mean, Indian Point was brought up as an example. Let's say you live within, I mean there's millions and millions and millions of people living within 50 miles of that plant. Let's say you're a parent, your kid is at school going the opposite way of exiting, getting away from there.

Mr. Lochbaum, do you think that we need to improve on what we're doing?

Mr. LOCHBAUM. Around Indian Point, for example, the local and state officials have said they can't get their people out if they need to. The Federal Government overruled what the local and state government said and said, it would happen anyway that some miracle would occur and the people would not be harmed. I tend to trust the local and state officials. They deal with issues on a daily basis.

If in their best judgment they can't protect those people, I don't know why anybody else should believe that we can.

Senator FRANKEN. Thank you. I'm way over my time. Thank you, gentlemen.

The CHAIRMAN. Senator Murkowski.

Senator MURKOWSKI. Just very quickly. Do you think that it was confusing the fact that the evacuation order from the Japanese government that it be 12 ½ miles initially and then the United States coming in and saying 50-mile radius. What does that message say that Americans are more worried about the radiation than the Japanese are to those that are living there?

Was that a confusing directive?

Mr. PIETRANGELO. We support what the President recommended for American citizens in Japan. I think it's a different decision to evacuate U.S. citizens. There's not going to be as many living within that radius as it is for Japanese people who have been raised there and live there now.

I can understand where some of the confusion comes. But again, based on the information they had at the time and the potential for it to degrade. I think they made a conservative decision, but I understand where the confusion could come.

Senator MURKOWSKI. Mr. Lochbaum.

Mr. LOCHBAUM. In the United States one of the things we learned from Three Mile Island was it's good to have one voice to avoid confusion like you're suggesting. I think what this accident may suggest is we need to look at an international concept of one voice. So that there's not a discrepancy that one side or the other could say it was either too much or too less.

So that I think the same reason we went to a one voice after Three Mile Island, it probably be a good idea to look at it on an international level to see if the same factors apply.

Senator MURKOWSKI. I appreciate that.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you both for your testimony. I think this has been a useful hearing or useful briefing for us. We appreciate it.

If additional issues come to your attention, please let us know and we'll try to inform the full committee on all of those as well.

Thank you.

Mr. PIETRANGELO. Thank you, Senator.

[Whereupon, at 11:43 a.m., the briefing was adjourned.]

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