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THE U.S. GOVERNMENT RESPONSE TO THE NUCLEAR POWER PLANT INCIDENT IN JAPAN

HEARING

BEFORE THE

SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS

OF THE

COMMITTEE ON ENERGY AND COMMERCE

HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

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THE U.S. GOVERNMENT RESPONSE TO THE NUCLEAR POWER PLANT INCIDENT IN JAPAN

WEDNESDAY, APRIL 6, 2011

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS,
COMMITTEE ON ENERGY AND COMMERCE,
Washington, DC.

The subcommittee met, pursuant to call, at 9:05 a.m., in room 2322 of the Rayburn House Office Building, Hon. Cliff Stearns (chairman of the subcommittee) presiding.

Members present: Representatives Stearns, Whitfield, Terry, Murphy, Burgess, Blackburn, Bilbray, Gingrey, Scalise, Gardner, Griffith, Barton, DeGette, Markey, Green, Christensen and Waxman (ex officio).

Staff present: Carl Anderson, Counsel, Oversight; Michael Beckerman, Deputy Staff Director; Karen Christian, Counsel, Oversight; Stacy Cline, Counsel, Oversight; Todd Harrison, Chief Counsel, Oversight/Investigations; Cory Hicks, Policy Coordinator, Energy & Power; Dave McCarthy, Chief Counsel, Environment/Economy; Carly McWilliams, Legislative Clerk; Andrew Powaleny, Press Assistant; Krista Rosenthall, Counsel to Chairman Emeritus; Ruth Saunders, Detailee, ICE; Alan Slobodin, Deputy Chief Counsel, Oversight; Peter Spencer, Professional Staff Member, Oversight; Kristin Amerling, Democratic Chief Counsel and Oversight Staff Director; Jeff Baran, Democratic Senior Counsel; Alison Cassady, Democratic Senior Professional Staff Member; Karen Lightfoot, Democratic Communications Director, and Senior Policy Advisor; and Ali Neubauer, Democratic Investigator.

OPENING STATEMENT OF HON. CLIFF STEARNS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA

Mr. STEARNS. Good morning, everybody, and welcome to the Subcommittee on Oversight and Investigation for this hearing this morning, the United States Government's response to the nuclear power plant incident in Japan. I will open with my 5-minute opening, and the ranking member is on her way and she should be here shortly.

Today, the Subcommittee on Oversight and Investigations will examine the United States government's response to the ongoing incident at the Fukushima Daiichi nuclear power plant in Japan. We will look in particular at the Nuclear Regulatory Commission's response to the events in Japan and the safety and preparedness of U.S. commercial nuclear power plants.

Congress, in large part led by this committee, the Energy and Commerce Committee and the Oversight Subcommittee, should conduct vigorous oversight of nuclear power plant safety and security. And we should confront any lessons from the incident in Japan and assess carefully whether they apply to the United States. Today represents the beginning of that work for this committee.

As we begin the hearing today, the death toll from the tsunami has mounted to more than 12,000 people, with some 15,000 people still missing. We are reminded of the heart-wrenching devastation Japan suffered from the March 11th earthquake and tsunami. Our thoughts and prayers must continue to be with the Japanese people, who have faced great turmoil with courage and with grace.

As of today, the situation at the Fukushima nuclear power plant remains of concern, especially for people that are still living in the area. While reactors crippled from the long-term power outage at the site appear to have been stabilized, cooling has not yet been completely restored and emergency crews continue to work around the clock. The United States government and industry are contributing technical expertise to assist the Japanese, and we are hopeful this will more rapidly end this crisis.

But let us not lose sight of these facts. Radiological releases from the facility have been much less than feared. The Department of Energy's own Aerial Measuring Systems and the NNSA's Consequence Management Response Teams, after conducting hundreds of hours of surveillance and collecting thousands of measurements, reported this past Monday that radiological material has not deposited in significant quantities since March 19th. All measurements, except for in the immediate vicinity of the plant, are well below 30 millirem per hour, a low level, and have been declining. That is good news.

Nevertheless, in the wake of the incident in Japan, we in the United States should ask some very critical questions about the safety and preparedness of our Nation's 104 commercial nuclear reactors. The testimony today will better inform our oversight of the government and industry response to lessons that are learned from Japan.

As we examine the incident, we should not confuse what is happening in Japan with our own preparedness and assume they are one and the same. We should not make unsupported assumptions about risks or response measures or get ahead of the facts.

There should be no question about the experience and responsiveness of America's nuclear power system. Each operating reactor in the United States undergoes 2,000 hours of baseline inspections, with additional inspections bringing the average up to 6,000 hours of inspections per plant every year. The industry has more than 3,500 years of total operational experience, which has resulted in the highest levels of safety for a large fleet of operators in the global industry and a robust safety standard and review process. This process involves both the United States government and an industry operations standard-setting body, which is often cited as the gold standard for industry self-regulation.

Today we will hear testimony from two panels of witnesses. On the first panel, we will hear from the Nuclear Regulatory Commis-

sion. This independent agency has played a central role in the United States government's response to the Japanese incident, and will be an essential guide to identifying lessons from the Japan incident that may be applied to United States safeguards and ultimately our preparedness.

We will be able to receive an update from the NRC and explore some of its actions regarding the Japan response. More broadly, I look forward to learning the NRC's perspective on the current safety of U.S. commercial nuclear plants, and the particular safeguards in place to address station blackouts, to respond to events that go beyond the design basis of the reactors, and to respond to new risks.

Our second panel will provide perspective from the Nuclear Energy Institute, the American Nuclear Society and the Union of Concerned Scientists. This testimony will assist the subcommittee to place whatever we see in Japan in perspective of actual industry operations and practices, and the reality of how safety and preparedness is assured here in the United States.

So let me welcome all the witnesses from the two panels.

[The prepared statement of Mr. Stearns follows:]

PREPARED STATEMENT OF HON. CLIFF STEARNS

Today, the Subcommittee on Oversight and Investigations will examine the U.S. government's response to the ongoing incident at the Fukushima-Daiichi nuclear power plant in Japan. We will look in particular at the Nuclear Regulatory Commission's response to the events in Japan and the safety and preparedness of U.S. commercial nuclear power plants.

Congress—in large part led by this Committee—should conduct vigorous oversight of nuclear power plant safety and security. And we should confront any lessons from the incident in Japan and assess carefully whether they apply to the United States. Today represents the beginning of that work for this Committee.

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As of today, the situation at the Fukushima nuclear power plant remains of concern, especially for people living in the region. While reactors crippled from the long-term power outage at the Fukushima site appear to have been stabilized, cooling has not yet been completely restored and emergency crews continue to work around the clock. The United States government and industry are contributing technical expertise to assist the Japanese, and we're hopeful this will more rapidly end the crisis.

But let's not lose sight of the facts: radiological releases from the facility have been much less than feared. The Department of Energy's own Aerial Measuring Systems and the NNSA's Consequence Management Response Teams, after conducting hundreds of hours of surveillance and collecting thousands of measurements, reported this past Monday that radiological material has not deposited in significant quantities since March 19. All measurements, except for in the immediate vicinity of the plant, are well below 30 millirem per hour—a low level—and have been declining.

Nevertheless, in the wake of the incident in Japan, we should ask critical questions about the safety and preparedness of our nation's 104 commercial nuclear reactors. The testimony today will better inform our oversight of the government and industry response to lessons learned from Japan.

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to 6,000 hours of inspections per plant each year. The industry has more than 3,500 years of total operational experience, which has resulted in the highest levels of safety for a large fleet operator in the global industry and a robust safety standard and review process. This process involves both the U.S. government and an industry operations standard-setting body, which is often cited as the gold standard for industry self-regulation.

We will hear testimony today from two panels of witnesses. On the first panel, we will hear from the Nuclear Regulatory Commission. This independent agency has played a central role in the U.S. government's response to the Fukushima incident, and will be an essential guide to identifying lessons from the Japan incident that may be applied to U.S. safeguards and preparedness.

We will be able to receive an update from the NRC and explore some of its actions regarding the Japan response. More broadly, I look forward to learning NRC's perspective on the current safety of U.S. commercial nuclear plants, and the particular safeguards in place to address station black outs, to respond to events that go beyond the design basis of the reactors, and to respond to new risks.

Our second panel will provide perspective from the Nuclear Energy Institute, the American Nuclear Society, and the Union of Concerned Scientists. This testimony will assist the subcommittee to place whatever we see in Japan in perspective of actual industry operations and practices, and the reality of how safety and preparedness is assured in the United States.

Let me welcome all the witnesses. I will now yield to Ranking Member DeGette for the purposes of an opening statement.

# # #

Mr. STEARNS. At this point I will yield to the ranking member of the full committee, the gentleman from California, Mr. Waxman.

Mr. WAXMAN. Mr. Chairman, we would like to have your side take a second 5 minutes while we are waiting for Ms. DeGette, and then we will take our two 5s.

Mr. STEARNS. That is very good. I recognize Mr. Murphy for 2 minutes.

Mr. MURPHY. Thank you, Mr. Chairman, and first I join you in praying for the safety and for the future of the people of Japan.

In this hearing there are two questions Congress needs to be asking on behalf of the public. One, can what happened to the reactors in Japan happen here, and two, how confident can the public be in the safety of nuclear energy, which provides at least 20 percent of electricity in the United States?

Learning comes from experience, and a lot of that learning comes from troubling and difficult experiences, and I certainly want us to review aspects of nuclear design, location, and emergency services, but they should be based on science and careful review, not Congress drawing conclusions without science or legislating science.

I have had the opportunity to discuss with leaders in nuclear energy, including executives from Westinghouse back in my district, about the events at the Fukushima plant and about U.S. nuclear plant safety. We must use the problems incurred from the natural disaster as opportunities to learn that the American nuclear industry can and must become stronger and smarter. The global fleet of commercial operations of nuclear power plants will continue to supply the world with safe and clean energy. Building on this record of safe operations, our engineers in southwestern Pennsylvania at Westinghouse, Curtiss-Wright and many other facilities across America, these companies are bringing to market the latest generation, for example, of safe nuclear energy plants like the AP1000 that have different design of passive safety features, which will

continue to make nuclear an attractive and better option as countries seek to establish or expand their nuclear energy portfolio.

This hearing should be an opportunity to listen and learn and adapt and do what we need to do to assure safety of nuclear power. I continue to believe that the future is bright for nuclear energy and it will continue providing reliable emissions-free electricity but this is a time that we must be asking the difficult questions and asking for the straight and honest answers from this panel, and I look forward to this information in this hearing, and Mr. Chairman, with that, I yield back.

Mr. STEARNS. The next gentleman is recognized, Dr. Burgess, recognized for 1 minute.

Mr. BURGESS. Thank you, Mr. Chairman.

This hearing is as timely as it gets. The seriousness of the incident in Japan must not be minimized. But watching our neighbors deal with the containment of nuclear radiation from the reactors that were devastated by the earthquake and tsunami, we really have to be cognizant of our own safety record and our own assets. If changes need to be made to our nuclear safety plans and regulations, then so be it, but unfortunately, sometimes in the past we have had a history of moving a little too quickly and letting our regulations get ahead of the facts, but in no way should we minimize the seriousness of this incident.

I am looking forward to the testimony of our witnesses. I would like to hear more about what has been going on with the computer modeling of what has occurred and what we might quite expect, and quite honestly, letting our constituents, letting the American people know what they should expect in the weeks and months ahead. It is a serious problem. It is going to be with us for some time. We need to have our best and brightest minds focused on the issue.

Thank you, and I will yield back.

[The prepared statement of Mr. Burgess follows:]

PREPARED STATEMENT OF HON. MICHAEL C. BURGESS

Thank you, Mr. Chairman.

This hearing is as timely as it gets. As we watch our friends in Japan dealing with containing the nuclear radiation from the reactors devastated by the tsunami, we must be cognizant of our own industry and its safety record. If changes need to be made to our nuclear safety plans and regulations, so be it. But let's not rush to judgment, like this body has so many times following disasters, chomping at the bit to add more laws and regulations before we truly know all the facts about any given situation.

This is what this subcommittee does best—investigate. This hearing is exemplary of that skill. We have before us today some of the best and brightest in the nuclear industry to give us the facts we need to make reasoned decisions about next steps in moving our country forward.

Nuclear power has a demonstrated record of being a reliable, clean, and safe energy source. That basic, underlying fact has not changed in the last few weeks.

I hope my colleagues on this committee listen to our witnesses with open ears, and don't use this hearing to demagogue their own partisan positions on nuclear energy. We are here to focus on the U.S. nuclear industry and its safety record. Let's leave the politics for the campaign trail.

With that, Mr. Chairman, I yield back.

Mr. STEARNS. I thank the gentleman and recognize the gentlelady from Tennessee, Ms. Blackburn.

Mrs. BLACKBURN. Thank you, Mr. Chairman, and to our witnesses, thank you for being here.

I think you are hearing a common theme. We are going to look at the lessons learned from Japan and then distill how that applies to us. In Tennessee, we have the TVA, the Tennessee Valley Authority, and as you all are aware, 40 percent of our power is not generated by nuclear power generators. So we are interested in how those lessons will apply to this, the safety measures that are there for the people of TVA.

We are also looking at the modular reactor project, and as you know, TVA is putting some energy into this. So as we look at Japan, let us look at our design differences and talk about those and what lessons we have learned from those. Also, I want to look at the redundant safety systems and what the application and what we know from Japan and what the application of that is to our U.S. marketplace and to our power-generating capacity.

I think that also we are going to want to look at the safety systems, the preparedness, the response components that took place in Japan, and what the expectation would be for here.

And with that, Mr. Chairman, I yield back.

Mr. STEARNS. I thank the gentlelady, and recognize the ranking member, the gentlelady from Colorado.

OPENING STATEMENT OF HON. DIANA DEGETTE, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF COLORADO

Ms. DEGETTE. Thank you very much, Mr. Chairman. Nothing like in the nick of time. Thank you for your comity.

Immediately following the earthquake and the tsunami that set off a nuclear crisis in Japan, Representatives Waxman, Rush, and Markey as well as myself asked this committee to hold hearings into the safety and preparedness of nuclear reactors in the United States. So I am pleased that we have the opportunity to explore these issues today.

On March 16, the committee heard testimony from the Chairman of the Nuclear Regulatory Commission about how grave the situation in Japan was. Unfortunately, here we are 3 weeks later and the status of the Fukushima reactors and spent fuel pools is still extremely serious. There continue to be significant releases of radioactive contaminants into the environment, including, in recent days, highly radioactive water finding its way into the Pacific Ocean. And every day we hear more and more reports of radiation in tap water, milk, and the food supply.

It has become abundantly clear that it will be quite some time before we know the full scope of the catastrophe. So this causes us in the United States here to turn our attention to the dangers that our Nation faces should such a severe disaster strike in the area of one of our 104 nuclear reactors. As part of that effort, the NRC has prepared a report which uses modeling and simulations to analyze potential consequences of severe reactor accidents that, as of now, are considered highly unlikely to occur, unfortunately, just like the one in Japan was.

While I commend the NRC for taking the initiative to conduct this important analysis, the draft report raises grave questions about our Nation's preparedness to address reactor accidents.

One of the two plants the NRC analyzes is the Peach Bottom GE Mark I boiling-water reactor near Lancaster, Pennsylvania, co-owned by Exelon and PSEG. The Peach Bottom reactor has the same design as the Fukushima Daiichi reactors in Japan. In fact, in the United States, 35 boiling-water reactors are operating, and 23 of these reactors were constructed with the same Mark I containment system as Fukushima. So this is a common reactor design in the United States.

For the Peach Bottom boiling-water reactor, NRC modeled two key scenarios involving the loss of power at the plant. Both of these scenarios reflect the effects of an extreme external event, such as an earthquake, flood, or fire. For each of the two scenarios, NRC looked at what would happen if the plant had the latest equipment and procedures introduced since the September 11th attacks. They also looked at what would happen if the plant didn't have the new equipment and procedures. Under the more severe loss-of-power scenario, the site loses all power, even the backup batteries. In their severe loss-of-power scenario, the Peach Bottom reactor came dangerously close to core damage. With all its power lost, the operator was able to prevent core damage for 2 days; but after only 2 days, the modeling showed that the Peach Bottom reactor came within one hour of core damage.

So in other words, when a major earthquake, flood or fire was assumed to knock out all of the power of a nuclear reactor—that is the same design as Fukushima and it stands less than 40 miles from the city of Baltimore, well within the contamination zone the United States called for in Japan—that plant came less than an hour away from partial nuclear meltdown. This is a frightening scenario for the American people for sure.

And while these draft findings are already very troubling, they don't even take into account the issue of the spent fuel pools, which have been a major source of radiation and radioactive contamination in Japan. So as alarming as this report's findings are, it is sadly clear that we still have much to evaluate before we can know the true threats to our Nation from a disaster like what we have seen in Japan.

Mr. Chairman, the American people have questions, and we in Congress have questions. But the first question I have to ask is, why do we keep finding ourselves here? It seems that we say over and over, don't worry, it is safe, and oh but that would never happen. But here we are again having these conversations.

So Mr. Chairman, I am happy that we are having this hearing. I want to commend you for having this hearing, but I have got to say that rather than just asking questions that always go without an answer, we have got to start working with our regulators to make sure that we have an answer because what happened in Japan cannot happen anyplace else, and it is our job to help make sure that that is the case. I yield back.

Mr. STEARNS. The gentlelady yields back and we recognize the ranking member of the full committee, Mr. Waxman from California, for 5 minutes.

OPENING STATEMENT OF HON. HENRY A. WAXMAN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. WAXMAN. Thank you, Mr. Chairman.

I want to follow up on the issues Ms. DeGette discussed in her opening statement about the modeling and simulation work NRC has done on the Peach Bottom boiling-water reactor under the NRC's State-of-the-Art Reactor Consequences Analysis. According to the NRC staff, a draft NRC report reveals that the Peach Bottom plant came within one hour of core damage in a severe loss-of-power scenario. That result raises questions about whether our reactors may be as vulnerable as those in Fukushima.

When a simulation purporting to determine the realistic consequences of a severe accident nearly results in a partial meltdown, Congress should be asking tough questions.

The NRC's simulations do not consider the impact of a disaster event on spent fuel pools. We know from the Japan incident that uncovered spent fuel was a major source of radiation and radioactive contamination. At crucial points in the Japanese response effort, radiation from uncovered spent fuel rods has been a significant obstacle. We need additional analysis to account for these potential risks.

The NRC terminated its models 2 days after the simulated loss of power. According to NRC staff, the assumption was that response efforts would only get more numerous and more effective after 2 days.

There is a lot we still don't know about what went wrong at the Fukushima plant. But we can safely conclude 2 days is not enough time to know whether a reactor will melt down and release radioactive contamination into the environment after a major disaster. Stopping the analysis after just 2 days means that NRC may be overlooking important consequences.

There are also questions the Committee should explore about whether the new equipment and procedures ordered after the September 11 attacks are actually in place and would be effective. The new equipment and procedures made an important difference in the NRC's modeling. With the new equipment and procedures, a meltdown is narrowly avoided in a complete loss-of-power scenario. Without the new equipment and procedures, a simulated meltdown results, even when the backup battery power is still operational.

The starting point for the NRC models is a major earthquake, flood or fire that leads to a loss of power at the reactor. In the briefing NRC provided our staff, the agency indicated that it assumes that critical backup equipment would survive the earthquake or flood or fire and be fully operational. That is a big assumption.

Internal NRC e-mails described in a memo the Union of Concerned Scientists is releasing today also indicate that there were disagreements among NRC analysts as to whether the new equipment and procedures, known as B.5.b. measures, that allowed Peach Bottom to narrowly avoid a meltdown would actually work. According to the UCS memo, one NRC staff e-mail summarized concerns of NRC senior reactor analysts who work in NRC's regional offices as follows: "One concern has been that SOARCA cred-

its certain B.5.b. mitigating strategies...that have really not been reviewed to ensure that they will work to mitigate severe accidents. Generally, we have not even seen licensees credit these strategies in their own probabilistic risk assessments but for some reason the NRC decided we should during SOARCA."

This e-mail specifically raises concerns about the Reactor Core Isolation Cooling System. This is the exact system that NRC staff told us allowed Peach Bottom to avert core damage in the simulated full loss-of-power scenario. These emails and the results of the NRC's draft report raise questions about the safety and preparedness of nuclear reactors in the United States. The review initiated by NRC is an important first step. NRC should absolutely conduct a thorough review of safety at U.S. plants and what changes should be made in light of the events in Japan. But this Committee has an independent obligation to conduct oversight. We need to gather the facts so that we can determine whether the laws and regulations governing these reactors are adequate and effective.

Americans are asking whether U.S. nuclear plants are safe. That is a reasonable question that deserves a thoughtful answer. I look forward to working with my colleagues to conduct the bipartisan oversight necessary to answer that question.

Mr. WAXMAN. Mr. Chairman, I would like to ask unanimous consent to enter into the record the Union of Concerned Scientists memo and a supplemental memo prepared by the Democratic staff.

Mr. STEARNS. By unanimous consent, so ordered.

[The information appears at the conclusion of the hearing.]

Mr. STEARNS. And I thank——

Mr. TERRY. Mr. Chairman, do we have a copy of that?

Mr. STEARNS. I think, as I understand it from our staff, we received a copy of it a couple minutes ago. But I ask the member, would he like to see it himself?

Mr. TERRY. No, I have it now.

Mr. STEARNS. OK. Without objection, so ordered then.

We have 1 minute left over on this side of the aisle, and I will recognize Mr. Murphy, and Mr. Murphy, if you have any extra, you can give it to Mr. Bilbray.

Mr. MURPHY. I just want to take a few seconds to reiterate the importance of science here. I know by my friend from Colorado, who for some reason always likes to talk about Pennsylvania when it comes to Clairton Coke Works or fracking and now it is a nuclear power plant. Lancaster, Pennsylvania, is 368 feet above sea level. That is quite a few meters higher than Japan, and it was the tsunami that wiped out that plant. We are all interested in design issues but I want to make sure we are focusing on the facts in this to make sure we are dealing with this in the most honest and straightforward way.

With that, I will yield to Mr. Bilbray.

Mr. BILBRAY. Mr. Chairman, I appreciate it.

San Diego County, where I lived my whole life as a resident, has one major nuclear power plant and has many government-owned nuclear reactors within a mile of downtown San Diego, so it is important, but I am concerned that as the former chairman has asked the preparedness council, nobody points out the fact that 11,000

people died from the tsunami, no confirmed deaths from the nuclear reactor. That means for those of that live on the coast, that is more dangerous, 11,000 times more dangerous to live by the coast than it is to live by a nuclear power plant if you take out basically the data that the 16,000 that are missing are going to be recovered.

So I think as we keep this in perspective, I think one of the things we should be really concerned about is so much has been talked about the reactors while we ignore the fact that the real death and carnage occurred to those who were living close to the coast, which is an important issue for those of us that live by the coast and by nuclear facilities, so I will we are able to clarify that in this hearing, and I yield back.

Mr. STEARNS. I thank the gentleman, and with that, I believe we are prepared for Mr. Virgilio. Mr. Martin J. Virgilio is Deputy Executive Director for Reactor and Preparedness Programs, and he is accompanied by Dr. Donald A. Cool, a Senior Advisor for Health Physics Chairman, Nuclear Regulatory Commission. We want to welcome both of you, and we look forward to your opening statement, and you have 5 minutes. If you can, turn the microphone on and bring it close to you. It will be helpful to all of us.

TESTIMONY OF MARTIN J. VIRGILIO, DEPUTY EXECUTIVE DIRECTOR FOR REACTOR AND PREPAREDNESS PROGRAMS, U.S. NUCLEAR REGULATORY COMMISSION; ACCOMPANIED BY DR. DONALD A. COOL, SENIOR ADVISOR, RADIATION SAFETY AND INTERNATIONAL LIAISON

Mr. VIRGILIO. Thank you, Mr. Chairman. Good morning. Good morning, Ranking Member, also to the members of the committee here today.

As was noted by the chairman, my name is Marty Virgilio. I am the Deputy Executive Director for Operations at the NRC. With me today is Don Cool. Don is the Senior Radiation Protection Expert from the NRC. Both of us have stood numerous watches in our operations center since the Fukushima event has occurred, and we are here today to provide answers to the questions that you have raised in some of the opening statements that you have made.

I have a brief statement I would like to read into the record. NRC is mindful of our primary responsibilities and they are to ensure the adequate protection of the public health and safety of the American people. We have been closely monitoring the activities in Japan and reviewing all currently available information. Review of this information combined with our ongoing inspection, licensing and oversight allows us to say with confidence that the U.S. plants continue to operate safely.

On Friday, March 11th, an earthquake hit Japan, resulting in the shutdown of more than 10 reactors. From what we know now, it appears that the reactors' response to the earthquake went according to design. It was in fact the tsunami that caused or apparently caused the loss of normal and backup electrical power to the six units at the Fukushima Daiichi site.

On that Friday morning, we went into the monitoring mode at the NRC. What that meant is that we activated our response center and individuals like Don and others were brought forward to

that center and focused our attention on the events that were occurring. Our first concern was of course for the possible impacts of the tsunami on the U.S. plants and the radioactive materials that are on the West Coast of the United States, Hawaii, Alaska and the U.S. territories in the Pacific. On that same day, we began our interactions with our Japanese regulatory counterparts. We dispatched two experts to help the U.S. embassy in Japan.

By Monday, March 14, we had dispatched a total of 11 staff to Japan. We continue to have staff on the ground in Japan and their areas of the focus are to assist the Japanese government as part of the U.S. response to the event and to support the U.S. ambassador. NRC's chairman, Dr. Gregory Jaczko, traveled to Tokyo on March 28th, met with his regulatory counterparts and sent messages of support and cooperation to the current situation.

As you may be aware, NRC made a recommendation regarding the 50-mile evacuation of U.S. citizens, and that was based on conditions as we understood them at the time. We also have had—you have to recognize the situation at the time was that we had limited understanding of what was happening on the ground. There was a large degree of uncertainty about plant conditions. It was difficult for us to actually adequately assess our accurately assess the radiological hazards. But in order to determine that distance, we performed a series of calculations to assess possible offsite consequences looking at some of the worst possible cases that occurred. The source terms were based on hypothetical estimates of core damage, containment and other conditions and factors that could affect the release. Our calculations at the time demonstrated that the Environmental Protection Agency's Protective Action Guidelines that we would have used in the United States or would use in the United States could have been exceeded out to a distance of 50 miles. Acting in accordance with our U.S. emergency planning framework and with the best information available to us at the time, we did make a recommendation that U.S. citizens evacuate out to 50 miles, and we thought that that was a prudent course of action given what we knew at the time.

I would now like to turn to some factors that assure us of ongoing domestic reactor safety. We have since the beginning of our regulatory program in the United States used a philosophy of defense and depth. What we require is the highest standards of design, construction and oversight of the nuclear reactors. We rely on multiple levels of safety to protect the public and the environment.

We begin with the design of every reactor to make sure that it takes into account the site-specific factors that include a detailed evaluation of natural events and phenomena like earthquakes, tornadoes, hurricanes, tsunamis. We have taken advantage of lessons learned from previous operating experience including probably the most significant event in the United States, Three Mile Island, which occurred in 1979. We implement a process and a philosophy of continuous improvement for all the U.S. commercial reactor fleet. As a result of all the lessons learned, we significantly revised emergency planning requirements and emergency operating procedures following Three Mile Island.

I think the most significant changes after Three Mile Island included the expansion of our resident inspector program and the

way we look at incident response today. With respect to the resident inspection program, we have two resident inspectors assigned to each site in the United States, and they serve as NRC's eyes and ears on the ground. With respect to emergency preparedness, our headquarters operational center that we activated following the Fukushima event and the centers that we have in the regions, our regional offices, are prepared to respond to all emergencies including any that result from operational events, security events or natural phenomena. We have multidisciplinary teams that are ready to be dispatched to a site if there were an event to occur.

NRC's response to an event in the United States would in fact include a dispatch of a site team and integration of all of our emergency response capabilities. Our program is designed to provide quick response and adequate response should an event occur.

Our culture involves continuous improvement, and I think we will talk a little bit more today about the State-of-the-Art Consequence Analysis, which is a part of that culture where we are constantly looking, we are constantly testing the edge to see what could happen in the event of an unlikely scenario. We have begun—in response to this event, let me say that we have already begun inspection activities in the United States to look at licensees' readiness to deal with the kinds of events that might have occurred in Japan. We have also issued information notices to our licensees to make sure they are aware of the facts as we know them today.

In response to these information notices, licensees have voluntarily verified their capabilities to mitigate conditions that result from severe accidents. They are also verifying the capability to mitigate problems associated with flooding, both inside and outside the plant, and ensuring that they have the necessary equipment in place to mitigate any event or concern.

Beyond the initial steps to address the experiences from the event, the Chairman with full support from the commission tasked the staff to conduct a very systematic and methodical lessons learned review and that activity has started. In the near term, we will provide, first is a 90-day review effort that is really focused on the short term to look at what are the immediate lessons learned and what, if anything, we need to do to ensure the continued safety of the reactors that are operating in the United States.

Our investigation and assessment will include the ability to protect against natural disasters, response to station blackouts, severe accidents, spent fuel pool accidents and other conditions. This 90-day report will develop recommendations as appropriate. We will brief the commission and provide a copy of that report to the public.

Beyond that taskforce review, we will identify other areas that we will want to study in the longer term and hope to have that work completed in about 6 months after the conclusion of that first 90-day study.

In conclusion, I would just like to say that we continue to take our domestic responsibilities for licensing and oversight of the nuclear power plants in the United States as our top priority, and we believe that the plants continue to operate safety. In light of the events in Japan, there is a near-term evaluation. We will continue to gather information. We will perform a longer-term assessment,

and based on these efforts, we will take any appropriate actions that are necessary to ensure the continued safety of the American public. Thank you.

[The prepared statement of Mr. Virgilio follows:]

TESTIMONY OF MARTIN VIRGILIO
DEPUTY EXECUTIVE DIRECTOR FOR REACTOR AND PREPAREDNESS PROGRAMS
UNITED STATES NUCLEAR REGULATORY COMMISSION
TO THE COMMITTEE ON ENERGY AND COMMERCE
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
UNITED STATES HOUSE OF REPRESENTATIVES

NRC RESPONSE TO RECENT NUCLEAR EVENTS IN JAPAN AND THE CONTINUING SAFETY OF THE U.S. COMMERCIAL NUCLEAR REACTOR FLEET

APRIL 6, 2011

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 and to the Japanese people.

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 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 as a result of the substantial effort we are making to assist Japan.

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 continually make 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, including our recommendation for U.S. Citizens in Japan to evacuate out to 50 miles from the Fukushima-Daiichi site. I then will discuss 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. Finally, I will give you an overview of NRC incident response capabilities here in the U.S.

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 replacement 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. The NRC's Chairman, Dr. Gregory Jaczko, traveled to Toyko on March 28th to convey directly to his Japanese counterparts a message of support and cooperation, and to discuss the situation. While our focus now is on helping Japan in any way that we can, the experience will also help us assess the potential implications for U.S. citizens and the U.S. reactor fleet in as timely a manner as possible.

We have had ongoing interaction with the White House, Congressional staff, our state regulatory counterparts, a number of other federal agencies, and international regulatory bodies around the world. We recently sent an NRC staff member to Hawaii to support the United States Armed Forces Pacific Command (USPACOM).

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

The 50 mile evacuation recommendation that the NRC made to the U.S. Ambassador in Japan was made in the interest of protecting the health and safety of U.S. citizens in Japan. We based our assessment on the conditions as we understood them at the time. Since communications with knowledgeable Japanese officials were limited and there was a large degree of uncertainty about plant conditions at the time, it was difficult to accurately assess the

potential radiological hazard. In order to determine the proper evacuation distance, the NRC staff performed a series of calculations using NRC's RASCAL computer code to assess possible offsite consequences. The computer models used meteorological model data appropriate for the Fukushima Daiichi vicinity. Source terms were based on hypothetical, but not unreasonable, estimates of fuel damage, containment, and other release conditions. These calculations demonstrated that the Environmental Protection Agency's (EPA's) Protective Action Guidelines could be exceeded at a distance of up to 50 miles from the Fukushima site, if a large-scale release occurred from the reactors or spent fuel pools. The U.S. emergency preparedness framework provides for the expansion of emergency planning zones as conditions require. Acting in accordance with this framework, and with the best information available at the time, the NRC determined that evacuation out to 50 miles for U.S. citizens was a prudent course of action, and would be consistent with what we would do under similar circumstances in the United States, and we made that recommendation to the Ambassador and other U.S. Government agencies.

Let me 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 EPA's system has identified trace amounts of radioactive isotopes consistent with the Japanese nuclear incident, but still far below levels of public health concern. 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 significantly revised emergency planning requirements and emergency operating procedures for licensees, and made substantive improvements in NRC's incident response capabilities. We also addressed many human factors issues regarding control room indicators and layouts, 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.

Two significant changes after Three Mile Island were the expansion of the Resident Inspector Program and the incident response program. Today, there are at least two

Resident Inspectors at each nuclear power plant. The inspectors have unfettered access to all licensees' activities, and serve as NRC's eyes and ears at the power plant. The NRC headquarters operations center and regional incident response centers are prepared to respond to all emergencies, including any resulting from operational events, security events, or natural phenomena. Multidisciplinary teams in these centers have access to detailed information regarding licensee facilities, and access to plant status information through telephonic links with the Resident Inspectors, an automated emergency response data system, and directly from the licensee over the emergency notification system. NRC's response would include the dispatch of a site team to augment the Resident Inspectors on site, and integration with the licensee's emergency response organization at their Emergency Offsite Facility. The program is designed to provide independent assessment of events, to ensure that appropriate actions are taken to mitigate the events, and to ensure that State officials have the information they would need to make decisions regarding protective actions.

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 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 for additional evaluation of 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.

NRC has 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. In response to the events licensees have voluntarily verified 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 that any necessary mitigating equipment is in place to compensate for the potential loss of equipment due to seismic events appropriate for the site, because each site has its own unique seismic profiles.

Subsequent to the 1979 event at Three Mile Island, there have been a number of new regulatory requirements imposed by the NRC 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 beyond-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 regulatory processes to determine whether the agency should make additional improvements to our regulatory system and to 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 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. 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 additional regulations are needed.

This 90-day effort will include a briefing to the Commission after approximately 30 days 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. This briefing 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.

Mr. STEARNS. I thank the gentleman. Mr. Virgilio, before I start my questions, I think Mr. Waxman brought up a point in his opening statement. He made reference to some e-mails regarding the B.5.b. and the SOARCA issue. Have you seen those e-mails?

Mr. VIRGILIO. Yes, sir, I have.

Mr. STEARNS. Can you explain them to us?

Mr. VIRGILIO. Yes, sir, I can.

Mr. STEARNS. Just briefly, if you could.

Mr. VIRGILIO. I will. To understand the context, there is this State-of-the-Art Reactor Consequence Assessment, SOARCA, that has been referred to a couple of times. That is a study that is done without full respect of risk involved, and let me explain what I mean by that. Risk is what can happen, how likely can it happen and what are the consequences. The SOARCA analysis pretty much ignores those first two questions and goes straight to what can happen, so we look at very unrealistic events as part of that analysis and we do that as part of our culture of continually looking at the safety of the operating nuclear power plants in this country to make sure that we are looking beyond the obvious issues. So in that context, the staff has looked at a number of different scenarios, and we do what we call parametric studies. We turn on certain systems, we turn off certain systems. One of the parametric studies we did was to turn on and turn off equipment that was required to be installed after 9/11. This is often referred to as B.5.b. It refers to a very specific section of an order that we issued following 9/11 to require licensees to install equipment.

So this B.5.b. equipment is the subject of the e-mails, and in the e-mails, what you see is NRC in operation. You see that our staff is encouraged to challenge various issues as they are being evaluated, and what is in those e-mails is really staff in one of our regional offices challenging the staff and headquarters office to say I know you are turning this equipment on and off but do you realize that some of this equipment is not seismically qualified and so why would you even turn it on in this event.

Mr. STEARNS. Because it is not a valid test is what you are saying?

Mr. VIRGILIO. Right. That is what this individual was raising.

Mr. STEARNS. Right. OK.

Mr. VIRGILIO. Now, notwithstanding the fact that it was not seismically qualified, our staff had walked down that equipment and come to believe that while it didn't have the pedigree that there was a potential that equipment would in fact still operate. So that is what you are seeing in the e-mails is that healthy debate that goes on inside the NRC around any issue that we evaluate.

My final comment on this is, all the equipment that is required to operate in a seismic event is seismically qualified. We only rely on qualified structure systems and components to respond to an earthquake.

Mr. STEARNS. OK. Thank you. Let me ask my questions. If you can, just answer yes or no if possible. This is the current status of the reactors in Japan. Has the cooling been brought under control, in your opinion? Yes or no.

Mr. VIRGILIO. Yes.

Mr. STEARNS. Is the water covering the cores in the reactor?

Mr. VIRGILIO. It is unknown at this time.
Mr. STEARNS. Unknown. Is water covering the spent fuel?
Mr. VIRGILIO. Yes and no.
Mr. STEARNS. It has got to be either yes or no, right?
Mr. VIRGILIO. What happens is they put water in, sir. The water evaporates and then they put more water in.
Mr. STEARNS. OK. So right now you have to say it is not covering?
Mr. VIRGILIO. Not completely at all times.
Mr. STEARNS. OK. Can you describe how stable the—is the situation stable? Would we say it is stable today?
Mr. VIRGILIO. I would be pressed to say that it is stable today.
Mr. STEARNS. So you would say no, it is not stable?
Mr. VIRGILIO. Not stable.
Mr. STEARNS. It is not stable. OK. Is there a risk to overheating right now?
Mr. VIRGILIO. Yes.
Mr. STEARNS. And how do you corroborate that fact? What indicates to you that there is a risk for overheating?
Mr. VIRGILIO. We have a lot of conflicting information that tells us at times the core is covered and times the core is uncovered.
Mr. STEARNS. And so if it is not covered, then there could be the risk for overheating?
Mr. VIRGILIO. Yes.
Mr. STEARNS. What should we expect to be the next step to restore cooling, briefly?
Mr. VIRGILIO. More reliable fresh water being placed into the reactor core.
Mr. STEARNS. OK. Is there a plan in place and is it being shared with the United States? In other words, do you have transparency?
Mr. VIRGILIO. Yes.
Mr. STEARNS. Do you believe you have transparency of information?
Mr. VIRGILIO. With the staff that we have on the ground in Japan today and with the others that are there including the International Atomic Energy Agency, yes, we do.
Mr. STEARNS. In my eagerness to ask you some questions, I forgot to swear you in, so if you don't mind, bear with me here.
Mr. VIRGILIO. Would you like me to stand?
Mr. STEARNS. Yes, if you would.
As you know, the testimony that you are about to give is subject to Title 18, section 1001 of the United States Code. When holding an investigative hearing, this committee has the practice of taking testimony under oath. Do you have any objection to testifying under oath?
Mr. VIRGILIO. No, sir.
Mr. STEARNS. The chair advises you that under the rules of the House and the rules of the committee, you are entitled to be advised by counsel. Do you desire to be advised by counsel during your testimony today?
Mr. VIRGILIO. I have counsel here with me, and we may draw on the counsel.
Mr. STEARNS. All right. If you would raise your right hand?
[Witness sworn.]

Mr. STEARNS. Thank you. I apologize for that. All the answers you have given are true, correct?

Mr. VIRGILIO. Yes, sir.

Mr. STEARNS. In terms of radiological releases, what are the current specific measurements in the area surrounding the facilities in terms of—give us a little perspective what this means. I mean, would I want my family to be there or not?

Mr. VIRGILIO. I am going to turn to my colleague, Don Cool. But first I would say that there is a larger degree of certainty around some of the radiation measurements, primarily because many of them come from NRC, U.S. assets that are there in Japan today.

Mr. STEARNS. So we have real clear measurements?

Mr. VIRGILIO. We do have some very good measurements.

Mr. STEARNS. All right. Dr. Cool, you are the one that is going to give us the insight here.

Mr. COOL. Thank you, Mr. Chairman. There are a whole series of measurements which we have been tracking since the time of the incident.

Mr. STEARNS. Just give me the essence here. Are they dangerous levels that would cause death?

Mr. COOL. They are not dangerous levels that would cause death over a short period of time, even in the immediate——

Mr. STEARNS. And what do you mean by short period of time?

Mr. COOL. That is in hours or days.

Mr. STEARNS. In hours or days?

Mr. COOL. Weeks or months.

Mr. STEARNS. OK. Has the facility been emitting significant doses of radiation into the air in recent days, like yesterday?

Mr. COOL. We do not believe so.

Mr. STEARNS. So in your opinion, it is under control and it is safe in the areas?

Mr. COOL. The current conditions are stable. They should remain safe.

Mr. STEARNS. Is the situation then getting better?

Mr. COOL. The radiological conditions are getting better. Dose rates are decreasing.

Mr. STEARNS. So you can say conclusively that the current measured levels do not pose any immediate risk to the public in Japan or the United States? At least in Japan, we will start.

Mr. COOL. With the current circumstances at the facility, yes, sir.

Mr. STEARNS. And obviously not in the United States?

Mr. COOL. Yes, sir.

Mr. STEARNS. With that, my time is expired and the ranking member is recognized.

Ms. DEGETTE. Thank you very much, Mr. Chairman.

Mr. Virgilio, you were talking about this SOARCA analysis, and as I understand it, that analysis is something that the NRC does for modeling and simulations of sort of the worst-case scenario. Is that right?

Mr. VIRGILIO. That is correct.

Ms. DEGETTE. And something like that had not been done since the 1980s and that was one of the reasons why given the new advancements after September 11th and everything else the NRC de-

cided to go through one of these SOARCA assessments. Is that correct?

Mr. VIRGILIO. It was a combination of new plant design features and new tools for doing these analyses.

Ms. DEGETTE. OK. And so your staff recently briefed my staff about the modeling, and I know there is a draft report but it is not out yet so I wanted to ask you some questions about that report. As I mentioned in my opening statement, the SOARCA project analyzed two plants including the Peach Bottom plant near Lancaster, Pennsylvania, and I am certainly not meaning to disparage the State of Pennsylvania, and I wish my colleague was here, but the SOARCA model is talking about if power goes out at one of these facilities, correct?

Mr. VIRGILIO. Yes, that is one of the——

Ms. DEGETTE. That is one of the scenarios?

Mr. VIRGILIO. Yes.

Ms. DEGETTE. So it is not really how the power goes out, it is if the power goes out, right?

Mr. VIRGILIO. Right.

Ms. DEGETTE. I mean, anything could cause the power to go out. Certainly, in Lancaster, Pennsylvania, we are not going to have a tsunami like we did in Japan, but what you are looking at irrespective of the cause of the power outage, one of the things you are looking at is, is the power going to go out, right?

Mr. VIRGILIO. Irrespective of the probability and cause.

Ms. DEGETTE. Probability and cause, what would happen. And now, am I correct when I say that the Peach Bottom reactors are of the same design as the Fukushima reactors in Japan?

Mr. VIRGILIO. The containment and reactor designs are very similar.

Ms. DEGETTE. Very similar. OK. So for the Peach Bottom reactors, NRC modeled three scenarios. Under one scenario, the plant is assumed to lose offsite power and its backup diesel generators but the battery backups operate safe systems for about 4 hours until the battery is exhausted, right?

Mr. VIRGILIO. You are getting into a level of detail about the modeling that I would have to check with the staff on.

Ms. DEGETTE. OK. If you don't mind checking with the staff on that and supplementing your answer, that would be great.

Mr. VIRGILIO. Sure.

Ms. DEGETTE. Thank you. Now, under another scenario—and your staff told our staff about this during the briefing—the site loses all power, even the battery power backups, and so all safety systems are inoperable. Now, are these so-called station blackout scenarios similar to what occurred in Japan where the power goes out and then the backup power goes out?

Mr. VIRGILIO. Yes.

Ms. DEGETTE. What happened at the Daiichi plant is that it lost electricity and backup diesel generators and then the batteries worked until they were depleted, right?

Mr. VIRGILIO. That is our understanding today.

Ms. DEGETTE. OK. So your staff told us that for each of the scenarios that I just talked about a minute ago, the NRC modeled two sub-scenarios, one that assumed the presence and use of new

equipment and procedures since September 11 and one that did not. So what types of equipment and procedures are we talking about here? Additional pumps and generators?

Mr. VIRGILIO. Yes, additional generators and additional pumps and other equipment.

Ms. DEGETTE. OK. So the NRC results are sobering because without the post-9/11 equipment and procedures, both of the simulated station blackout scenarios led to core damage at the Peach Bottom plant within 2 days, and so here is my question to you. Does this mean that America's nuclear plants were not prepared to respond to station blackouts before September 11?

Mr. VIRGILIO. No, not at all.

Ms. DEGETTE. OK. That is a relief.

Mr. VIRGILIO. As a matter of fact, we issued a station blackout rule that required licensees to establish the capability to cope with the complete loss of external power and emergency onsite power.

Ms. DEGETTE. OK. So now, since September 11, have all of our nuclear plants been equipped with these same precautions that you looked at in the Pennsylvania plant?

Mr. VIRGILIO. Yes. It was part of an order which eventually became part of a regulatory requirement.

Ms. DEGETTE. OK. I just have one last question. Now, in this simulation, the Peach Bottom reactors performed better with the new equipment and procedures. In the less severe station blackout scenario where the batteries operated for 4 hours, they averted core damage. In the more severe scenario in which all power was lost, however, they only avoided core damage by 1 hour. So I am wondering if this SOARCA project, the 1 hour under the more severe scenario, if that gives you any cause for concern.

Mr. VIRGILIO. Well, once again, what we do in the SOARCA analysis is, we ignore all probabilities. You go straight to the event. So you have to first consider how likely is this to occur. As part of our culture, we constantly push the envelope.

Ms. DEGETTE. So your answer is no, it doesn't give you concern?

Mr. VIRGILIO. No, it doesn't give me concern.

Ms. DEGETTE. OK. Thank you.

Mr. STEARNS. I thank the gentlelady. The gentleman from Nebraska is recognized for 5 minutes.

Mr. TERRY. Thank you, Mr. Chairman.

This is an interesting discussion and one I wasn't totally prepared for here in the sense of SOARCA and these e-mails, but it is certainly interesting. I guess the assumption here is that you are not following through on suggestions made by your own staff. Would you reply to that assumption?

Mr. VIRGILIO. That is far from the truth. We encourage our staff to raise issues as we do these kinds of analyses, and as a matter of fact, on that very issue the question is still open. I spoke to the office director, deputy office director and the division director responsible for this area once we became aware of those e-mails, and this is still an open issue as to whether the equipment in fact would operate in a seismic event or not, and again, this was a parametric study. We turned it on, we turned it off to see what——

Mr. TERRY. So you actually followed through on some of the feedback that you received that you actually invited?

Mr. VIRGILIO. We always do. We invite the feedback and we follow up on it.

Mr. TERRY. Very good. The other assumption that is being used or at least I am hearing in statements and questions here, the syllogism would somewhat like the GE plant in Fukushima is in crisis, core melting and we have the same GE plants in the United States so therefore we are at risk for the same thing. Is that a fair syllogism and assumption?

Mr. VIRGILIO. I don't think so at all.

Mr. TERRY. Why?

Mr. VIRGILIO. I don't think the events that occurred—given the seismology and geology of that area, you have to realize that we are dealing with a subduction zone, which is a very powerful earthquake, leads to very large tsunamis. We don't have that siting issue here. Furthermore, I think that there are differences in the designs of those reactors. While they are basically the same reactor, we have done quite a bit to modify that design over the life of the facilities as a result of operating experience. We don't know for sure but there is some evidence that we are seeing that the Japanese designs did not keep pace, they did not make the same modifications that we made to install hardened vents, to install the B.5.b. equipment that we installed post 9/11.

Mr. TERRY. Let me ask this question. You mentioned about your NRC site team. You have got regulators on staff. There is a nuclear power plant in Fort Calhoun that is just a couple miles outside of my district that I have visited probably four or five times before 9/11, after 9/11. I have seen the changes that occurred there. I have seen your regulators there. I am just curious if Japan has something similar to onsite nuclear regulators and site teams when there is an issue. Are we more prepared for a problem than they are?

Mr. VIRGILIO. I believe we are, based on what we are seeing today in terms of the response to the event.

Mr. TERRY. And what assurances could you give the American public that if there is an event at a nuclear power plant in the United States that your site teams can act quickly and efficiently to avert any risk to human health?

Mr. VIRGILIO. Well, I would go back to first say that the design features that I would start with, with respect to our ability to cope with those kinds of events and then I would go to our regulatory structure that includes dispensing or dispatching a team to the site along with standing up our operations center in Washington, DC until the site team is established, and that team is there to oversee the operations and make recommendations to the state that has the final say in protective actions.

Mr. TERRY. Well, I appreciate that. I think that is probably one of the things that we need to—one result from this hearing is to be able to assure the American public that we are on top of this to avoid any crisis. I think there will be some people that will try and take advantage of this who are just simply anti-nuclear whether it is nuclear power or nuclear weapons, and most people that I have talked to in Nebraska are fearful that it is going to be used to shut down nuclear power across the United States, and I think that may be a real agenda of some, and those are also ironically

the same people that are trying to shut down coal, and at least we realize if you shut down 75, 80 percent of our generation of electricity, that may actually hurt our country as well. Yield back.

Mr. STEARNS. The gentleman from California, Mr. Waxman, is recognized for 5 minutes.

Mr. WAXMAN. Mr. Virgilio, I appreciate the work the NRC is doing to make sure our nuclear power in this country is as safe as possible. I guess the questions that Ms. DeGette and I are raising is whether the simulations of the worst case, we can be assured—of course, you can never be completely assured. You are working on certain modeling, certain assumptions. The NRC did a modeling called a State-of-the Art Reactor Consequence Analysis, or the SOARCA analysis, and they stimulated crisis scenarios at this Peach Bottom nuclear facility in Pennsylvania. I assume that is because it is so similar to the one in Fukushima Daiichi. Is that right?

Mr. VIRGILIO. No, we selected the plants quite some time ago.

Mr. WAXMAN. But it is similar?

Mr. VIRGILIO. It is a similar design, yes.

Mr. WAXMAN. Now, the worst-case scenario is what the modeling was supposed to pick up, and they said there is a narrow margin of safety under the best of circumstances but some questions have been raised about the assumptions the NRC used in its SOARCA modeling. First, the nuclear crisis in Japan is now in its fourth week with no end in sight. NRC's simulation of a massive power loss at Peach Bottom stopped only after 2 days under the assumption that operators would be able to restore full power by then. Why was it stopped after a 2-day analysis? Why just 2 days?

Mr. VIRGILIO. I would have to go back to the staff and get the details on why we specifically truncated that at 2 days.

Mr. WAXMAN. Well, I would like to get that information because we would like to know if the Peach Bottom or similar reactor could withstand a longer crisis. Japan is already in its fourth week of its crisis.

In addition, the NRC explained to our committee staff that the operator was able to avert core damage in the full power loss scenario by activating a steam-powered reactor cooling system, also known as the RCIC, but some NRC analysts have questioned the ability of this system to function when battery power is lost. There has been a Freedom of Information Act request by the Union of Concerned Scientists. They obtained an e-mail from a senior reactor analyst at NRC expressing concerns to other NRC staff about the utility of this steam-driven cooling system. The e-mail states that one concern has been that SOARCA credits certain mitigating strategies such as the steam-powered RCIC operation without DC power that have not really been reviewed to ensure that they will work to mitigate severe accidents. How do you react to that concern that was expressed by one of the NRC high-ranking personnel involving the worst-case scenario?

Mr. VIRGILIO. In conducting that analysis, our staff did a walk-down of that system, and based on that walk-down, they made some engineering judgments about its ability to operate following a seismic event. Consistent with our culture, that was questioned by other staff members and that remains an open item today. As

you know, that SOARCA analysis is still in draft. It is still under internal review, and that open item will need to be resolved before we move forward.

Mr. WAXMAN. And what is the open item?

Mr. VIRGILIO. Whether the systems that were credited in that parametric study would in fact work in that particular accident scenario.

Mr. WAXMAN. And the SOARCA simulation assumed that the loss of power occurs in the result of a major earthquake, flood or fire. The NRC assumes that the new equipment and procedures put in place after 9/11 will help stave off a core melt in its simulated scenarios but the Union of Concerned Scientists obtained another internal NRC e-mail that raises concerns about these assumptions. That e-mail states that concern involves the manner in which credit is given to these measures such that success is assumed. Mitigations are just equipment on site that can be useful in an emergency when used by knowledgeable operators if post-event conditions allow. If little is known about these post-event conditions, then assuming success is speculative. As we have seen in Japan, these post-event conditions can be dire.

Mr. Virgilio, you said earlier that the equipment is not seismically qualified. Are you confident that this equipment will be up to the task in the event of a major earthquake or another disaster?

Mr. VIRGILIO. Let me go back and say that we don't rely on this equipment for safety. We have seismically qualified equipment, structure systems and components that are there to ensure the reactor is safely shut down in the event of an earthquake. We take these studies and we go well beyond the design basis and we assume that for whatever reason, and I guess I can back to where were in the beginning in terms of we are ignoring what can happen, the likelihood of what can happen and we just focus on the consequences. We assume——

Mr. WAXMAN. Why is it so important in the study that the equipment be present?

Mr. VIRGILIO. You are trying to understand how significant the consequences could be of these highly improbable events.

Mr. WAXMAN. Well, I guess that is what worries us all.

Mr. VIRGILIO. You are going out to test the envelope. This is—I think this is one of the advantages of the way we operate as opposed to an issue that you should be concerned about.

Mr. WAXMAN. Well, I am not trying to be critical. I know you are trying to do the best job you can, but when some of your own people send e-mails questioning the assumptions, I just think it is important for us to raise it. We don't know all the facts about what went on in Japan but we do know that emergency workers have had to focus considerable time and effort on cooling down the spent fuel pools, but NRC's simulation of a full loss of power at the Peach Bottom nuclear facility does not even consider the impact on spent fuel pools, which require constant water circulation or cooling. Is there any reason to believe that spent fuel pools at Peach Bottom would be immune to the potentially catastrophic impacts of a full loss of power?

Mr. VIRGILIO. Yes, because the spent fuel pools are seismically qualified at the plants in the United States and there are backup

systems to provide water in to the spent fuel pools as well as cooling.

Mr. WAXMAN. And is that all dependent on the assumptions that have already been made that some people are already questioning at the NRC?

Mr. VIRGILIO. The assumptions that are being questioned go well beyond the design basis. They assume for non-mechanistic reasons that all of the seismically qualified structure systems and components are not there. We are testing the envelope. We are trying to understand the worst case absent any probabilities. The realistic case is that an accident occurs, structure systems and components that are seismically qualified will be there to respond.

Mr. WAXMAN. I assume that was the assumption in Japan as well but the worst case happened. We just want to be prepared for the worst case here as well.

Mr. VIRGILIO. And that is why we do these types of studies.

Mr. STEARNS. The gentleman's time has expired. The gentleman from Texas, Mr. Barton, is recognized for 5 minutes.

Mr. BARTON. Thank you, Mr. Chairman. I want to thank you for holding the hearing. I want to thank our witnesses for being here.

What is the total number of deaths so far in the United States because of incidents at nuclear power plants that resulted in a failure of the safety systems at the power plants?

Mr. VIRGILIO. I am not aware of any, sir. What you have is electric—you do have in fact fatalities as a result of electrocutions at any power plant but not as a result of the nuclear——

Mr. BARTON. So at Three Mile Island there was——

Mr. VIRGILIO. No, sir.

Mr. BARTON. And there has never been a death because of a radiation issue at a civilian nuclear power plant?

Mr. VIRGILIO. No.

Mr. BARTON. What about the situation in Japan right now? How many deaths have resulted because of the failure at the Fukushima plant units in Japan?

Mr. VIRGILIO. We know of a couple of deaths that occurred as a result of the earthquakes but as far as radiation exposures, there have been no deaths that we are aware of.

Mr. BARTON. Do you know how many people have died because of the earthquake and the tsunami overall in Japan?

Mr. VIRGILIO. I think we have estimates now on the order of over 11,000 people who are confirmed dead and maybe as many still missing.

Mr. BARTON. So we have 11,000 people confirmed dead because of Mother Nature but because of the failures of the Japanese containment systems and the safety systems, so far there are no deaths?

Mr. VIRGILIO. That is our understanding.

Mr. BARTON. Are any of the workers at the plant suffering radiation sickness, to your knowledge?

Mr. VIRGILIO. There were some workers that were overexposed, extremity overexposures as a result of walking in radioactive or contaminated water, but to the best of our knowledge, none of the workers have received more than we would set as a limit, the 25 rem, in the event of an emergency.

Mr. BARTON. So is it fair to say that in spite of what Chairman Waxman just talked about, worst case, in spite of the weaknesses, if that is the right term, of some of the safety systems in Japan, we are still protecting the public safety, no one has been killed, and at least so far no one has been seriously impaired in terms of illness. Is that a fair thing to say?

Mr. VIRGILIO. That is our understanding, yes, sir.

Mr. BARTON. Now, I would assume that it is the NRC's mission to do everything humanly possible to keep our zero fatality safety record in the United States intact. I would assume you would agree with that.

Mr. VIRGILIO. Yes, sir.

Mr. BARTON. Is it also fair to say that the safety systems in our existing plants in the United States and the new plants that are being considered are at a minimum at least as robust as those in Japan and in most cases stronger and more able to withstand worst-case situations?

Mr. VIRGILIO. Yes sir, and we believe that there are systems that we have installed in the United States that may not have been installed on the Fukushima reactors.

Mr. BARTON. Now, just as an example, in terms of earthquakes, if it is not proprietary, to get a design certified and a facility certified to withstand an earthquake, what is the margin of safety that the plant has to withstand in addition to the most likely earthquake? In other words, in Texas, if you think you might have a 5.0 Richter scale earthquake, would that plant be designed to withstand a 6.0, which would be 10 times stronger than the most likely, or would it be five times more? What is the margin of safety that you generally look at?

Mr. VIRGILIO. It is hard to generalize, and it might depend on the age of the plant as to how much margin. Early design requirements required margin but we didn't specify a certain percentage. Today when we look at the design of a nuclear power plant, we include a margin of about 1.5 to 1.67 percent to ensure that there is adequate margin to safety.

Mr. BARTON. I don't understand.

Mr. VIRGILIO. It is somewhat complicated by the way we have written our regulations, and they have modified over time, but we look at the worst-case earthquake that has occurred in that vicinity and we translate that. We look at how far away the plant is and what the geology is between the location of that fault and the nuclear power plant and what the structural——

Mr. BARTON. But you put real thought into making sure that it is safe and then plus some?

Mr. VIRGILIO. Yes, sir, we do include additional margins.

Mr. BARTON. My time is expired, Mr. Chairman, but I would encourage every member to go to the nearest operating nuclear plant in their districts or near their districts. I went to Comanche Peak several weeks ago and spent 2 or 3 hours there. In Texas, if there is any kind of a serious earthquake or natural disaster, I want to be in the control room at Comanche Peak because that is the absolute safest place to be, and I would encourage every member to go.

Mr. STEARNS. I thank the gentleman, and the gentleman from Texas, Mr. Green, is recognized for 5 minutes.

Mr. GREEN. Thank you, Mr. Chairman. I don't know if I will follow my colleague, because where we have ours near Houston, it is 11 miles from the coast and it probably is safe if a hurricane came through there, because we are not in an earthquake zone. There hasn't been one in what most people feel like geological time.

Mr. Virgilio, as we have seen from accounts of the events in Japan, the spent nuclear fuel sitting in pools at Fukushima site have caused many problems. My understanding, there are two acceptable storage methods in the United States for spent fuel after it has been removed from the reactor core: spent fuel pools and dry cask storage. Most spent fuel is stored in pools and individual reactor sites and plants can also move the spent fuel to above-round casks, and then there is the Yucca Mountain issue, which the Subcommittee on Environment and the Economy plans to take up relatively soon. Even though I support Yucca Mountain, I won't put this in acceptable storage categories yet because there are so many diverse views on that issue. The question I have, as the spent pools are nearing their capacity in many plants around the country, how do the spent pools in the United States compare with the pools at the Fukushima reactor and are we holding more spent fuel than what Japan would be?

Mr. VIRGILIO. The comparisons, I am not prepared to answer, but I can tell you that today in the United States we use two methods as you describe. There is the wet storage and spent fuel pools and the dry storage. Spent fuel after it is cooled for a few years is typically moved into dry cask storage. We believe that both methods of storage are in fact acceptable from a safety perspective. We do in fact see some advantages to the dry cask storage designs.

Mr. GREEN. In 2006, the National Academy of Sciences issued a report showing that moving spent fuel from pools to dry cask reduces both the likelihood and potential impact of radioactive release from spent fuel. In fact, in 2008, Dr. Jaczko seemed to agree with that assessment, stating the most clear-cut example of an area where additional safety margins can be gained involved additional efforts to move spent nuclear fuel from pools to dry cask. In that same speech, he stated that the NRC should develop new regulations to require spent fuel be moved to dry cask storage after it has been allowed to cool for 5 years. That was 3 years ago, and I understand such rulemaking has not been initiated.

Mr. Virgilio, in light of the events in Japan, does the NRC have any plans to require reactor owners to store more of their spent fuel in dry casks rather than pools, and if not, can you elaborate on what the hesitancy is among the NRC or the industry to do so?

Mr. VIRGILIO. We don't have any rulemaking plans underway today but we are looking at this again as part of our short-term and longer-term lessons learned from the Fukushima event.

Mr. GREEN. Are there any new regulations being considered for extending the battery life of the U.S. reactors in case of future natural disasters?

Mr. VIRGILIO. Not at this time, but again, this is something that we are going to look at as a result of our lessons learned from this event.

Mr. GREEN. How does the Mark I system differ today than the system used 39 years ago, and how would you respond to the 2006

Sandia National Lab report saying that the likelihood of containment failure in the event of a core melt is nearly 42 percent with the Mark I design? How specifically has GE updated this model?

Mr. VIRGILIO. One of the most significant features I would say that has been installed on those Mark I containments is what we called a hardened vent, and that allows the release of hydrogen gas that has built up inside the containment to be vented out safely. As we saw in Fukushima, there were a number of explosions which we are assuming related to that hydrogen gas buildup. Had they had the hardened vent or had they used the hardened vent, this would not have been an issue.

Mr. GREEN. We see images on TV and the newspapers the devastation caused by tsunami and earthquake in the situation at the facility in Japan. Today, over 3 weeks after the tsunami, they are still fighting to cool the nuclear reactor and contain exposure to radiation and stop a complete meltdown of the nuclear core. Can you give us a status update on the situation at the Fukushima Daiichi nuclear facility and how fragile is that situation and in Japan currently?

Mr. VIRGILIO. All three of the reactors now are being supplied cooling with freshwater via makeshift systems. They are basically using fire pumps and fire trucks to provide water into those reactors. This is an improvement because it is a lot more reliable than what we were dealing with 2 or 3 weeks ago, and it is better because they are using freshwater rather than saltwater, which they were using at the beginning of the event. So we are seeing some improvements but we are still relying on fire trucks and pumpers and freshwater supplies that are not what I would consider the optimum of where we would like to see that facility be.

Mr. GREEN. Well, and again, hopefully we are learning that we have to have redundancy and backups to deal with it instead of having, like you said, fire trucks and offshore boats trying to squirt water on the facility. There has got to be a way we can engineer it and plan for it and of course capitalize it over a period of years. Hopefully we will never have to use it, but if we do, it will be there.

Mr. VIRGILIO. Yes.

Mr. GREEN. Thank you, Mr. Chairman.

Mr. STEARNS. Thank you. The gentleman from Pennsylvania is recognized for 5 minutes.

Mr. MURPHY. Thank you very much, and I appreciate the comments of the witness.

There are a couple things I just want to find out. When decisions are made to shut down or decommission a nuclear power plant, can you give me an idea of how long that takes and the scope of what kinds of decision are made in that process? It must be quite a big decision to go through.

Mr. VIRGILIO. Those decisions are made by the licensees that we regulate, and I would have to defer to them as to what goes into their decisionmaking process. I am sure it has to do with economics around continued operation.

Mr. MURPHY. But are there levels too and recommendations made on safety issues too with regard to how if plants are safe designs or safe functioning, et cetera, these are, I assume, pretty massive sort of evaluations that are made.

Mr. VIRGILIO. We license a nuclear power plant for 40 years. Licensees are allowed to come in and ask for an extension. Half of the U.S. fleet now has extended their licenses an additional 20 years. That involves a significant safety assessment on our part focused primarily on the aging effects and what they might be with respect to continued operation of those facilities.

Mr. MURPHY. When you are also looking at these aspects and you are evaluating safety of a power plant, I am trying to get my arms around the magnitude of the probability of problems that may occur that you are looking at—the likelihood of a failure, all the things that must happen. Some of my colleagues on the other side of the aisle are bringing up things about some of these plants, and I am assuming—and if you could just walk me through briefly, although "brief" may not be giving you a fair assumption here. But a whole string of events have to occur and some of those I am assuming from what is being brought up are highly improbable things. I say again that Lancaster, Pennsylvania, is a few hundred feet above sea level and it was a tsunami that wiped out the Japanese plant. It wasn't the earthquake, it was the tsunami. The plant, I understand, was built to be tolerated 5-meter-high water level and it was about 13, 14 meters high of water. We would have to have a flood that would make Noah look small to handle this.

But can you give us some idea of the magnitude of the probability of things that you look at when you are trying to evaluate the safety of plants and if we need to increase that?

Mr. VIRGILIO. As part of the design review for the licensing of a nuclear power plant, we look at a whole host of scenarios of what could happen within a reasonable range of probabilities and ensure that there are design features there to mitigate each one of those events and we look at what is beyond the likely. We go out to severe accidents. And again, we look at what could happen and what are the features of the plant that are designed in order to ensure that those events are mitigated.

Mr. MURPHY. And you also look at various mixtures of those?

Mr. VIRGILIO. Thousands of hours of NRC and licensee input to evaluating each one of those scenarios to make sure that we understand what could happen, how likely is it, what the consequences are and what systems are installed in order to ensure that that doesn't happen or cannot happen.

Mr. MURPHY. And when you identify a plant that doesn't have those kind of systems installed and they can't adapt to it, what recommendations do you make then?

Mr. VIRGILIO. Well, during the licensing process, the plant wouldn't get a license if it didn't have the systems we felt necessary. If in fact there was an operating event that brought us to a conclusion that a plant or a category of plants did not have the required equipment, we would issue orders and change our regulations, and we have done that time and time again throughout the history of the NRC.

Mr. MURPHY. I know for example the Fort St. Vrain plant in Colorado was shut down because it could not make those kind of standards. That was an example of the system working. And we want to know if the system is working or if there are things we need to do regulation-wise or with regard to legislation to increase

those levels. Do you need things from us to increase the level of oversight or other regulatory changes in this?

Mr. VIRGILIO. Not at this point in time. If we do, we will certainly make that request.

Mr. MURPHY. I want to ask too, if I could, about the points have been brought up about some of the e-mails going back and forth between scientists on that and if you are using those e-mails to come up with some regulations as well. I think you have not come up with any final version. Can you tell me what impact these e-mails are having upon what you are reviewing and what you are doing?

Mr. VIRGILIO. Those e-mails will in fact have an impact on how we complete the SOARCA study that we have talked about earlier. The staff raised some very interesting and I think very good considerations that we need go back and look at in this study that we took credit for certain equipment that is not seismically qualified. We need go back and either convince ourselves that that equipment would work or do the analysis in a very different way.

Mr. MURPHY. I appreciate that. We want to know that you are rising this to the highest standards of science. Thank you very much.

Mr. STEARNS. The gentleman's time is expired. The gentleman from Massachusetts, Mr. Markey, is recognized for 5 minutes.

Mr. MARKEY. Thank you, Mr. Chairman.

The cores of at least two of the Japanese reactors are severely damaged. I have just been informed by the Nuclear Regulatory Commission that the core of unit 2 has gotten so hot that it has probably melted through the reactor pressure vessel. To bring the reactors and their spent fuel pools under control, the Japanese have had to resort to sending young workers in to risk their lives as they operate what amounts to giant water guns. To assess and then sop up the radioactive water that has been spewing into the ocean, they are relying on the use of bath salts and diapers. Just like the use of pantyhose and golf balls to stop last year's BP oil spill, the Japanese have been compelled to try a nuclear junk shot in a desperate amount to stop an environmental calamity. The Japanese are making it up as they go along. Yet the Nuclear Regulatory Commission insists that our systems are safe even before beginning, let alone completing, its review of our reactors and spent fuel pools.

Mr. Virgilio, you have said several times today that the Fukushima reactor did not have the same hardened vents that some reactors here have to prevent hydrogen explosions but just yesterday my office was informed by the Nuclear Regulatory Commission that this is not the case and that the Japanese reactors did have them. So which is it?

Mr. VIRGILIO. If they have them, sir, I don't believe they used them, given what we saw in terms of the detonation and——

Mr. MARKEY. Why would they not have used them?

Mr. VIRGILIO. That is not clear to us, nor is it clear to us that the reactor has penetrated the vessel——

Mr. MARKEY. I think what happened was, they had them but they did not work. I think that is the only conclusion which we can reach, but they did have hardened vents. I just wanted to put that

on the record, and that came to me from the Nuclear Regulatory Commission yesterday.

After Three Mile Island, which also involved a hydrogen explosion, a requirement to include a number of measures to prevent hydrogen from building up and causing explosions were put into place, but in 2003 the NRC removed some of these requirements from its regulations, in part because it concluded that they would not help in a severe accident like a Fukushima meltdown. Although some nuclear reactors may still have these systems installed, the NRC does not require them to actually work. Is that not right?

Mr. VIRGILIO. We have removed the technical specifications and requirements for their operability, yes, sir.

Mr. MARKEY. Meaning you don't require that they have to work, which I don't think is something that should be the law. I think you should change it. They should have to work.

Now, don't many of these measures also require electricity so that they could fail to operate if there was an electricity outage at a nuclear reactor?

Mr. VIRGILIO. The systems, if they are there and installed and still required are to have backup power.

Mr. MARKEY. And that backup power could be a battery and your request that it last 8 hours maximum. Is that correct?

Mr. VIRGILIO. More likely the diesel generators that are required to operate for at least 72 hours.

Mr. MARKEY. What is your requirement for batteries? Eight hours?

Mr. VIRGILIO. It depends. It depends on the design of the onsite and offsite power systems.

Mr. MARKEY. What is the maximum for batteries that you require?

Mr. VIRGILIO. I would have to check on that detail.

Mr. MARKEY. Now, the diesel failed, did it not, in Fukushima?

Mr. VIRGILIO. We believe as a result of the tsunami washing away the——

Mr. MARKEY. So if the diesel fails, then the batteries become the backup, and if the battery is only required to last 8 hours, that probably isn't something that is reassuring to people because there are going to be perhaps hundreds of billions of dollars of loss in Japan because these systems did not work and many of these costs are just going to be for the compensation of innocent victims.

Two of the hydrogen explosions in Japan occurred due to hydrogen buildup in the spent fuel pools. Isn't it true that none of these measures are ever used to protect spent fuel containment from a hydrogen explosion?

Mr. VIRGILIO. Correct.

Mr. MARKEY. That is correct? Thank you. So basically whatever equipment is in place to prevent hydrogen explosions has been made optional by the NRC or has just catastrophically failed in Japan. So that is something that we just have to take note of here in our country and require a full-scale reevaluation of all of the assumptions which we have made. There was a 9.0 earthquake in Oregon 100 years ago. We are not talking about prehistoric times. And we just have to make sure that we have got these protections that are in place, that work and are mandated by the NRC.

Mr. BARTON. Mr. Chairman?

Mr. MARKEY. And that is not the case today.

Mr. STEARNS. And I thank the gentleman. The gentleman's time is expired.

Mr. BARTON. Mr. Chairman?

Mr. STEARNS. Yes. The gentleman is recognized.

Mr. BARTON. I would like to ask you to ask former Chairman Markey if the materials that he referred to that he received from the NRC with regard to the vessel wall and some of the issues, if they could be made available to other members of the subcommittee?

Mr. MARKEY. Without any problem at all.

Mr. BARTON. Since there seems to be some question from this witness whether the materials that Mr. Markey obtained are as valid as they are purported to be, so I would appreciate that.

Mr. STEARNS. OK, and I appreciate the gentleman from Massachusetts providing that for the rest of the committee members, and the gentleman from California, Mr. Bilbray, is recognized for 5 minutes.

Mr. BILBRAY. Thank you, Mr. Chairman. Just for the record, as the gentleman from Massachusetts pointed out, that Oregon, Washington and Alaska is where a 9.0 could occur anywhere within the United States territory. California, it has been pointed out, that a 7.0 is the maximum that is possible on our side, and the gentleman from Massachusetts may be interested that Secretary of Energy Chu has pointed out that that 7.0 will occur every 7,000 to 10,000 years. So I think that when we talk about what is possible out there, I think Secretary Chu made it quite clear that you guys, Mr. Virgilio, are planning for the worst possible as geologists have pointed out and then on top of that the lateral stresses that places like San Onofre was designed for looks like it was almost twice of what the original design of the Japanese plant was. Isn't that fair to say?

Mr. VIRGILIO. We are not exactly sure about the design details on the Japanese plant.

Mr. BILBRAY. My big question is, the number of the original design was half, and they were trying to retrofit up to a standard somewhere close to us, and I was just wondering if anybody knows how far they got with that retrofit before this earthquake.

Mr. VIRGILIO. We would have to get back to you on that, sir.

Mr. BILBRAY. OK. Let me just tell you one thing as somebody who has listened to a lot of testimony here. There is a lot of reason why people testify and vacillate around here but for you to say allowing us to say with confidence that the U.S. plants continue to operate safely, you realize the risk you are taking by coming out and saying that out front? This is the reason why witnesses usually aren't making those kind of decisions. Mr. Virgilio, do you understand how much you are taking a risk of being attacked?

Mr. VIRGILIO. I don't think that that is a risk at all, sir, based on the design and operation of the nuclear power plants.

Mr. BILBRAY. You are talking facts, you are not talking politics. I am just saying that in this town, anybody who stands up and lays out what they think is the truth in clear and defined limits. It exposes them to attack. And I would just like to say, I guess you are

used to it, but expect to be assaulted for being brave enough to say in public what a lot of people know or think they know, and the fact is other people don't want to hear about.

So let me go back. Mr. Chairman, Mr. Waxman pointed out quite appropriately that we want to make our nuclear facilities as safe as possible, and I would ask that while we are talking here that we ask the Science Committee to join us in a joint hearing to talk about the fact that we are operating with 40-year-old technology and what can we do in the future to go to technology, and as the witnesses will know, there is technology out there that eliminates the possibility of the hydrogen being created. There is a lot of these kinds of issues that we ought to be talking about, not just talk about what we do with these older plants but do we do to move forward with a safe program, and I hope that we can join with the Science Committee——

Mr. STEARNS. Will the gentleman yield?

Mr. BILBRAY. Go ahead.

Mr. STEARNS. I think that is a very good idea, and particularly with these backup generators and understand how to make sure that they work and the batteries, so I think that is a good suggestion to work with Mr. Ralph Hall, who is the present chairman of the Science Committee, who is a former member of Energy and Commerce, so your suggestion is well taken and I will talk to Mr. Hall.

Mr. BILBRAY. I appreciate that.

Mr. Virgilio, the comparison that we are looking at in California where our earthquake faults are to the inland, not out. Ours do not plunge and fall like the Japanese. Do we have any indication there was major failure in the Japanese plant before the tsunami hit?

Mr. VIRGILIO. No. As a matter of fact, it appears from what we know today that as a response to the earthquake, the plant shut down safely as designed. It was the tsunami that has caused the problems.

Mr. BILBRAY. So even though their design looks like it was much less than ours and was never designed up to the 9.0 or at least in theory wasn't, it did survive that hit even though that earthquake was only 100 miles from their area, so it was the tsunami that we have really got to talk about. OK. So they were inundated, their units. Our units at San Onofre and at Diablo, they are protected not by a ten-foot surge wall but I think one is 25 and I think Diablo is over 85?

Mr. VIRGILIO. Yes, Diablo is up on a cliff.

Mr. BILBRAY. Up on a cliff. And second of off, the generating systems at those two facilities are encased in the mountain, sealed off so they are protected even if the surge wall was breached, are protected from the hit?

Mr. VIRGILIO. Yes. As a matter of fact, what we know today about the Fukushima design was it was their fuel oil tanks that were not as protected and that may have been the cause of the loss of——

Mr. BILBRAY. And in the California example, our fuel oil basically is way up on top of the hillside?

Mr. VIRGILIO. It is well protected.

Mr. BILBRAY. OK. And even if the units were submerged, they are designed to operate with that capability in most instances?

Mr. VIRGILIO. No, the units are not designed to be submerged. They are protected from being submerged.

Mr. BILBRAY. OK. Thank you. I appreciate that. I just think that we are trying to clarify the limits. So basically you are willing to say that right now under the same situation, even though geologists say it could not happen within 7,000 to 10,000 in frequency but the fact is, we have designed to that where the Japanese had not created those safety buffers that we have now?

Mr. VIRGILIO. It appears that they were not designed for that tsunami.

Mr. BILBRAY. Thank you very much. I appreciate it.

Mr. STEARNS. The gentleman's time is expired and yields back the balance and Ms. Christensen of the Virgin Islands is recognized for 5 minutes.

Dr. CHRISTENSEN. Thank you, Mr. Chairman.

My question, Mr. Virgilio, is about the evacuation zone. On March 16th, the Nuclear Regulatory Commission in collaboration with the Department of Energy and other U.S. government agencies advised American citizens within a 50-mile range around the stricken Fukushima nuclear plant evacuate. The Japanese limited their mandatory evacuation zone to within 12 miles of the site. In a speech on Monday, Chairman Jaczko called the NRC's decision, and I am quoting, "a prudent course of action." He also stated that the evacuation range was predicated on information that the NRC had available at that time. So Mr. Virgilio, can you briefly describe the information on which NRC based that decision?

Mr. VIRGILIO. Let me let my colleague, Don Cool, answer that, please.

Mr. COOL. The NRC had available to is limited information but knew that there was damage at the reactor and that there appeared to be damage to some of the spent fuel pools. Under that circumstance, we determined that it was prudent to include a significant portion of two of the spent fuel pools and one of the reactors in a release that could possibly occur. Under that circumstance and using our modeling, we included that if such a release occurred all at once with a wind direction which was over land, that radioactive materials could be moved out to a distance that would include 50 miles. As we try to make our recommendations on the possibility of what could happen so that the actions can take place before any individuals are actually put at risk, we deemed it was prudent to make that recommendation.

Dr. CHRISTENSEN. Thank you. And Chairman Jaczko also said that the 50-mile zone was, again, I am quoting, "consistent with what we would do in a similar situation in the United States." But U.S. nuclear power plants are only required to develop emergency evacuation plans for people living within 10 miles of a reactor. So could you describe how this 50-mile evacuation zone is consistent with the Protective Action Guidelines established for emergencies here in the United States?

Mr. COOL. The Protective Action Guidelines provide both for a 10-mile protective action for a plume and a 50-mile zone. We also require and work diligently on training and planning for other sce-

narios. The planning guides specifically provide for the option to increase the distance out as information becomes available as necessary using the planning base, which is well trained. We would rely on the licensee interacting with the State. We would be trying to validate that information and validate to the State the recommendations that would be made. It is consistent with the planning guides that we work with FEMA and Homeland Security.

Dr. CHRISTENSEN. OK. Since the NRC issued its 50-mile evacuation advisory, the International Atomic Energy Agency and others have measured high levels of radiation in areas surrounding the Fukushima plant including towns outside of the 12-mile Japanese evacuation zone. Does any of that data make you doubt the Commission's decision to advise evacuate for a 50-mile radius?

Mr. COOL. No, ma'am.

Dr. CHRISTENSEN. And does the NRC plan to consider enlarging the 10-mile evacuation radius for reactors in the United States in light of the events in Japan?

Mr. COOL. That will be one of the items which we will certainly be reexamining as to a comprehensive look at all of the aspects and lessons learned from this facility.

Dr. CHRISTENSEN. Thank you.

And Mr. Virgilio, in your testimony you said in response to the events, licensees have voluntarily verified their capabilities to mitigate conditions that result from severe accidents including the loss of significant operational safety systems. Is this something that ordinarily they would voluntarily have to do or are they required? Are there specifics requirements and how often do you review these plans for safety?

Mr. VIRGILIO. It did not surprise me at all that the licensees voluntarily took this action. They actually got out a little bit ahead of us on this, and again, that is the culture of the nuclear community in the United States today. We provided information to them and they acted on it immediately.

Dr. CHRISTENSEN. And do you think would ordinarily they just do this voluntarily or had they not jumped out ahead of you, would you have required——

Mr. VIRGILIO. Yes, we would have, but again, it did not surprise me that they voluntarily took that action.

Dr. CHRISTENSEN. And the incidents also of course raised much-publicized questions—well, my time is up.

Mr. STEARNS. I thank the gentlelady. The gentleman from Colorado, Mr. Gardner, is recognized for 5 minutes.

Mr. GARDNER. Thank you, Mr. Chairman. Thank you, Mr. Virgilio, Dr. Cool, for your time and testimony today.

And obviously what has taken place in Japan is tragic. In the wake of this disaster, I believe it is very important that we learn, as do you, everything we can from what happened and move forward in the United States on our energy policy including our nuclear policy, and I applaud you at the NRC for your 90-day review to take stock of what lessons can be learned from Japan and how to move forward, but a couple of questions based on some of the things that I have heard today and some of the other questions you have raised.

Post-September 11, 2011, what extra measures has the United States put in place that really ensures nuclear power safety and our nuclear plants will continue to have power in the wake of an earthquake or other incident?

Mr. VIRGILIO. Well, 9/11, the focus was on security, so while we did have security forces as a requirement at all of the nuclear facilities, the power plants in particular, what you saw was an expansion and a hardening of the security we had in place. We also looked at a few events that could also occur involving—and I am dancing around this a little bit because I am trying not to get into any classified information.

Mr. GARDNER. I understand.

Mr. VIRGILIO. But we also took a look at what else could happen as a result of either terrorist attacks or other things, and we came upon this notion of requiring licensees to have additional equipment in place. In addition to having the hardened facility, in addition to hardening the perimeter and having more guards there, we actually required some additional equipment. This is what was referred to earlier as the B.5.b. equipment.

Mr. GARDNER. So power continuity has certainly been a part of your plan and requirements, making sure that power is in place and up and running after——

Mr. VIRGILIO. Really, our requirements are more about the safety of the nuclear facility. We are not about generating power. Our focus is really on ensuring that the power that is generated is done safely.

Mr. GARDNER. Yes. I am sorry for that line of questioning. I just want to make sure that we are giving you enough opportunity to answer some of the questions that were raised about the power supply to the plant in times of a situation where there may be power disruption to the plant.

Mr. VIRGILIO. We look very carefully at that. We ensure that there is in fact multiple redundant and diverse supplies of power to the plant. We require onsite power supplies in terms of emergency diesel generators. And then we assume all of that fails and we require the plants to be able to cope with the loss of onsite and offsite power for a certain period of time, and that period of time is determined by the reliability of both the onsite and the offsite power supplies, which vary across the country, particularly the offsite power supplies.

Mr. GARDNER. And as we have seen and you have said today, the challenge in Japan of course was not the earthquake; the challenge in Japan was the tsunami.

Mr. VIRGILIO. Yes, that is our understanding.

Mr. GARDNER. And in some of the conversations we have heard today about e-mails regarding scientists, scientists were doing what they were supposed to be doing, which is trying to put any question, any scenario forward and having a good back-and-forth and an open discussion. Is that correct?

Mr. VIRGILIO. Absolutely. That is the culture that we encourage at the NRC.

Mr. GARDNER. And based on that, some of the discussions we have heard about FOIA and other e-mails, that was a year ago, the

draft report. It has never been concluded and your actions haven't had anything to do with those e-mails. Is that correct?

Mr. VIRGILIO. Where we are today, it is still a draft report, and those issues are still open items that have not yet been resolved. If you looked at any study that we do in the NRC today, you would probably find similar e-mails where staff are debating the issues internally.

Mr. GARDNER. Trying to find the holes, trying to make sure you are covering every possible contingency?

Mr. VIRGILIO. Right. Exactly. Yes, that is correct.

Mr. GARDNER. Including tsunamis in Pennsylvania?

Mr. VIRGILIO. I don't think we are doing any studies on that today.

Mr. GARDNER. And Mr. Virgilio, with respect to the spent fuel pools, we talked a little bit about the dry storage casks. What are the advantages and disadvantages of—some believe the United States should remove older spent fuel pools and place them in dry storage casks. What are the advantages and disadvantages of that policy?

Mr. VIRGILIO. Today we believe both designs are safe, but if you look at the highest level, you look at the dry cask storage, it is all passive systems. If you have it in the pool, you are required to have cooling systems, heat removal systems and systems to maintain the level as well as the purity of the water. So you put it in a cask, it is pretty much done with for the life of the cask.

Mr. GARDNER. And in the United States, what do U.S. plants do to protect against explosion or leaks in these pools?

Mr. VIRGILIO. Today, what we—explosions are prevented in terms of ensuring that you have safety-related seismically qualified systems to provide level control and cooling, so there is always water over the fuel to prevent fuel damage and hydrogen generation.

Mr. GARDNER. And after September 11th, you went to a checkerboard type of pattern of storage. Has Japan done the same thing?

Mr. VIRGILIO. I don't know if they have. We have not only gone to disperse the hottest fuel in the pool so it is located in different locations so it is not all grouped together and we have also provided additional measures to put water into the pools.

Mr. GARDNER. But we don't know if Japan has done the same thing?

Mr. VIRGILIO. We don't know.

Mr. GARDNER. And the safety of the fuel pools, particularly the design of the reactor types in Fukushima appears to raise legitimate vulnerability concerns. What has been done in the United States—you have talked a little bit about it before—to assure adequate emergency cooling rather than what we have seen?

Mr. VIRGILIO. For the spent fuel pools?

Mr. GARDNER. Correct.

Mr. VIRGILIO. All of what is there for cooling is seismically qualified, which I believe is probably true in Japan as well today. What we have today as a result of some of the lessons learned and analysis that we did post 9/11 are additional backup systems beyond the seismically qualified safety-related systems. There are now systems in place that put additional water into the spent fuel pools

should an event occur that would disable all of the safety-related equipment.

Mr. GARDNER. Thank you.

Mr. STEARNS. I thank the gentlelady. Next, I believe, is the gentleman from Virginia, Mr. Griffith, for 5 minutes.

Mr. GRIFFITH. Thank you, Mr. Chairman. Thank you all for being here. I have learned a lot already.

Let me go back to some of the questions that the gentlelady was asking a couple of minutes ago. As I understand it, right now we only have for 10 miles if there is a nuclear problem, is that correct, to evacuate, et cetera?

Mr. COOL. The planning requirements include a 10-mile EPC, evacuation planning zone, for a plume and a 50-mile zone related to ground contamination and food contamination, so there are two different zones. The 10-mile zone is the area related directly to the plume and short-term exposure, which is carefully planned and drilled and prepared.

Mr. GRIFFITH. All right. And in light of the fact that we evacuated our folks from Japan at 50 miles and the fact that it does appear that they have had problems further than 10 miles, they did a 12-mile and I think that Dr. Lyman's data indicates that there were some hot spots 25 miles out and so forth—and I think you said yes but I want to clarify—do you anticipate that there may be an extension of the evacuation zone out a little bit farther than the 10 miles?

Mr. COOL. I do not want to speculate whether that change will or will not be put in place. That is something that needs to be looked at, needs to be looked at in the context of all of the other requirements that we have in place and done in consultation with our States, with FEMA, DHS and other organizations that we work cooperatively with.

Mr. GRIFFITH. Let me ask this, and it is just something that I think is pretty easy. Evacuation is not easy but providing the potassium iodide in sufficient quantities in areas around nuclear reactors, that should be fairly easy. Doesn't it keep fairly well?

Mr. COOL. Potassium iodide tablets will keep reasonably well. I can't give you a specific half-life.

Mr. GRIFFITH. So we would theoretically at the very least—I know evacuation takes a lot of plans but we could fairly quickly provide or make arrangements to have potassium iodide produced in sufficient quantities and have it in a larger area than the 10-mile zone, could we not?

Mr. COOL. That could be one possibility. Ideally, you would provide protection by not having the individuals exposed, and also keep in mind that potassium iodide is good only if you are going to be subject to an inhalation or intake hazard of iodine. It does not provide you from any other external radiation or other forms.

Mr. GRIFFITH. All right. I heard something on the news this morning, and I apologize—I had to step out for a minute—if you already covered it, but there was something that I heard that indicated that there was some deterioration of the building surrounding the nuclear plants in Japan. Do you all have any up-to-date information on that?

Mr. VIRGILIO. Our latest updates are there have not been changes of that nature in the last several weeks, I mean, since the hydrogen detonations that you all hopefully saw on television.

Mr. GRIFFITH. All right. And then is there anything that I should ask that I haven't asked?

Mr. VIRGILIO. Not that I can think of. You were pretty comprehensive.

Mr. GRIFFITH. All right. Mr. Chairman, I yield back my time.

Mr. STEARNS. The gentleman yields back and we have the gentleman, Mr. Scalise, is recognized for 5 minutes.

Mr. SCALISE. Thank you, Mr. Chairman. It sounds like all the questions have been asked based on the witnesses' testimony, but I appreciate the hearing, Mr. Chairman, as well as our panelists, and I know we have got another panel afterwards. On the next panel, there is a witness, just looking at some of the testimony, that looks like is going to give testimony that there is not sufficient battery backup at U.S. nuclear facilities, and in particular he alleges that 90 percent of U.S. reactors only have 4-hour capability. Can you address that concern from what we see in the testimony of the next panel will be brought up?

Mr. VIRGILIO. Over a decade ago when we promulgated this what we call station blackout rule that assumed that all these diverse sources of offsite power are unavailable and all the diesel generators that are required, onsite power supplies are unavailable. So you assume all those conditions occur and then you have to cope with a station blackout for a certain period of time. Now, the coping time sort of depends on the reliability of the offsite network so we used reliability and ability to restore the offsite power supplies as a mechanism to define the coping times. There is roughly a 60/40 split. If you look at the 104 nuclear power plants in the United States, roughly 60 percent of those have alternating power, additional onsite power supplies, either additional diesel generators or gas turbines beyond the safety-related equipment that are assumed to have railed in this analysis. So roughly 40, 40 percent of the plants rely on batteries. The battery coping times again vary depending on the analysis that was performed. But in each case, the analysis we concluded as the NRC that there was a sufficient amount of time on those batteries that would allow the restoration of power either from onsite or offsite sources.

Mr. SCALISE. What would a sufficient amount of time be?

Mr. VIRGILIO. It could be 8 to 16 hours. I can't recall offhand today exactly what the time period was. Each coping analysis was different, again, depending on the location of the plant and the reliability of the offsite power supplies. But again, only 40 percent of the plants relied on the batteries. Sixty percent of the plants relied on other sources of alternating power onsite.

Mr. SCALISE. But even within the 40 percent of the facilities in America, we are just talking about America right now, not comparing what is happening in Japan.

Mr. VIRGILIO. Right.

Mr. SCALISE. But of the 40 percent of the U.S. nuclear facilities that have a battery backup, you are confident from what you all have seen that the amount of time that would be required for that battery capacity sufficient to prevent this type of disaster?

Mr. VIRGILIO. Yes. That said, yes, given our culture of continuous evaluation, in light of the Fukushima events we are going to go back and look at that again.

Mr. SCALISE. OK, and I appreciate that, and I know you all have said you all are going to obviously from any disaster—and, surely in south Louisiana we have gone through more than our fair share—and you learn from each of those and you improve your redundant systems, even the ones that fail. And so I would imagine you are all doing that as well.

Another lesson from Fukushima, it looks like the combination of events seemed to go beyond the design for a basic facility is where they are having their problems. When you look at United States nuclear facilities, how do we prepare for those kinds of events where it actually does go beyond the design?

Mr. VIRGILIO. We actually look at severe accident management by use of additional equipment, some of which we have already talked about today, and procedures for using that equipment. A lot of what we are doing today in terms of coaching and supporting the Japanese is right in that area. We are using our severe accident management guidelines and strategies. We are actually providing advice to the Japanese government on how to use those kinds of strategies, given the conditions that they have today.

Mr. SCALISE. And I appreciate you all's help in working with them because it is something that we are all concerned about. We, of course, are very concerned about the people of Japan and their health and safety, but also we want to make sure that if we can give them expertise, we are, and then we are also looking to make sure that our facilities have the proper backup, and I appreciate the work you all are doing to not only review what you have already done but to see if there are other steps we can take because it is still an important source, I think, of our energy needs in the future just as it is today, so I appreciate that and I yield back.

Mr. STEARNS. The gentleman yields back, and by unanimous consent, we have the chairman of the Energy and Power Subcommittee who would like to participate and ask questions, and if there is objection, Mr. Whitfield will be recognized for 5 minutes.

Mr. WHITFIELD. Well, thank you, Chairman Stearns, and thank you all for being here today. We appreciate it.

When was the first nuclear power plant put into operation in the United States?

Mr. VIRGILIO. 1957.

Mr. WHITFIELD. And the only significant incident was Three Mile Island. Would that be correct?

Mr. VIRGILIO. I think that was the most significant issue that we have had in the United States.

Mr. WHITFIELD. And it is my understanding that international agencies have a matrix from level one to level seven with seven being the most serious incident. Is that correct?

Mr. VIRGILIO. Yes. The International Nuclear Event Scale goes from one to seven. TMI was a five on that scale.

Mr. WHITFIELD. Three Mile Island was a five?

Mr. VIRGILIO. Three Mile Island was a five on that scale.

Mr. WHITFIELD. And Chernobyl was seven?

Mr. VIRGILIO. Seven on that scale.

Mr. WHITFIELD. And have they determined yet where the Japan incident would be?

Mr. VIRGILIO. I think it is yet to be determined but right now they are preliminarily calling it a five.

Mr. WHITFIELD. Now, I read this somewhere. I don't know if it is correct or not, so you all can let me know. But I had read that if you had been on the property line at Three Mile Island when that incident occurred that a person would have been exposed to radiation equivalent to a chest x-ray. Is that accurate or not accurate?

Mr. COOL. I do not recall if that is specifically accurate. My recollection is it was actually less than that.

Mr. WHITFIELD. Less than that? OK. Now, one other question I wanted to ask, then I know there is another panel and I appreciate you all giving me this opportunity. I know that there is a nuclear plant in Japan that is sort of modular plant, a smaller plant that is cooled by liquid sodium, and my question is, I don't think there are plants in the United States cooled by liquid sodium, or is there?

Mr. VIRGILIO. We had one at one time. Fort St. Vrain was a sodium-cooled reactor but it is now decommissioned.

Mr. WHITFIELD. But it is my understanding that the liquid sodium cooling what was basically discovered in the United States or developed in the United States?

Mr. VIRGILIO. We did develop that technology, yes.

Mr. WHITFIELD. Now, is there anything inherently safer about that kind of cooling system versus any other?

Mr. VIRGILIO. There are advantages and disadvantages to each of the designs, and you mentioned the small modular reactors. Today in the United States, we are looking at a full including the sodium-cooled reactors but I think the more likely ones, the ones that are being talked about being first deployed in the United States, are light water-cooled reactors.

Mr. WHITFIELD. All right. I yield back the balance of my time. Thank you.

Mr. STEARNS. I thank my colleague for participating and we look forward to him again coming to visit with us.

I think before, Mr. Virgilio, we let you go, I am going to ask briefly some questions and offer this opportunity for the ranking member also. Was the 50-mile evacuation plan an NRC decision?

Mr. VIRGILIO. It was an NRC recommendation.

Mr. STEARNS. Was there a vote on this recommendation?

Mr. VIRGILIO. It was coordinated with a number of other agencies including Department of Energy, OSTP, the White House.

Mr. STEARNS. Well, if there wasn't a vote on it, how did it get implemented? Can these recommendations, the 50-mile evacuation plan be implemented without a vote by the commission? Just yes or no.

Mr. VIRGILIO. I don't know. We are talking about Japan and the events in Japan. That was done without a commission vote.

Mr. STEARNS. In 1988, the NRC adopted the station blackout rule or the 50 C.F.R. 50.63. That rule requires plants to be able to provide a station blackout for a specific period based on certain factors like the reliability of emergency power sources, the time needed to

restore offsite power and certain information about the reactor core. What blackout period can U.S. plants survive?

Mr. VIRGILIO. It depends on the location of the facility but it is typically on the order of 4 to 16 hours.

Mr. STEARNS. We are having on the second panel Dr. Lyman. He is a witness on the next panel. In his written testimony, he states that the U.S. plants are only required by the NRC to have sufficient battery capacity to cope with a blackout for only 4 to 8 hours. In fact, Dr. Lyman states that 90 percent of U.S. reactors have only 4 hours of backup battery power. Is that true? Do you agree?

Mr. VIRGILIO. I don't agree.

Mr. STEARNS. You don't agree?

Mr. VIRGILIO. I believe that 60 percent of the plants in the United States don't rely solely on the batteries. In that rulemaking, they rely on other sources of power on site, and that is preceded by the fact that each site has to have redundant emergency diesel generators and multiple ties to the offsite network. So the station blackout rule assumes that none of that is operable, and then it goes on to postulate and require additional onsite power supplies.

Mr. STEARNS. Does the NRC require any other form of backup power other than the batteries?

Mr. VIRGILIO. Well, the normal power supplies are diesel generators that are located onsite that are seismically qualified safety-related diesel generators that would provide power should there be a loss of offsite power to the nuclear power plant.

Mr. STEARNS. If that paradigm was true in Japan that is here in the United States, would that have made a difference, in your opinion?

Mr. VIRGILIO. I believe it was in place in Japan, and what made the difference was the tsunami and we believe now it had an impact on the fuel oil supply for the onsite diesel generators.

Mr. STEARNS. Before we let you go, I want to make sure we put in place some of the basics. I guess a potential lesson from what happened in Japan involves events or a combination of events that seem to go beyond the design basis for the facility. I guess the question would be, what measures do the United States facilities need to take to address the emergencies for events that surpass the design basis of the facility? And does the NRC require the industry to ensure assumptions about design basis and related emergency response are tested? How can we in Congress assess the quality of the work and what sort of planning is done to anticipate a confluence of events such as the power blackout and loss of road access? If you can, just answer those questions together and perhaps take me through what your thinking is.

Mr. VIRGILIO. We do have severe-accident management strategies in place at all of these nuclear power plants that are in operation today. And again, these strategies look at the most improbable events that could possibly occur at the nuclear power plants and these are the strategies that we are using to help coach the Japanese in responding to the events in their country today.

Mr. STEARNS. Is there anything we in Congress that you would recommend this morning that we do perhaps in terms of planning or implementation? Is there anything that Congress should follow up with?

Mr. VIRGILIO. There is nothing that we need immediately, but as we proceed through the 90-day assessment and the longer-term assessment, we will certainly come back to you if we believe we need legislation to support any actions that we need to take.

Mr. STEARNS. All right. The gentlelady from Colorado is recognized.

Ms. DEGETTE. Thank you so much, Mr. Chairman. Sometimes in Congress, we get into these kind of modes where it looks like all the Democrats are attacking nuclear power and all the Republicans are defending it, and I don't think that is what we are intending here. What we are intending is to make sure that the unintended and the emergency doesn't happen here like it happened in Japan. We saw this in the Gulf last year when everything that could have gone wrong with the Deepwater Horizon did, and so as a result we had the unthinkable happen. So that is why I just want to follow up on the questions that we are asking you because in Japan, you know, it is one of the most advanced technologies in the world and the most advanced economies, and in fact at this Fukushima Daiichi plant, they knew that they were in an earthquake zone and they designed the plant for the earthquake zone to the best of their technologies at that time, correct?

Mr. VIRGILIO. That is our understanding, yes.

Ms. DEGETTE. And so they designed it for the earthquake, and in fact it appears at this early stage that the plant survived the earthquake, correct?

Mr. VIRGILIO. That is our understanding.

Ms. DEGETTE. But then the next thing that happened was, the tsunami, correct?

Mr. VIRGILIO. That is our understanding.

Ms. DEGETTE. And they had designed the plant to withstand a tsunami. They had the seawalls, correct?

Mr. VIRGILIO. The details around the design for the tsunami, I am not familiar with.

Ms. DEGETTE. Right. But they thought they were designing it——

Mr. VIRGILIO. Yes.

Ms. DEGETTE [continuing]. To withstand a tsunami, right?

Mr. VIRGILIO. Some level of——

Ms. DEGETTE. But then the tsunami breached the seawall, right?

Mr. VIRGILIO. Correct.

Ms. DEGETTE. So this was an extraordinary circumstance that had not been predicted, right? And then the way that the plant was designed is, it got the electricity for the cooling off the grid, right?

Mr. VIRGILIO. Normally, yes.

Ms. DEGETTE. And then it had a backup of the diesel, right?

Mr. VIRGILIO. Yes.

Ms. DEGETTE. But then when the tsunami breached the seawall, then the diesel supply was cut off, as you said, correct, Mr. Virgilio?

Mr. VIRGILIO. Yes, that is correct.

Ms. DEGETTE. So then they had a battery backup after that but that only lasted 6 to 8 hours, correct?

Mr. VIRGILIO. Our understanding, yes.

Ms. DEGETTE. And then so what happened is, they were not able to reconnect any other power supply because of the devastation of the earthquake and so on, and that is what led to some of these problems, right?

Mr. VIRGILIO. Now they are connecting the power supply.

Ms. DEGETTE. Right. But it is weeks later now. So some of our plants in the United States have a similar backup type of design where they go off the grid, then there is a diesel backup and then there is a battery backup for that, correct?

Mr. VIRGILIO. Yes.

Ms. DEGETTE. And that includes the Peach Bottom plant that we were talking about earlier, right?

Mr. VIRGILIO. Yes.

Ms. DEGETTE. And so if those mechanisms all fail and you have to go to the battery backup at the U.S. plants, the question someone else was trying to ask you is, those batteries that are the third-tier backup are 4 to 8 hours, correct?

Mr. VIRGILIO. Yes.

Ms. DEGETTE. And so one of the things we need to look at, and I am sure the NRC is looking at in its analysis, especially with what happened in Japan is, can we get that third-tier battery backup, can we get batteries that will last longer in case there is some devastating rupturing of the electrical source so you can't get it hooked back up right?

Mr. VIRGILIO. A specific line item in our lessons learned actions.

Ms. DEGETTE. Is that——

Mr. VIRGILIO. Look at station blackout, look at in light of Fukushima is a specific line item in our action plan.

Ms. DEGETTE. And the NRC when it looks at plants in the United States, it doesn't just look at plants that might be impacted by, say, tsunamis, right?

Mr. VIRGILIO. We look at all plants against a certain range of——

Ms. DEGETTE. I mean, there are plants in the United States that could have different reasons for disruption of the electricity which would cause the cooling systems to fail, right?

Mr. VIRGILIO. A specific line item in our plan to look at all natural phenomena.

Ms. DEGETTE. And unnatural phenomena. The unspoken word the chairman and I are talking is terrorism. You could have some kind of devastating terrorist attack, God forbid, that knocked out the electricity and you couldn't get it reconnected and for some reason the diesel failed and then you are on the battery, right?

Mr. VIRGILIO. Therein lies the rationale for why we required the B.5.b. equipment.

Ms. DEGETTE. Right. And so one of the things that you are looking at in this SOARCA analysis is, does that B.5.b. equipment work, right?

Mr. VIRGILIO. Yes.

Ms. DEGETTE. And that is all we are asking is that we continue as we get more knowledge and information, we continue to think the unthinkable. That is what we are looking for here, and I think you would agree.

Mr. VIRGILIO. That is our culture.

Ms. DEGETTE. Thank you very much. I yield back.

Mr. STEARNS. I thank the gentlelady, and we are now going to call up the second panel, and thank you both for your time.

Mr. VIRGILIO. Thank you, sir.

Mr. STEARNS. On the second panel, the first witness is Mr. William Levis. Mr. Levis is currently the President and Chief Operating Officer of PSEG Power. This company operates two nuclear generating stations and is part owner of another. Mr. Levis is testifying on behalf of the Nuclear Energy Institute, or NEI. The second witness is Dr. Edward Lyman. Dr. Lyman is Senior Staff Scientist at the at the Global Security Program at the Union of Concerned Scientists. And the third witness is Dr. Michael Corradini. He is Chair of the Nuclear Engineering and Engineering Physics Program at the University of Wisconsin in Madison. He is a member of the Department of Energy Nuclear Energy and NRC's Advisory Committee for Reactor Safeguards. He is testifying today on behalf of the American Nuclear Society.

I say to all of you, your testimony that you are about to give is subject to Title 18, which is section 1001 of the United States Code. When holding an investigative hearing, this committee has the practice of taking testimony under oath. Do you have any objection to testifying under oath? I hear no.

I advise you that under the rules of the House and the rules of the committee, you are entitled to be advised by counsel. Do you desire to be advised by counsel during your testimony today? If not, if you would please rise and raise your right hand I will swear you in.

[Witnesses sworn.]

Mr. Levis we will start with you with a 5-minute opening statement. Welcome.

TESTIMONIES OF WILLIAM LEVIS, PRESIDENT AND CHIEF OPERATING OFFICER, PSEG POWER LLC; EDWIN LYMAN, SENIOR STAFF SCIENTIST, UNION OF CONCERNED SCIENTISTS; AND MICHAEL CORRADINI, CHAIR, ENERGY AND PHYSICS DEPARTMENT, UNIVERSITY OF WISCONSIN—MADISON

TESTIMONY OF WILLIAM LEVIS

Mr. LEVIS. Chairman Stearns, Ranking Member DeGette, and members of the subcommittee, thank you for the opportunity to appear before you today. I appreciate your invitation to testify at today's hearing to discuss the status of the U.S. nuclear industry and the implications of the Fukushima nuclear accident on nuclear energy in the United States. I am testifying today on behalf of the Nuclear Energy Institute, the nuclear energy industry's Washington-based policy organization.

My remarks today will cover four points. First, U.S. nuclear power plants are safe. Second, safety is the U.S. nuclear energy industry's top priority. Third, the U.S. nuclear energy industry has a long history of continuous learning from operational events. We will do the same as a result of the Fukushima accident. And fourth, the U.S. nuclear energy industry has already taken proactive steps to verify and validate or readiness to manage extreme events. We took these steps early without waiting for clarity on the sequence of failures at Fukushima.

Regarding the first point, U.S. nuclear power plants are safe. They are designed and operated conservatively to manage the maximum credible challenges appropriate to each nuclear power plant site. U.S. nuclear power plants have also demonstrated their ability to maintain safety through extreme conditions including floods, hurricanes and other natural disasters. U.S. nuclear reactors are designed to withstand earthquakes, tsunami, hurricanes, floods, tornadoes and other natural events equal to the most significant historical event or maximum projected event plus an added margin for conservatism without any breach of safety systems. Recent experience with earthquakes in California, Hurricane Andrew in Florida and Katrina in New Orleans repeatedly demonstrate that U.S. nuclear plants can withstand severe natural events. In each case, safety systems functioned as designed, operators responded effectively and emergency training proved successful.

Regarding the second point, safety is the U.S. nuclear industry's top priority and complacency about safety performance is not tolerated. We know we operate in an unforgiving environment where the penalties for mistakes are high and where credibility and public confidence once lost are difficult to recover. All of the safety-related metrics tracked by industry and the Nuclear Regulatory Commission demonstrate high levels of excellent. Worker radiation exposure, events with safety implications, lost-time accident rates have all trended down year over year for a number of years.

Regarding the third point, the U.S. industry routinely incorporates lessons learned from operating experience into its reactor design and operations. I could point to many, many examples of improvements made to the United States nuclear power plants over the years in response to lessons learned from operational events. Let me just list a few.

In the 1970s, concerns were raised about the ability of the boiling-water reactor Mark I containment to maintain its design during an event where steam is vented to the torus. Subsequently, every United States operator with a Mark I containment implemented modifications to dissipate energy released to the suppression pole and installed stringent supports to accommodate loads that could be generated.

As a result of the Three Mile Island accident, NRC required all sites to have emergency plans including both an emergency operations facility and a joint information center. These offsite facilities were mandated to ensure the States and NRC could have direct access to information coming from the plant. In 1988, the NRC concluded additional station blackout regulatory requirements were justified and issued the station blackout rule to provide further assurance that a loss of both offsite and onsite emergency AC power systems would not adversely affect public health and safety.

Since the terrorist events of September 11, 2001, U.S. nuclear plant operators identified other beyond design basis vulnerabilities. As a result, U.S. nuclear plant designs and operating practices since 9/11 are designed to mitigate severe accident scenarios such as aircraft impact, which includes the complete loss of offsite power and all onsite emergency power sources and loss of large areas of the plant. All U.S. nuclear power plants have enhanced capacity for fighting very large fires, alternatives for bringing cooling water to

used fuel storage pools and the ability to bring in additional sources of power from remote locations. Also, all plants have ability to diesel-driven portable water pumps, for example, to bring cooling water to the reactor and fuel storage pool without offsite or onsite electric power.

Regarding the final point, the U.S. nuclear energy industry has already started an assessment of the events in Japan and is taking steps to ensure that U.S. reactors could respond to events that may challenge safe operation of the facilities. These actions include verifying each plant's capability to manage the severe accident scenarios developed after 9/11 that I previously described, verifying each plant's capability to manage a total loss of offsite power, verifying the capability to mitigate flooding and the impact of floods on systems inside and outside of the plant, and performing walk-downs and inspection of important equipment needed to respond successfully to extreme events like fires and floods.

In conclusion, Mr. Chairman, it will take some time before we understand the precise sequence of what happened at Fukushima, before we have a complete analysis of how the reactors performed, how equipment and fuel performed, how the operators performed. As learn from this tragic event, however, you may rest assured that we will internalize those lessons and incorporate them into our designs, training and operating procedures.

That concludes my oral testimony, Mr. Chairman. I look forward to answering questions that the committee may have.

[The prepared statement of Mr. Levis follows:]

STATEMENT
by
William Levis
President and Chief Operating Officer
PSEG Power LLC
to the
Subcommittee on Oversight and Investigations
Committee on Energy and Commerce
U.S. House of Representatives

April 6, 2011

Chairman Stearns, Ranking Member DeGette, and members of the subcommittee, thank you for the opportunity to appear before you today.

My name is William Levis. I am President and Chief Operating Officer of PSEG Power which is a subsidiary of Public Service Enterprise Group, headquartered in Newark, New Jersey. PSEG Power is a merchant generating company and owns approximately 14,000 megawatts of electric generating capacity. We own 100 percent of the Hope Creek nuclear generating station, 57 percent of the Salem nuclear station, and 50 percent of the Peach Bottom nuclear station. PSEG Power operates Salem and Hope Creek; Exelon operates Peach Bottom. Salem consists of two pressurized water reactors; Hope Creek is a single boiling water reactor; the Peach Bottom station has two boiling water reactors.

I appreciate your invitation to testify at today's hearing to discuss the status of the U.S. nuclear energy industry and the implications of the Fukushima nuclear accident on nuclear energy in the United States. I am testifying today on behalf of the Nuclear Energy Institute, the nuclear energy industry's Washington-based policy organization. NEI members include all companies licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, materials licensees, and other organizations and individuals involved in the nuclear energy industry.

My remarks will cover four major points:

First, U.S. nuclear power plants are safe.

Second, safety is the U.S. nuclear energy industry's top priority.

Third, the U.S. nuclear energy industry has a long history, over several decades, of continuous learning from operational events, and we have incorporated lessons learned into our nuclear plant designs (through structural or systems upgrades) and our operating practices and training. We will do the same as a result of the Fukushima accident.

And fourth, the U.S. nuclear energy industry has already taken pro-active steps to verify and validate our readiness to manage extreme events. We took these steps early – without waiting for clarity on the sequence of events at Fukushima.

Before I address these four points, however, let me note that the U.S. nuclear energy industry works very hard not to grow complacent about safety. This is not always easy when our 104 nuclear power plants are operating well, with an average capacity factor above 90 percent for the last 10 years. Similarly, we cannot be complacent about the accident at Fukushima. I am quite confident that we will learn important

lessons from this experience and identify additional steps we can and will take to further improve safety and response capability at our nuclear plants.

U.S. Nuclear Power Plants Are Safe

That said, we do believe U.S. nuclear power plants are safe. They are designed and operated conservatively, to exacting standards, to manage the maximum credible challenges appropriate to each nuclear power plant site. U.S. nuclear power plants have also demonstrated their ability to maintain safety through extreme conditions, including floods, hurricanes and other natural disasters.

I can think of no better summary of the status of U.S. nuclear power plants than the one delivered by President Obama to the American people on March 17. Mr. Obama said: "Our nuclear power plants have undergone exhaustive study, and have been declared safe for any number of extreme contingencies. But when we see a crisis like the one in Japan, we have a responsibility to learn from this event, and to draw from those lessons."

The industry invests heavily in our nuclear power plants to ensure safe, reliable operation. The industry invested approximately $7 billion in 2010 in our 104 reactors – to replace steam generators, reactor vessel heads and other equipment and in other capital projects.

U.S. reactors are designed to withstand earthquakes, tsunamis, hurricanes, floods, tornadoes and other natural events equal to the most significant historical event or the maximum projected event, plus an added margin for conservatism, without any breach of safety systems. We have many, many examples of U.S. nuclear power plants achieving safe shutdown during extreme events where offsite power was lost. During Hurricane Katrina in 2005, for example, the Waterford nuclear power plant in Louisiana shut down safely, lost all off-site power, and maintained safe shutdown on emergency diesel generators for three-and-a-half days until grid power was restored.

For earthquakes, nuclear plants are designed and constructed to withstand the maximum projected earthquake that could occur in its area, with additional margin added. Plant earthquake-induced ground motion is developed using a wide range of data and review of the impacts of historical earthquakes up to 200 miles away. Those earthquakes within 25 miles are studied in great detail. This research is used to determine the maximum potential earthquake that could affect the site. Each reactor is built to withstand the respective strongest earthquake; for example, a site that features clay over bedrock will respond differently during an earthquake than a hard-rock site.

It is important not to extrapolate earthquake and tsunami data from one location of the world to another when evaluating these natural hazards. These catastrophic natural events are location-specific, based on tectonic and geological fault line locations. The Tohoku earthquake that struck the Fukushima nuclear power plant occurred on a "subduction zone," the type of tectonic region that produces earthquakes of the largest magnitude. A subduction zone is a tectonic plate boundary where one tectonic plate is pushed under another plate. Subduction zone earthquakes also produce the kind of massive tsunami seen in Japan.

In the continental United States, the only subduction zone is the Cascadia subduction zone which lies off the coast of northern California, Oregon and Washington. In an assessment released last week, the California Coastal Commission concluded that a "nuclear emergency such as is occurring in Japan is extremely unlikely at the state's two operating nuclear power plants. The combination of strong ground motion and massive tsunami that occurred in Japan cannot be generated by faults near the San Onofre Nuclear Generating Station and the Diablo Canyon Power Plant."

Safety Is the U.S. Nuclear Energy Industry's Top Priority

This leads to my second point: Safety is the U.S. nuclear energy industry's top priority, and complacence about safety performance is not tolerated.

Our industry operates in an unforgiving environment where the penalties for mistakes are high and where credibility and public confidence, once lost, are difficult to recover.

All of the safety-related metrics tracked by industry and the Nuclear Regulatory Commission demonstrate high levels of excellence. Forced plant outage rates, unplanned safety system actuations, worker radiation exposures, events with safety implications, and lost-time accident rates have all trended down, year over year, for a number of years.

We have confidence in nuclear plant safety based on those indicators, but we should derive even greater confidence from the process that produces those indicators, from the institutions we have created to share best practices, to establish standards of excellence and to implement programs that hold us to those standards.

After the 1979 accident at Three Mile Island, the nuclear industry created the Institute of Nuclear Power Operations (INPO). In INPO, the nuclear industry — unique among American industries — has established an independent form of self-regulation through peer review and peer pressure. In fact, the President's Oil Spill Commission, in its report on the Deepwater Horizon accident, identified INPO as the model for self-regulation by the offshore oil and gas industry.

INPO is empowered to establish performance objectives and criteria, and nuclear plant operating companies are obligated to implement improvements in response to INPO findings and recommendations. INPO has some 400 people monitoring nuclear plant operations and management on a daily basis. INPO evaluates every U.S. nuclear plant every two years, and deploys training teams to provide assistance to companies in specific areas identified as needing improvement during an evaluation.

INPO provides management and leadership development programs, and manages the National Academy of Nuclear Training, which conducts formal training and accreditation programs for those responsible for reactor operation and maintenance.

Among its many activities, INPO maintains an industrywide database called EPIX — for Equipment Performance and Information Exchange — and all companies are required to report equipment problems into the database. EPIX catalogues equipment problems and shows, for example, expected mean time between failures, which allows the industry to schedule predictive and preventive maintenance, replacing equipment before it fails, avoiding possible challenges to plant safety. INPO also maintains a system called Nuclear Network that allows companies to report and share information about operating events, to ensure that an unexpected event at one reactor is telegraphed to all, to ensure that an event at one plant is not repeated elsewhere, to ensure high levels of vigilance and readiness.

It may not be obvious to the outside world, but we have an enormous self-interest in safe operations. The industry preserves and enhances the asset value of our 104 operating plants first and foremost by maintaining focus on safety. Safety is the basis for regulatory confidence, and for political and public support of this technology.

Commitment to Continuous Learning

The U.S. industry routinely incorporates lessons learned from operating experience into its reactor designs and operations. U.S. nuclear power plants have implemented numerous plant and procedural improvements over the past 30 years. Some of these improvements have been designed to mitigate severe natural and plant-centered events similar to those experienced at the Fukushima nuclear power plant. In addition, the equipment and procedures could be used to mitigate other severe abnormal events. The type of events include a complete and sustained loss of AC power, a sustained loss of vital cooling water pumps, major fires and explosions that would prevent access to critical equipment, hydrogen control and venting, and loss of multiple safety systems.

Starting in the 1990s, U.S. nuclear power plants developed guidelines to manage and mitigate these severe events that are beyond the normal design specifications. Plants evaluated site-specific vulnerabilities and implemented plant and procedural improvements to further improve safety. These severe accident management guidelines were developed in response to probabilistic risk assessments (PRAs), which identified several high-risk accident sequences. These guidelines provide operators and emergency managers with pre-determined strategies to mitigate these events The strategies focus on protecting the reactor containment structure as it assumes the zirconium cladding around the fuel and reactor cooling system are lost.

I could point to many, many examples of improvements made to U.S. nuclear power plants over the years in response to lessons learned from operational events. Let me list just a few:

- In the 1970s, concerns were raised about the ability of the BWR Mark I containment to maintain its design during an event when steam is vented to the torus. Subsequently, every U.S. operator with a Mark I containment implemented modifications to dissipate energy released to the suppression pool and stringent supports to accommodate loads that could be generated.
- As a result of the Three Mile Island accident, the industry made significant improvements to control room configuration and operator training – making it easier for operators to respond to plant issues, without taking time to diagnose what had occurred. The industry also learned significant lessons about emergency preparedness and the importance of ensuring the public receives timely and accurate information during a plant event. It was after TMI that the NRC required all sites have emergency plans including both an Emergency Operations Facility and a Joint Information Center. These offsite facilities were mandated to ensure the states and NRC could have direct access to the information coming from the station and that there was a means for the state, utility and NRC to communicate directly through the media to the public.
- In 1988, the Nuclear Regulatory Commission concluded that additional Station Black Out (SBO) regulatory requirements were justified and issued the Station Black Out rule (10 CFR 50.63) to provide further assurance that a loss of both offsite and onsite emergency AC power systems would not adversely affect public health and safety. The SBO rule was based on several plant-specific probabilistic safety studies; operating experience; and reliability, accident sequence and consequence analyses completed between 1975 and 1988.
- Since the terrorist events of September 11, 2001, U.S. nuclear plant operators identified other beyond-design-basis vulnerabilities. As a result, U.S. nuclear plant designs and operating practices since 9/11 are designed to mitigate severe accident scenarios such as aircraft impact, which include the complete loss of offsite power and all on-site emergency power sources *and* loss of large areas of the plant. The industry developed additional methods and procedures to provide cooling to the reactor and the spent fuel storage pool, and staged additional equipment at all U.S. nuclear power plant sites to ensure that the plants are equipped to deal with extreme events and nuclear plant operations staff are trained to manage them.

The U.S. Nuclear Energy Industry Has Already Taken Steps in Response to Fukushima

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

- Verifying each plant's capability to manage major challenges, such as aircraft impacts and losses of large areas of the plant due to natural events, fires or explosions. Specific actions include testing and inspecting equipment required to mitigate these events, and verifying that qualifications of operators and support staff required to implement them are current.
- Verifying each plant's capability to manage a total loss of off-site power. This will require verification that all required materials are adequate and properly staged and that procedures are in place, and focusing operator training on these extreme events.
- Verifying the capability to mitigate flooding and the impact of floods on systems inside and outside the plant. Specific actions include verifying required materials and equipment are properly located to protect them from flood.
- Performing walk-downs and inspection of important equipment needed to respond successfully to extreme events like fires and floods. This work will include analysis to identify any potential that equipment functions could be lost during seismic events appropriate for the site, and development of strategies to mitigate any potential vulnerabilities.

Until we understand clearly what has occurred at the Fukushima Daiichi nuclear power plants, and any consequences, it is difficult to speculate about the long-term impact on the U.S. nuclear energy program. The U.S. nuclear industry, the U.S. Nuclear Regulatory Commission, the Institute of Nuclear Power Operations, the Nuclear Energy Institute, the World Association of Nuclear Operators and other expert organizations in the United States and around the world will conduct detailed reviews of the accident, identify lessons learned (both in terms of plant operation and design), and we will incorporate those lessons learned into the design and operation of U.S. nuclear power plants. When we fully understand the facts surrounding the event in Japan, we will use those insights to make nuclear energy even safer.

In the long-term, we believe that the U.S. nuclear energy enterprise is built on a strong foundation:

- reactor designs and operating practices incorporate a defense-in-depth approach and multiple levels of redundant systems
- oversight by a strong, independent regulatory infrastructure, which includes continuous assessment of every U.S. reactor by the Nuclear Regulatory Commission, with independent inspectors permanently on site and additional oversight from NRC regional offices and headquarters
- transparent regulatory process that provides for public participation in licensing decisions, and
- continuing and systematic processes to identify and incorporate lessons learned from operating experience.

In conclusion, let me leave you with a short-term and a longer-term perspective.

In the short term, all of us involved with the production of electricity from nuclear energy in the United States stand in awe of the commitment and determination of our colleagues in Japan, as they struggle to bring these reactors to safe shutdown.

In the longer term, it will be some time before we understand the precise sequence of what happened at Fukushima, before we have a complete analysis of how the reactor performed, how equipment and fuel performed, and how the operators performed. As we learn from this event, however, you may rest assured that we will internalize those lessons and incorporate them into our designs and training and operating procedures.

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Mr. STEARNS. I thank the gentleman, and Dr. Lyman, welcome for your 5-minute opening statement.

TESTIMONY OF EDWIN LYMAN

Mr. LYMAN. Good morning. On behalf of the Union for Concerned Scientists, I would like to thank Chairman Stearns, Ranking Member DeGette and the other members of the subcommittee for the opportunity to provide our views on the still-unfolding accident at Fukushima Daiichi and the implications for nuclear power in this country. UCS would like to extend its deeply sympathies to the people of Japan during this crisis.

Before proceeding, I would like to say that the Union of Concerned Scientists is neither pro no anti nuclear power but we have served as a nuclear power safety and security watchdog for more than 40 years.

Today, nearly 4 weeks after the catastrophic earthquake and subsequent tsunami, there is still much that is uncertain and it will be a long time before we learn all the lessons from the still-evolving accident. However, the severe and unacceptable consequences of this disaster for human health, the environment and the economy are already apparent, and everyone concerned should not hesitate to take steps to make sure that such a dire event will not happen in the United States.

To that end, the Nuclear Regulatory Commission has announced that it will conduct both short- and longer-term reviews of its regulations and procedures, and we believe that the issues that the NRC is going to look at are the right issues. However, we are concerned that the NRC's review may not be sufficiently thorough without stringent oversight, and the defensive public posture that the NRC has taken since March 11th raises concerns, in our view, that the agency does remain too complacent to conduct a critical self-examination of its past decisions and practices. The NRC has to confront the overarching question of whether it has allowed safety margins to decline to unacceptably low levels and it may have to adjust its perception in light of Fukushima.

One issue we are concerned with is also the promptness of implementation of any lessons learned. Following the 9/11 attacks, the NRC undertook what it called a top-to-bottom review of its security regulations. Although the review did uncover serious shortcomings in its requirements, the process of fixing them has been so slow that even today, nearly 10 years after 9/11, some nuclear plants have not completed the required security upgrades. We need to act faster than that.

Now, there are some lessons learned I think we can say with confidence we need to turn our attention to. One is whether it was an earthquake and a tsunami or any other event that could cause a loss of offsite power and onsite power called a station blackout. There needs to be a coping strategy that is longer than what the United States requires today. Whether it is battery backup or anything else, the coping strategy is not longer than 8 hours for any plant, and I think we have already seen the consequences of having a complete station blackout for a long period of time and the potential situation that can evolve.

The second issue has to do with spent fuel pools. We believe that the evidence is already abundant that there will be a safety advantage and a security advantage to accelerating the transfer of spent fuel from overloaded wet pools into dry cask storage. That would reduce both the radioactive inventory and the heat load of the pools and also allow for more time to intervene should there be an interruption of cooling. So we do believe there is a significant safety advantage and there shouldn't by any more hesitation to accelerate that transfer.

The third issue has to do with how do you cope with an event like we are see in Fukushima if there is already core damage. Now, the Japanese are engaging in truly heroic actions but they are barely managing to contain the situation. In fact, there already has been a large radiological release into the atmosphere and into the ocean. We need to do better than that. And so the issue comes up, are U.S. plants better prepared to cope once damage has occurred or once safety systems have been lost for a long period of time and cooling has been interrupted.

And this is the issue that I wanted to bring out with the e-mails that have been referred to before that we received through FOIA. The issue is really that the NRC and the industry are taking credit for these measures. We have already heard it today as an example that we are better prepared to deal with the aftermath of the Japanese accident, but the fact is, many of these measures, they are not seismically qualified. There is no guarantee that they would work under these severe conditions. In fact, the memos indicate that there is concern among some NRC staff about whether credit should be taken for internal studies, so I question why credit should be taken for them when the NRC and the industry are out talking about the safety of plants today. They need to establish more secure and more reliable equipment and supplies and procedures for dealing with the aftermath of this event.

Finally, with regard to emergency planning zones, we believe the expansion out to 50 miles was appropriate for U.S. citizens of Japan, and we do believe there needs to be a new examination of the requirements here at home. Simply saying that we can expand from 10 to 50 miles if we have to is not adequate because if you don't plan for that kind of an expansion, certainly in some areas of this country of densely populated areas, that expansion may be chaotic and ineffective. So you need planning for emergency planning.

And with that, I would like to stop and I would be happy to take your questions. Thank you.

[The prepared statement of Mr. Lyman follows:]

Testimony of Dr. Edwin Lyman

Senior Scientist, Global Security Program

Union of Concerned Scientists

on "The U.S. Government Response to the Nuclear Power Plant Incident in Japan"

Before the

Subcommittee on Oversight and Investigations

Committee on Energy and Commerce

U.S. House of Representatives

April 6, 2011

Summary

- The crisis underway at the Fukushima Daiichi nuclear plant has revealed serious nuclear safety shortcomings that have major implications for nuclear power plants in the United States and around the world.
- Although the events are still unfolding in Japan, it is not too soon to begin to learn lessons from the evidence available so far.
- The Nuclear Regulatory Commission is initiating comprehensive internal reviews of its regulations and practices, but stringent external oversight will be required to ensure that these reviews effectively challenge prior assumptions that the Fukushima crisis has called into question, and that any weaknesses identified by the reviews are promptly corrected.
- Steps that the NRC should take in the near term include
    - Strengthening requirements to cope with prolonged losses of electric power (station blackouts) in order to prevent damage to reactor cores and spent fuel.
    - Requiring the accelerated transfer of spent fuel from densely packed wet pools to dry casks.
    - Strengthening requirements for management of severe events that cause damage to reactor cores and spent fuel, and ensuring plans are realistic and workable.
    - Revising emergency planning requirements in the vicinity of U.S. nuclear plants to ensure that all populations at risk from excessive radiation exposure will be protected.

Good morning. On behalf of the Union of Concerned Scientists, I would like to thank Chairman Stearns, Ranking Member DeGette, and the other members of the Subcommittee on Oversight and Investigations for the opportunity to provide our views on the still unfolding accident at the Fukushima Daiichi plant and its implications for nuclear power in this country.

The Union of Concerned Scientists would like to extend its deepest sympathies to the people of Japan during this crisis. While the dire situation in Japan should remain a main focus of U.S attention, the U.S. also urgently needs to assess whether we are doing all that we can do to prevent a Fukushima-like nuclear disaster from happening here.

Before proceeding, I would like to say that the Union of Concerned Scientists is neither pro nor anti-nuclear power, but has served as a nuclear power safety and security watchdog for over 40 years.

Today, nearly four weeks after the catastrophic earthquake and subsequent tsunami that precipitated the Fukushima Daiichi crisis, there is still much that is uncertain, and it will be a long time before we learn all the lessons from this still-evolving accident. However, the severe and unacceptable consequences of this disaster for human health, the environment and the economy are already apparent. Hence lawmakers, regulators and the nuclear industry should not hesitate to take steps to help ensure that such a dire event will not happen here.

In the aftermath of the Chernobyl accident in 1986, many argued that such a large release of radioactivity could not happen in the United States or other countries with Western-designed reactors because those reactors had containment structures, unlike Chernobyl. However, it is now clear from Fukushima that significant releases of radioactivity can occur following a severe accident even without a catastrophic failure of containment. The Austrian Central Institute for Meteorology and Geodynamics has estimated that up to approximately 80 percent of the quantity of the long-lived isotope cesium-137 that was released after the Chernobyl accident was released from the Fukushima site in the first week after the accident. As large as this may sound, it only represents about one-tenth the total amount of cesium-137 in the three damaged reactor cores themselves. Further damage to the fuel, reactor vessel and containment could result in far greater releases. And the Fukushima Daiichi Units 1-3 boiling-water reactors have a type of containment structure, known as Mark I, which analysts have long known to be unusually vulnerable to breach in a severe accident. A 2006 study by Sandia National Laboratories estimated that in the event of a core melt, there was a nearly 36 percent chance that the molten core would melt through the containment wall ("Risk-Informed Assessment of Degraded Containment Vessels," NUREG/CR-6920, November 2006, Table 4.5, p. 76). This mode of containment failure would not be affected by the changes that the NRC ordered for the 23 Mark I containment boiling-water reactors in the United States to reduce the chance of containment failure by a hydrogen explosion. Perhaps even more serious is the risk of further damage to the irradiated fuel in four compromised spent fuel pools, which also contain massive quantities of radioactive material but are not enclosed in leak-tight containment structures.

The Nuclear Regulatory Commission has announced that it will conduct both short- and longer-term reviews of its regulations and procedures. To that end, it announced last week that it had formed an internal task force to conduct a 90-day comprehensive examination of issues raised by the Fukushima accident, including station blackout risks and emergency preparedness. We believe that the task force has identified many of the right issues for scrutiny. However, we question whether the NRC's review will be sufficiently thorough without stringent oversight by Congress and entities such as the National Academies of Science. The defensive public posture that the NRC has taken since March 11 raises concerns that the agency remains too complacent to conduct a critical self-examination of its past decisions and practices. The NRC must confront the overarching question of whether it has allowed safety margins to decline to unacceptably low levels, based on a perception that severe accidents resulting in core damage are so infrequent that they do not require a high level of regulatory attention. It must adjust this perception in light of Fukushima.

We are also concerned about whether the NRC can adapt quickly to changed circumstances. Following the 9/11 attacks, the NRC undertook what it called a "top to bottom" review of its regulations for protecting nuclear power plants against radiological sabotage. Although the review uncovered serious shortcomings in the NRC's security requirements, the process of fixing them has been so slow that even today—nearly ten years after 9/11—some nuclear plants still have not completed required security upgrades, including Diablo Canyon, H.B. Robinson, Shearon Harris and Farley.

The Fukushima accident has already revealed a number of apparent vulnerabilities that may also affect U.S. plants. Some early lessons include the following:

1. The accident was initiated by a massive earthquake and tsunami, but the direct cause was the loss of both off-site and on-site power supplies, a situation known as a station blackout. There are many other types of initiating events that could cause such a situation, including terrorist attacks. In the event of a station blackout, only battery power is available to operate systems needed to prevent core damage. The NRC requires U.S. plants to have sufficient battery capacity to cope with a station blackout for no more than either four or eight hours, as well as plans to restore AC power by the time the batteries run out. Ninety percent of U.S. reactors only have a four-hour capability. We need to re-evaluate the adequacy of these plans, and whether they can be realistically implemented. Fukushima has demonstrated the extreme challenges that can be encountered in trying to restore power supplies after a catastrophic event that causes great disruption to the surrounding infrastructure.
2. At least one of the spent fuel pools at the Fukushima plant is believed to have lost coolant and caught fire, causing fuel damage, a hydrogen explosion and the release of long-lived radioactive particles. The pools are on the upper floors of these Mark I boiling-water reactors. The United States has 33 boiling-water reactors with similarly situated spent fuel pools that are far more densely packed than those at Fukushima and hence could pose far higher risks if damaged because of higher heat loads, less space available for coolant flow and greater radionuclide inventories. The United States should act as quickly as practicable to remove older spent fuel from these pools and place them in dry storage casks to reduce the heat load and radioactive inventories of the pools, and allow

greater spacing between assemblies. While NRC should give priority to the elevated spent fuel pools, it should also address risks at those pools that are at or below ground level, which are also vulnerable to loss-of-cooling events.

The NRC and the industry continue to maintain that U.S. spent fuel pools do not pose unacceptable risks and there is no need to transfer any spent fuel into dry storage other than fuel exceeding licensed pool capacities. However, NRC and industry officials have recently testified that as part of the post-9/11 plans for coping with the aftermath of terrorist attacks, the NRC has required changes to the way spent fuel is arranged in the pools, so that hotter fuel is not bunched together (so-called "checkerboarding"), and has also imposed new requirements for providing makeup water to the pools. The NRC would not have made these changes if it were not concerned about spent fuel pool risks. But what the public doesn't know is whether these changes are sufficient to mitigate the risks, since further details are not publicly available. The difficulties and risks the Japanese have experienced in getting jury-rigged emergency cooling water supplies to the pools – using fire hoses, helicopters and concrete spraying pumps – raise questions about the workability of such plans.

3. Although the Japanese are engaged in truly heroic efforts to mitigate the worst effects of this accident and reduce radioactive releases that could harm the public, these efforts have only been partially effective, are already resulting in life-threatening conditions for the workers on site, and may ultimately fail. U.S. nuclear plants have severe accident management plans, but these plans are not required by regulations and are not evaluated by the NRC or tested for their effectiveness. In the case of aircraft attack on a nuclear

plant, the NRC does require plants to have plans to cope with the loss of large areas of the plant due to explosion and fire. The NRC now claims that these plans would also provide reactor operators with the capability to recover from a wide range of severe accidents, including natural disasters such as the events that triggered Fukushima.

However, these plans now must be re-evaluated to judge whether they can be realistically carried out in every circumstance under which the NRC takes credit for them, such as the extreme conditions now being encountered at Fukushima. For instance, a Nuclear Energy Institute official asserted in a Senate briefing on March 17 that the industry has pre-staged diesel-driven fire pumps and other equipment to enhance the capability of nuclear plant operators to mitigate severe events. But upon questioning, the official admitted that this equipment is not seismically qualified or otherwise "safety-related." Thus it is unclear if it would actually be available following an earthquake. And even if the equipment were available, it is far from assured that it could actually be used safely and effectively for the duration of a crisis.

Because the industry's post-9/11 plans are treated as "security-related information," members of the public cannot access them and are not able to judge for themselves whether the plans are credible. For instance, the public does not know if these plans address serious issues in post-accident response that have been revealed at Fukushima, from the ability to manage and contain the large volumes of highly contaminated water generated by manual injection of coolant to the ability to ensure an adequate supply of personal dosimeters for all workers required for emergency response actions.

Presumably these plans are supported by a whole host of pre-Fukushima assumptions that may need to be revisited. Independent oversight of these plans is critical to ensure that such plans are robust and realistic, and that licensees are fully in compliance with them.

The regulatory concept of "defense in depth" means that efforts must be made both to prevent accidents from occurring and to mitigate them should they occur. We believe that the Fukushima experience indicates that mitigation is extremely challenging and may be impossible in some circumstances. NRC should place a far greater emphasis on preventing accidents and terrorist attacks from disabling multiple safety systems and disrupting core cooling by increasing safety margins, rather than trying to control events after core damage has occurred.

4. Levels of radioactive contamination and radiation dose rates high enough to be of significant concern have already been detected more than twenty miles from the release site, well beyond the 12-mile evacuation zone established by Japan. Lower but still elevated levels have been detected more than one hundred miles away. At one site approximately 25 miles northwest, hot spots are causing dose rates about forty times background levels. Residents occupying these areas would receive the maximum annual dose limit from artificial sources recommended by the International Commission on Radiological Protection within a week. These measurements confirm the wisdom of the U.S. decision to evacuate all Americans within fifty miles of Fukushima Daiichi.

However, if there was a reactor accident in the United States, the emergency preparedness measures that would directly protect the public, including evacuation planning and potassium iodide distribution, are limited to a 10-mile radius. The federal government should seriously consider increasing this distance, and should reassess the workability of emergency plans in the context of natural disasters or terrorist attacks that could disrupt emergency response activities. The NRC is defending the apparent inconsistency between its domestic requirements and the recommendations it issued for Japan by suggesting that the U.S. could always expand the evacuation zone beyond 10 miles as the situation warrants. However, the key to emergency planning is planning. The notion that an orderly and quick spontaneous evacuation could be carried out for large areas downwind of some U.S. nuclear plants in densely populated regions, such as Indian Point near New York City, simply strains credulity. Some degree of advance planning should be required for all populations who may be at significant risk in the event of a severe reactor accident, based on the best technical assessment. In particular, potassium iodide should be made available to all children who may be at risk of exceeding recommended intervention levels due to exposure to radioactive iodine either through direct plume inhalation or consumption of contaminated food or water.

There are many other areas where we believe the NRC has allowed safety margins to decrease too far. Now, not after an accident, is the time to reconsider whether the NRC's position on "how safe is safe" is truly adequate to protect public health and safety. Thank you for your attention, and I would be happy to answer any questions you may have.

Mr. STEARNS. I thank the gentleman. Mr. Corradini, welcome, and we would appreciate your opening statement for 5 minutes.

TESTIMONY OF MICHAEL CORRADINI

Mr. CORRADINI. Thank you, Chairman Stearns and Ranking Member DeGette and subcommittee members. I will try to be brief since I am the last.

Currently, I am Chair of Nuclear Engineering and Engineering Physics at UW Madison. I also serve on the DOE's Nuclear Energy Advisory Committee and the NRC's Advisory Committee on Reactor Safeguards. I appear today on behalf of the American Nuclear Society, and the ANS is a professional society comprised of about 11,000 men and women who work in the nuclear industry, the medical community, our national labs, universities and government. On their behalf, I would like to express my deepest sympathies to the people of Japan for their loss and hardship. Also, I have been asked by the ANS to co-chair with Dr. Dale Klein, former chairman of the Nuclear Regulatory Commission, a special commission on Fukushima Daiichi. This commission will bring together experts from the nuclear and health physics disciplines to examine the major technical aspects of the event.

I would like to focus today on what we know so far based on news reports and reports from within Japan. Following the March 11th earthquake, the reactors at Fukushima Daiichi, Daini, and Osonowa all shut down automatically as designed, and emergency power systems were successfully activated. This occurred even though the quake exceeded the reactor's design base. It was the tsunami which dealt a crippling blow to Fukushima Daiichi. The surge of water reportedly was over 40 feet high, overwhelmed the 17-foot seawalls, and by all indications wiped out the plant's offsite power supply as well as its backup generators, associated pumping, electrical and venting systems for units 1 through 4.

Battery power control and pumping systems operated until about midnight Friday. Then the plant slipped into a blackout condition. With no cooling available, the reactor cores heated up, damaged fuel rods and caused chemical reactions that resulted in a buildup of hydrogen inside the reactor vessels. Tokyo Electric Power Company, or TEPCO, was able to begin so-called feed-and-bleed seawater injection by Saturday afternoon using portable generators and pumps. However, as steam was released from the reactors, so was hydrogen, which ultimately accumulated at the top of the reactor buildings exploded, causing severe damage to the structure outside the containments. The spent fuel pools experienced problems as well. For reasons that are not completely clear at this time, water levels dropped in the first few days, causing hydrogen generation and combustion, fuel rod cladding failures and releases of radioactivity to the environment. Subsequently, TEPCO used seawater, then freshwater to refill the pools.

Clearly, this was a major accident. So what are the effects of the accident on the surrounding region? Immediately after problems at Fukushima were apparent, Japanese officials quickly evacuated people within the 12- and then eventually 20-kilometer radius of the plant. In the first few days after the earthquake, the airborne radiation levels in the vicinity spiked repeatedly. However, by a

week after the event they had fallen to levels a couple of times natural background, and in fact, readings outside the 60-kilometer radius of the plant are now close to normal.

Clearly, the cleanup will be long and expensive. It is necessary to continue monitoring the effects of radioactive releases. We will have to be mindful of the migration of radionuclides into the food chain. Also, we hope that the plant personnel that are onsite dealing with and stabilizing the situation do not suffer excessive radiation exposure but none to date. However, at this time all indications that this event will not have significant public health consequences in Japan.

So what are the relevant lessons for the U.S. plants? First, it is highly unlikely that a Fukushima event could happen in the United States. We have no operating plants on active subduction faults. Our plants are robustly designed to withstand seismic events, and each has a diverse and redundant array of safety systems. All have a strict regulator, the NRC. The U.S. nuclear industry has implemented a number of equipment upgrades post 9/11 including hardened vents to prevent hydrogen explosions and systems that allow for reactor cooling and blackout conditions. Finally, U.S. plants run regular drills simulating adverse conditions so they are better prepared to manage unforeseen events.

The first main lesson which I believe extends to our civilian infrastructure, to our entire civilian infrastructure is that emergency preparedness for extreme natural disasters is critically important to preserve life, health and property. Secondly, we continually need to ask ourselves the hard what-if questions. We did this after the Three Mile Island accident which resulted in severe-accident management guidelines being used in U.S. plants today. We also need to reexamine our short- and long-term management of spent nuclear fuel. Lastly, we have to be prepared to recognize success within failure. I think the Fukushima situation is about as bad as it gets for light-water reactors. Yet if no major public health impacts emerge, I would argue this is a successful outcome given the enormous scope of the natural disaster.

So with that, I will thank you and look forward to questions.

[The prepared statement of Mr. Corradini follows:]

TESTIMONY OF
Michael Corradini
American Nuclear Society

BEFORE THE
HOUSE ENERGY AND COMMERCE COMMITTEE
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS

April 6, 2011

Chairman Stearns, Ranking Member DeGette, members of the Subcommittee, thank you for the opportunity to testify.

I am currently chair of the Nuclear Engineering and Engineering Physics program at the University of Wisconsin, Madison. I am also involved in a number of nuclear energy activities for the National Academies, the Department of Energy (DOE) and the Nuclear Regulatory Commission (USNRC). Specifically, I am a member of the DOE Nuclear Energy Advisory Committee and Chair of its Reactor Technology Subcommittee. In addition, I am a member of the French Atomic Energy Scientific Committee and the NRC's Advisory Committee for Reactor Safeguards.

I appear today on behalf of the American Nuclear Society (ANS), a professional organization comprised of 11,000 men and women who work in the nuclear industry, the medical community, our national laboratories, universities and government agencies.

On behalf of all ANS members, I would like to express my deepest sympathies to the people of Japan for their loss and hardship. My sons and I were in Osaka in 1995 at the time of the Kobe earthquake and we witnessed the tragic effects of that natural disaster. From what I have seen from news reports and photos on the web, this is a tragedy that is orders of magnitude more devastating and thus, even more sobering. While we are here to discuss the Fukushima power plants, I wanted to be sure we put this in context to this tragic natural disaster with over 12,000 dead and over 15,000 missing.

The American Nuclear Society has organized the "Japan Relief Fund" targeted specifically to help our friends, colleagues, and their families in Japan who have been affected by the earthquake and tsunami. More information can be found at the American Nuclear Society website: http://www.ANS.org .

The leadership of ANS has asked me to serve as co-chair of a *Special Commission on Fukushima Daiichi*. This Commission will examine the major technical aspects of the event to help policymakers and the public better understand its consequences and its lessons for the US nuclear industry.

It is probably useful to begin by providing some current information and perspectives about the events and how they relate to the U.S plants and safety practices. That is my role here today. I want to briefly focus on three general topics:

- The effects of the natural disaster on the Fukushima-Daiichi plants,
- The effects of the accident progression on the surrounding region, and
- How we can learn from these events for our U.S. nuclear industry?

To review these topics, I have made use of the information provided on the websites of the Tokyo Electric Power Company (TEPCO), the Nuclear and Industrial Safety Agency (NISA), the Ministry of Education, Culture, Science and Technology (MEXT), Japan Atomic Industrial Forum (JAIF), the International Atomic Energy Agency (IAEA) as well as discussions with colleagues and specific press reports. Although there is so much that we do not know about what has happened in Fukushima and surrounding areas, I have found the information from these sources to be consistent and helpful to answer many questions. This timely availability of information is a tribute to Japan and its institutions since these nuclear troubles occurred in the midst of the response to the many injuries and property destruction caused by the earthquake on the general population.

EFFECTS OF THE NATURAL DISASTER ON THE FUKUSHIMA PLANTS

As we now know, the Tohoku earthquake, which occurred at 2:46pm on Friday, March 11th on the east coast of northern Japan, was measured at 9.0 on the Richter scale and is believed to be the 4th largest earthquake in recorded history. As a point of reference the next most serious quake was in 2004 off the coast of Sumatra with a tsunami resulting in 227,000 deaths. Following the earthquake on Friday afternoon, the nuclear plants at Fukushima-Daiichi, Fukushima-Daini and Osonawa plant sites shut down as designed, and emergency power systems were activated as expected; even though the earthquake was beyond the design basis. At the Daiichi plants the design basis safe-shutdown earthquake was 8.2 as measured on the Richter scale, which is a design base above historical values. The Tohoku earthquake caused a tsunami, which hit the east coast of Japan within the first hour of the quake. The size of the water waves that hit the Daiichi plant were significantly above the design base on which the seawall was constructed (17 ft) to mitigate its effects. The tsunami appears to have been the primary cause of the initial on-site damage, making the backup power systems and associated pumping, electrical and venting systems inoperable for Units 1, 2, 3, 4.

On-site battery power was able to run the emergency control and pumping systems at the plant site until about midnight on Friday and then the plants experienced a loss of all electrical power for an extended period of time. By the afternoon of Saturday, March 12th, portable generators and portable fire pumps were moved onto the Fukushima-Daiichi site and seawater was pumped in to cool the reactor cores for Units 1, 2 and 3. Decay heat was removed by venting the steam from above the containment suppression pools. The initial lack of water-cooling caused the reactor cores to be severely degraded, causing metal-water chemical reactions and hydrogen gas generation. Hydrogen was released during steam venting causing the destructive combustion events in reactor buildings outside of containment.

In addition to cooling the reactors, it has been necessary for plant personnel to replenish the water in each unit's spent fuel pools that was lost

due to water evaporation caused by decay heat. This is especially true for Unit 4, since it was undergoing maintenance at the time of the earthquake and its relatively "hotter" reactor core fuel assemblies were also placed in the spent fuel pool. For reasons that are not completely clear at this time, the water supply at spent fuel pools at these Units reached very low levels over the first few days causing the spent fuel to become severely damaged resulting in hydrogen generation and combustion, fuel rod cladding failures and radioactivity releases to the environment. Seawater was then sprayed in to refill these water pools and they now remain cooled.

This mode of cooling continued until fresh water was brought to the site about two weeks after the earthquake. The reactor plants and the spent fuel are now being cooled by injection of fresh water.

EFFECTS OF THE ACCIDENT ON THE SURROUNDING REGION

Immediately following the earthquake and tsunami and the subsequent loss of on-site electrical power, the Nuclear and Industrial Safety Agency (NISA) declared a site emergency and by the evening of March 11th, residents within 10km of the Fukushima-Daiichi plant were instructed to evacuate. By Saturday afternoon, NISA advised residents within 20km to evacuate and those between 20 to 30km away to remain in their homes as shelter or voluntarily leave the area. In the first few days after the earthquake, the air-borne radiation levels were much higher than natural background (normally around 0.3 to 0.4 microSieverts per hour). By a week after the event, they had already fallen to levels a couple of times above natural background. In fact, the air-borne doses outside of a 60km radius from the plant now have readings close to normal. At this time this event has not become a national health disaster for Japan.

I would also note that we have the technical capability to measure radiation and its elemental sources in extremely small amounts far below any levels that are harmful to the human body.

The source of the radioactive release is not precisely known, but some indications are that it came primarily from the heating, degradation and subsequent failure of the spent fuel. The levels of radiation on the plant site were much higher and following the hydrogen combustion events only a select crew of workers in rotating shifts was allowed on-site to deal with the emergency. Nevertheless, based on reports from NISA, 21 workers received doses exceeding 100 mSv. No worker has received a dose above 250 mSv, which is the allowable dose limit for emergency workers, and this is similar to standards in the U.S.

HOW WE CAN LEARN FROM THESE EVENTS FOR OUR INDUSTRY?

The safety approach used in designing and testing the plants in Japan are similar to those used in the U.S. The U.S. has adopted a philosophy of Defense-in-Depth, which recognizes that nuclear reactors require the highest standards of design, construction, oversight, and operation. Designs for every individual reactor in the U.S. take into account site-specific factors and include a detailed evaluation for natural events, as they relate to that site. There are multiple physical barriers to radiation in every nuclear plant 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 accident situation.

Nevertheless, this natural disaster exceeded the design basis envelope for those nuclear plants at the Daiichi site and we need to learn from this and continually improve our safety posture so that beyond design basis events can be managed. In the coming months, the USNRC will do a review of the accident and the safety posture of our plants. Over the longer term, lessons-learned from this event will be used to review the key areas of plant design, operation and readiness. I know I speak for all the ANS members, that we stand ready to help the industry and the government in this effort.

To promote some further discussion on these points let me suggest some items to consider. First, the events in Japan accentuated the need for the

U.S. to evaluate our entire civilian infrastructure (not just nuclear plants) and emergency preparedness for extreme natural disasters. Second, for our nuclear plants, we continually need to ask ourselves 'what-if' questions and what we may have missed. This was done for Three Mile Island accident and this resulted in the Severe Accident Management Guidelines (SAMGs) being used in U.S. plants today. I expect that these guidelines will be reviewed in light of lessons-learned from these events. The USNRC has also pioneered the use of Probabilistic Risk Assessment in WASH-1400 and has been used extensively. This technique can be used for such beyond-design basis events. Finally, we need to reexamine how we manage spent fuel both in its storage on-site as well as its final disposition. The ANS has recently issued a study on technical options for spent-fuel disposition that may be useful to this end. Also I assume the Blue Ribbon Commission will consider these recent events as they formulate their policy recommendations for spent nuclear fuel as directed by the President.

So in closing, let me offer some final thoughts.

First, while there is still much more information to gather, I think we now have an overall understanding of what happened at Fukushima Daiichi.

Second, while radioactive materials have been released into the environment, it does not appear, based on current data, that there will be widespread public health consequences.

Finally, because of differences in U.S. seismology and installed safety equipment, it is highly unlikely that Fukushima-like event could occur at a US nuclear plant. Nonetheless, the US nuclear industry - and every other industrial sector for that matter -- should use this opportunity to ensure that it can respond quickly and effectively to extreme natural events.

Thank you.

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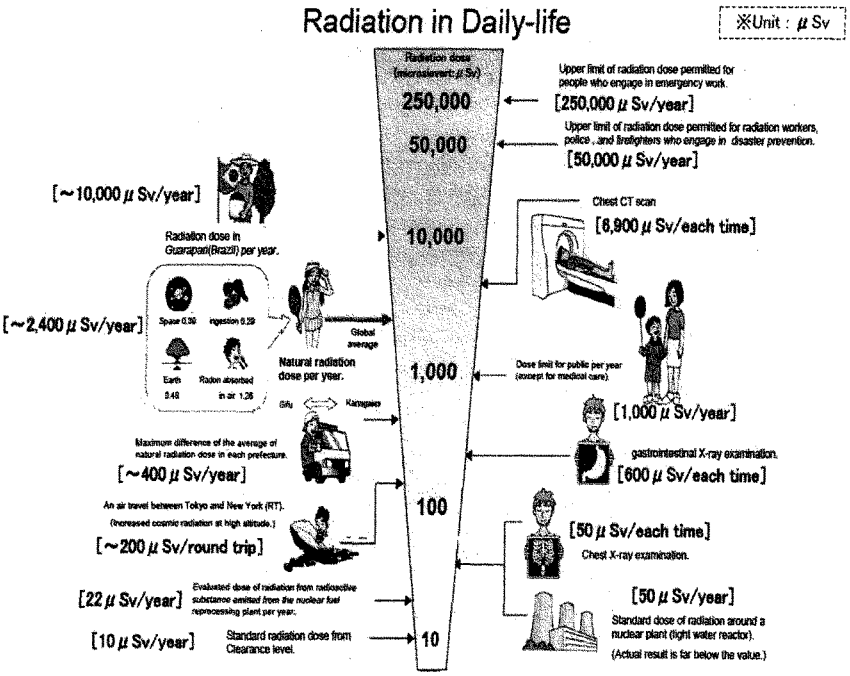
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Radiation in Daily-life
※Unit : μ Sv
Radiation dose (microsievert: μ Sv)
250,000
50,000
10,000
1,000
100
10
Upper limit of radiation dose permitted for people who engage in emergency work.
[250,000 μ Sv/year]
Upper limit of radiation dose permitted for radiation workers, police , and firefighters who engage in disaster prevention.
[50,000 μ Sv/year]
Chest CT scan
[6,900 μ Sv/each time]
[~10,000 μ Sv/year]
Radiation dose in Guarapari(Brazil) per year.
[~2,400 μ Sv/year]
Space 0.39
ingestion 0.29
Earth 0.48
Radon absorbed in air 1.26
Global average
Natural radiation dose per year.
Dose limit for public per year (except for medical care).
[1,000 μ Sv/year]
Sv
Kerma
gastrointestinal X-ray examination.
[600 μ Sv/each time]
Maximum difference of the average of natural radiation dose in each prefecture.
[~400 μ Sv/year]
An air travel between Tokyo and New York (RT).
(Increased cosmic radiation at high altitude.)
[~200 μ Sv/round trip]
[50 μ Sv/each time]
Chest X-ray examination.
[22 μ Sv/year]
Evaluated dose of radiation from radioactive substance emitted from the nuclear fuel reprocessing plant per year.
[50 μ Sv/year]
Standard dose of radiation around a nuclear plant (light water reactor).
(Actual result is far below the value.)
[10 μ Sv/year]
Standard radiation dose from Clearance level.

Mr. STEARNS. I thank you, and I will start with the questions.

Mr. Levis, as I understand it, you have actually had experience operating a nuclear power plant. Is that correct?

Mr. LEVIS. Yes, sir.

Mr. STEARNS. And was your title then the chief nuclear officer for the plant?

Mr. LEVIS. That is correct.

Mr. STEARNS. Was this while you were in the military?

Mr. LEVIS. No, this was my previous job with Public Service Enterprise Group was as chief nuclear officer responsible for the Salem and Hope Creek station.

Mr. STEARNS. OK. Dr. Lyman has indicated a little concern about preparedness of the United States. Based upon your experience actually operating a nuclear power plant, do you see what is happening in Japan ever happening here in the United States?

Mr. LEVIS. The question of could it happen here, I like to start with saying we assume it can happen here but I have confidence that we can deal with it because we start saying it can and we work from there to make sure we have in fact built into our process a sufficient——

Mr. STEARNS. Do you think we have built into our procedures——

Mr. LEVIS. Yes, sir, I do. I think we have built it into our design, built it into our operating practices and also our emergency plans.

Mr. STEARNS. So again, I would ask you the question, do you think what happened in Japan could likely happen in the United States based upon your experience?

Mr. LEVIS. No, sir, I don't.

Mr. STEARNS. Dr. Corradini, you made a statement. You said no health consequences will occur in Japan because of the nuclear incident. Did I hear you correctly say that?

Mr. CORRADINI. I said something like that.

Mr. STEARNS. So in your opinion, notwithstanding what had happened there, you feel confident no long-term health care problems will occur in Japan. And what do you base that on?

Mr. CORRADINI. So I think in my written testimony, what I have had access to are essentially reports from NISA, the Nuclear and Industrial Safety Agency, and their releases of radiation monitoring, and from what is seen to date, I don't think there will be severe health consequences from the accident.

Mr. STEARNS. Mr. Levis talked a little bit about preparedness that Dr. Lyman talked about. Do you mind just maybe commenting upon what Dr. Lyman said in terms of U.S. preparedness?

Mr. CORRADINI. He said a number of things. Which one would you like to me to comment on?

Mr. STEARNS. Well, you are welcome to comment on all of them. It is an open-ended question for you to answer.

Mr. CORRADINI. I think I know Dr. Lyman from a number of times when we have spoken either together or between sessions, so I think some of the things that he says we have to take serious thought with. I think his comments about having to review what we have currently in plants is a logical thing to do. I don't particularly specifically agree with some of his conclusions. So I apologize for starting off like this, but as an engineer, I qualify everything,

right, because we don't—the first thing you learn as an engineer is, you don't trust anybody else except yourself, and even that you double check. So I agree on many counts with what Dr. Lyman says in terms of we have to be concerned about. I don't necessarily come to the same conclusions about how I would act upon those concerns.

Mr. STEARNS. And what conclusions do you draw differently than Dr. Lyman?

Mr. CORRADINI. I don't think necessarily—well, now I am getting into personal opinion so I am going to have to be careful.

Mr. STEARNS. Well, no, that is why you here. Dr. Lyman is giving his personal opinion too.

Mr. CORRADINI. I am sure he has. I don't necessarily think I would come to the same conclusions about evacuation zone planning because I think we are early in the game of that. I just remind the committee that at TMI since I was the alternative events sequence scenario for the Presidential Commission for 3 weeks, I enjoyed my stay in Washington. Two days after TMI, we asked to move the evacuation zone from 10 miles to 20 miles based on some hypothetical possibilities. So we can take actions as appropriate to protect health and safety of the public and the areas surrounding the plant but we have to be careful how we do it. I would say that if I were personally to think a plan forward, I would say I would like to risk-informed decisions relative to evacuation planning where I would actually look at—and I think Mr. Virgilio said this probably best where you are looking at essentially the possibility of events that can occur, the consequences of those events and try to decide and form some sort of risk context. So assuming for a size for an evacuation zone to me is a bit too early.

Mr. STEARNS. Mr. Levis, you heard the first panel, and Dr. Lyman mentioned the SOARCA analysis and the B.5.b. e-mails. Is there anything you would want to comment based upon what Dr. Lyman said about that or perhaps what the first panel talked about?

Mr. LEVIS. Since the SOARCA is a draft report, I haven't had the benefit of seeing it since it hasn't been released, but what I can comment on is the B.5.b. items we talked about. I mentioned in my testimony we verified them. We know the work. We have trained our people to make them work and we have demonstrated the equipment will work, and if I could add there, this is not just one or two checklists we developed. For our particular station, this is over 100 procedures that we have put in place to basically address the what-if questions that we don't know and understand today. So I am very, very confident that we can implement these procedures and the equipment will work.

Mr. STEARNS. My time is expired. The gentlelady from Colorado is recognized for 5 minutes.

Ms. DEGETTE. Thank you so much, Mr. Chairman.

Mr. Levis, I think we are all happy to hear you say that it industry's view that what happened in Japan could not happen in the United States today, but I am going to assume that you don't mean that we can't take lessons from what happened in Japan and improve our situation in the United States even better, correct?

Mr. LEVIS. That is correct.

Mr. DEGETTE. And Dr. Corradini, you are nodding your head yes. You would also agree with that?

Mr. CORRADINI. Every system that we build as individuals or groups can be improved, and so we learn from every event.

Ms. DEGETTE. So that is all we are trying to figure out today is how can we take lessons from this and improve on that. The new equipment and the procedures for nuclear reactors that was ordered by the NRC after September 11, the B.5.b. mitigating systems that we have been talking about actually made a big difference in the draft results of the modeling that we have been talking about of the severe reactor accident scenarios at the Peach Bottom nuclear plant which as we have heard coincidentally has the same design as the Fukushima reactors in Japan. With the new post-9/11 equipment, the Peach Bottom reactor narrowly avoided core damage and a complete loss-of-power scenario and without that equipment core damage occurred in the simulation.

And so Dr. Lyman, I want to ask you a couple of questions about the memo and the documents that the Union of Concerned Scientists released today about NRC's modeling and simulation as part of the SOARCA project. I believe that you testified you got these documents through a Freedom of Information Act request, right?

Mr. LYMAN. That is correct.

Ms. DEGETTE. So you are releasing two internal NRC e-mails that indicate that there were disagreements about NRC analysts as to whether the new equipment and procedures, the B.5.b. measures would really work, right?

Mr. LYMAN. That is correct.

Ms. DEGETTE. And Mr. Chairman, I ask unanimous consent to put those e-mails into the record now that they have been released.

Mr. STEARNS. No objection. So ordered.

Ms. DEGETTE. Thank you.

Mr. STEARNS. By unanimous consent, so ordered.

[The information appears at the conclusion of the hearing.]

Ms. DEGETTE. Now, on July 28, 2010, an NRC staff e-mail summarized the concerns of the NRC senior reactor analysts, or SRAs, who work in NRC's regional office as follows: "One concern has been SOARCA credits certain B.5.b. mitigating strategies such as RCIC operation without DC power that have really not been reviewed to ensure that they will work to mitigate severe accidents. Generally, we have not even seen licensees credit these strategies in their own PRAs, or probabilistic risk assessments, but for some reason the NRC decided we should during SOARCA."

Dr. Lyman, briefly, what is the significance of this e-mail?

Mr. LYMAN. The significance of this e-mail is that in the context of the actions which certain NRC wanted to credit in the event of a severe accident like occurred at Fukushima where you have a complete loss of power, which is called a station blackout, and then eventual loss of battery power. The question is, there is one system that you might be able to rely on to continue providing cooling even in the most severe circumstances, and there are presumably some techniques or equipment that would enable you to do that, but the problem is, well, first of all from our perspective, we don't know what those actually are because those plans are not publicly avail-

able. But what the e-mail does say is that some staff have looked at them and question whether they can be credited, whether you can actually say with confidence you would be able to do that and continue to keep the core cool, even in the severe circumstance.

Ms. DEGETTE. So it sounds like the NRC analysts were arguing that maybe this mitigation measure is unproven and shouldn't be relied on in the modeling. Is that what you are saying?

Mr. LYMAN. That is correct.

Ms. DEGETTE. The second NRC e-mail refers to mitigation measures required by NRC's March 2009 reactor security regulation. This one says, "The concern involves the manner in which the credit is given to these measures such that success is assumed," and the e-mail continues, "Mitigation measures are just equipment on site that can be useful in an emergency when used by knowledgeable operators if post-event conditions allow. If little is known about these post-event conditions, then assuming success is speculative." And so what it shows is the NRC reactor analysts responsible for the day-to-day safety were challenging the SOARCA assumption that the presence of new equipment could be equated with the successful use of the equipment. Do you think that is a reasonable concern?

Mr. LYMAN. Yes, I do. It makes no sense to credit a piece of equipment that is not seismically qualified with use after a severe earthquake. You simply can't guarantee that piece of equipment will be available. So I think it is clear that without the highest standards, you can't certify that equipment will be there if you need it.

Ms. DEGETTE. Just one last question, Mr. Chairman.

Mr. Levis, do you think this is something that would be worthwhile following up on and investigating in attempts to make sure that we ensure the safety of our system?

Mr. LEVIS. I think any questions we have relative to safety should be followed up on and answered.

Ms. DEGETTE. Thank you.

Mr. STEARNS. I thank the gentlelady. The gentleman from California, Mr. Bilbray, is recognized for 5 minutes.

Mr. BILBRAY. Yes, Mr. Levis, I have a question about that, because there seems to be a concern that this backup seems, which seems a logical effect that if you have got steam, steam is a problem, you have got the ability to generate, basically run pumps off of this stuff that maybe is a problem or maybe an opportunity. The question might have been during a major earthquake there may be a problem there. But we are talking about the inundation issue being the real problem in Japan where steam application seems to be one technology that is pretty impervious to inundation when it gets to operation. So isn't there sort of a mixing here of a concern that may apply in one application but in the application that we are talking about here is where the electricity is knocked out, pumps are knocked out by a tidal wave, the steam operation, though, maybe susceptible to one would still be operational with a tsunami.

Mr. LEVIS. I think Mr. Virgilio explained that fairly well this morning. It wasn't the event that got you there but the consequence and the consequence may be a loss of total power off site

and on site and whether water caused or didn't cause it, but having the mechanisms to deal with that loss of offsite power is what was reviewed, and every licensee demonstrate that they have ability to do that.

Mr. BILBRAY. So basically the interesting thing here is that you have got the one technology that might be susceptible to water but the other one won't be. Even if the assumption was this one may be susceptible to earthquake, the other system is less susceptible to earthquake. So having a variable backup system rather than being damned seems like we should be embracing. But let me move on to this.

Somebody spent a little time on disaster preparedness. Does anybody know if the Japanese in this area had a reverse 911 for their emergency evacuation system?

Mr. LEVIS. I am not aware, but what I do understand is they took early and timely action to evacuate citizens within the area.

Mr. BILBRAY. OK. Well, I just want to point out that in San Diego, we use our nuclear warning system during the major fires in California to evacuate people, that in the United States we have the capability of calling directly into the home and calling each home and telling them they are in an area that needs to be moved or they are in area that may have to be moved in 15 minutes. We have got that capability, and as far as I know, I don't see the rest of the world has come up to that, and that is one of those things that we are way ahead that we don't even talk about, but for those of us that are involved in disaster preparedness, I think it is a really important factor we need to address.

I have a question for you, Doctor, about the public safety issue because I may have a nuclear power plant up north but I have got three of them within a half of mile of San Diego, down San Diego, and I have got one that—and some of them that are within 100 yards of residences in Coronado and we probably have totally about 20 nuclear reactors right in that urban core. How does this equate to the safety of our military facilities that I have in San Diego where I have got reactors, six of them, within a half a mile of downtown San Diego? Is there something we can learn in those reactors that are really close to our civilian population?

Mr. LYMAN. Well, that is an interesting point, and the safety of naval reactors is something that most civilians don't really know too much about because most details are highly classified so I can only speculate, but I would say that I think there is a general concern when you have a nuclear reactor close to a large urban population that there is a potential for something to go wrong and a radiological release and so I believe that probably emergency preparedness should also deal with those questions as well. However, I think there are differences between the way the military regulates its nuclear power plants and the way the Nuclear Regulatory Commission does. The fact is, you have an industry that in some cases, let us say it doesn't always operate with military precision. So my concerns about the civilian nuclear power industry are perhaps even greater than about naval power plants.

Mr. BILBRAY. I appreciate that. I know the safety record of the military application seems very good. I can't say the same thing for aviation. I have had constituents killed by planes falling out of the

sky. In fact, we have had a lot of that over the years. But one technology seems to have not had that problem, and we ought to keep an eye on it.

Mr. Chairman, I think that we need to talk about the fact quickly the hydrogen problem in Japan, they had a structure built over their containment structure that contained the hydrogen, and I guess I would go to Mr. Levis. The reactors we have in California do not have that kind of structure so there could not be the containment of the gas that caused the explosion. Is that a fair assumption?

Mr. LEVIS. The reactors in California are pressurized water reactors.

Mr. BILBRAY. No, I am not talking about that. I am talking about just the gassing. I will point out, maybe you brought it up, the gassing off caused the hydrogen to be moved out, and because they have a structure, a metal structure over the top of their containment structure, it confined that enough to where it could—do you want to elaborate quickly on that one?

Mr. LEVIS. No, you said it just fine.

Mr. BILBRAY. And basically it couldn't happen in San Onofre, it couldn't happen at Diablo, OK, because we don't allow that kind of structure in California.

Thank you very much. I yield back, Mr. Chairman.

Mr. STEARNS. The gentleman yields back, and the gentleman from Virginia, Mr. Griffith, is recognized for 5 minutes.

Mr. GRIFFITH. Thank you, Mr. Chairman.

Mr. Levis, if I could start with you, Dr. Lyman has raised some concerns about the seismic capabilities or whether or not the equipment should be relied upon if it has not been tested in the right conditions. Can you just tell me what the failsafes are on the plants in the United States? Do you feel comfortable that we are safe?

Mr. LEVIS. I feel comfortable that we are safe for a number of reasons. First, the equipment that we are describing is designed to withstand the worst natural event that can occur at that site including seismic events. So those systems with built-in redundancies are able to survive the worst earthquake and ensure that the plant shuts down and remains shut down. In the event that, the what-if scenarios that we are talking about here today, there are additional pieces of equipment that can be brought to bear to help the plant shut down and keep it shut down, and I am confident that that equipment works in the conditions they need to.

Mr. GRIFFITH. Can you elaborate a little bit more? I mean, maybe I say safety at nuclear plants for dummies is what I need. But unlike my colleague, who has got plants all around him, we rely mainly on coal, and can you go into a little more detail on what safety features are there?

Mr. LEVIS. I could just talk a little bit about the plants that we have. We have a boiling-water reactor, the Hope Creek Station. We have four emergency diesel generators to provide emergency AC power that can power a number of different safety systems that can inject water into the reactor and keep the reactor cool and other systems that can remove heat from the containment. Each one of those systems is required to have a backup or redundant

system with separate power supplies and separate rooms and structures so we have two of everything to start with from a design standpoint, each of which are designed to withstand the worst earthquake, flood, hurricane or whatever event of concern there is at the particular station. In addition to that, we have operators trained on how to operate those systems, our licensed operators going through simulators that replicate the actual reactor cores that we have so they see real time what it is they would face, indications they would have and how they would respond to it, and those procedures have been upgraded so it made it easier for them so they can respond to symptoms and not events. They don't have to figure out if a hurricane came, they just have to figure out what they have to do to get water to the reactor or what they have to do to cool the containment. We have made it easier for even the instrumentation in the control room that can help them look at those various parameters and we make sure those instruments are qualified for the conditions that they will see during these events.

So, this training is continual. Folks go through it all the time and we are always asking ourselves the what-if questions so we can continue to learn lessons from that and events around the world, and we will in this case also.

Mr. GRIFFITH. Dr. Corradini, do you concur?

Mr. CORRADINI. Yes.

Mr. GRIFFITH. Is there anything you would like to add?

Mr. CORRADINI. No. I think that Mr. Levis has run a plant. I have been in plants. I have worked at a plant but I haven't run a plant so I would say his experience trumps mine by orders of magnitude.

Mr. GRIFFITH. Mr. Chairman, I yield back.

Mr. STEARNS. The gentleman yields back. Dr. Gingrey is recognized for 5 minutes. Oh, OK, I am sorry. Mr. Markey from Massachusetts came back. Mr. Markey, you are recognized for 5 minutes.

Mr. MARKEY. Thank you, Mr. Chairman, very much.

In the United States, we have a 10-mile emergency planning zone around each nuclear power plant, and it is only within this zone that there are plans and emergency drills for evacuation, sheltering in place and stockpiling of potassium iodide, which can eliminate thyroid cancers caused by radioactive iodine. Yet in Japan, the NRC has recommended a 50-mile evacuation zone for residents of the United States. Cesium has been found at levels that triggered relocation after Chernobyl 25 miles away. So the NRC has provided potassium iodide to its staff in Japan. The U.S. Embassy is making it available to U.S. personnel as far away as Tokyo, and the U.S. government is stockpiling it outside the 50-mile evacuation zone.

Mr. Lyman, the NRC has obviously concluded that a 10-mile emergency planning zone isn't large enough to deal with the Japanese meltdown. Do you think the emergency zone in the United States is large enough at 10 miles?

Mr. LYMAN. No, Congressman Markey, I do not. I believe that U.S. plants are vulnerable to the type of event we have seen at Fukushima and that event has demonstrated there could be significant radiological exposures far beyond 10 miles.

Mr. MARKEY. After Chernobyl everyone—and I was the chair of the committee, the Energy Subcommittee that had a hearing right after Chernobyl, and everyone said, well, you know, that is a bad design at Chernobyl and a repressive political regime and it couldn't happen here. That was that hearing. At this hearing, however, it is more difficult because Japan is our technological equal. We import all of our electronic equipment from Japan that we buy on a daily basis. So it is obvious that we can learn a lot of lessons if we are willing to from Japan and be a little more modest about mankind's ability to control nature, to control unpredicted events technologically.

Let me move on. In terms of the spent fuel, which has been one of the main sources of radiation at the Japanese nuclear reactors, in 2008, Chairman Jaczko said that he believed that "the most clear-cut example of an area where additional safety margins can be gained involves additional efforts to move spent nuclear fuel from pools to dry cask storage." Dr. Lyman, do you agree that the changes of a spent fuel fire and radiation release would be lower if spent fuel was moved out of the giant swimming pools and into dry cask storage as soon as possible?

Mr. LYMAN. Yes, I do believe that you would get a lower risk if you removed some of the fuel from the pools, reducing the density and reducing the heat load and also improving the potential for circulation.

Mr. MARKEY. So some people might say that the likelihood of anything bad happening is so small that there really isn't any difference between having them in the swimming pools or moving them into dry casks. What would you say to that?

Mr. LYMAN. Well, I would say what happened in Fukushima shows us that we do not really understand the fundamental likelihood of a variety of accidents. It is apparent that there is already a challenge to one of the spent fuel pools that was probably not predicted. It surprised a lot of people. And so I would say there is going to have to be a reevaluation of what we do know and what we don't know.

Mr. MARKEY. So a terrorist might be able to attack one of these swimming pools outside a nuclear power plant?

Mr. LYMAN. Yes, there is always a concern that a terrorist attack on the spent fuel pool could cause what is called a rapid draindown which would lead to an overheating of the pool in a relatively short period of time.

Mr. MARKEY. And again, these swimming pools are not inside a containment dome in the United States. They are outside of the containment dome. Is that correct?

Mr. LYMAN. That is right. They are not contained within the primary containment and the structure. They are contained around the reactor building. It is not designed to be leak-tight or pressure resistant.

Mr. MARKEY. And we learned from documents captured from al Qaeda that nuclear power plants are at the very top of the terrorist target list of al Qaeda in the United States. Is that correct?

Mr. LYMAN. I am not familiar with the intelligence but the Nuclear Regulatory Commission has said that there is an ongoing threat to U.S. nuclear power plants.

Mr. MARKEY. Thank you. The meltdown in Japan was caused by an electricity outage that was itself triggered by the earthquake and tsunami but most nuclear reactors here are only required to have 7 days' worth of diesel fuel for their emergency generators and only 4 to 8 hours' worth of battery capacity in the event of their diesel generators failing. In Japan, the reactors had 8 hours' worth of battery generation capacity. Don't you agree that the NRC's regulations should be changed to require more diesel fuel and greater battery capacity in order to give emergency responders more time to be able to figure out the physics and the electronics of the mess that they could be confronted with because of some natural disaster?

Mr. LYMAN. Yes, I do agree that there needs to be a reexamination of the assumptions about the ability to rescue a plant in the event of a significant natural disaster or terrorist attack that could have damage to the surrounding infrastructure. I think the assumptions for a coping capability at plants are based on overly optimistic assumptions about the arrival of the cavalry.

Mr. MARKEY. I thank you, and I thank you, Mr. Chairman.

Mr. STEARNS. The gentleman's time is expired. The gentleman from Georgia, Mr. Gingrey, is recognized for 5 minutes.

Dr. GINGREY. Mr. Chairman, thank you for recognizing me. And just in a follow-up to what the gentleman from Massachusetts was just saying in regard to the concern over the pools containing the spent fuel, there, in fact, he is right, 144 million pounds of spent fuel above ground at these 103 reactor sites across the country just sitting there waiting to be transported to Yucca Mountain in dry storage, I don't know how many hundreds of meters below the surface in that abandoned salt mine like of course they do in Scandinavia and yet I never heard the gentleman from Massachusetts express any outrage when President Obama a year and a half or so ago defunded any ability to transport that dangerous, as he described it, spent fuel in those swimming pools to Yucca Mountain. It is kind of interesting.

Let me let our witnesses, Mr. Levis and Dr. Corradini, answer a couple of quick questions. At this point it appears that loss of power and backup power was a key factor to the loss of control of the cooling in the Japan incident. Would you agree with that, the two of you?

Mr. LEVIS. Yes.

Dr. GINGREY. And they are shaking their heads yes. What safeguards in the United States can you point to that suggest our facilities would be prepared for a disaster that knocks out two forms of power, the diesels and the electric grid?

Mr. LEVIS. If I could start first with the design of where the diesels in particular, they are in seismic rugged structures and designed to be also flood-proof so if you look at the elevations and the height, water would be prevented from getting in there and the diesels themselves would be qualified for the seismic events, so safety-related, very rugged structures to begin with.

Dr. GINGREY. Dr. Corradini?

Mr. CORRADINI. No, I agree with you. I agree with Mr. Levis. I was just going to comment on that the whole premise of the way nuclear power plants are designed and operated in the United

States is defense and depth that you have multiple independent barriers for protecting and keeping radioactive materials where they should be.

Dr. GINGREY. And in fact, at least the two nuclear plants that are being licensed and in the process of being constructed now, at Plant Vogtle in Waynesboro, Georgia, in my State by the Southern Company, their ability to cool is not dependent, is it, on electric grid? They have sort of a gravity situation which would protect them from this kind of a catastrophe?

Mr. LEVIS. That is correct.

Dr. GINGREY. Is that correct?

Mr. CORRADINI. Yes, sir.

Dr. GINGREY. Thank you. Dr. Lyman expressed concern that there is not sufficient backup battery requirements at facilities, that 90 percent of the United States reactors only have four-hour capability. I would like for both of you to respond to that concern.

Mr. LEVIS. The 4-hour requirement actually came into regulations in 1988. I have one of those 4-hour plants, and I can tell you what it is we have done since that period of time is, our procedures that I have talked about that we have to cope with this event, the first thing we do is, we strip the battery of its load so that 4 hours becomes 8 hours. And in addition to that, if it looks like the battery life has become depleted, I have backup emergency generators on the site that I can power the battery chargers and do that indefinitely until such time as I can get AC power restored to the point.

Dr. GINGREY. Dr. Corradini, are you confident at present that the United States facilities have sufficient redundancies to provide that backup power after some such disaster?

Mr. CORRADINI. Yes, sir.

Dr. GINGREY. Mr. Levis, what about beyond design basis failures? What does your company and industry do to ensure that it has the ability to respond, let us say, to a 9/11?

Mr. LEVIS. The particulars of 9/11, we had to demonstrate that we could respond to a large area of fire, loss of large areas of the plant and be able to keep cooling to the fuel pools, and we were able to demonstrate that through a wide range of scenarios that we had the capability, training and wherewithal to do just that.

Dr. GINGREY. And let me go back to Dr. Corradini. Dr. Corradini, you are the engineer. You are the nuclear physicist.

Mr. CORRADINI. No, no, he is an engineer too.

Dr. GINGREY. You both are. All right. But anyway, what are some of the general engineering considerations for developing a design basis for earthquakes and these used fuel pools that Mr. Markey was talking about?

Mr. CORRADINI. Well, as I know from others, not from my own expertise, fuel pools are seismically qualified in the United States as Mr. Levis was talking about, and the number of other alternative abilities of the pool to be kept cool during any sort of event, but I thought your question was a bit broader, which was that the plant as a whole has a design, what is called a safe shutdown earthquake such that all systems can essentially bring the plant to a cold shutdown condition and keep it cool and stable even in the event of the worst-case earthquake with margin. I think Mr.

Virgilio explained that in much better detail than I did earlier in questioning.

Dr. GINGREY. Doctor, you are right. That is the question that I should have asked, and I really appreciate the answer. My time is expired and I will yield back.

Mr. STEARNS. All right. I thank the gentleman.

We have a rare opportunity. Generally the votes are going to be later so we still have an opportunity. If you bear with us, I will take a second round here and I will start with my questions for 5 minutes.

I just want to establish this quickly. Dr. Levis, you are on the executive board of the Institute for Nuclear Power Operations. Isn't that correct?

Mr. LEVIS. Board of directors, sir, yes.

Mr. STEARNS. And simply, what role does the INPO play in response to events such as what happened in Japan, just briefly?

Mr. LEVIS. In particular, we started a series of conference calls the day after the event to mobilize, to understand what had happened and determine what actions we needed to take as an industry, and so the four actions that I described in my testimony about verifying our ability to respond to these series of beyond design basis events essentially were spearheaded by the INPO organization and that is who we are reporting the completion of those to in the next 2 weeks.

Mr. STEARNS. That is impressive. Is it possible that you can operate more quickly than the NRC?

Mr. LEVIS. Well, safety is our business, and NRC provides an independent function but we recognize that importance and we take whatever actions are necessary in a time period to do it to make sure those plants are safe.

Mr. STEARNS. Mr. Levis, in your testimony you reference a flooding experience during Hurricane Katrina at the Waterford nuclear plant. You state that the plant lost all offsite power and maintained safe shutdown on emergency diesel generators for 3–1/2 days until grid power was restored. Obviously, the Japan plants have been without power for more than 2 weeks now. Are our plants prepared to go without power for that long?

Mr. LEVIS. The plants could operate for that period of time on emergency diesel generators. The only issue would be is refueling the fuel tanks that would be on site and the ability to get fuel to those.

Mr. STEARNS. OK. Dr. Corradini, what is the Probabilistic Risk Assessment in lay terms and how does that apply to you as commercial reactor safety?

Mr. CORRADINI. Well, let me start by trying to avoid answering your question by saying you should bring Commissioner Apostolakis on since he was one of the early originators of the process and knows it quite well. But from my understanding, it is simply answering three questions, which is what can go wrong, what is the likelihood of something going wrong and what are the consequences of it, and in fact, you can think of it exactly in that way when we talk about it for a number of events. The SOARCA questions that had come up earlier in some sense was strictly the third,

what are the consequences. There was no discussion of the ways in which things can go wrong nor the likelihood. Does that help?

Mr. STEARNS. A little bit.

Mr. CORRADINI. Feel free to ask more.

Mr. STEARNS. How is it used to plan for extreme and beyond design basis events and is it an approach widely used by other nations?

Mr. CORRADINI. It is used now, and I will make sure Mr. Levis corrects me if I get it incorrectly relative to the NRC. It is one of the requirements of an ongoing look on how we do maintenance procedures, on how we look at any sort of changes in the plant's state, how we actually then keep an ongoing, what is called an ongoing PRA on what the plant's state is so that you can understand if something would occur, and we go beyond the design base what the likelihood of what we do. In fact, the final thing I think was mentioned by Mr. Levis and also by Mr. Virgilio. The Severe Accident Management Guidelines in some sense are informed by the PRA process so that we know what we could do given some sort of symptom. If something occurs, if we see a symptom, we then would respond in some way to essentially alleviate the problem or to make sure we keep the reactor cool. So that is an example of what we use it for.

Mr. STEARNS. Mr. Levis, anything you want to add to that?

Mr. LEVIS. The only thing I could add is our plants were designed to—that is, those single failure proof could prevent safety function from occurring. Since that period of time, PRAs were put in place to look at essentially another lens looking at the situation, and we determined there were improvements that could be made because of the PRA, we have in fact put those in place at our stations to improve our margins of safety.

Mr. STEARNS. Just for the neophytes, what is the PRA?

Mr. LEVIS. Oh, the Probabilistic Risk Assessment. That is the process I just described.

Mr. STEARNS. Oh, that is the acronym. OK.

I think my questions are accommodated. The gentlelady from Colorado is recognized.

Ms. DEGETTE. Thank you very much, Mr. Chairman.

Mr. Levis, I was intrigued by what you said about the third-tier backup that you had at your plant, which is the batteries, and you said, I believe, that they are rechargeable batteries. Is that right?

Mr. LEVIS. We have the capability to charge them, yes.

Ms. DEGETTE. And is this a battery that to your knowledge is available as a third-level backup in all of the nuclear power plants in the United States?

Mr. LEVIS. There are battery chargers that keep batteries at all plants. The power we would provide would be to the battery charger so we can keep them charged.

Ms. DEGETTE. So what would happen to those batteries then if—I mean, we are assuming a worst-case scenario obviously. What would happen to those batteries? I mean, all those batteries, the technology is, they stay charged 4 to 8 hours as understand it. Is that right?

Mr. LEVIS. Without a charger.

Ms. DEGETTE. So what would happen then if the—this is what I am concerned with. What would happen if the electricity were cut off to the battery charger?

Mr. LEVIS. The alternates—if the electricity were cut off to the charger, then the battery lifetime would be dependent whether it is a 4-hour or 8-hour battery.

Ms. DEGETTE. Right.

Mr. LEVIS. However, if you hook up an emergency power source to the battery charger, you can keep that battery charging indefinitely.

Ms. DEGETTE. Right. But then you can hook it up to the cooling system too. I mean, you know, if you had a diesel system, then that could cool it too, right?

Mr. LEVIS. I am not sure I understand the question.

Ms. DEGETTE. OK. Dr. Lyman, you know, this is one of the concerns that your organization expresses, that these backup batteries had only a 4- to 8-hour life, and in the SOARCA project that has not yet been released, the Peach Bottom plant came within 1 hour of complete failure because the batteries were only 4 to 8 hours. What is the solution of that?

Mr. LYMAN. Well, the solution has to be a reevaluation of the requirements for making sure that if you get to such a severe station, a station blackout and run out of battery capacity, that there are more robust measures for coping with that and so there are a variety of things that can be done. Certainly if you had robust—I am not sure, but the power requirements for recharging a battery are probably not the same that you would need to restore the cooling system so I would have to double-check on that.

Ms. DEGETTE. OK.

Mr. LYMAN. But the requirements for that, which should be safety related and seismically qualified and be able to protect against all these other events. I think the core of our concern is that you don't take credit for things that you can't guarantee will actually be there, and what I hear is they are trying to—the industry is trying to have both sides of the coin. They want to take credit for these things but they are not willing to reinforce them, to harden them against a variety of events that they need to protect against.

Ms. DEGETTE. OK. So I just wanted to ask, we have all been talking about the March 2009 security requirements that were put into place, and everybody was supposed to upgrade to that. Do you know, have all the nuclear power plants in the United States gone into full compliance with that?

Mr. LYMAN. To my knowledge, no, they haven't.

Ms. DEGETTE. And how many of them have not?

Mr. LYMAN. I am not sure. I counted four that I saw had gotten extensions so that they still wouldn't be in compliance today but I am not sure that is the extent.

Ms. DEGETTE. And the requirements were focused on security threats rather than natural disasters, right?

Mr. LYMAN. That is correct.

Ms. DEGETTE. Now, how confident do you think we can be that the new equipment required by the NRC after 9/11 would remain operational after a major earthquake or flood?

Mr. LYMAN. Well, unfortunately, we don't have access to the actual plans where that equipment and the specifications are detailed because that is security-related information, but from public comments that have been made, there are indications that they don't require seismic qualification, for example. So of course, to the extent that they don't meet the most rigorous standards, we can't have confidence that they could survive severe events.

Ms. DEGETTE. Thank you very much. I want to thank the whole panel for coming and also the previous panel. These are serious questions, and as I say, what I want to make sure and I think all of us do is that we use this Japan example as a way to make sure that we are making our nuclear energy as safety as we possibly can. I yield back.

Mr. STEARNS. The gentlelady yields back. You had a few more seconds. Maybe Mr. Corradini and Mr. Levis might want to just comment on what Dr. Lyman said.

Mr. BILBRAY. Now that they are all gone.

Mr. STEARNS. Mr. Bilbray, you are recognized for 5 minutes. You might ask these other two just to comment on that because I think that is important too.

Mr. BILBRAY. I think we have got it. First of all, for the record, we have 8 hours' reserve battery in San Diego in our reactors.

Mr. Levis, I have a question for you that the gentlelady from Colorado brought up this issue. Our battery backup, is it a lead acid, is it glass mat technology or are you using gel for the batteries? Do you know the technology being used?

Mr. LEVIS. Generally, lead acid.

Mr. BILBRAY. Lead acid. So the fact is, is when the generators come on to run the pumps they would put in cycle for recharging at the same time so basically developing another backup.

I would like to ask all three of the witnesses, President Obama's Secretary of Energy, somebody who is very well respected on both sides of the aisle, made a very clear statement to those of us in California that even though the Japanese plant was designed for what we would equate as a 7.0 was hit by a 9.0 and still survived it, that our units are designed for what is perceived as the maximum at 7.0, and I would just like to ask, do you agree with the Secretary of Energy that the design parameters show that we can survive an event that would occur between every 7,000 to 10,000 years? Would you agree with the Secretary on that issue?

Mr. LEVIS. I am not familiar with the 7,000 to 10,000. What I am familiar with is the Japanese plant experienced horizontal ground motion of .52 G's. The plants in California are designed well above that number, both the San Onofre and Diablo Canyon Station. If I remember the numbers correctly, it is .67 and .75 G's, so a significant margin above what the plant in Japan actually experienced.

Mr. BILBRAY. Doctor, do you think the Secretary is right by basically saying——

Mr. LYMAN. I can't comment on that because I think the jury is still out, first of all, on whether the plant was within the—whether Fukushima was within the design basis and survived it or not. There were a number of systems that were disabled.

Mr. BILBRAY. OK. My question is really on the event. The Secretary is saying that we have designed to an event that will happen every 7,000 to 10,000 years. Do you agree with that event perspective by the Secretary of Energy?

Mr. LYMAN. I would have to reserve on that. I am not familiar with that. But there is also an issue whether equipment is survivable or whether it can actually be used and whether the operators are there to use it, and my understanding is, only survivability is considered——

Mr. BILBRAY. So your point is that even though the events may happen only every 7,000 to 10,000 years, the fact is, the claim of survivability you don't believe?

Mr. LYMAN. Well, if the equipment is qualified to be survivable, that doesn't mean that someone is going to be able to actually use it, and you also have to consider the whole range of particularities which aren't considered.

Mr. BILBRAY. Well, I understand that, and I guess the proof in the pudding is the fact that when you have a facility that is not designed to take a 9.0 and does take a 9.0, and we would never have a 9.0. All geologists say that California will never be hit, our reactors won't be exposed to it, Alaska maybe and the others, and the Secretary I guess kind of reinforced that. Your comment about the Secretary's statement about our engineering to a 7,000 to 10,000 years——

Mr. CORRADINI. I am going to see to it just for the group as a whole, when people use the Richter scale, it is kind of a very fuzzy——

Mr. BILBRAY. Right.

Mr. CORRADINI. And I think what Mr. Levis talked about I think is a very precise way of saying it, what the ground acceleration was and what the ground acceleration we were designed to at Diablo Canyon and San Onofre. So I do agree.

Mr. BILBRAY. And the biggest issue is the geologist's predictions of when those events would happen and the probability, he gave 7 to 10, and I just thought that that was very telling of exactly what we were shooting for here.

I would like to go back to the fact where we go from here. I would like to give you a chance to be able to articulate one thing. We are doing all these studies. In fact, I probably should go to the engineer. The ground motion stability and the survivability on this stuff, is this all being done just by engineering projections? Is there any modeling?

Mr. CORRADINI. No, no, no, no, no. Let me back up and say—because I got cornered on a couple of radio discussions about this. All that we are talking about relative to analysis is tested based on analysis compared to testing. In fact, some of the best testing is done in some of the universities out on the West Coast where the concerns are high. So most of this is done with empirical testing.

Mr. BILBRAY. OK, because that is how we do our earthquake survival for structures or whatever. It was interesting that even if you found the problem, Mr. Chairman, it was interesting that the way you would reinforce a concrete structure if you found it was deficient would be to reinforce it by lining it with carbon finger and epoxy composites which as the nuclear physicists will tell you is a

great heat sink for dispersing the heat caused by the fuel itself. So actually even if you come in deficient, how you would repair it would actually make the system more efficient than just having the traditionally designed system. So I yield back, Mr. Chairman.

Mr. STEARNS. I thank the gentleman. I thank you for that point. The gentleman from Massachusetts is recognized for a second round for 5 minutes.

Mr. MARKEY. Thank you, Mr. Chairman, very much.

Again, it is important to remember that this committee selected Yucca Mountain and that it was not high on the list of the National Academy of Sciences. We eliminated New Hampshire because John Sununu wasn't interested in having it in granite. We eliminated Mississippi because Trent Lott didn't want it there and Bennett Johnson didn't want it in Louisiana in the salt domes, just so we are humble with regard to the problem with Yucca. We selected it along with our Senate counterparts. I voted no. I didn't think that we should be selecting and I thought that the National Academy of Sciences and others should be followed in their recommendations. So the inherent problems that obviously exist in Yucca are naturally flowing from the fact that politicians selected something that scientists should have done, and the same way, by the way, that this afternoon the House Floor a bill came out of this committee, is going to be on the House Floor telling the Environmental Protection Agency to ignore the science of global warming and not to do anything about that problem.

Again, this is a committee that is—you know, we are political experts but that is an oxymoron like jumbo shrimp or Salt Lake City nightlife, but nonetheless, it does not stop the committee from continuing to delve into making scientific decisions that then have long-term ramifications, and Yucca Mountain is one of them. If people want to be moving nuclear fuel there, then they should have allowed the scientists to have made the decision.

Moreover, as we know, the nuclear fuel, even if Yucca was open, would be oversubscribed right now. We would need a second nuclear repository. Right now it is already oversubscribed. It can't accept it because there are many geological unanswered questions at Yucca. You really don't want to be building it that near an earthquake fault probably if you could go and do it all over again. But the reality is that the spent fuel is so hot that it has to be kept on site right next to the reactor anyway for 5 years while it cools down. It is not even ready to get moved. So we have to make sure that it is secure next the plant for at least 5 years because it needs to be cooled down before it can get moved anyway. So we just have to be realistic about the problem. Yucca Mountain would be oversubscribed and the remaining fuel would have to sit there for at least 5 years anyway because of the inherent danger of the heat that is in that spent fuel.

So Dr. Lyman, when you look at this General Electric design here in the United States, do you think it is important for the Nuclear Regulatory Commission to go back and to reexamine the assumptions that they have made about the safety devices, procedures inside of those plants?

Mr. LYMAN. With regard to the Mark I in particular?

Mr. MARKEY. Yes, the Mark I.

Mr. LYMAN. Yes, there are certain issues that we think would bear a closer look. One issue that has been known for a long time is that the Mark I has a particular vulnerability to containment failure, which is called vessel melt-through, and this would not be remedied by the hardened vents and the other hydrogen mitigation measures that you heard about. And there are a number of different containment types in the United States that also have similar vulnerabilities. So we think fundamentally there has to be a great emphasis on prevention at this point and looking at where safety margins have been reduced unnecessarily or too closely for a whole range of different designs.

Mr. MARKEY. Now, last year there was an earthquake in Chile and then later last year there was an earthquake over in New Zealand, which everyone remembers, and then an earthquake in Fukushima up in Japan, and the fourth part of that quadrant is over here in the United States, Alaska, Oregon, maybe down to California. Who knows? We should be a little bit humble about pretending to understand the totality of the geology of the planet.

The Japanese, of course, we would assume would be those that were most concerned about earthquakes since that is part of their culture, and yet they weren't prepared for a 9.0. And it turns out that in the year 865, there was a 9.0 in that part but they weren't of course preparing for something that happened in 865. You can, I guess, assume that a nuclear power plant won't be there long enough, you know, that you can kind of take the risk. That is part of a calculated risk.

But the humility I think that we should bring to this subject right now is to basically assume that something bad could happen and begin to prepare for it. Chile, New Zealand, Japan, the United States. We don't know. We don't want it to happen but our job is to make sure that we have the proper safeguards and preparations in place in the event that the worst does occur. Thank you, Mr. Chairman.

Mr. STEARNS. I thank the gentleman from Massachusetts and I thank our witnesses for staying with us, and we are ready to close.

I ask unanimous consent that the contents of the document binder be introduced into the record and to authorize staff to make any appropriate redactions. Without objection, the documents will be entered into the record with any redactions that staff determines are appropriate.

[The information appears at the conclusion of the hearing.]

I want to thank the witnesses again for the testimony, and members of this committee for participating. The committee rules provide that members have 10 days to submit additional questions for the record to the witnesses.

And with that, the subcommittee is adjourned.

[Whereupon, at 12:20 p.m., the subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

April 5, 2011

To: Subcommittee on Oversight and Investigations, House Energy and Commerce Committee

Re: Forthcoming UCS Analysis on NRC E-Mails Concerning Fukushima-Type Events

Tomorrow, after the Subcommittee's hearing, the Union of Concerned Scientists will publish the following analysis and additional documentation (also attached), which we have just obtained and are still in the process of fully evaluating. We apologize for delivering this to the Subcommittee so close to the hearing, but we were unable to prepare it in time for inclusion in the written testimony.

INTERNAL NUCLEAR REGULATORY COMMISSION E-MAILS REVEAL DOUBTS ABOUT MEASURES TO HELP U.S. PLANTS SURVIVE FUKUSHIMA-TYPE EVENTS

Edwin Lyman

Senior Scientist, Global Security Program

Union of Concerned Scientists

April 6, 2011

In the weeks following the Fukushima accident, officials from the U.S. Nuclear Regulatory Commission (NRC) and the nuclear industry have been asserting that U.S. nuclear plants are better prepared than Japanese plants to withstand a catastrophic event such as the March 11 earthquake and tsunami, because U.S. plants have additional measures in place to cope with such disasters. According to internal NRC documents obtained by the Union of Concerned Scientists, however, there is no consensus within the NRC that these additional measures will be effective. Therefore, it remains highly uncertain whether U.S. plants would be better prepared than the Japanese to manage the aftermath of such severe events. Although the Japanese have engaged in heroic efforts, they have not able to prevent significant damage to reactor cores, spent fuel and containment structures, resulting in huge radioactive releases into the atmosphere and the ocean.

The NRC has testified that U.S. plants are safer than those in Japan. In a hearing of the Senate Energy and Water Appropriations Subcommittee on March 30, NRC Chairman Gregory Jaczko testified that

> "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, the NRC requires licensees to have available and staged in advance, as well as new procedures and policies to help deal with a severe situation."

Similarly, at the same hearing, nuclear utility official William Levis, testifying on behalf of the Nuclear Energy Institute, said that

> "Since the terrorist events of September 11, 2001, U.S. nuclear plant operators identified other beyond-design-basis vulnerabilities. As a result, U.S. nuclear plant designs and operating practices since 9/11 are designed to mitigate severe accident scenarios such as aircraft impact, which include the complete loss of offsite power and all on-site emergency power sources and loss of large areas of the plant. The industry developed additional methods and procedures to provide cooling to the reactor and the spent fuel pool, and staged additional equipment at all U.S. nuclear power plant sites to ensure that the plants are equipped to deal with extreme events and nuclear plant operations staff are trained to manage them."

These post-9/11 measures are referred to as "B.5.b," in reference to the section of the Compensatory Measures order issued by the NRC in 2002 to all reactor licensees. These measures were codified in NRC's regulations in 2009 in 10 CFR 50.54(hh)(2). The specific details of the B.5.b measures are considered by NRC to be security-related information and are not publicly available.

Both the NRC and the industry sound confident about the ability of these B.5.b measures to effectively cope with a situation such as the ongoing crisis at Fukushima Daiichi, in which both off-site and on-site power was lost for an extended period, eventually leading to the loss of all cooling at the site.

However, internal NRC e-mails obtained by UCS under the Freedom of Information Act tell a different story. In February 2011, UCS filed a FOIA request for all information associated with a secretive NRC program known as the "State of the Art Reactor Consequence Analyses," or SOARCA. SOARCA, according to the NRC, is "a research effort to realistically estimate the outcomes of postulated severe accident scenarios that might cause a nuclear power plant to release radioactive material into the environment. The SOARCA project applies many years of national and international nuclear safety research, and incorporates the improvements in plant design, operation and accident management to achieve a more realistic evaluation of the consequences associated with such accidents." The NRC also states that SOARCA takes into account the enhancements required by NRC after 9/11—that is, the B.5.b measures.

The SOARCA program was initiated in 2006, and the pilot study initially has focused on two plants: Surry in Virginia and Peach Bottom in Pennsylvania. Coincidentally, Peach Bottom is a Mark I boiling-water reactor, like Fukushima Daiichi units 1-4. One of the accidents that the NRC selected for analysis by SOARCA was a station blackout with failure to recover power prior to battery depletion, that is, the very situation that occurred at Fukushima. Thus the results of SOARCA could be very useful for anyone trying to understand more about what is happening at Fukushima. However, almost all documents related to SOARCA have been withheld from the public as "official use only" information. NRC has repeatedly delayed public release of the results of SOARCA.

In most Mark I BWRs experiencing a station blackout, a cooling system that runs on battery power, known as the Reactor Core Isolation Cooling system, or RCIC, is available. But when the battery runs down—after eight hours or less—the RCIC will cease to operate. If AC power has not been restored by then, no cooling systems will be available and the fuel in the reactor will start to overheat and eventually begin to melt, as most believe has occurred in Fukushima Daiichi units 1-3.

According to the e-mails obtained by UCS, NRC's B.5.b measures contain unspecified strategies to continue operating the RCIC even after battery power is lost. However, the e-mails make clear that there are disagreements between NRC senior reactor analysts (SRAs), who work in NRC's regional offices under the Office of Nuclear Reactor Regulation (NRR), and the staff conducting the SOARCA project, who are in the Office of Research (RES). In particular, one NRC staff e-mail, dated July 28, 2010, characterizes the objections of the SRAs to SOARCA as follows:

> "One concern has been that SOARCA credits certain B5b mitigating strategies (such as RCIC operation w/o DC power) that have really not been reviewed to ensure that they will work to mitigate severe accidents. Generally, we have not even seen licensees credit these strategies in their own PRAs [probabilistic risk assessments] but for some reason the NRC decided we should during SOARCA.
>
> "My recollection is that RI [Region I] SRAs in particular have been vocal with their concerns on SOARCA for several years, probably because Peach Bottom is one of the SOARCA plants."

Thus the SRAs that work directly with the Peach Bottom Mark I BWRs apparently do not have faith in the effectiveness of the very B.5.b measures that NRC and NEI officials are now touting as a reason why the U.S. is better prepared to deal with a Fukushima-like event than Japan was.

Another (undated) e-mail reinforces this concern:

> "The application of 10 CFR 50.54(hh) mitigation measures still concerns a number of staff in NRR. The concern involves the manner in which credit is given to these measures such that success is assumed ... 10 CFR 50.54(hh) mitigation measures are just equipment onsite that can be useful in an emergency when used by knowledgeable operators if post event conditions allow. If little is known about these post event conditions, then assuming success is speculative."

If the public is to have confidence that U.S. plants are safe, the NRC and the industry should be fully transparent and honest in disclosing what they know and what they don't know. They are doing a disservice to the public if they express a level of confidence in the effectiveness of untested measures that is not justified. The concerns of NRC senior reactor analysts with regard to the credibility of post-accident mitigative measures need to be taken seriously by the NRC task force established to review regulations and policies in light of Fukushima.

FRED UPTON, MICHIGAN
CHAIRMAN

HENRY A. WAXMAN, CALIFORNIA
RANKING MEMBER

ONE HUNDRED TWELFTH CONGRESS

Congress of the United States
House of Representatives
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2125 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–6115

Majority (202) 225-2927
Minority (202) 225-3641

SUPPLEMENTAL MEMORANDUM

April 6, 2011

To: Democratic Members of the Subcommittee on Oversight and Investigations

Fr: Democratic Staff of the Committee on Energy and Commerce

Re: NRC Modeling of Severe Reactor Accident Scenarios at U.S. Nuclear Plants

This morning, the Subcommittee on Oversight and Investigations will hold a hearing on the nuclear crisis in Japan. Nuclear Regulatory Commission (NRC) staff recently briefed the Democratic staff of the Committee regarding NRC's modeling and simulations of severe reactor accident scenarios for a U.S. plant of the same design as the Fukushima reactors in Japan. A draft NRC report found that in a complete loss of power scenario the reactor would come to within one hour of core damage.

These findings may actually understate the risk of core damage at a U.S. nuclear power plant because of the scope and assumptions of the study. This memo discusses the information NRC recently provided to Committee Democratic staff regarding its modeling and simulations and the issues raised by this information.

NRC's State-of-the Art Reactor Consequence Analyses (SOARCA)

The objective of the NRC's State-of-the Art Reactor Consequence Analyses (SOARCA) project is "to analyze the realistic outcomes of postulated severe reactor accidents, even though it is considered highly unlikely that such accidents could occur."[1] According to NRC staff, the SOARCA analyses aim to account for the findings of research that has been conducted during the last 25 years as well as significant plant changes and updates that were not factored into earlier assessments.

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[1] Nuclear Regulatory Commission, Overview of the SOARCA Project (Nov. 2, 2010) (online at: http://www.nrc.gov/about-nrc/regulatory/research/soar/overview.html).

The SOARCA project analyzes two plants: the Peach Bottom GE Mark 1 boiling-water reactor (BWR) near Lancaster, Pennsylvania – co-owned by Exelon and PSEG, whose President and Chief Operating Officer is testifying today – and the Surry pressurized-water reactor (PWR) near Newport News, Virginia. The Peach Bottom reactor is of the same design as the Fukushima Daiichi reactors in Japan. In the United States, 35 boiling water reactors are in operation and 23 of these reactors were constructed with the Mark 1 containment system.

According to NRC staff, NRC modeled three scenarios for the Peach Bottom BWR reactor. Under the "long-term station blackout" scenario, the plant is assumed to lose offsite AC power and its backup diesel generators, but the battery backups operate safety systems for about four hours until the batteries are exhausted. Under the "short-term station blackout" scenario, "the site loses all power (even the batteries) and, therefore, all of its safety systems quickly become inoperable in the 'short term.'"[2] Both of these scenarios are supposed to reflect the effects of an extreme external event, such as an earthquake, flood, or fire. The third scenario was the random failure of a vital power cable connection. NRC's modeling showed that the third scenario did not result in core damage because the unaffected safety systems were adequate to keep the core cool.

For each of the two station blackout scenarios, NRC modeled two sub-scenarios: one that assumed the presence and utilization of new equipment and procedures introduced since the September 11 attacks and one that did not account for the new equipment and procedures.

Draft Results of SOARCA

In the more severe "station blackout" scenario in which all power was lost, the operator was able to take mitigation measures to prevent core damage for the first two days after the loss of power. However, under this scenario, the Peach Bottom BWR reactor came within one hour of core damage. NRC staff explained that a simulated meltdown was narrowly averted through the manual turning of steam valves to activate the reactor core isolation cooling system, which does not require AC power and is driven by steam. According to NRC staff, the simulation was structured to end after the two-day period based on the assumption that interventions would only get more numerous and effective after that time.

In the less severe loss of power scenario, in which the plant was assumed to have operational battery backup power for four hours, core damage was prevented. Because modeling showed that it would take the fuel rods ten hours to rupture from overheating, there was adequate time to employ mitigation measures.

Both of these scenarios assumed the Peach Bottom BWR used the new equipment and procedures introduced since the September 11 attacks. Without the new equipment and procedures, both simulated "station blackout" scenarios led to core damage and the release of radioactive contamination within two days. NRC staff explained that the radioactive fuel in the reactor core melts, tears through the reactor vessel, and then ruptures the primary containment

[2] Nuclear Regulatory Commission, SOARCA Process, Step 2 (Nov. 2, 2010) (online at: http://www.nrc.gov/about-nrc/regulatory/research/soar/soarca-accident-progression.html).

drywell if there is no water covering the floor of the drywell. NRC staff noted that most of the radioactive contamination was projected to be contained in the suppression pool and emphasized that the meltdown progressed more slowly than previous calculations from the 1980s would suggest, providing time for nearby residents to evacuate.

Internal NRC emails obtained by the Union of Concerned Scientists indicate that NRC analysts disagreed as to whether the new equipment and procedures (known as B5b measures), which allowed Peach Bottom to narrowly avoid core damage in the complete loss of power scenario, would be effective. According to a memo the Union of Concerned Scientists is releasing today, a July 28, 2010, NRC staff e-mail summarized concerns of NRC senior reactor analysts (SRAs) who work in NRC's regional offices as follows:

> One concern has been that SOARCA credits certain B5b mitigating strategies (such as RCIC operation w/o DC power) that have really not been reviewed to ensure that they will work to mitigate severe accidents. Generally, we have not even seen licensees credit these strategies in their own PRAs [probabilistic risk assessments] but for some reason the NRC decided we should during SOARCA.
>
> My recollection is that RI [Region I] SRAs in particular have been vocal with their concerns on SOARCA for several years, probably because Peach Bottom is one of the SOARCA plants.

This e-mail specifically references concerns about operating the Reactor Core Isolation Cooling (RCIC) system without battery power. According to NRC staff, this is the specific system and mitigation strategy that allowed Peach Bottom to narrowly avert core damage in the simulated full loss-of-power scenario.

The Union of Concerned Scientists memo quotes a second internal NRC e-mail, which refers to the March 2009 reactor security regulation. The e-mail states:

> The application of 10 CFR 50.54(hh) mitigation measures still concerns a number of staff in NRR [the Office of Nuclear Reactor Regulation]. The concern involves the manner in which credit is given to these measures such that success is assumed ... 10 CFR 50.54(hh) mitigation measures are just equipment onsite that can be useful in an emergency when used by knowledgeable operators if post event conditions allow. If little is known about these post event conditions, then assuming success is speculative.

This e-mail indicates that the NRC reactor analysts responsible for ensuring the day-to-day safety of nuclear reactors in the United States were challenging the SOARCA assumption that the presence of new equipment could be equated with the successful use of such equipment in a disaster scenario.

Issues Regarding Scope and Assumptions of the Draft SOARCA Report

NRC staff explained that the first draft of the SOARCA report was completed in mid-2009 and provided to 11 outside scientific and technical experts for external peer review. NRC staff currently is working to address comments from these outside experts, other NRC personnel, and the operators of the Peach Bottom and Surry plants. Before the crisis in Japan, the plan was to release the report for public comment within the next few months and finalize the report in December. According to NRC staff, this schedule will likely slip by several months due to the pressing focus on events in Japan. This delay could provide NRC with the opportunity to further improve the realism of the SOARCA simulations by accounting for important aspects of a major natural disaster.

The Committee does not know all of the facts about what went wrong at the Fukushima Daiichi reactors, but the events in Japan raise a number of questions about the scope and assumptions of NRC's modeling. First, the SOARCA simulations explicitly do not consider the impact of a disaster event on spent fuel pools. At crucial points in the Japanese response effort, radiation from uncovered spent fuel rods at Daiichi has been a significant impediment to such efforts.

Second, NRC terminated the models two days after the simulated loss of power. Events in Japan demonstrate that the question of whether a reactor will melt down and release radioactive contamination into the environment cannot be definitively answered in the first two days. In the United States, reactors have lost power for more than two days. For example, in August 1992, Hurricane Andrew passed directly over the Turkey Point plant and knocked out offsite power for six and a half days.[3] Five onsite diesel generators also were unavailable due to moisture problems.

Third, SOARCA postulates that the "station blackout" scenarios occur as a result of a major earthquake, flood, or fire. But during the briefing with Committee staff, NRC staff indicated that NRC assumed that loss of power is the only damaging result of the natural disaster. It is not clear whether all of the new onsite equipment intended to address security threats after the September 11 attacks would remain functional after a natural disaster of a magnitude large enough to cause a partial or complete loss of power.

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[3] Nuclear Regulatory Commission, Regulatory Effectiveness of Station Blackout Rule at F-2 (Aug. 2003).

------Original Message------
From:
To:
Subject: RE: NRC: Question regarding Fukushima Unit 2
Sent: Apr 5, 2011 8:43 AM

It is our understanding that:
Fukushima Daiichi reactors did have hardened vents.

Congressional Affairs Officer
U. S. Nuclear Regulatory Commission

From: [mailto: @mail.house.gov] Sent: Tuesday, April 05, 2011 8:33 AM To:
Cc: Subject: Re: NRC: Question regarding Fukushima Unit 2

Thanks. One more question - did the fukushima reactors have hardened vents?
Office of Representative Edward J. Markey 2108 Rayburn House Office Building Washington, DC 20515 202-225-2836 ---------- Sent using BlackBerry
From: [mailto: @nrc.gov] Sent: Tuesday, April 05, 2011 08:16 AM To:
Cc: < nrc.gov> Subject: NRC: Question regarding Fukushima Unit 2 You had asked if the core of Unit 2 had melted into the torus. Here is the view from the NRC Emergency Operations Center:

Based on radiation readings in the drywell and the torus (3340 rem/hour and 91 rem/hour, respectively), the NRC staff speculates that part of the Unit 2 core may be out of the reactor pressure vessel and may be in the lower space of the drywell. Lower radiation readings in the torus suggest that there is not core material in the torus.

Please let me know if I can provide additional information,

Congressional Affairs Officer
U. S. Nuclear Regulatory Commission
Office of Congressional Affairs

Office of Representative Edward J. Markey
2108 Rayburn House Office Building
Washington, DC 20515
202-225-2836

Sent using BlackBerry

------Original Message------
From:
To:
Cc:
Subject: RE: NRC: Question regarding Fukushima Unit 2
Sent: Apr 5, 2011 8:47 AM

Part of the Unit 2 core may have melted into the drywell.

Congressional Affairs Officer
U. S. Nuclear Regulatory Commission
Office of Congressional Affairs

From: Sent: Tuesday, April 05, 2011 8:35 AM To: Cc: Subject: Re: NRC: Question regarding Fukushima Unit 2

Also is the view that it melted into the drywell? ffice of Representative Edward J. Markey 2108 Rayburn House Office Building Washington, DC 20515 202-225-2836 -------- ---------- Sent using BlackBerry
From: [mailto: @nrc.gov] Sent: Tuesday, April 05, 2011 08:16 AM To: Cc: < nrc.gov> Subject: NRC: Question regarding Fukushima Unit 2 You had asked if the core of Unit 2 had melted into the torus. Here is the view from the NRC Emergency Operations Center:

Based on radiation readings in the drywell and the torus (3340 rem/hour and 91 rem/hour, respectively), the NRC staff speculates that part of the Unit 2 core may be out of the reactor pressure vessel and may be in the lower space of the drywell. Lower radiation readings in the torus suggest that there is not core material in the torus.

Please let me know if I can provide additional information.

Congressional Affairs Officer
U. S. Nuclear Regulatory Commission
Office of Congressional Affairs

Office of Representative Edward J. Markey
2108 Rayburn House Office Building
Washington, DC 20515
202-225-2836

Sent using BlackBerry

Committee on Energy and Commerce

Subcommittee on Oversight and Investigations

The U.S. Government Response to the Nuclear Power Plant Incident in Japan

April 6, 2011

Exhibits Index

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March 23, 2011

MEMORANDUM TO: R. W. Borchardt
Executive Director for Operations

FROM: Chairman Jaczko **/RA/**

SUBJECT: TASKING MEMORANDUM – COMGBJ-11-0002 – NRC ACTIONS FOLLOWING THE EVENTS IN JAPAN

The staff should 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. The review should address the following near term and then longer term objectives.

Near Term Review

- This task force should evaluate currently available technical and operational information from the events that have occurred at the Fukushima Daiichi nuclear complex in Japan to identify potential or preliminary near term/immediate operational or regulatory issues affecting domestic operating reactors of all designs, including their spent fuel pools, in areas such as protection against earthquake, tsunami, flooding, hurricanes; station blackout and a degraded ability to restore power; severe accident mitigation; emergency preparedness; and combustible gas control.
- The task force should develop recommendations, as appropriate, for potential changes to inspection procedures and licensing review guidance, and recommend whether generic communications, orders, or other regulatory requirements are needed.
- The task force efforts should be informed by some stakeholder input but should be independent of industry efforts.
- The report would be released to the public per normal Commission processes (including its transmission to the Commission as a Notation Vote Paper).

To ensure the Commission is both kept informed of these efforts and called upon to resolve any policy recommendations that surface, the task force should, at a minimum, be prepared to brief the Commission on a 30 day quick look report; on the status of the ongoing near term review at approximately the 60 day point; and then on the 90 day culmination of the near term efforts. Additional specific subject matter briefings and additional voting items that request Commission policy direction may also be added during the Commission's agenda planning meetings.

(EDO) (SECY Suspense: 30, 60, & 90 days)

Longer Term Review

- The task force's longer term review should begin as soon as NRC has sufficient technical information from the events in Japan with the goal of no later than the completion of the 90 day near term report, and the task force should provide updates on the beginning of the longer term review at the 30 and 60 day status updates.
- This effort would include specific information on the sequence of events and the status of equipment during the duration of the event.
- The task force should evaluate all technical and policy issues related to the event to identify potential research, generic issues, changes to the reactor oversight process, rulemakings, and adjustments to the regulatory framework that should be conducted by NRC.
- The task force should evaluate potential interagency issues such as emergency preparedness.
- Applicability of the lessons learned to non-operating reactor and non-reactor facilities should also be explored.
- During the review, the task force should receive input from and interact with all key stakeholders.
- The task force should provide a report with recommendations, as appropriate, to the Commission within six months from the start of the evaluation for Commission policy direction.
- The report would be released to the public per normal Commission processes (including its transmission to the Commission as a Notation Vote Paper).
- Before beginning work on the longer term review, staff should provide the Commission with estimated resource impacts on other regulatory activities.
- The ACRS should review the report as issued in its final form and provide a letter report to the Commission.

(EDO) (SECY Suspense: 9 months, if needed)

cc: Commissioner Svinicki
Commissioner Apostolakis
Commissioner Magwood
Commissioner Ostendorff
OGC
CFO
OCA
OPA
Office Directors, Regions, ACRS, ASLBP (via E-Mail)
PDR

RESPONSE SHEET

TO: Annette Vietti-Cook, Secretary

FROM: COMMISSIONER SVINICKI

SUBJECT: COMGBJ-11-0002 – NRC ACTIONS FOLLOWING THE EVENTS IN JAPAN

Approved XX Disapproved _____ Abstain _____

Not Participating _____

COMMENTS: Below ___ Attached XX None ___

SIGNATURE

03/23/11
DATE

Entered on "STARS" Yes ✓ No ___

Commissioner Svinicki's Comments on COMGBJ-11-0002
NRC Actions Following the Events in Japan

I approve the proposal advanced by the Chairman to establish a senior level task force to review our processes and regulations in light of the recent earthquake and tsunami in Japan. The devastation in Japan constitutes an unprecedented tragedy for that nation. We need to keep in mind, however, that this crisis has not created an emergency in the United States, and the Commission and the staff should adhere to existing protocols.

The staff should conduct their review in ways consistent with the agency's goals of regulatory stability and predictability. To date, agency representatives have consistently communicated that, based on what is known so far, there is no reason to believe that the NRC's current practices, protocols, and regulations are not effective. In addition, the Near Term Review should have a clearly stated objective of confirming the safety of currently operating plants and identifying regulatory gaps that require immediate attention. I have attached to this vote some additional, minor edits. Finally, I support, in their entirety, the edits that Commissioners Apostolakis and Magwood included in their votes on this matter.



Kristine L. Svinicki 03/22/11

COMGBJ-11-0002

March 21, 2011

MEMORANDUM TO: Commissioner Svinicki
Commissioner Apostolakis
Commissioner Magwood
Commissioner Ostendorff

FROM: Chairman Jaczko /RA/

SUBJECT: NRC ACTIONS FOLLOWING THE EVENTS IN JAPAN

The tragic events in Japan have reinforced the importance of this agency's mission and efforts. The NRC's existing licensing and oversight process have provided us with a robust framework for assuring safety at our existing facilities. I also believe that one of our greatest assets as an agency is our ability to analyze and learn from new information. This tragedy requires us to do just that. Therefore, I ask my colleagues to join me in directing the Executive Director for Operations 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. I believe the review must necessarily unfold with near term and then longer term objectives.

Near Term Review

- This task force should evaluate currently available technical and operational information from the events in Japan to identify potential or preliminary near term/immediate operational or regulatory issues affecting domestic operating reactors of all designs in areas such as protection against earthquake, tsunami, flooding, hurricanes; station blackout and a degraded ability to restore power; severe accident mitigation; emergency preparedness; and combustible gas control.
- The task force should develop recommendations, as appropriate, for potential changes to inspection procedures and licensing review guidance, and recommend whether generic communications, orders, or other regulatory requirements are needed.
- The task force efforts should be informed by some stakeholder input but should be independent of industry efforts.
- The report would be released to the public per normal Commission processes.

To ensure the Commission is both kept informed of these efforts and called upon to resolve any policy recommendations that surface, I believe the task force should, at a minimum, be prepared to brief the Commission on a 30 day quick look report; on the status of the ongoing near term review at approximately ~~a~~ the 60 day ~~interval~~ point; and then on the 90 day culmination of the near term efforts. Additional specific subject matter briefings and additional voting items that request Commission policy direction may also be added during the Commission's agenda planning meetings. ~~and thus, the staff should be prepared in advance to adapt to the Commission's requests following those agenda planning sessions in this dynamic environment.~~

Longer Term Review

- The task force's longer term review should begin as soon as NRC has sufficient technical information from the events in Japan with the goal of no later than the completion of the 90 day near term report, and the task force should provide updates on the beginning of the longer term review at the 30 and 60 day status updates.
- This effort would include specific information on the sequence of events and the status of equipment during the duration of the event, to the extent they are known from sources in Japan, who may still be addressing mitigative measures as their highest priority.
- The task force should 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 conducted by NRC.
- The task force should evaluate potential interagency issues such as emergency preparedness.
- Applicability of the lessons learned to non-operating reactor and non-reactor facilities should also be explored.
- During the review, the task force should receive input from and interact with all key stakeholders.
- The task force should provide a report with recommendations, as appropriate, to the Commission within six months from the start of the evaluation for Commission policy direction.
- The report would be released to the public per normal Commission processes.

The proposal described above is intended to provide high-level guidance to a new agency task force. I look forward to reaching Commission consensus on an appropriate approach on this important issue as soon as possible.

SECY, please track.

cc: CFO
EDO
OGC
SECY

RESPONSE SHEET

TO: **Annette Vietti-Cook, Secretary**

FROM: **Commissioner Apostolakis**

SUBJECT: **COMGBJ-11-0002 – NRC ACTIONS FOLLOWING THE EVENTS IN JAPAN**

Approved X **Disapproved** _____ **Abstain** _____

Not Participating _____

COMMENTS: **Below** X **Attached** X **None** ___

I approve COMGBJ-11-0002 subject to the edits by Commissioner Magwood and the attached further edits.

SIGNATURE

3/22/11
DATE

Entered on "STARS" **Yes** X **No** ___

Commissioner Apostolakis' Edits to COMGBJ-11-0002

March 21, 2011

MEMORANDUM TO: Commissioner Svinicki
Commissioner Apostolakis
Commissioner Magwood
Commissioner Ostendorff

FROM: Chairman Jaczko **/RA/**

SUBJECT: NRC ACTIONS FOLLOWING THE EVENTS IN JAPAN

The tragic events in Japan have reinforced the importance of this agency's mission and efforts. The NRC's existing licensing and oversight process have provided us with a robust framework for assuring safety at our existing facilities. I also believe that one of our greatest assets as an agency is our ability to analyze and learn from new information. This tragedy requires us to do just that. Therefore, I ask my colleagues to join me in directing the Executive Director for Operations 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. I believe the review must necessarily unfold with near term and then longer term objectives.

Near Term Review

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- The task force efforts should be informed by some stakeholder input but should be independent of industry efforts.
- The report would be released to the public per normal Commission processes.

To ensure the Commission is both kept informed of these efforts and called upon to resolve any policy recommendations that surface, I believe the task force should, at a minimum, be prepared to brief the Commission on a 30 day quick look report; on the status of the ongoing near term review at approximately a 60 day interval; and then on the 90 day culmination of the near term efforts. Additional specific subject matter briefings and additional voting items that request Commission policy direction may also be added during the Commission's agenda planning meetings and thus, the staff should be prepared in advance to adapt to the Commission's requests following those agenda planning sessions in this dynamic environment.

Longer Term Review

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- The task force should provide a report with recommendations, as appropriate, to the Commission within six months from the start of the evaluation for Commission policy direction.
- The report should be provided to ACRS for review prior to it being submitted to the Commission.
- The report would be released to the public per normal Commission processes.

The proposal described above is intended to provide high-level guidance to a new agency task force. I look forward to reaching Commission consensus on an appropriate approach on this important issue as soon as possible.

SECY, please track.

cc: CFO
EDO
OGC
SECY

RESPONSE SHEET

TO: Annette Vietti-Cook, Secretary

FROM: COMMISSIONER MAGWOOD

SUBJECT: COMGBJ-11-0002 – NRC ACTIONS FOLLOWING THE EVENTS IN JAPAN

Approved X **Disapproved** _____ **Abstain** _____

Not Participating _____

COMMENTS: **Below** ___ **Attached** X **None** ___

I approve COMGBJ-11-0002 as edited in the attached.



SIGNATURE

21 March 2011

DATE

Entered on "STARS" **Yes** Y **No** ___

COMGBJ-11-0002

March 21, 2011

MEMORANDUM TO: Commissioner Svinicki
Commissioner Apostolakis
Commissioner Magwood
Commissioner Ostendorff

FROM: Chairman Jaczko /RA/

SUBJECT: NRC ACTIONS FOLLOWING THE EVENTS IN JAPAN

The tragic events in Japan have reinforced the importance of this agency's mission and efforts. The NRC's existing licensing and oversight process have provided us with a robust framework for assuring safety at our existing facilities. I also believe that one of our greatest assets as an agency is our ability to analyze and learn from new information. This tragedy requires us to do just that. Therefore, I ask my colleagues to join me in directing the Executive Director for Operations 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. I believe the review must necessarily unfold with near term and then longer term objectives.

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- The report would be released to the public ~~per normal~~ subsequent to its approval by the Commission ~~processes~~.

To ensure the Commission is both kept informed of these efforts and called upon to resolve any policy recommendations that surface, I believe the task force should, at a minimum, be prepared to brief the Commission on a 30 day quick look report; on the status of the ongoing near term review at approximately a 60 day interval; and then on the 90 day culmination of the near term efforts. Additional specific subject matter briefings and additional voting items that request Commission policy direction may also be added during the Commission's agenda

planning meetings and thus, the staff should be prepared in advance to adapt to the Commission's requests following those agenda planning sessions in this dynamic environment.

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The proposal described above is intended to provide high-level guidance to a new agency task force. I look forward to reaching Commission consensus on an appropriate approach on this important issue as soon as possible.

SECY, please track.

cc: CFO
EDO
OGC
SECY

RESPONSE SHEET

TO: Annette Vietti-Cook, Secretary

FROM: COMMISSIONER OSTENDORFF

SUBJECT: COMGBJ-11-0002 – NRC ACTIONS FOLLOWING THE EVENTS IN JAPAN

Approved XX **Disapproved** _____ **Abstain** _____

Not Participating _____

COMMENTS: **Below** XX **Attached** ___ **None** ___

I appreciate the efforts of the Chairman and the staff in developing this proposal. As noted during the dialogue with the Executive Director for Operations during today's Commission meeting, I wish to emphasize, though not as an edit to the proposal, that it is important, given the ambitious nature of the proposal, that the task force stay focused on the scope of the review.

SIGNATURE

3/21/2011
DATE

Entered on "STARS" Yes XX No ___

NRC NEWS

U.S. NUCLEAR REGULATORY COMMISSION

Office of Public Affairs Telephone: 301/415-8200
Washington, D.C. 20555-0001
E-mail: opa.resource@nrc.gov Site: www.nrc.gov
Blog: http://public-blog.nrc-gateway.gov

No. 11-049 March 15, 2011

NRC ANALYSIS CONTINUES TO SUPPORT JAPAN'S PROTECTIVE ACTIONS

NRC analysts overnight continued their review of radiation data related to the damaged Japanese nuclear reactors. The analysts continue to conclude the steps recommend by Japanese authorities parallel those the United States would suggest in a similar situation.

The Japanese authorities Monday recommended evacuation to 20 kilometers around the affected reactors and said that persons out to 30 kilometers should shelter in place.

Those recommendations parallel the protective actions the United States would suggest should dose limits reach 1 rem to the entire body and 5 rem for the thyroid, an organ particularly susceptible to radiation uptake. The currently reported Japanese radiation measurements are well below these guidelines.

A rem is a measure of radiation dose. The average American is exposed to approximately 620 millirems, or 0.62 rem, of radiation each year from natural and manmade sources.

###

News releases are available through a free *listserv* subscription at the following Web address: http://www.nrc.gov/public-involve/listserver.html. The NRC homepage at www.nrc.gov also offers a SUBSCRIBE link. E-mail notifications are sent to subscribers when news releases are posted to NRC's website.

NRC NEWS

U.S. NUCLEAR REGULATORY COMMISSION

Office of Public Affairs Telephone: 301/415-8200
Washington, D.C. 20555-0001
E-mail: opa.resource@nrc.gov Site: www.nrc.gov
Blog: http://public-blog.nrc-gateway.gov

No. 11-050 March 16, 2011

NRC PROVIDES PROTECTIVE ACTION RECOMMENDATIONS BASED ON U.S. GUIDELINES

Under the guidelines for public safety that would be used in the United States under similar circumstances, the NRC believes it is appropriate for U.S. residents within 50 miles of the Fukushima reactors to evacuate.

Among other things, in the United States protective actions recommendations are implemented when projected doses could exceed 1 rem to the body or 5 rem to the thyroid. A rem is a measure of radiation dose. The average American is exposed to approximately 620 millirems, or 0.62 rem, of radiation each year from natural and manmade sources.

In making protective action recommendations, the NRC takes into account a variety of factors that include weather, wind direction and speed, and the status of the problem at the reactors.

Attached are the results of two sets of computer calculations used to support the NRC recommendations.

In response to nuclear emergencies, the NRC works with other U.S. agencies to monitor radioactive releases and predict their path. All the available information continues to indicate Hawaii, Alaska, the U.S. Territories and the U.S. West Coast are not expected to experience any harmful levels of radioactivity.

###

News releases are available through a free *listserv* subscription at the following Web address: http://www.nrc.gov/public-involve/listserver.html. The NRC homepage at www.nrc.gov also offers a SUBSCRIBE link. E-mail notifications are sent to subscribers when news releases are posted to NRC's website.

15 March 2010 02:51am (EDT), NRC Operations Center, Protective Measures Team

This data is based on system condition estimates for a hypothetical, single reactor site, 2350 MWt, Boiling Water Reactor. Model results are projections only and may **not** be representative of an actual release. This projection uses modeled forecast meteorological conditions and is subject to change.

Maximum Dose Values (rem) - Close-In

Dist from release miles (kilometers)	0.5 (0.8)	1. (1.61)	1.5 (2.41)	2. (3.22)	3. (4.83)	5. (8.05)	7. (11.27)	10. (16.09)
Total EDE	5.4E+03	2.0E+03	1.2E+03	8.2E+02	4.8E+02	2.4E+02	1.6E+02	9.5E+01
Thyroid CDE	2.8E+04	1.1E+04	6.2E+03	4.3E+03	2.5E+03	1.3E+03	8.4E+02	5.1E+02
Inhalation CEDE	3.7E+03	1.4E+03	8.0E+02	5.6E+02	3.3E+02	1.7E+02	1.1E+02	6.7E+01
Cloudshine	1.9E+01	9.3E+00	5.8E+00	4.1E+00	2.5E+00	1.4E+00	9.7E-01	6.2E-01
4-day Groundshine	1.7E+03	6.5E+02	3.8E+02	2.6E+02	1.5E+02	7.3E+01	4.6E+01	2.8E+01
Inter Phase 1st Yr	2.4E+04	9.4E+03	5.4E+03	3.8E+03	2.2E+03	1.1E+03	6.6E+02	3.9E+02
Inter Phase 2nd Yr	1.1E+04	4.4E+03	2.6E+03	1.8E+03	1.0E+03	4.9E+02	3.1E+02	1.8E+02

Notes:
- Doses exceeding PAGs are underlined.
- Early-Phase PAGs: TEDE - 1 rem, Thyroid (iodine) CDE - 5 rem
- Intermediate-Phase EPA PAGs: 1st year - 2 rem, 2nd year - 0.5 rem
- *** indicates values less than 1 mrem
- To view all values - use Detailed Results | Numeric Table
- Total EDE = Inhalation CEDE + Cloudshine + 4-Day Groundshine

Maximum Dose Values (rem) - To 50 mi

Dist from release miles (kilometers)	15 (24.1)	20 (32.2)	30 (48.3)	40 (64.4)	50 (80.5)
Total EDE	8.6E+01	6.3E+01	3.7E+01	1.8E+01	8.1E+00
Thyroid CDE	3.3E+02	2.7E+02	1.3E+02	5.9E+01	2.3E+01
Inhalation CEDE	3.9E+01	3.1E+01	1.3E+01	4.4E+00	1.3E+00
Cloudshine	4.5E-01	3.8E-01	1.7E-01	7.4E-02	2.7E-02
4-day Groundshine	4.7E+01	3.2E+01	2.4E+01	1.3E+01	6.7E+00
Inter Phase 1st Yr	7.2E+02	4.8E+02	3.8E+02	2.2E+02	1.3E+02
Inter Phase 2nd Yr	3.4E+02	2.3E+02	1.8E+02	1.1E+02	6.9E+01

Notes:
- Doses exceeding PAGs are underlined.
- Early-Phase PAGs: TEDE - 1 rem, Thyroid (iodine) CDE - 5 rem
- Intermediate-Phase PAGs: 1st year - 2 rem, 2nd year - 0.5 rem
- *** indicates values less than 1 mrem
- To view all values - use Detailed Results | Numeric Table
- Total EDE = CEDE Inhalation + Cloudshine + 4-Day Groundshine
- Total Acute Bone = Bone Inhalation + Cloudshine + Period Groundshine

16 March 2010 12:24pm (EDT), NRC Operations Center, Protective Measures Team

This data is based on system condition estimates for a hypothetical, four reactor site. Model results are projections only and may **not** be representative of an actual release. This projection uses modeled forecast meteorological conditions and is subject to change.

Maximum Dose Values (rem) - Close-In

Dist from release miles (kilometers)	0.5 (0.8)	1. (1.61)	1.5 (2.41)	2. (3.22)	3. (4.83)	5. (8.05)	7. (11.27)	10. (16.09)
Total EDE	5.4E+03	1.5E+03	6.7E+02	3.9E+02	1.8E+02	7.5E+01	4.0E+01	1.4E+01
Thyroid CDE	2.9E+04	7.9E+03	3.6E+03	2.1E+03	9.6E+02	4.0E+02	2.1E+02	7.5E+01
Inhalation CEDE	3.8E+03	1.0E+03	4.8E+02	2.8E+02	1.3E+02	5.4E+01	2.9E+01	1.0E+01
Cloudshine	2.2E+01	8.0E+00	3.9E+00	2.3E+00	8.0E-01	2.6E-01	2.1E-01	1.1E-01
4-day Groundshine	1.5E+03	4.1E+02	1.9E+02	1.1E+02	5.0E+01	2.1E+01	1.1E+01	4.3E+00
Inter Phase 1st Yr	2.6E+04	7.0E+03	3.2E+03	1.9E+03	8.5E+02	3.6E+02	1.9E+02	7.5E+01
Inter Phase 2nd Yr	1.3E+04	3.5E+03	1.6E+03	9.2E+02	4.2E+02	1.8E+02	9.5E+01	3.8E+01

Notes:
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4-day Groundshine	4.1E+00	3.4E+00	2.8E+00	2.6E+00	2.5E+00
Inter Phase 1st Yr	7.1E+01	6.0E+01	4.7E+01	4.5E+01	4.3E+01
Inter Phase 2nd Yr	3.6E+01	3.0E+01	2.3E+01	2.2E+01	2.1E+01

Notes:
- Doses exceeding PAGs are underlined.
- Early-Phase PAGs: TEDE - 1 rem, Thyroid (iodine) CDE - 5 rem
- Intermediate-Phase PAGs: 1st year - 2 rem, 2nd year - 0.5 rem
- *** indicates values less than 1 mrem
- To view all values - use Detailed Results | Numeric Table
- Total EDE = CEDE Inhalation + Cloudshine + 4-Day Groundshine
- Total Acute Bone = Bone Inhalation + Cloudshine + Period Groundshine

T EDE - Total Effective Dose Equivalent
CDE - Committed Dose Equivalent
CEDE - Committed Effective Dose Equivalent
PAGs – Protective Action Guidelines
EPA – Environmental Protection Agency

U.S. DEPARTMENT OF ENERGY

NNSA

Radiological Assessment
March 22, 2011

U.S. DEPARTMENT OF ENERGY

AMS Summary

NNSA

- Ops Summary
  - Aerial Measurement Systems totaled more than 40 hours of flying
- Plot interpretation
  - AMS data is presented as exposure rate 1 meter from the ground at the time the measurements occurred.

U.S. DEPARTMENT OF ENERGY

Guide to Interpretation

NNSA

- US radiological assessments are composed of aerial and ground measurements and indicate the amounts of radiological material that has settled on the ground.

- Each measurement corresponds to the radiation a person receives in one hour at that location.

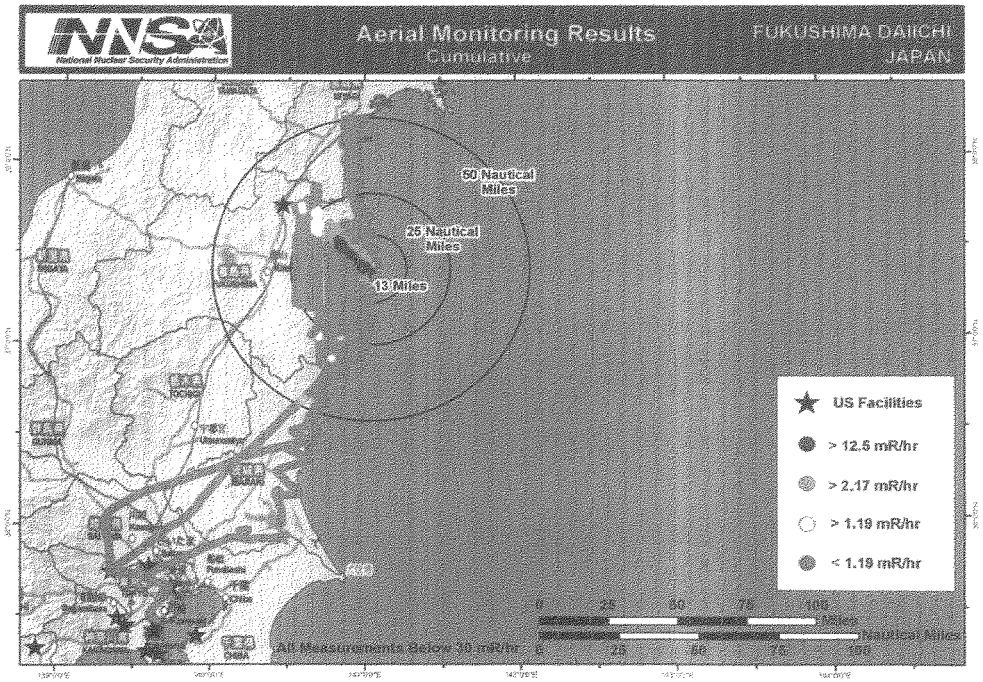
- These calculations account for multiple variables. For instance, radiation is most intense in the first days following its release. Therefore, dose reduction may be achieved by evacuating early in the response.

- All measurements in this plot are below 0.03 Rem per hour – a low level. And nearly all elevated readings are within 25 miles of Fukushima Daiichi.

- Measurements also show an area of greater radiation extending northwest from the accident. This area may be of interest to public safety officials and responders.

U.S. DEPARTMENT OF ENERGY

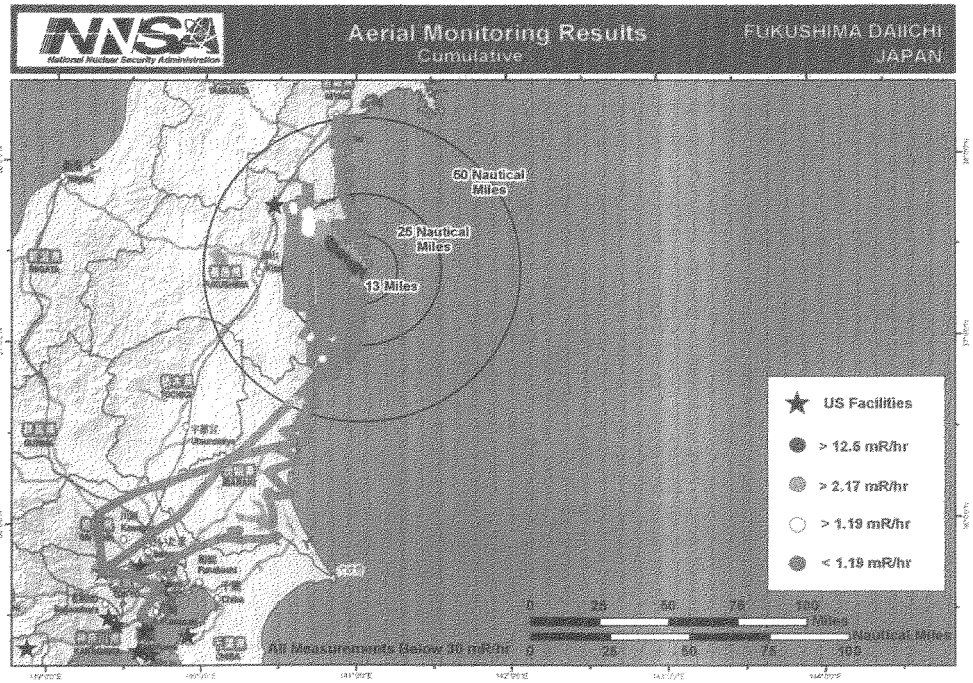
NNSA



Map created on 03222011 0245 JST

U.S. DEPARTMENT OF ENERGY

NNSA



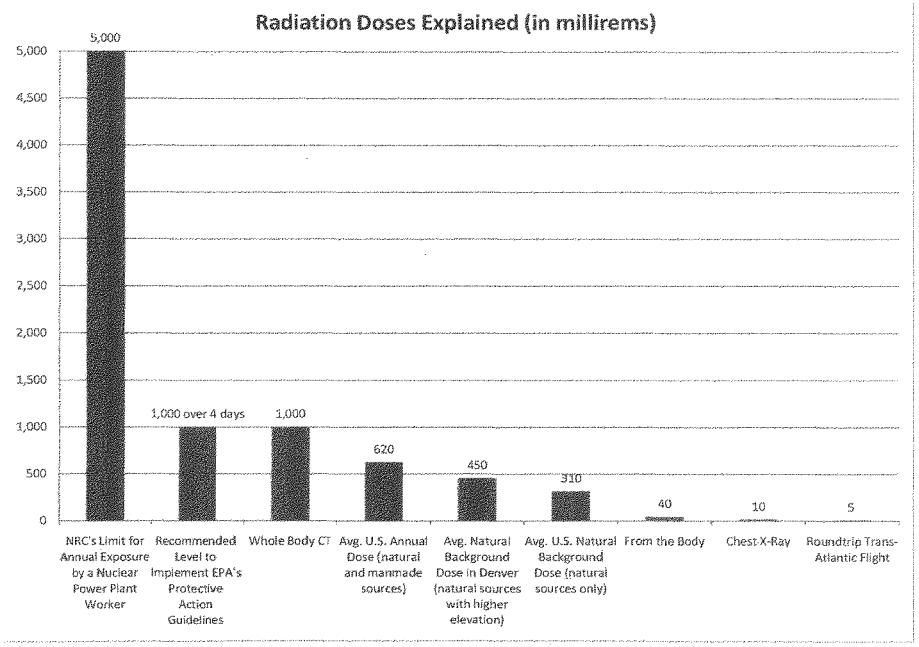
U.S. DEPARTMENT OF ENERGY

NNSA

Context

- The Nuclear Regulatory Commission estimates that the average American absorbs 620 mRem a year* (or 0.071 mRem/hour)
- An average transatlantic flight produces an exposure of 2.5 mRem*
- A typical chest x-ray produces 10 mRem per image
- EPA guidelines call for public health actions if exposure exceed 1000 mRem over 4 days

* Source: NRC: http://nrc.gov/images/about-nrc/radiation/factoid2-lrg.gif


Radiation Doses Explained (in millirems)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
5,000
1,000 over 4 days
1,000
620
450
310
40
10
5
NRC's Limit for Annual Exposure by a Nuclear Power Plant Worker
Recommended Level to Implement EPA's Protective Action Guidelines
Whole Body CT
Avg. U.S. Annual Dose (natural and manmade sources)
Avg. Natural Background Dose in Denver (natural sources with higher elevation)
Avg. U.S. Natural Background Dose (natural sources only)
From the Body
Chest X-Ray
Roundtrip Trans-Atlantic Flight

U.S. DEPARTMENT OF ENERGY

NNSA

Radiological Assessment
March 29, 2011

U.S. DEPARTMENT OF ENERGY

AMS Summary

NNSA

- Ops Summary
  - Aerial Measuring Systems totaled more than 130 hours of flying
    - Flight operations were curtailed on March 20-22 and March 25 due to weather
    - Flight operations conducted March 27 and 28 focused on areas outside of a 25 mile radius from the incident site
  - NNSA's Consequence Management Response Teams have collected thousands of ground measurements provided by DOE, DoD and the Japanese monitoring teams

U.S. DEPARTMENT OF ENERGY

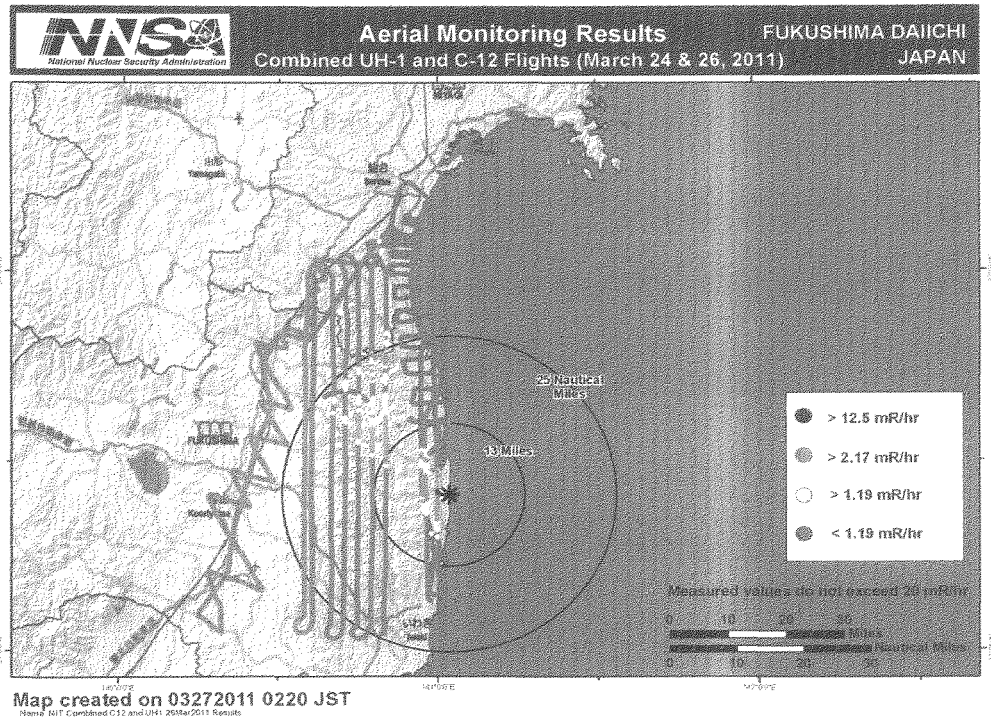
NNSA

Guide to Interpretation

- US radiological assessments are composed of aerial and ground measurements and indicate the amounts of radiological material that has settled on the ground.
- Each measurement corresponds to the radiation a person receives in one hour at that location. AMS data is presented as exposure rate 1 meter from the ground at the time the measurements occurred.
- All measurements in this plot are below 0.03 Rem per hour – a low but not insignificant level.

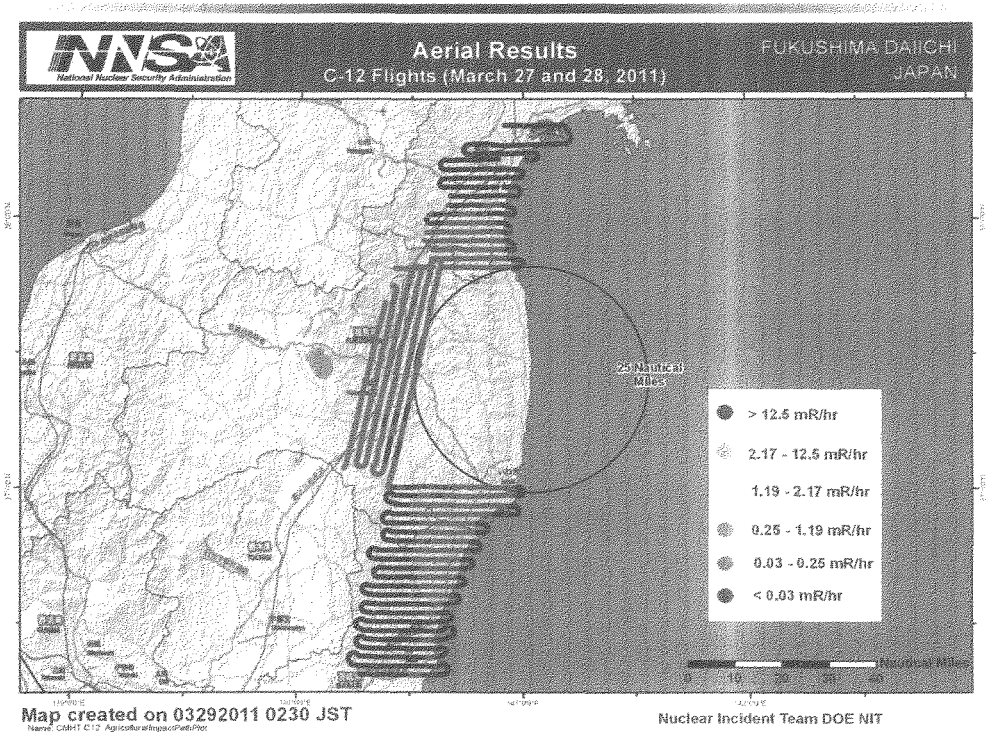
U.S. DEPARTMENT OF ENERGY

NNSA



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NNSA

Assessment

Assessment:

- The dose rates measured by AMS have decreased since last week. This is expected due to radioactive decay of the material deposited on the ground

- AMS monitoring results in areas beyond 25 miles from the Fukushima Daiichi reactors show areas where dose rates are many times higher than historical background.
  - The measured external dose rates in these areas are not high enough to warrant evacuation or relocation of the population, however, lower levels of radioactive contamination in food provide more of a risk because the radioactive material can be ingested into the body. Agricultural monitoring in these areas may be warranted.

- Radiological material has not deposited in significant quantities in the areas measured since March 19.

U.S. DEPARTMENT OF ENERGY

NNSA

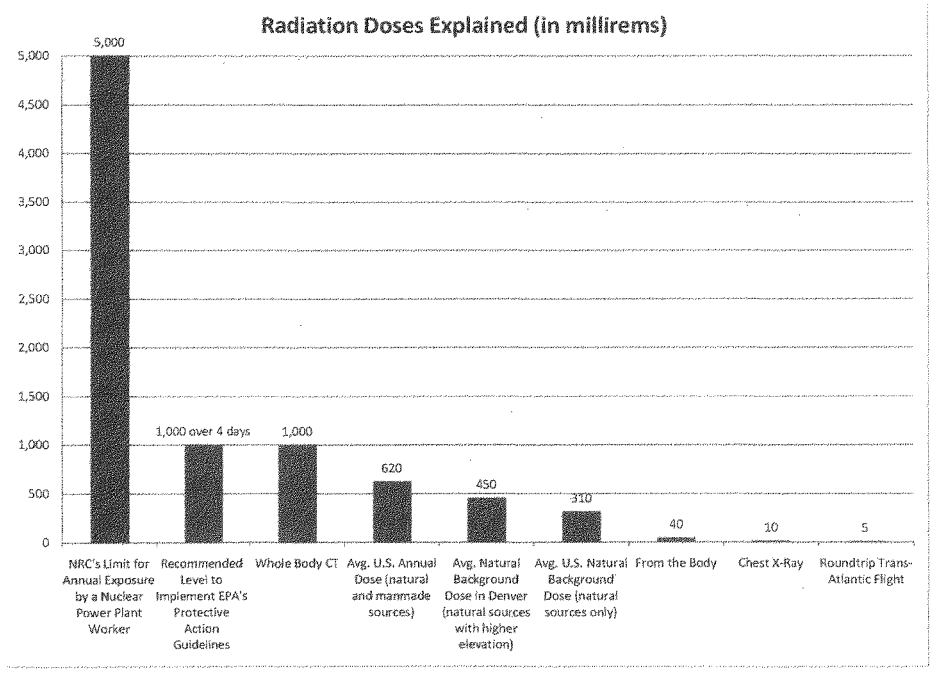
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* Source: NRC: http://nrc.gov/images/about-nrc/radiation/factoid2-lrg.gif

U.S. DEPARTMENT OF ENERGY

NNSA



U.S. DEPARTMENT OF ENERGY

NNSA

Radiological Assessment
April 4, 2011

U.S. DEPARTMENT OF ENERGY

AMS Summary

NNSA

- Ops Summary
  - Aerial Measuring Systems have totaled more than 221 flight hours in support of aerial monitoring operations
  - NNSA's Consequence Management Response Teams have collected thousands of ground measurements provided by DOE, DoD and the Japanese monitoring teams

U.S. DEPARTMENT OF ENERGY

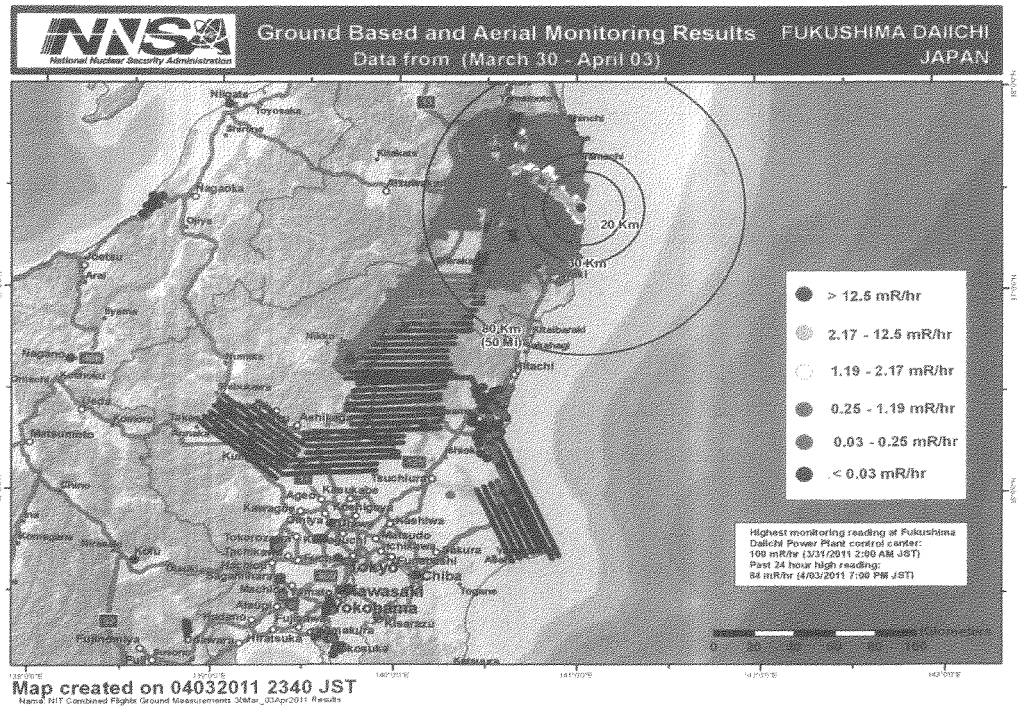
Guide to Interpretation

NNSA

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- All measurements in this plot are below 0.03 Rem per hour – a low but not insignificant level.

U.S. DEPARTMENT OF ENERGY

NNSA



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NNSA

Assessment

- An assessment of measurements gathered through April 3 continues to show:
  - Radiation levels consistently below actionable levels for evacuation or relocation outside of 25 miles
  - Radiological material has not deposited in significant quantities since March 19
- An assessment of measurements gathered at US military installations in the Tokyo area through April 3 shows:
  - Radiation levels far below actionable levels for evacuation or relocation
  - All aerial measurements at US facilities were less than 32 microrem/hr - a level that poses no known health risk
  - Monitoring of these locations will continue although no increases in deposited radiation are anticipated

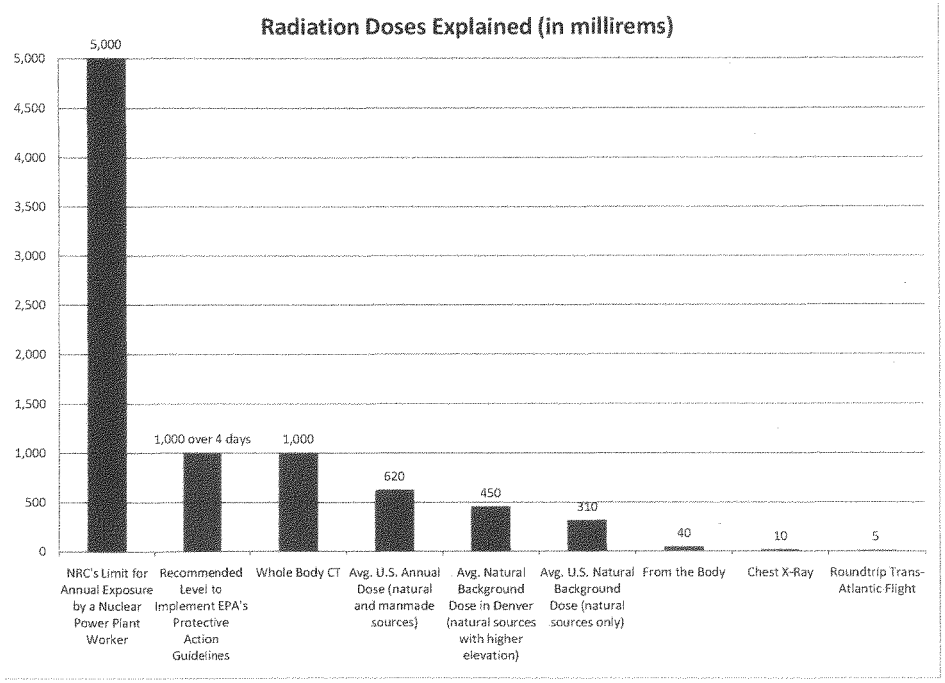
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NNSA

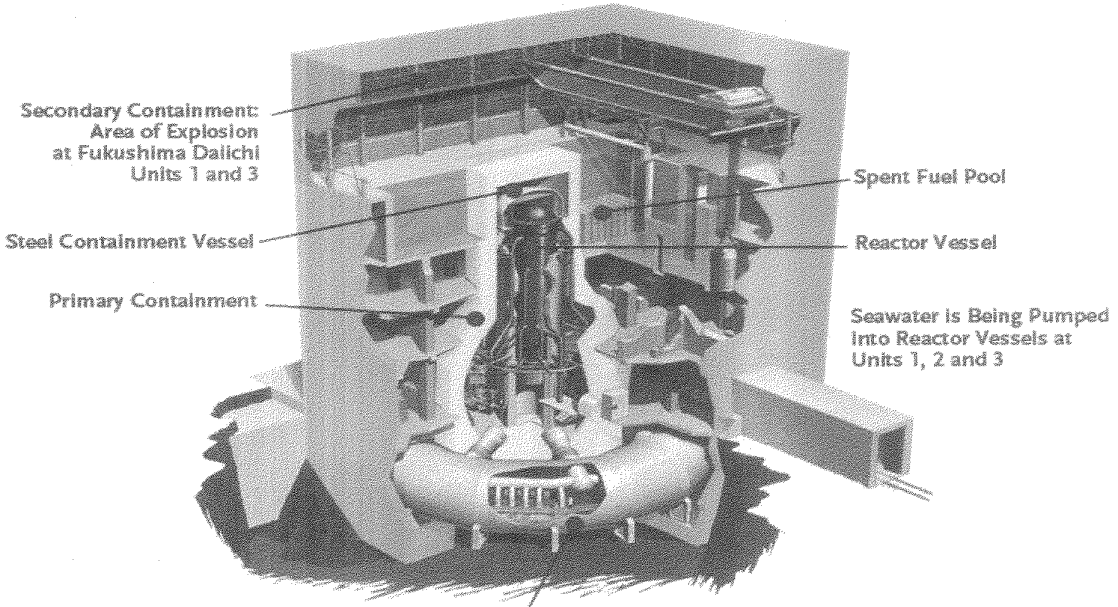
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From the Body
Chest X-Ray
Roundtrip Trans-Atlantic Flight

Boiling Water Reactor Design at Fukushima Daiichi



Updated 3/23/2011