UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

July 29, 2011

MEMORANDUM TO: Said Abdel-Khalik, Chairman
Advisory Committee on Reactor Safeguards
Fukushima Subcommittee

FROM: Antonio Dias, Technical Advisor RA
Office of the Advisory Committee on Reactor Safeguards

SUBJECT: WORKING COPY OF THE MINUTES OF THE MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS FUKUSHIMA SUBCOMMITTEE ON THE EVENTS AT THE FUKUSHIMA SITE, ON MAY 26, 2011, IN ROCKVILLE, MARYLAND

A working copy of the minutes of the subject meeting is attached for your review. Please send me any comments and changes for incorporation. If you are satisfied with the minutes, please sign, date, and return the attached certification letter.

Attachments:

1. Certification Letter
2. Minutes (Working Copy)

cc: C. Santos
E. Hackett

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

MEMORANDUM TO: Antonio Dias, Technical Advisor
Office of the Advisory Committee on Reactor Safeguards

FROM: Said Abdel-Khalik, Chairman
Advisory Committee on Reactor Safeguards
Fukushima Subcommittee

SUBJECT: CERTIFICATION OF THE MINUTES OF THE MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS FUKUSHIMA SUBCOMMITTEE ON THE EVENTS AT THE FUKUSHIMA SITE, ON MAY 26, 2011

I hereby certify, to the best of my knowledge and belief, that the minutes of the subject meeting held on May 26, 2011, are an accurate record of the proceedings for that meeting.

RA 07/29/2011

Said Abdel-Khalik, Chairman Date
Advisory Committee on Reactor Safeguards
Fukushima Subcommittee

Certified on: July 29, 2011
Certified by: Said Abdel-Khalik

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MINUTES OF THE (ACRS) FUKUSHIMA SUBCOMMITTEE MEETING
MAY 26, 2011
Rockville, MD

The ACRS Fukushima Subcommittee held a meeting on May 26, 2011 in Room T2B1, 11545 Rockville Pike, Rockville, Maryland. The meeting convened at 1:00 p.m. and adjourned at 4:28 p.m. The entire meeting was open to the public. Dr. Edwin Hackett was the Designated Federal Official for the meeting.

ATTENDEES

ACRS Members/Consultants
Said Abdel-Khalik, Chairman
John Stetkar, Member
J. Sam Armijo, Member
Sanjoy Banerjee, Member
Dennis Bley, Member
Charles Brown, Member
Michael Corradini, Member
Dana Powers, Member
Harold Ray, Member
Joy Rempe, Member
Michael Ryan, Member
William Shack, Member
John Sieber, Member
Thomas Kress, Consultant

E. Hackett, ACRS staff - Designated Federal Official

NRC Staff
Colin Beck, NSIR
Tim Collins, NRR
Arthur Kevin Heller, DRR/DSS/SNPB
Michael Salay, RES
Nathan Sanfilippo, OEDO
Elizabeth Stuckle, OPA
Anthony Ulses, NRR
Rachel Vaucher, NRR
Jenny Weil, OCA

Other Attendees
Mark Blackburn, DOE
Patricia Campbell, GEH
David Fischer, AdSTEM
Vic Fregonese, AREVA
Jairus Greene, Mitsubishi
Kevin Kamps, Beyond Nuclear/Don't Waste Michigan
John Kelly, DOE
Alan Levin, AREVA

Mike Meiton, Westinghouse
Vijay Nilekani, NEI
Hannah Northey, Greenwire
Esther Park, Morgan Lewis
Tony Pietrangelo, NEI
James Ross, GEH
Walter Schumitsch, GEH

SUMMARY OF MEETING

The purpose of the meeting was to review and discuss the events at the Fukushima site in Japan. The briefing was provided by representatives from the Nuclear Energy Institute (NEI) and the Department of Energy (DOE). The meeting transcripts are attached and contain an accurate description of each matter discussed during the meeting. The presentation slides and handouts used during the meeting are attached to these transcripts. No slides or handouts were provided by NEI.

Mr. Arnold Gundersen of Fairewinds Associates Inc., Mr. Kevin Kamps of Beyond Nuclear, and Mr. Bob Leyse made oral statements following the presentations by NEI and DOE. Mr. Donivan Porterfield and Mr. Arnold Gundersen submitted written comments, which are attached to the end of the meeting transcripts.

SIGNIFICANT ISSUES/TOPICS DISCUSSED	Reference Pages in Transcript
Members Powers, Armijo, Sieber, Ryan, and Abdel-Khalik indicate questions they'd like to have answered by NEI.	6-8
NEI's analysis of the BP rig explosion last year and application of lessons-learned to the nuclear industry.	9
Lesson learned from Fukushima: multi-unit events do take place. B5B measurements, instead, were meant for single unit response. Why harden some of the required portable equipment? Why allocate everything to the same site? Beginning to consider regional offsite response strategies: equipment available in timely manner but not subjected to natural phenomena or terrorist attack aimed at the plant. Responsibility for controlling/delivering response equipment not yet determined. Probably public/private partnership. Regional compacts, already in place along the Atlantic corridor, provide operation supporting equipment.	13-17
Station blackout implementation in the US. Previous history. Very reliable diesel generators due to surveillance & maintenance procedures. Induced station blackout during fires. How other plants responded to the Vogtle event. Extending coping time by redirecting resources, including the ones allocated for B5B events: need for regulatory oversight and guidance. Looking forward to interactions with NRC after 90-day short-term report.	18-26

Strategic goals for the industry: 1. Improve nuclear safety by learning and applying the lessons from Fukushima. 2. Ensure U.S nuclear industry is capable of responding effectively to any significant event. 3. Integrate effectively B5B strategies with external event responses, including accounting for multi-unit events. 4. Establish protection margins based on last hazard analyses and historical data. 5. Insure spent fuel pool cooling and makeup functions are continuously adequate. 6. Insure primary containment protective strategies can effectively manage and mitigate post-accident conditions	32-44
Guiding principles established for the industry: 1. Ensure equipment and guidance improve response effectiveness. 2. Address guidance, equipment, and training to assure long-term viability of safety improvements. 3. Insure response strategies are performance based, risk-informed, and account for unique site characteristics. 4. Coordinate with federal, state, local governments and their emergency response organizations on industry actions to improve overall emergency response effectiveness. 5. Communicate aggressively their actions post Fukushima.	45-46
Addressing initial question from Member Powers: Has the industry identified or is trying to identify weakness in design, procedures and capabilities revealed by Fukushima that might be in our plants? Answer: No fatal flaws have been seen yet but there are areas for enhancement. One weakness so far: need for multi-unit strategy.	48
Addressing initial question from Member Ryan: Any comments on the information gaps between worker exposure and public dose? Answer: NEI does not have much to add here. Referral to presentation by Dr. John Boyse two weeks ago to the House Science and Technology Committee.	48
Comment from Member Brown: Need for reliable monitoring data. Based on recent reports, some instrumentation did not work properly in Fukushima (e.g., level of spent fuel pool). Should instrumentation be hardened? Need for reliable instrumentation and not trying to out-guess Mother Nature. Equipment flexibility is also important. Lack of power at Fukushima was a key issue.	50-55

Addressing initial question from members Armijo and Sieber: Accuracy and timeliness of information sources. Answer: no special source in the beginning. IAEA is now trying to put a timeline together and a set of facts that we all can agree on. Not sure if spent fuel pool, especially in Unit 4, dried out quickly as initially indicated. Tried to calculate dry out time but not sure about starting conditions. Will rely on IAEA team to get correct answers.	56-60
Addressing initial question from Member Abdel-Khalik: Any comments on the effectiveness of recent requests to licensees (NRC Bulletin 2011-01, INPO IERs, and Temporary Instruction)? Are we asking licensees to do same thing several times? Answer: Walkdowns were self initiated, Temporary Instruction come out later providing opportunity to analyze what had been found in walkdowns. Bulletin makes sure things are fixed in the allocated time. NEI working on a template for frequency of testing and training.	61-62
Question from Member Sieber: Is industry looking at design issues that may require current plants to be modified? Some things didn't work in Fukushima. Answer: Corrective actions should be enough.	64-66
Question from Member Sieber: What alternative policy to deal with spent fuel in the pools? Answer: Not an urgent issue today but steps must be taken towards national policy.	66-67
Comments from Members Powers and Rempe: Importance of well thought cleanup process; otherwise very important information may be lost. It happened at TMI.	70-75 141- 143
DOE's position right now is to learn a lot more about what and why it happened. This will lay down the foundation base of understanding. Lessons learned will come from that.	77
Still uncertain of how much damage done by earthquake itself at Fukushima site. Units 5 & 6 did not meltdown and will be inspected to identify results from quake. Pretty sure grid lines were knocked off by quake, leading to loss of offsite power. Flood knocked out diesel generators (switchgears and electric pumps) leading to loss of offsite power without heat sink as well. Unit 1 was cooling too rapidly, even though isolation condenser was off. Speculation of damage to plant prior to flood. Daini site barely survived the flood because of higher elevation and one offsite power line still remained.	77-86
Summary of activities and interactions among different US agencies. INPO was coordinating point for all US activities. DOE responsible for airborne radiation monitoring system maintained by NNSA for various nuclear disasters in the U.S. NARAC group from Lawrence Livermore responsible for plume modeling. Flyovers and soil samples taken to confirm code predictions. NRC provided them with source term.	87-93

DOE plans to publicly release all their supporting calculations. Need to resolve proprietary issues with TEPCO. Also, DOE does not want to prejudice results from current investigation by the Japanese.	103
Cooling of the reactor. No other solution: currently a feed-and-bleed approach being used. Lack of instrumentation makes it harder to control. Bleed coming through the head seals. No venting through drywell head vents. RHR pumps are probably inoperative. Oak Ridge's study indicates very small time for pumps to fail due to salt content in water. Feed is being throttled so bleed is just steam. Argonne's study indicates close to one year for bleed-feed to stop at unit 1, longer for other units. TEPCO thinking of adding heat exchangers. Using water to cool the drywell would speed up process but probably impossible due to shield plugs and inoperable cranes. Vessel may be leaking. No instrumentation to indicate water level. Investigating drilling technology to drill through concrete structure and not drill through the drywell to inject water. Immense engineering challenges. No option yet chosen.	103-109
Unit 4 spent fuel pool. Not sure what exactly happened. No one heard it. Original theory of a hydrogen explosion doesn't fit. Low levels of radiation and fission product assays both indicate presence of water. Zirconium fire would last for days. Calculations indicated 10 days to boil. Was slosh bigger than assumed 1 meter? Japanese thermal mapping indicated pool at 80°C, not near saturation. One theory: flammable materials due to outage activities. Other theory (now believed as most probable): hydrogen transferred from Unit 3.	109-116 136-139
Effect of salt within vessel upon mitigating efforts. Based on Hanford experience, separating out the radioactive material (especially Cesium) will not be a problem. Current goal: get water out of turbine building so that radiation levels go down, treat/clean the water so that it can still be used for cooling the reactor. Also looked at processes for removing/treating reactor vessel water. A533B steel was used for pressure vessel. Very little data on this class of steel for concentrated salt solution. In September 1972, Millstone experienced salt in the reactor resulting in severe stress corrosion. The same is expected for Fukushima but not certain at what rate and scale. Studies being performed by DOE. Salt water concentration estimated at 0.5 molar which amounts to 100-200 tons of salt.	117-127
Comments from Member Powers: TMI experience shows lots of prompt steps taken that had to be reversed subsequently. BWRs in US midlands not susceptible to quakes and tsunamis at same time. ACRS can help define what needs to be done and when. FSARs in Japan are different from US, we should look at that. Also, many Japanese reactors survived the quake. Lots of lessons to be learned from that.	158 -160

Action Items	
Action Item	**Reference Pages in Transcript**
NEI will share industry action plans of post Fukushima goals and outcomes with the ACRS when they become available	35, 47

Documents provided to the Subcommittee

1) U.S. Department of Energy, "DOE Response to Fukushima Dai-ichi Accident," Dr. John E. Kelly, Deputy Assistant Secretary for Nuclear Reactor Technologies, Office of Nuclear Energy, May 26, 2011.

Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title:	Advisory Committee on Reactor Safeguards Subcommittee on Fukushima
Docket Number:	(n/a)
Location:	Rockville, Maryland
Date:	Thursday, May 26, 2011

Work Order No.: NRC-905 Pages 1-164

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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, as reported herein, is a record of the discussions recorded at the meeting.

This transcript has not been reviewed, corrected, and edited, and it may contain inaccuracies.

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

SUBCOMMITTEE ON FUKUSHIMA

+ + + + +

THURSDAY

MAY 26, 2011

+ + + + +

ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 1:00 p.m., Said Abdel-Khalik, Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

SAID ABDEL-KHALIK, Chairman

JOHN W. STETKAR, Member-at-Large

J. SAM ARMIJO, Member

SANJOY BANERJEE, Member

DENNIS C. BLEY, Member

CHARLES H. BROWN, Member

MICHAEL L. CORRADINI, Member

DANA A. POWERS, Member

HAROLD B. RAY, Member

JOY REMPE, Member

MICHAEL T. RYAN, Member

WILLIAM J. SHACK, Member

JOHN D. SIEBER, Member

ACRS CONSULTANTS PRESENT:

THOMAS S. KRESS

NRC STAFF PRESENT:

EDWIN HACKETT, ACRS Executive Director, Designated Federal Official

ALSO PRESENT:

KEVIN CAMPS, Beyond Nuclear/Don't Waste Michigan

ARNOLD GUNDERSEN*

JOHN E. KELLY, Deputy Assistant Secretary for Nuclear Reactor Technologies, Office of Nuclear Energy, U.S. Department of Energy

ROBERT LEYSE*

TONY PIETRANGELO, Nuclear Energy Institute

JIM WARREN*

*Participating via telephone

A G E N D A

P R O C E E D I N G S

(1:03:34 p.m.)

CHAIR ABDEL-KHALIK: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Fukushima. I'm Said Abdel-Khalik, Chairman of the Subcommittee.

ACRS Members in attendance are Sieber, Banerjee, Ray, Powers, Armijo, Stetkar, Ryan, Shack, Brown, and Corradini. Our consultant, Tom Kress, is also present. Dr. Edwin Hackett, Executive Director of ACRS is the Designated Federal Official for this meeting.

The Subcommittee will review information regarding the events of the Fukushima site in Japan. We will hear presentations from representatives of the Nuclear Energy Institute, and the U.S. Department of Energy.

We have received written comments from Mr. Donivan Porterfield of Los Alamos, New Mexico regarding today's meeting. Copies of his comments have been provided to the members and consultant.

We have also received a request from Mr. Arnold Gundersen to provide oral comments. Mr. Gundersen will be given time to provide his comments following the scheduled presentations. The entire meeting will be open to the public.

The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate for deliberations by the full Committee.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register. There is a phone bridge line for members of the public. To preclude interruption of the meeting, the phone will be placed in a listen-only mode during the presentations and Committee discussions.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice. Therefore, we request that participants in this meeting use the microphones located throughout the meeting room when addressing the Subcommittee.

The participants should first identify themselves and speak with sufficient clarity and volume so that they can be readily heard. I see we have been joined by Dr. Rempe, also.

We will now proceed with the meeting, and I call upon Mr. Pietrangelo, Senior Vice President and

Chief Nuclear Officer for the Nuclear Energy Institute to begin. Tony.

MR. PIETRANGELO: Well, thanks for the opportunity to chat with you today. I do not have a formal presentation, and I'd much rather keep this as a dialogue with the Committee Members. I'm as interested in your insights into Fukushima as the NRC's and anyone else's because, quite frankly, we still do not have a lot of data yet about what transpired on March 11th and since then.

So, before I get into what we're doing as an industry, I'd just ask is there anything in particular that the Committee is interested in hearing about from an industry perspective on Fukushima, and then I can direct my remarks towards that.

MEMBER POWERS: Well, it seems to me the thing the Committee would be most interested in is whether the industry has identified or has processes in place to identify weaknesses in design, procedures, capabilities revealed by Fukushima that might be present in our plants.

MR. PIETRANGELO: Okay.

MEMBER ARMIJO: I have a general question.

MR. PIETRANGELO: Sure.

MEMBER ARMIJO: The extent to which the

NEI or the industry has effective information sources with the Japanese utilities.

MEMBER SIEBER: Yes, I might add to that. I read all the NEI bulletins, which I consider very helpful, and I would be curious as to where that information that you published came from, and your opinion as to its accuracy and timeliness. And the extent to which we can rely on that information as one of the many building blocks for our analysis of what happened at Fukushima, what needs to be done here. And what changes need to be made with regard to the United States' fleet of nuclear reactors.

MR. PIETRANGELO: Okay.

CHAIR ABDEL-KHALIK: Yes, Mike.

MEMBER RYAN: Tony, I'd be interested in your comments on gaps in information with regard to worker exposure analysis, to public dose analysis. For example, as some data that I've seen on exposure rates, but that's not directly helpful for assessing dose. And how do we get to the measurements we've seen and real dose assessments to real people both in and out of the plants. Thank you.

CHAIR ABDEL-KHALIK: To add to a long list, Tony --

MR. PIETRANGELO: How long do I have?

(Laughter.)

MEMBER POWERS: I suspect many of them won't have --

CHAIR ABDEL-KHALIK: I mean, we just had INPO IER 11-1, 11-2. We had NRC Bulletin 2011-01. There were the inspections that were recently performed by the Resident Inspectors. And, originally, as part of the implementation of the mitigating strategies a comprehensive inspection was presumably done in 2008, and these were incorporated in the Reactor Oversight process as part of that triennial fire protection inspection.

MR. PIETRANGELO: Right.

CHAIR ABDEL-KHALIK: Perhaps, your perspective on the effectiveness of these processes that had been going on for a while in light of the findings of the recent inspections made by the Resident Inspectors, and whatever industry responses were provided to INPO in response to IER 11-1 and 11-2.

MR. PIETRANGELO: Okay.

MEMBER CORRADINI: Do you want more, or are you okay?

(Laughter.)

CHAIR ABDEL-KHALIK: And you can address

these issues in any logical order you may deem appropriate.

MR. PIETRANGELO: Okay. I've got half a dozen bullets here. I'm going to try to put them in some semblance of order here. And, again, question any time. Let's keep this as a dialogue.

First of all, the event itself, March 11^{th}. We, basically, went into our emergency response mode at NEI as to the NRC and INPO. We were fortunate, I think, as an industry here that following the BP rig explosion, Deepwater Horizon, last year, we kind of did a Lessons Learned on that for how we would apply that to our industry if we had an event like that in our country, and revised our emergency plan and response center, actually did a tabletop last October as a result of that.

And just from a pure industry perspective that, I think, put us in a much better position to be able to carry out what we're supposed to do in a response mode like that in terms of setting up communications, coordinating our role with INPO's and EPRI's. Basically, the roles broke down as follows: INPO was responsible for getting as much data on the ground in Fukushima as they could through the TEPCO Center of WANO, the World Association of Nuclear

Operators, as well as through TEPCO, which is a member of both INPO, and NEI, and EPRI. So, we had some of those contacts.

We were responsible for keeping abreast of what regulatory actions were, as well as from a media and government communications outreach, all the data you saw, I think we were sending out every three or four hours updates to the information we had from the sources I mentioned, but we had NHK English version up on our screen, CNN, all the cable news networks, so it was really a compilation of all of that, that we were trying to assemble that information and provide what we thought was the most credible. Usually, if you're just hearing it from one source or news service that's not much to go on.

I think that that continues to some extent today; although you're seeing, I think, more analysis of information from Fukushima by the print journalists taking more time to get into the stories. But, certainly, we had a major role for our industry in terms of communication, so we had daily noon conference calls with all the Chief Nuclear Officers in the industry, as well as the Board of Directors of INPO, and other advisory committees around the industry. That went on for about three or four weeks.

We are down to a weekly summary now based on information we're getting through some of the Japanese associations. And I agree with what I think the EDO has said about the situation at Fukushima, "While static, certainly far from stable." And that'll be three, six, nine months before they establish cooling and containment to be able to go to cold shutdown.

And I think we knew from the beginning that until that cooling loop was established, this was not going to be a stable situation. And you can feed and bleed for a long time, and they're showing that you can. But, obviously, that's not the preferred method of dealing with the event.

And I understand they're setting up temporary systems now at Fukushima to plug into, hopefully, some existing piping that can establish the cooling to bring those units to cold shutdown.

But I want to stress that our efforts thus far, and I'll go through some of the activities we have underway. It's going to take quite some time to get a full understanding of what transpired at Fukushima, months if not years to get some of the data, to understand the differences in design, differences in operational practices, training, emergency response, et cetera.

So, we're having to -- we've adopted kind of a roughly right premise that based on the observations we've seen, this is what we think -- we think it's roughly right that this was the cause, and we need to move forward on that basis, because if you waited to get a full understanding of everything that transpired there, you wouldn't do anything for maybe three, four, five years. So, I don't think that's an acceptable response either.

Let's see. Let's start with the actions the industry took almost immediately after Fukushima. The accident happened on Friday, March 11th. On Monday, the Chief Nuclear -- the following Monday, the Chief Nuclear Officers in the industry confer and agree on a set of actions under the INPO Executive Advisory Group, which is all the Chief Nuclear Officers, to do four sets of walkdowns at the plants. These were focused on some of the measures we put in place for the B5B order that was later codified in 10 CFR 50.54(h)(h). Those walkdowns were completed by, I believe, the end of April, so we got out fairly early on those walkdowns.

There have been many, many observations from those walkdowns of the measures we took. And some of them are, I'll call them some non-compliance issues that the staff in the subsequent Temporary Instruction that was issued, saw the same things that the licensee found in the walkdowns. But I think what a lot of people don't understand is that the measures put in place after 9/11 were specifically targeted at aircraft impact, and large fires and explosions.

So, for example, some of the portable equipment that was staged to provide contingency measures assuming quadrants of the plant had been destroyed by aircraft impact, that equipment was staged such that it would not be impacted by the aircraft impact. You keep it far enough from the plant so that the airplane didn't take out your contingency measures, as well. But we weren't thinking about floods, we weren't thinking about earthquakes, we weren't thinking about hurricanes or tornados when that equipment was staged.

So, I think one of the key Lessons Learned from Fukushima was that you can have a multi-unit event, and the other element of the B5B measures was that it was based on a single event response, an aircraft hitting a unit. So, the strategies were by unit, not by station.

So, given -- I think an irrefutable Lesson

Learned is that you can have a single event, natural phenomena, or potentially other event that affects multiple units at a single station. And that's an area of potential improvement for us, is to expand what was done per the B5B measures to a multi-unit strategy. And that also takes into consideration some of the natural phenomena that the plant could potentially expect to see given where it's located.

We shouldn't jump to conclusions with that, though. I mean, some of the observations were while this -- where you put the portable diesel-driven fire pump could be subject to a flood there. That's a good observation, potential enhancement, but I think the -- some lead to a -- well, we ought to harden the structures around some of the portable equipment make it seismically qualified, hurricane-proof, tornado-proof, et cetera.

Personally, I don't think that makes any sense whatsoever. We built the plant to withstand that natural phenomenon, and the assumption is, is that that phenomena takes out everything at the plant, such that you need these measures. Why would you expect the same kinds of structures that you put in place at the plant to protect your portable? So, that's leading us to consider offsite response strategies with equipment, perhaps regionally where a lot of plants are located where you'd have that equipment available in a timely way, but not subject to the same natural phenomena and/or terrorist attack that the plant would be subjected to.

MEMBER CORRADINI: If I might just build on that. So, does that kind of open the door to thinking from a probabilistic standpoint both manmade and natural disasters, and how you might consider staging or doing things, whether it be operator action or predetermined, so that you'd actually start thinking through this.

I guess I'm kind of going further -- in my mind, I'm going further than this, but in some sense to try to risk-inform --

MR. PIETRANGELO: You can to a certain extent.

MEMBER CORRADINI: Okay.

MR. PIETRANGELO: I call it event-inform.

MEMBER CORRADINI: That's fine. That's fine.

MR. PIETRANGELO: If you're not subject to tsunamis, you don't build a tsunami wall, for example. And there's natural phenomena associated with each site.

MEMBER CORRADINI: I'm okay in Wisconsin.

MR. PIETRANGELO: You're okay in Wisconsin, hopefully. But you do it smart. And I think that's what we're trying to do out of the box here, is be smart about how we look at -- really, this is an additional layer of defense-in-depth that was put in place after 9/11 for a very specific reason. And I think my take based on Fukushima is, that's an additional layer that could be enhanced and expanded to deal with the multi-unit aspect of it, as well as consider natural phenomena and being smart about where you stage the equipment, be it on site or off site.

MEMBER CORRADINI: The reason I asked the question in that regard is that, if you think about it from the possible events in any one specific site --

MR. PIETRANGELO: Right.

MEMBER CORRADINI: -- you might look at one and say I should move the diesels from low to high, but then some other event may -- that's what I was trying to get to.

MR. PIETRANGELO: Okay.

CHAIR ABDEL-KHALIK: Now, you indicated that what -- the logic, if you put these things in a hardened facility, whatever took the plant out might do the same thing.

MR. PIETRANGELO: Right.

CHAIR ABDEL-KHALIK: And that sort of leads you to the idea of offsite staging of equipment, perhaps regional staging of equipment.

MR. PIETRANGELO: Right.

CHAIR ABDEL-KHALIK: Would these equipment then be under the control of an industry organization, or would they still be under the control of individual utilities?

MR. PIETRANGELO: That remains to be seen. I think each station is going to have -- going to need to have a strategy for how they would respond. I could see a public/private partnership with the U.S. Government to try to do this.

Early on, we're thinking well, there's a lot of Army bases around the country where you could stage this equipment, and they would have the transportation equipment to deliver it, as well. So, that's a possible thought.

A lot of the plants along the Atlantic corridor are relatively close together, and a number of companies could come together and form a regional compact to all use the same equipment. We've done that for transformers and other -- we call it pooled inventory management for long lead time, hard to get components that you would need to come back from an outage, and so forth. So, there's a lot of thinking in that regard.

The other, I think, irrefutable Lessons Learned from Fukushima was that they clearly could not cope with a station blackout condition long enough to preclude fuel damage.

Now, that leads us to questions on our own station blackout implementation here in the country. Based on the plants' configurations, they did coping assessments for two, four, eight hours. You might say well, why the Fukushima? That doesn't even pass the red-face test for being able to cope. But I think you heard at the Commission briefing at the end of March that in the United States, at least, with probably 3,500 reactor years of operating experience, we've had one station blackout in 1990 for about 44 minutes at Plant Vogtle during an outage. And it was a truck backed into a transformer in the switchyard. One diesel failed to start, and the other diesel was down for maintenance, station blackout.

Now, they were able to restart the diesel that failed to start in 44 minutes, and restored AC power. But that's the only station blackout we've had in the United States. That doesn't mean it can't happen here from some other combination of events. We've had several events, hurricane, Hurricane I believe it was Andrew in Florida, Turkey Point was on diesels for quite some time, a week or two. We just had Browns Ferry go through some very significant tornados, and were on their emergency diesel generators at three units.

Our diesel generators are very, very reliable. One of the first issues I worked at NuMark when I came to Washington was on diesel generator reliability. That was a key part of the station blackout implementation. And we tracked that in the Reactor Oversight process for the mitigating systems performance index. We had very, very high diesel generator reliability, and in the index you can track that. I think the reliability is upwards of 99.7 percent, something in that range.

That doesn't say you can't have a common mode failure across all the diesels that potentially could make them non-functional, but I think, and what we've been saying pretty consistently from the get-go is that we cannot say an event like Fukushima could never happen here. It could happen here. It's very, very remote based on the reviews that were done when the plants were licensed, and the subsequent improvements made over the years, both by requirements imposed by the NRC, as well as initiatives taken by the industry. But it doesn't matter at the end of the day. We have to be prepared for an emergency like this, whether it was tsunami, seismic event, terrorist attack, operator error, manufacturing defect, whatever, we want to keep these symptom-based events that we can respond to no matter what the event.

MEMBER RAY: Tony, I just want to make an observation. You made a point well taken about diesels. They've always had pretty stringent tech specs.

MR. PIETRANGELO: Right.

MEMBER RAY: And I guess as somebody who's operated a plant for a long time, I would say that's got something to do with how reliable they are, the fact that you've got very stringent LCOs, required surveillance testing.

MR. PIETRANGELO: Right. For those who don't know, diesels are tested on a monthly basis at the power plants to start and load run, I guess for approximately two hours, Harold. If you fail that test, you are inoperable, and you are in a tech spec action state.

MEMBER RAY: And it's a short one.

MR. PIETRANGELO: Right. Now, just in terms of insights with diesels, before the Vogtle event, some of the indicators we tracked as an industry rewarded doing diesel outage and maintenance during shutdown. We don't do that any more because of a simple risk insight that doing the diesel maintenance at power, if you did lose AC power, at least you'd have some steam to drive turbine-driven feed pumps and other pumps for core cooling and other cooling. So, we went from doing diesel maintenance from during an outage to on line.

I think that's a major improvement, and it's one of the ways we've managed to reduce, I think, outage duration across the industry, is by doing more and more maintenance on line, stringent tech spec still in place. I think the maintenance rule and the configuration risk management requirement in that greatly facilitated that, and told us when it was okay to take things out and when it wasn't. So, we've been managing that risk like that since the mid-90s.

Let's get back to station blackout for a second. So, we have the two, four, and eight coping duration. I would stress that that's a licensing basis number. It doesn't, necessarily, mean that that's the time that that licensee or that plant can cope with loss of all AC power.

I have one example. One of our members about stripping battery load, non-essential battery loads once you're on batteries following station blackout, that he could operate what he needed to for core cooling for 32 hours.

MEMBER SHACK: Does he have a procedure to do that, or he's figuring that out on the fly?

MR. PIETRANGELO: Figuring that out now.

MEMBER CORRADINI: So, that really is a Lesson Learned. It's alternative means of operator action to extend.

MR. PIETRANGELO: Right. I'll get into kind of the whole framework for that in a second. But I'm stressing that the two, four, eight was based on that plant's assessment with very -- using approved guidance, I think that we developed, that the staff endorsed on how to do the assessment, and how you wound up with your number.

MEMBER STETKAR: Tony, can I -- talking about station blackout, I'm aware of some plants who have in place at least guidelines, if not formal procedures, to induce a station blackout under certain fire scenarios. Is the industry rethinking that?

MR. PIETRANGELO: I haven't heard that

one. Induced station blackout?

MEMBER STETKAR: Some induce station blackout. There are not many plants, but there are some.

MR. PIETRANGELO: That's a first for me. I haven't heard that.

MEMBER POWERS: It's, actually, getting surprisingly large number of them.

MEMBER STETKAR: Depending on who you talk to, you get different counts, but it's not zero.

MEMBER POWERS: Non-zero. Oh, interesting.

MEMBER STETKAR: And that's a little bit of what Mike was asking about before in terms of this integrated thought that actions that are deemed prudent for one specific focus of an event may not be prudent in a more integrated --

MR. PIETRANGELO: In a more holistic look.

MEMBER STETKAR: -- view of risk.

MR. PIETRANGELO: Right.

CHAIR ABDEL-KHALIK: You may also be aware that as a result of this Vogtle station blackout event, Vogtle established what is called a "Power Options Book," which, essentially, gives the operators a list of all different ways of getting power from

Point A to Point B under all conceivable circumstances. And is that something that the rest of the industry is following up on?

MR. PIETRANGELO: What we did back then, and I was actually the Project Manager on the shutdown guidelines for NuMark, turned into an industry initiative that we all adopted. There were guidelines in there for key safety functions, AC power was one of them. They were very high level, but it allowed the licensees, I think, a lot of room to develop measures to meet the high-level principles for the key safety functions. So, I'm not surprised to hear that a plant went to that length to identify ways that they could restore AC power.

I can't say everybody has done the same thing as Southern has at Vogtle, but I suspect there's measures in place to restore AC power even per station blackout, as well as some of the guidance we put in place.

All right. Back to station blackout. So, we think there may be some room for extended coping beyond what you were licensed to in your coping assessment simply by looking at means to, whether it's shutdown essential loads on the batteries, or do other things.

The other thing that we think we have but don't know how to take credit for yet are the B5B measures we put in place. That's a catalogue of contingency measures to back up key safety functions, core cooling, containment integrity, and spent fuel pool cooling.

And you don't know what you're going to have available after you got hit by aircraft, and you assume a quadrant of the plant was wiped out, so these contingency measures go all around the plant looking at those key safety functions, and identifying in advance measures you could take to restore those functions until you got AC power back, or whatever.

Again, I don't know how long, having not assessed this, and we don't have any -- I'll say not only do we not have guidance, we don't have approved guidance for how we would assess how those B5B measures could be used to extend the per station blackout coping duration. But I think it's an important fact to know before we start trying to develop enhancements to those measures. You have to have a starting point.

And we know we've got the licensed coping duration from the station blackout rule. We know there are certain things we can do to potentially extend that, and we know we have the B5B measures as another way to expand or extend coping duration.

But the key is you have to have sufficient coping duration such that you can put some form of mitigating capability in place to preclude core damage. And, again, that's the essential Lesson Learned from Fukushima, is they could not do that long enough before they got cooling --

CHAIR ABDEL-KHALIK: I guess I'm trying to understand the statement you made that we don't know how to take credit for the B5B equipment. Do you mean because we don't know what's going to be available, or we don't know --

MR. PIETRANGELO: I think those assumptions -- there are several assumptions one will have to make to say whether I can employ this measure versus that measure. And depending on the event, the external phenomena, or aircraft impact -- maybe it's just because I'm sensitive to it because I worked in Washington for 22 years with the NRC, but I'm uncomfortable going forward with some form of assessment of that as a step in a plan to enhance my overall layer of defense-in-depth without some regulatory buy-in to the method we use to do that, and what we could take credit for in expanded or enhanced measures.

MEMBER CORRADINI: So, you want to do it in a reasoned fashion. That's what I heard you just say.

MR. PIETRANGELO: In other words, we want to do it in a reasoned fashion.

(Laughter.)

MEMBER CORRADINI: But I do think what Said is asking, I think is a fair point, because I think your concern, or your thinking through this in whether it be available equipment that has been considered in certain situations, or operator actions that could be done, but you don't want them to be done extemporaneously, but in some sort of planned thinking process.

MR. PIETRANGELO: Right.

MEMBER CORRADINI: All kind of goes into the idea of thinking through what you called events that are possible, maybe not be probable, but events possible how you attack --

MR. PIETRANGELO: Right. And both the things I'm talking about, station blackout and B5B 54(h)(h)(2) are regulations.

CHAIR ABDEL-KHALIK: Right.

MR. PIETRANGELO: So, the NRC is,

necessarily, going to be interested in how we implement those regulations, or how they might be enhanced. So, I don't want to -- the worst thing that could happen is that we run out and do what we think we need to do without some kind of, I think, input from the regulator, or oversight from the regulator, because it's all at risk of doing it all over again, or paving over it later with something different that someone else had a different idea.

So, that's why we're looking forward to interactions after the 90-day short-term response. We want to make sure that we can effectively implement anything, any new enhancement or requirement that comes out of the NRC's process. It doesn't do us any good to get requirements that we can't implement effectively. That's in no one's interest, or to jump out ahead, spend resources, and then have to do it all over again.

MEMBER CORRADINI: Right.

MR. PIETRANGELO: So, I think there's a natural complementary interaction that's going to be needed after we get through this 90-day initial review.

CHAIR ABDEL-KHALIK: But that doesn't preclude sort of the possibility of pre sort of conceptual thinking about --

MR. PIETRANGELO: Yes, and we're doing that.

CHAIR ABDEL-KHALIK: -- what approaches one can take in these unforeseen circumstances --

MR. PIETRANGELO: Right.

CHAIR ABDEL-KHALIK: -- in terms of defining the problems, in terms of critical safety functions, et cetera that would need to be maintained regardless of the event.

MR. PIETRANGELO: Yes, considerations that would go into extending the coping durations with B5B measures that we could probably turn into a guidance document.

Let me step back for a moment and give you some context around this thinking. I would say the first month after March 11th, we were still in crisis response mode, and not thinking about what we're going to here, necessarily. It wasn't until, I think, the situation became more static in Japan that we started focusing more on what we're going to do here in the U.S. as an industry response.

So, about a month after that, that's kind of where my attention turned. We were lucky, fortunate that we have industry organizations set up to try to fashion a holistic industry response, not just NEI. We've got Institute of Nuclear Power Operations, as well as the Electric Power Research Institute, and there are several activities that we've done over the years with our sister organizations that have been very successful by pulling together an industry response, not just a regulatory response through NEI. So, that's what we set out to do.

We set up a Steering Committee for the industry organizations comprised, primarily, of Chief Nuclear Officers from various plants, as well as the senior executives from each industry organization. We've established a charter for that group. We're putting the finishing touches on a strategic plan, guiding principles, and some building blocks that each organization will be the lead on. And I'll go through that very quickly.

I mean, the charter, there's -- let's see, about 13 people on this group were chartered to develop a strategic plan, articulation of strategic goal, structure, and process for defining the industry's overall response to Fukushima. We want to insure that identified issues are appropriately coordinated between industry organizations, and that lead and supporting roles are established. And I'll get into how we're going to coordinate that in a moment. And then three, monitor the status of action plans on key issues to insure priorities and schedules are consistent with the strategic plan. And this probably most importantly, and that the overall impact on operating plants is balanced and appropriate to our prime focus, which is excellence in plant operation.

So, we're going to be doing a lot of work post Fukushima in response. And our first strategic goal speaks to this, and that we can't do it at the expense of the safety focus at the current plants. We've got 104 operating plants in this country. That has to be our first priority. It always has been. And even though we have to do a lot of work, we've got to be careful not to put a burden on that stations in the Fukushima response that dilutes the safety focus from current operations.

You see, many of the companies have set up separate groups just to make sure that you don't have a adverse impact on, say plant operations. We've done the same at NEI. I've got a separate group now just devoted to Fukushima-related events. I'll probably matrix across our organization to get the necessary expertise we need. INPO has done the same thing, EPRI has done the same thing. So, I think everyone is kind of on the same page in terms of there's a lot of work to do, we need to get organized to pull it off, but it cannot be at the expense of the current plants.

This was our cumulative effects issue before Fukushima and the number of requirements, both self-imposed by the industry and from the NRC that we thought were starting to dilute the safety focus at the plants. And Fukushima can be cumulative effects on steroids, if you're not careful, so we've got to deal with these decisively, deliberately, but not at the expense of current plant safety.

Let me run through the strategic goals we've established. These have been through the NEI Executive Committee, the INPO Board, and the EPRI Board, so these are -- I feel pretty safe in talking about these.

MEMBER STETKAR: Tony, when you move the paper be careful because it hits the microphone.

MR. PIETRANGELO: Oh, sorry. The first goal -- I'll just read you kind of the lead-in. Our primary objective is to improve nuclear safety by learning and applying the lessons from the Fukushima Daiichi nuclear accidents. In response, the U.S. nuclear industry has established the following strategic goals to maintain, and where necessary, provide added defense-in-depth for critical safety functions of core cooling, spent fuel cooling, and containment integrity.

The first strategic goal is that our workforce remains focused on safety and operational excellence at all the plants, maintains the appropriate sensitivity to their emergency response roles, particularly in light of the increased work that the response of the Fukushima event will represent.

So, that's really INPO's building block, is let's -- we cannot lose our focus on safe operation at the plants. There's never a good time to have an event at your plant. This is a particularly bad time to have events at your plant in light of Fukushima.

Now, we'll get into more of the issues. And this is kind of based on the roughly right, what we think happened and observations that warrant attention. It remains to be seen what actions we'll take from these. We don't have action plans developed for these, but they're clearly areas that we're going to examine in some detail.

First, the goal -- these are kind of outcomes. Time lines for emergency response capability to insure continued core cooling, containment integrity, and spent fuel pool cooling are synchronized to preclude fission product barrier degradation following station blackout. And all that means is, you've got to have enough coping duration such that you can get your mitigating measures in place before fuel damage. And those have to be synchronized.

This is also not going to be, in our observation, a one-size-fits-all exercise given that the plants are so different in terms of the natural phenomena they see, their designs, their configurations. We want to try to keep this performance-based such that the station has enough flexibility to fashion a response that meets that goal in whatever time it takes.

MEMBER CORRADINI: So, this would be -- I guess, just to make sure I understand, so this would, potentially, lead to differences in the emergency procedure guides?

MR. PIETRANGELO: Plant-by-plant?

MEMBER CORRADINI: Plant-by-plant.

MR. PIETRANGELO: Yes.

MEMBER CORRADINI: Okay.

CHAIR ABDEL-KHALIK: May lead to proximity of staging points.

MR. PIETRANGELO: That's correct. That's correct. And, again, I think -- we'll get into that later. Next one.

CHAIR ABDEL-KHALIK: Before you --

MR. PIETRANGELO: Yes?

CHAIR ABDEL-KHALIK: Since this document is apparently --

(Simultaneous speech.)

MR. PIETRANGELO: -- from you, Mike.

(Laughter.)

CHAIR ABDEL-KHALIK: Approved by your Board, is this a document that you can share with us?

MR. PIETRANGELO: We hope to make it public some time in June. There's a lot of other verbiage that goes around these pieces. These goals are pretty well set, though.

CHAIR ABDEL-KHALIK: Okay.

MR. PIETRANGELO: The second one, U.S. nuclear industry is capable of responding effectively to any significant event in the U.S. with the response being scalable to support an international event, as appropriate.

MEMBER CORRADINI: Can I understand that? Is that in response, because Admiral Ellis I think at the NEA Assembly made some suggestions. Is that --

MR. PIETRANGELO: No.

MEMBER CORRADINI: -- coordinated with that? That's not the same thing.

MR. PIETRANGELO: No, I think this one is more about -- we were trying to provide support to TEPCO following the event, as was just about everybody else in the world. It took a while to organize our industry through the federal government with NRC, with the OEM. I'm sure Dr. Kelly will probably talk about that in his presentation. It took a while to get that supply chain formed up.

We should have that ready as an industry here for an event in the U.S., as well as to help someone internationally. How we can help, have that organized, have the supply chain ready to go. We shouldn't have to take another week to get all that together while the event is happening, so that's what that means.

CHAIR ABDEL-KHALIK: So, this is a statement of the goal.

MR. PIETRANGELO: Yes. It's kind of a desired outcome.

CHAIR ABDEL-KHALIK: Right. But is there a time line associated with that?

MR. PIETRANGELO: Not yet. There's going

to be action plans associated with these. We'll put milestones, responsibility and accountability. That's coming, but these are -- we spent the last month trying to make sure we have the goals and outcomes right.

The next one, severe accident management guidelines, B5B response strategies, and external event response plans are effectively integrated to insure stations are capable of a symptom-based response to events that could impact multiple units at a single site. Lots of words, but I think pretty simple concept.

If you looked at the current structure of design-basis for external events, EOPs, SAMGs, emergency plans, B5B is somewhere over here.

CHAIR ABDEL-KHALIK: Training.

MR. PIETRANGELO: Training, yes. You shouldn't ask the operator to go to 13 different places in response to an event to get guidance. That should be an integrated well thought through holistic thing, so I think the intent there is to effect that. And it could be, you've got your station blackout coping duration, potentially extended coping durations, SAMGs, and that should be an integrated piece and the transition should be smooth for an operator.

The next one, margins for protection from external events are sufficient based on the last hazards analyses and historical data. That's happening right now with GI 199 on seismic. It also could be a potential, and another natural phenomena, be it flood, tornado, or hurricanes.

This is making sure that we have margin that we're comfortable with from the design-basis events, and looking at the latest data.

MEMBER ARMIJO: What I'm missing, Tony, is response to a natural disaster, huge natural disaster which would give you seismic plus flooding.

MR. PIETRANGELO: Yes.

MEMBER ARMIJO: Or take out infrastructure that you were counting on for transportation, not only just electrical power, but just a whole number of things, people dying, families at risk.

MR. PIETRANGELO: Right.

MEMBER ARMIJO: Is the NEI assessment going to think in terms of that kind of a situation, because that's what happened in Japan.

MR. PIETRANGELO: Right. And that's why, when I said before about the assessments one would do whether it's for extended coping duration or emergency planning, what assumptions do you make to fashion your plan? And I think we've all got to be on the same page with that.

This particular goal, I think, is really our prevention goal. Is there something we can do from a prevention standpoint from natural phenomena? Because I think, and based on at least my experience and the exhaustive reviews when the plants were licensed for these natural phenomena, I'm not sure there's a lot we're going to find here. But if there is something we can do from a prevention standpoint that makes sense, we should do it.

But to your point, I can always get one upped on --

MEMBER ARMIJO: NO, I know that. That's an infinite --

MR. PIETRANGELO: Right.

MEMBER ARMIJO: -- possibility.

MR. PIETRANGELO: I can always get one upped, and I'd rather -- I'd feel more comfortable with mitigating strategies that is not dependent, necessarily, on the event, but responding to the symptoms, and being able to do something about it.

MEMBER ARMIJO: Flexibility.

MR. PIETRANGELO: Right.

MEMBER ARMIJO: So, that you can --

MR. PIETRANGELO: Yes. Yes.

MEMBER POWERS: Tony, you mentioned several times already the exhaustive review that's done in the course of licensing these plants with respect to both internal events, and external events.

MR. PIETRANGELO: Right.

MEMBER POWERS: Do you have any reason to believe that there was a less exhaustive review done for the Fukushima and the Japanese plants?

MR. PIETRANGELO: Not at this time. I don't have enough information about that yet.

MEMBER POWERS: Okay.

MR. PIETRANGELO: I'll be honest with you, we don't really understand the regulatory differences yet from the way the Japanese license --

MEMBER POWERS: Are you going to try to look in -- because it strikes me that that's one area where one could make some progress now, not dependent on understanding the plant, to see if there are any differences. The Japanese system is very similar to our's, that would lead to oversights, perhaps, or probably the most interesting task, especially when we think about all of our plants, is the evolution in knowledge on the vulnerabilities to, or the frequencies with which natural events of large magnitude might occur, and how one factors that into the updating of the FSAR, which we all know moves about once a year.

MR. PIETRANGELO: Right.

MEMBER POWERS: That looks like a route where your group and those that are associated with NEI could make real progress without having to get into the plant itself --

MR. PIETRANGELO: Right.

MEMBER POWERS: -- and see things, which is going to go at the rate it's going to go.

MR. PIETRANGELO: Yes. We've got a lot of stuff to do. I'm hoping that our own regulator will be interested in the differences between our system and the Japanese system, and understand those differences about methodologies were acceptable there versus here.

I was at Senate hearing, and questions from one of the Senators to the EDO was, do you know what the differences are? Not yet we don't. Says well, whatever they did there didn't work, or required there didn't work. So, if we're doing the same thing, that's a reasonable question.

MEMBER POWERS: You say it didn't work,

but the truth is that we do a judgment on what's adequate protection.

MR. PIETRANGELO: Right.

MEMBER POWERS: There is always going to be some finite probability of an event, and it can be a single event that goes beyond what we think is adequate protection.

MR. PIETRANGELO: See, I don't think we know -- we think we know that these were beyond design-basis for the tsunami and earthquake that -- we think that, but we don't know what methodology they used, how --

MEMBER POWERS: That's right. That's right. And that -- we have to know not only what methodology, but would we have used a different methodology, or is there anything that's flawed about that methodology --

MR. PIETRANGELO: Correct.

MEMBER POWERS: -- or anything that's flawed about our methodology? It still could come out that --

MR. PIETRANGELO: Right.

MEMBER POWERS: -- when events go beyond those methodologies, to know --

MR. PIETRANGELO: Right.

MEMBER POWERS: Ignorance, or whatever it is, I mean, there are things that we don't know about. Mother Nature can always surprise us.

MR. PIETRANGELO: Yes, and I think that's why we do the additional layer of defense-in-depth for those scenarios --

MEMBER POWERS: Absolutely. We definitely do that.

MR. PIETRANGELO: Okay. Two more. These are, I think, somewhat maybe redundant to one of these, but we wanted to make sure that they were clear in the goals; spent fuel pool cooling and makeup functions are adequate during periods of high heat load in the spent fuel pool, and during extended station blackout conditions.

We have not given the same level of attention to spent fuel pools here as we have the reactors, and that's just a fact. The second INPO IER that went out specifically looked at spent fuel pool cooling. And it really is using the same measures we put in place 20 years ago for outages, and backups, and safety functions when you were taking equipment out of service for outages.

And then the last one, primary containment protective strategies can effectively manage and mitigate post-accident conditions, including pressure and elevated hydrogen concentrations. This one is, I think, one of the ones where we need a lot more information about what happened in Japan. We're seeing a lot of speculation about venting, what they did, what didn't work, what worked, when they did it, et cetera. But it's all speculative at this point.

I think we've got to have a very, very firm understanding of the designs there, the procedures they used, what additional measures after losing electric power they had for operating those valves.

I think one of the observations from our walkdowns is that we can improve the accessibility to these valves. You shouldn't have to be Spiderman to go try to manually operate this valve after some natural phenomenon. Okay? So, improving the accessibility to key equipment I think is going to be important, as well.

So, those are the goals. Again, these are kind of desired outcomes. We kind of thought of these in a way that, where do we want to be in five years when this is all over? These would all be good outcomes, I think.

We also put some guiding principles

together. These are more process-driven, how we want to conduct the reviews both generically across the industry, as well as at the plants.

The first one is, insure equipment and guidance, and has been supplemented, as necessary, improves response effectiveness. This gets to the controls one places on that equipment that's there for emergencies. Do we have to expand it, enhance it, et cetera?

The second, address guidance, equipment, and training to assure long-term viability of safety improvements. I think this is another observation from the walkdowns, is that there were not prescriptive controls placed on the measures put in place for B5B. And in some cases during the walkdowns, you found the equipment wouldn't work. Well, that's not acceptable. That's not acceptable. So, we have to have the guidance, training, et cetera in place such that the long-term viability of that measure is maintained.

We want to insure response strategies are performance-based, risk-informed, and account for unique site characteristics. This is the one-size doesn't fit all. Maintain a strong interface with our regulators to insure regulatory actions are consistent with safety significance, and can be complied with in an efficient manner. We want to make sure we can effectively implement any additional regulatory requirements, be that adequate protection, or enhancements.

We want to coordinate with federal, state, local government and their emergency response organizations on industry actions to improve overall emergency response effectiveness. This gets to the regional, make sure you're bringing in your partners. And there were, actually, a lot of discussions after 9/11. We did comprehensive reviews that were conducted with state and local officials on the plants, the equipment they needed. Did they have familiarity with the site, if they were asked to come in and help, whether it was a terrorist attack, or another event.

And, finally, we want to communicate aggressively what we're doing. We didn't go into a shell after the event happened. We tried to go forward with the information we had and try to provide context to what we were seeing coming out of Japan. I think we did that in a pretty good way based on the information we had. And it's hard not to speculate sometimes about what you're seeing, and we tried not to. But we want to make sure that we communicate.

The document I'm speaking of also names all the stakeholders that we need to pay attention to as we implement this. And it's a pretty broad list, including plant employees. They need to know the actions the industry is taking as a whole, all the way from plant employees to other industry organizations, to the general public, media, Congress, our regulators, state and local officials. There's a lot of stakeholders in this enterprise, and we want to make sure we communicate and what we're doing.

Let me go back to the questions you asked. We've got this set up. It's in place now. The next step is, we're assigning leads and supporting roles for accomplishing these goals. We're going to expect the lead organizations to come back with action plans and milestones, so we can flesh this plan out and get into the substance.

CHAIR ABDEL-KHALIK: And when this plan is finalized, would you share it with us?

MR. PIETRANGELO: This is more of the internal sausage-making we do. We'll share it. There'll be a public version of this plan that will include this stuff that I went through. But in terms -- we did not contemplate sharing all the action plans.

I think when we get into after the 90-day NRC review, and there's more stakeholder interaction, a lot of these things will come to light through the public meetings we have.

CHAIR ABDEL-KHALIK: Okay. Thank you.

MR. PIETRANGELO: First question was, identify weaknesses either in design, procedures, or capabilities. At least from a -- at this point, I'm kind of where the staff is in their review. We haven't seen any fatal flaws yet in terms of our design. I think we see areas enhancements that would improve margins to withstand events like these. But there's no ah-hah moment yet about some preventive measure we could take that would preclude this.

Certainly, we have to look at our, as the goal pointed out, kind of integrating our procedures and capabilities to respond to a multi-unit event. So, I think that's one of the weaknesses we see, is we need a multi-unit strategy.

We talked about where we got our info, talked about sources of info from Japan. I don't have a lot on the gaps in worker exposure. I would point you to testimony that Dr. John Boyse gave at the House Science and Technology Committee I think a week or two ago that's very, very good, puts this in context with respect to worker doses, as well as public exposure from the event.

MEMBER CORRADINI: Can I just ask a question about that, because I think Mike's question was both worker dose and public exposure. Because the one thing, I guess a big question in my mind was, is if you think about it working from the outside in, something that's reported commonly on all the websites is activity.

MR. PIETRANGELO: Right.

MEMBER CORRADINI: But what I think would help from a communication standpoint is a breakdown in terms of where is that activity coming from, and some very clear pathway so somebody can see that, and understand the effect. And I think Professor Boyse, I didn't hear him in this session, but I heard him in some other public -- some radio, where he went through and discussed this for worker. But I think Mike's point I thought was both worker, as well as offsite, because to me from a health effects standpoint, the further you draw the boundary, the more you can essentially speak to what we already know.

In some sense no matter how -- you used the term, I can't remember how you said it, but I would call however sketchy what occurred internally of the plant events were.

MR. PIETRANGELO: At least today, I can't shed a lot of light on this piece.

MEMBER BROWN: Could I backtrack to your design information piece for a minute?

MR. PIETRANGELO: Sure.

MEMBER BROWN: After reading all the stuff and the information coming out, if you're going to take corrective actions or procedures, or mitigating actions to do stuff, you really have to have some type of monitoring data coming out of the plant that you have some reliance on, like water levels, or pressures, or temperatures, et cetera. And in reading your early reports, there were assumptions made based on the outputs of the instrumentation that they had in place that what appears to be now at the later stages not exactly correct, like water levels were lower than what anticipated and, therefore, there was greater levels of fuel damage.

And I'm not aware of any requirements, I'm saying that in the broad term, of having a limited set of hardened instrumentation which would provide a better feel during these events which would not, necessarily, be reliant on -- it could be electrically powered if they had their own little --

(Simultaneous speech.)

MR. PIETRANGELO: -- batteries or something.

MEMBER BROWN: Well, they'd have to maybe even their own batteries, not the ones that just last for eight hours. I mean, you'd have to have some really -- instruments, typically, do not take humongous amounts of power. It's not like running pumps or things like that.

MR. PIETRANGELO: Right.

MEMBER BROWN: Or mechanical-type things, just gauges where they could be put in, or those that don't depend on -- a level indication that doesn't depend on a reference leg, which you may not --

MR. PIETRANGELO: Have.

MEMBER BROWN: You may not have it any more.

MR. PIETRANGELO: Right.

MEMBER BROWN: So, that was a thing that struck me, is assumptions were being made, mitigating actions were being taken for the in-plant. Even the knowledge of what the spent fuel pool levels were seemed to be questionable, and that -- I had not seen anybody addressing that, and I didn't hear you say anything about that during the -- in your all's consideration --

MR. PIETRANGELO: I think that's an excellent point. I think as we go through the strategies and what you think you need, obviously, if you're the operator you want some level of indication of what you're doing, and what's going where, is it going where it should go, is the valve open or not. So, I think when we look at what the loads are on the batteries, it has to include key instrumentation.

I think another step would be to try to, as you said, maybe harden or enhance that capability. Just in spent fuel pools alone, I know a lot of control rooms do not have spent fuel pool level indication, and they check it on an operator round.

MEMBER BROWN: And/or temperature.

MR. PIETRANGELO: Right.

MEMBER POWERS: I don't want to deter you in looking for opportunities to improve your instrumentation. I would point out that this is the third major accident I've had the joy of going through, and every one of them people said gee, if we only had better instrumentation of this sort or that sort. And in many cases, we've upgraded the instrumentation, and what I found out subsequently was not terribly useful to us, and it's not useful for the next accident. I'm not sure we can out-guess the accident when it comes to instrumentation.

MR. PIETRANGELO: Yes.

MEMBER POWERS: I think it's --

MEMBER BROWN: Well, I'm not trying to out-guess --

MEMBER POWERS: I think the --

MEMBER BROWN: You have to have something there.

MEMBER POWERS: Well, the trouble is the accident is defined by the failure of the systems that you have in place, so you chase your tail a little bit. I think these response things that you talk about after the event where you can respond to its symptoms rather than trying to say well, if I have this kind of accident, I'm going to need this kind -- the trouble, I don't think you can out-guess the system.

MEMBER BLEY: But there's something in what you'd said a little earlier about staging grounds for equipment, that sorts of things, having portable equipment that could be moved in that leans toward flexibility such that no matter what happens, if it's something they haven't thought of, you'd have the equipment to be flexible.

The same approach could be taken with respect to instruments. And, in fact, one plant we worked with some years ago actually developed in-house very simple procedures for ways to be flexible with looking at instrumentation. In fact, they wrote up and practiced being able, if they had no power, no instrument power to get -- go out to the parking lot and steal batteries out of cars and use bridge circuits, and where to do it, and train on it so that they wouldn't be thinking about it. So, flexibility, to me, seems key. And I agree with Dana, we're not going to out-guess Mother Nature on this.

MR. PIETRANGELO: I agree.

MEMBER BLEY: It's nice to have things that are flexible. And of course, Charlie, a few things, you might have a minimal set that you harden.

MEMBER BROWN: Fundamental things like levels and temperatures, and some pressures that they're not out-guessing anything, but they'll give you at least a plant condition --

MEMBER BLEY: But even here it wasn't so much hardening. It was not having power to do things. And if they'd had flexible arrangements in place, maybe they could have done a lot more with what they had.

MEMBER REMPE: Or having some sensors that could go to, for example, thermocouples that were valid for higher temperature ranges, even though they weren't intended for that purpose. That would be useful.

MR. PIETRANGELO: They key safety functions that don't go away. I take your point. But I take your point, as well, and I agree with it, that flexibility is key here, because you don't know the event -- the hand you're going to dealt at the time. That's why we want to kind of keep this performance-based and flexible in terms of the response measures, because they have to be. You don't know what event you're going to get.

But the key safety functions, we need to protect and enhance. So, at least from an instrumentation standpoint, I'd try to focus on those, making sure I had instrumentation that the operators could use.

CHAIR ABDEL-KHALIK: Please continue.

MR. PIETRANGELO: Let's see. That's about all I had.

CHAIR ABDEL-KHALIK: Okay. Well, let me just go and see if there are questions posed at the beginning, if Tony had addressed them, or you still have questions that you would like to pose for him.

MEMBER CORRADINI: Do you have a plan, Mr. Chair -- when --

CHAIR ABDEL-KHALIK: I think the agenda calls for Tony to be here until 2:30.

MEMBER CORRADINI: Okay.

CHAIR ABDEL-KHALIK: So, we have time.

MEMBER CORRADINI: I guess the one thing that was mentioned, at least the one thing that pops in my head, the one thing that was mentioned, I don't know if it was Mike or someone else, I do think that from NEI's perspective on this, the ability, maybe it was Jack, the ability to identify -- if you have an observation or something that you're -- because I've been watching your weekly now, but previously hourly, or every few hour updates, to the extent that a member of the public can find out where you got it from, I think is very important. The openness as to this is what you saw, and here's where I can go look at it myself, because I think, at least in this environment, this culture that we are in, the public not only wants to know, they want to know where you knew it from.

MR. PIETRANGELO: Let me just say, we don't have any special source.

MEMBER CORRADINI: No, I understand that.

Not so much that, it's just that a way to dig through it, I think -- because the one thing, I guess, I -- the one Lesson Learned that I came through, I mean, Dana mentioned three accidents. Thirty-two years ago when we started the information was not easily gathered. This time almost 180 degrees opposite of TMI. The information was flowing out so quickly, and you weren't sure what the source was, and you were looking for verification or validation of it. So, I think that kind of is the biggest Lesson Learned here, is that in the environment we're in now, any sort of event, forget about if it's a nuclear event, any sort of event, you're going to get this flood of information, a lot of it will be not very valuable.

MR. PIETRANGELO: Right.

MEMBER CORRADINI: So, the connection back to a source so that people will try to understand it, I think is beneficial.

MR. PIETRANGELO: Okay. Yes, I'm encouraged that IAEA team is there on the ground now, and they're trying to put a time line together, get a set of facts that everybody can agree to would be very, very helpful, such that we could use -- everyone could use that without a doubt, and no question about its validity or authenticity.

But, again, the two irrefutable things I take is multi-unit event, couldn't cope long enough. Other than that, I think a lot of what's happened is pure speculation, especially with the pools, let alone what's happened in the reactor vessels. And we had reports that Unit 4 spent fuel pool was gone early. I saw a picture last week, looked pretty in-tact to me, with fuel --

(Simultaneous speech.)

MR. PIETRANGELO: Looked like one of our pools.

MEMBER SHACK: But they're going to go build a concrete structure to support it.

MR. PIETRANGELO: Yes, shore it up on one side.

MEMBER SHACK: So you understand why the spent fuel pool seemed to dry out so quickly?

MR. PIETRANGELO: I don't know if it did.

MEMBER SHACK: Well --

MR. PIETRANGELO: I don't know if it did. We know just from the Kashiwazaki earthquake in 2007, you get a sloshing effect, they lost about a meter of water from those pools.

MEMBER SHACK: Oh, they did? Okay.

MR. PIETRANGELO: And there was a report, there was 36 workers in the reactor building at the time of the earthquake, and they came out of the building drenched. They were at the fuel pool floor and they came out drenched, so that was probably a pretty good splash. I don't know how much inventory they lost as a result of that.

I mean, we had guys trying to do calculations about how long it would take to evaporate and boil down that inventory, but what was your starting point? Right? You had to assume you lost something as a result of the earthquake. Especially in Unit 4, we didn't know if the gate was up for the refueling or not, whether that survived the earthquake, and that was another path that would almost get you down to the top of the actual fuel. So, just a lot of assumptions that were going into these calculations to try to figure out what the heck was going on.

MEMBER ARMIJO: So, how are you --

MR. PIETRANGELO: And we still don't know.

MEMBER ARMIJO: Are you going to get answers to that, all those kinds of just straight factual stuff? Do you have --

MR. PIETRANGELO: I'm relying on the IAEA team that's over there right now, and I'm hoping the

NRC has a person on that team that's going to --

MEMBER ARMIJO: You will get your information through the IAEA team? You don't have direct contacts with your counterparts in Japan then.

MR. PIETRANGELO: There have been various -- I mean, EPRI leadership was over there last week, did a tour of Hamaoka, and went to the Daini site where TEPCO is staging a lot of the people, and materiel for Daiichi. So, we have had missives over there to try to even offer help in the organization in terms of project management for the task they have at hand, getting to cold shutdown and then a big decontamination activity. But it's -- I would say the focus is still on the ground, because it's not a stable situation, and not yet on getting that information out to everybody. I think that will happen over time. I think it's done more effectively if one organization like IAEA does it versus every country trying to get their set of facts.

We're not getting anything more than -- during the first few days of the event, I'd call over here just to trade notes on what we were hearing versus what information the NRC was getting, and they weren't getting any better information than we were. So, I think everybody was in the same boat in that regard.

CHAIR ABDEL-KHALIK: I asked a question about NRC Bulletin 2011-01, INPO IERs, and the inspections that were performed in response to the Temporary Instruction. The question was meant in the vein of, are we asking licensees to do the same thing several times when they should be spending their time sort of doing the strategic thinking that is required, rather than sort of redoing things three different times?

MR. PIETRANGELO: Well, the walkdowns that the industry did were self-initiated. I think the Temporary Instruction came out after that, was a good hand-in-glove fit about inspecting what we were doing in the walkdowns and what we were finding. Those all went into inspection reports that were made public and summarized.

The Bulletin, I think, my understanding of it is to make sure that you fix the items or non-compliances that were found in the 30-day time period, or tell us what you're going to do within 30 days. And then I think the 60-day response is more targeted at the controls you have over those extreme -- over those measures for extreme events, what training, what surveillance, what periodicity of maintenance, that kind of thing, because that was not prescriptive in the requirement.

And I'll be honest with you, we're looking at establishing our own kind of generic template for well, how often should we be testing and exercising training, because of the question you just asked. I mean, we had a discussion with someone, it's not gold-plated, but it might have to be silver-plated. We goldplate design-basis tech specs, all those things for a good reason. These are for very extreme low probability things, should you afford the same measures over those kinds of things as you do for the more likely day-to-day events? That's risk-informed thinking, I think. Harold?

MEMBER RAY: Well, Tony, you made some comments that I certainly resonate with about seamless transition from normal operating and emergency procedures to severe accidents.

MR. PIETRANGELO: Yes.

MEMBER RAY: One thing that's come up in our discussions here, completely unrelated, has nothing to do with Fukushima. But it does have to do with the intervention of, I'll call it management, and what role they play in a severe accident, and whether they can play any role if they're not licensed to operate the plant, for example. Is any of that kind of discussion taking place?

MR. PIETRANGELO: Yes. Well, in terms of understanding differences from what appears to have happened in Japan versus how we would do it here.

MEMBER RAY: Well, yes. But, I mean, let me be more specific. What role does the TSC have in saying it's time to move to a different strategy, or not, as the case may be, or even higher levels of management. It seems like that's going to have to be on the table here.

MR. PIETRANGELO: Well, I think one of the differences we see today with the way our operators are trained, licensed, and what they execute is the authority is with the shift supervisor in the control room. They're going to make the decision to vent or not vent based on their procedures and executing them. And you're not going to seek senior management approval in your organization, nor from the federal government.

MEMBER RAY: Well, that's the way it stands today. I'm just wondering are we comfortable with that, and are we going to look at that again, or is it pretty well set as far as you're concerned? Because, I mean, that's my understanding of the rules, too.

MR. PIETRANGELO: Yes. I don't know I want to have it any other way, Harold, than the authority has to be --

MEMBER RAY: Okay. That's fine with me.

MR. PIETRANGELO: -- with the plant, and the trained, licensed operator following their procedures. I mean, that's --

MEMBER RAY: We've had some folks suggest that maybe there was a role for upper management to play when these things develop. And I've been trying to ask questions about that, so that's why I asked you the question.

MR. PIETRANGELO: I'm not even sure we let upper management in the control room.

(Laughter.)

MEMBER SIEBER: Well, that's the established protocol right now. And I think it's the right one, because these people are trained to do that job, and have the wherewithal to do it, and have the most information. And I would like to reserve more distant management with less knowledge and less experience get involved in prescribing detailed actions that people are to take.

I do have another question, though. You

know, what you have described to us is a lot of short-term actions, investigations, procedure changes, you know, things like that. And I think in order to get an immediate improvement, that's what you start on first. But is anybody in industry looking toward design issues for the plants that may be modified to prevent some things?

For example, the hardened vents, either they leaked or some other pathway leaked, or they didn't work because you ended up with three reactor buildings that exploded. There are other issues that sort of hint at design issues in these plants that at least ought to be evaluated, because software fixes and extra training in a staged diesel some place isn't going to do everything.

MR. PIETRANGELO: Right.

MEMBER SIEBER: Who is looking at that, and to what extent?

MR. PIETRANGELO: Yes. I think the walkdowns were -- those are the short-term actions, but I think some of the corrective actions that come out of that are certainly, I mean, from a flood protection standpoint, just for your design-basis flooding analyses, make sure your seals are functional, watertight doors, all that kind of stuff.

That has to be rechecked, and if you find some deficiencies, you need to fix those. And that's what the Bulletin, I think, is trying to drive, is corrective actions commensurate with their significance.

The other piece that I mentioned before is like improving the accessibility to those key equipment like the hardened vents, so that if you do get in that situation they are more readily accessible. You've got the nitrogen bottle staged to be able to operate the valve, et cetera, the right fittings there, that kind of thing. In the short term, I think that's what we need to focus on.

MEMBER SIEBER: And I think there are some policy issues out there, too. For example, the government's been collecting from electricity ratepayers for years, and years, and years as part of their electric bill to establish long-term spent fuel geologic storage. And we are making virtually no progress even thought the money has been spent in that area, and we end up with a large inventory of spent fuel located at plant sites stored where under normal conditions it's completely safe, but there ought to be some policy alternative to try to resolve that situation. Do you agree or disagree with that?

MR. PIETRANGELO: I agree, and if there's any silver lining to this horrible event, is that we've got a Blue Ribbon Commission looking at long-term national policy on used fuel.

MEMBER SIEBER: Right.

MR. PIETRANGELO: We're going to see their draft recommendations here I think in July, and final recommendations by the end of the year.

A lot of times you have these Blue Ribbon Commissions that make recommendations that stay on the shelf and nobody does anything with them.

MEMBER SIEBER: Right.

MR. PIETRANGELO: I think Fukushima really puts a spotlight on the aspect of used fuel management. We need a national integrated used fuel management policy. And to the extent Fukushima shines some light on that and the urgency of getting on with this. I don't think it's an urgent today issue, it's a longer term issue, but we need to start taking definitive steps towards some national goal and policy.

MEMBER SIEBER: I was a young man when this first became an issue, and I'm not longer younger and the issue is --

(Laughter.)

CHAIR ABDEL-KHALIK: You correctly identified sort of the fact that, in general, we have been looking at issues on a unit-specific basis rather than sitewide basis. And has the industry started thinking about the licensing implications of this if we change the paradigm of licensing rather than looking at it from a licensing of an individual unit, instead we look at it from the perspective -- from a sitewide perspective?

MR. PIETRANGELO: We do do that to a certain extent now. I'll note with new plant construction at Vogtle and Scana, you're doing heavy construction next to an operating plant. I think from a security standpoint we've looked at that very, very carefully, and the need to account for that with the security measures at the operating plant. I think you're suggesting something broader.

CHAIR ABDEL-KHALIK: Right.

MR. PIETRANGELO: I thought about it a little bit, not a lot, and the context was totally different for me. I was thinking it for small modular reactors versus big plants. But the same could be -- there are some plants that share turbine decks, share control rooms, share refueling floors.

CHAIR ABDEL-KHALIK: Right.

MR. PIETRANGELO: So, I think that's a legitimate area to investigate and look into.

CHAIR ABDEL-KHALIK: Shared switchyards.

MR. PIETRANGELO: Switchyards, right.

MEMBER REMPE: Said?

CHAIR ABDEL-KHALIK: Yes?

MEMBER REMPE: I'd be interested in your perspective about resolving some -- the long-term resolution of some uncertainties. You have mentioned the spent fuel pool Unit 4, for example, and there are several scenarios being thought about, whether there was hydrogen from three versus water sloshing out, and there's other things about some sort of flammable liquid.

To really get the answer to that might be important on what we think about doing in the future. And there's other issues like saltwater. Does industry have a perspective and an opinion that they plan to maybe promote, find some answers, as they go through it?

MR. PIETRANGELO: Absolutely. I think that's -- from day one when we all got together to start thinking about what we were going to do, an emphasis on needing a more detailed understanding of precisely what happened, timeline, actions, condition, as best we can get it. And I think the fuel pools --

MEMBER REMPE: Some of it may require going in and getting some sort of sampling, etcetera.

MR. PIETRANGELO: And that's probably years.

MEMBER REMPE: Yes.

MR. PIETRANGELO: Unfortunately. But it took a long time on the TMI lessons learned. It is probably going to take a long time for this as well. But nonetheless, we should get that information, because I think it will obviously inform our efforts going forward.

CHAIRMAN ABDEL-KHALIK: Go ahead.

MEMBER POWERS: One of the challenges -- the benefits that we have derived from the TMI incident was doing the diagnostics on -- post-accident diagnostics. And we were -- the problem is the very middle of the data you derive from dissecting a damaged reactor is of use to those cleaning up the reactor, and their imperative is to clean it up as quickly as possible at as low a cost as possible.

And they are disinterested in it rupturing their activities to acquire diagnostic information that may be of use to us in validating models of how accidents degrade and things like that.

At TMI, we operated very much in the blind, because we didn't know very much about severe accidents at that time. We know marginally more, I presume, now than we did. And so we don't have to operate nearly so blind, but we are still going to be under the pressures of time and the schedules of those doing the cleanup, if there is no recognized value to getting that information, and a well-developed strategy for getting that information, interfering as little as possible.

I think it would be exceptionally useful if NEI could add its weight to encouraging all interested parties in developing a good plan for what information we get, how it will be used, and encouraging those responsible for the cleanup to recognize that value.

MR. PIETRANGELO: Yes, that's an excellent point. And we have had that discussion just about domestically when we find flaws of indications and people want to do the weldover without knowing -- finding out exactly the extent. And I think we've got our protocol down now where we don't do that until we find out as much as we can.

MEMBER POWERS: Well, I may --

MR. PIETRANGELO: Yes.

MEMBER POWERS: -- this country for small things, but -- and a big thing, there is so much money involved, and time is money here.

MR. PIETRANGELO: Yes. But I think it's given that TEPCO has several other operating plants of a similar design in that country. They are going to want the lessons learned, perhaps more than anybody, for their own reasons. And I don't see why there would be any reason not to share that with international --

MEMBER POWERS: I don't think it's sharing. It's having --

MR. PIETRANGELO: A plan in advance.

MEMBER POWERS: Yes, a plan in advance --

MR. PIETRANGELO: Right.

MEMBER POWERS: -- that recognizes this drive that is going to go on to clean up as quickly as possible. Both parties have to recognize that.

MR. PIETRANGELO: Right.

MEMBER POWERS: And at the same time, we still need to get the information. There is so much information we did not get at TMI, quite frankly because we ran out of money, and because we were not well planned. And the drive to completion was just very, very heavy pressure, and you have to be very sympathetic with people.

MR. PIETRANGELO: Right. That's a balance.

MEMBER POWERS: Yes.

MR. PIETRANGELO: Well, I totally agree with your point, though.

MEMBER STETKAR: Tony, in light of that, you mentioned that there's an IAEA team on the ground now. And my impression from what you said is that you are relying, to a greater or lesser extent, on them to do a lot of the detailed forensics.

MR. PIETRANGELO: Initially at least.

MEMBER STETKAR: Okay. Well, I guess my question, in light of what Dana was discussing, is, who in the U.S. is coordinating with that team? In other words, if there is valuable information --

MR. PIETRANGELO: Right.

MEMBER STETKAR: -- that should be preserved, at a relative -- you know, at this stage of the process, three months, two and a half months --

MR. PIETRANGELO: Right.

MEMBER STETKAR: -- after the event, that could be lost because of cleanup efforts and things, who was working with that team if they are now the point international team for --

MR. PIETRANGELO: Right.

MEMBER STETKAR: -- collecting --

MR. PIETRANGELO: In our plan, we have actually got an international coordination building block in that plan that EPRI and INPO share the lean on.

MEMBER STETKAR: Okay. But you mentioned that that plan will be eventually developed and perhaps published by the end of this year. I'm talking about, you know, some time in the next two or three months in real time.

MR. PIETRANGELO: Yes. Well, EPRI was there last week, and I think, in my mind, it would be the right industry organization to say, "Here is kind of the questions we have been doing research on for a number of years, that this information" --

MEMBER STETKAR: Well, the question is --

MR. PIETRANGELO: -- "light on."

MEMBER STETKAR: -- in your mind that sounds right, but in real time who is doing it? I mean, does EPRI have the lead? Does EPRI know that it has the lead?

MEMBER CORRADINI: I guess John's question -- I guess more provocatively, so if tomorrow somebody said, "You really shouldn't clean that up. That might be some valuable information there," or could make the final decision to clean it up or to -- or to leave it there for forensics value -- that's what I guess John is asking.

MEMBER STETKAR: Well, it's -- in some sense. I mean, I'm not advocating delaying, but at least if someone thoughtful thought that information prior to cleanup might be useful, collecting as much information prior to cleanup should be, you know, given some priority.

And if, you know, at least from the U.S. perspective, if I can cast it that way, given an information flow to us to sort of enhance our understanding of severe accident -- event progression or severe accident phenomena, who has the lead today?

MR. PIETRANGELO: I'm going to take that question. That's a good one, given the time. I'm really glad the ACRS is involved in this, and I know -- I've heard -- don't know, but heard that you all have wanted to be more engaged on the Fukushima and the planning. And I know the staff is under duress right now to get this 90-day review done.

But I know if there is any subsequent actions that come out of that I trust that this Committee is going to be engaged in looking at those and providing your expertise to that, because this is something we all need to work on. It's very important.

There's a lot of lessons to be learned here, and the more we can get I think a consensus from all communities on what is fact and what is real versus kind of what is speculative, I think is very, very helpful going forward. So --

CHAIRMAN ABDEL-KHALIK: Thank you very much.

MR. PIETRANGELO: -- appreciate the opportunity to chat with you today.

CHAIRMAN ABDEL-KHALIK: We intend to do that.

MR. PIETRANGELO: Okay.

CHAIRMAN ABDEL-KHALIK: And we thank you very much for taking the time to meet with us today.

MR. PIETRANGELO: My pleasure. Thanks.

→ CHAIRMAN ABDEL-KHALIK: Thank you. At this time, we will move to the next presentation. Dr. John Kelly from DOE will give us a presentation on DOE's perspective.

DR. KELLY: Thank you, Mr. Chairman. So are my slides loaded, do you know?

CHAIRMAN ABDEL-KHALIK: I believe they

are. And if you can --

DR. KELLY: I know a couple of the people here.

MEMBER POWERS: Who are you again?

(Laughter.)

DR. KELLY: Well, I can't remember exactly -- I think Dana maybe initiated this request back a month or so ago, because he knew that I was heading up the Department of Energy Nuclear Energy Office's work on the Fukushima event. And so -- but the focus I think at this point needs to be, what did DOE do in the last two months on this?

And the forward-looking thing we are -- you know, our position right now is we need to learn a lot more about what happened and why it happened, and if we can lay that foundational base of understanding, then lessons learned will flow from that.

So here is the plant, you know, before the accident. I think everyone has seen that. And then, the -- you know, the extreme devastation that occurred within the first few days after the tsunami, and then the hydrogen explosions in the various buildings greatly damaged all of the facilities.

You know, the timeline that we know is the earthquake happened at 2:00 in the afternoon. About an hour later the tsunami hit. It was a magnitude approximate nine on the -- and the tsunami was about 14 feet, and their design base I think was about six meters.

Many thousands of people perished, and, you know, I think one thing that I recognized was that when we had the big earthquake or whatever, and thousands of people were killed, we always had this assumption that the -- whatever happened in the nuclear plant wouldn't be as important as all the other human devastation. Apparently, that's, you know, not valid.

But hundreds of -- over 100,000 people were homeless, without food, water, evacuated, etcetera. It wasn't just because of the nuclear accident.

So we are still uncertain about how much damage was done by the earthquake, and that information is still coming out as they inspect the other reactor buildings and the units that weren't damaged. Units 5 and 6 did not meltdown, so they can go in and see what damage occurred there.

But we're pretty sure that the grid lines were knocked down by the earthquake. That led to the loss of offsite power. And then, diesel generators operated, but when the tsunami came in and we have, you know, some simulations now looking at that, the diesel generator rooms were flooded, and this knocked out the diesel generators leading to basically long-term station blackout, without heat sink as well.

MEMBER CORRADINI: John, you mentioned 5 and 6, so maybe -- if this is the wrong time, you can hold us back. So in 5 and 6, has there been internal inspections of the building such that they know where the water went, or if any water made it into a lot of the compartments?

DR. KELLY: You know, I don't know the answer to that.

MEMBER CORRADINI: Because I think you have actually started bringing up questions that --

DR. KELLY: That we've been following, yes.

MEMBER CORRADINI: -- five or six weeks ago we were asking staff about, too, about a comparative point, maybe due to elevation things were different there. But then, given that, what sort of things they found when they were inspecting internals of it. So at this point, still a question mark.

DR. KELLY: Still a question mark. But we are pretty sure that there are, you know, various inspections going on to assess earthquake damage. In terms of tsunami damage, that seems like something they would also be interested in.

MEMBER CORRADINI: Okay.

MEMBER ARMIJO: Well, similarly, for the Daini sites, which survived, and it was a tsunami as severe where they're at higher elevations --

DR. KELLY: Well, the tsunami was I think worse, but they were up at higher elevations.

MEMBER ARMIJO: Yes. You know, some quantitative stuff like that would be --

DR. KELLY: They barely survived I think. You know, the indication -- I don't know if you know Dr. Omato, Japan Atomic Energy Commission. He and I spoke a few weeks ago. They did not loose all offsite power, so they had one line still remaining. And then, they were able to bridge that line to the units onsite. So it was through that mechanism that they were able to maintain power.

MEMBER CORRADINI: I guess I would -- just to follow Sam's question, I guess it was -- was it Onagawa that was at a much higher elevation? It was on cliffs.

DR. KELLY: Right.

MEMBER CORRADINI: And F2 was in a bay region, so even though the tsunami was worse there, it was mitigated by the bay? Or is that still a big question?

DR. KELLY: Onagawa or --

MEMBER CORRADINI: No.

DR. KELLY: -- Fukushima 2?

MEMBER ARMIJO: Daini.

MEMBER CORRADINI: Daini, excuse me. I guess that's back to --

DR. KELLY: I think what saved Daini was the fact that they did not completely lose connection to the grid. At least that's what Dr. Omato reported to me.

MEMBER SHACK: But is the implication of that that they had lost their emergency diesels? They do seem to need them.

DR. KELLY: I think that was the implication.

MEMBER SHACK: Okay.

DR. KELLY: Maybe I'll say a little bit more when I -- I can talk to it as I go through here. So station blackout occurred due to the earthquake at the Fukushima Daiichi plants.

Loss of emergency diesels due to the

tsunami -- now, they had both water-cooled and air-cooled diesel generators, so they had added redundancy some time before. I think people were talking -- I can't remember, because we talk about this all the time, but they had done extensive relooks at seismic hazards and tsunami hazards within the last five years I think it was.

What Dr. Omato explained was that there are four fault lines off the coast, and in their modeling they never assumed that they would all operate at the same time. And so these four in harmony went up and down generating massive earthquake and tsunami. So the fault lines were known. The fact that they would work together I think was overlooked in the analysis.

Eventually, they were able to maintain some control for a while, but there is, you know, speculation now that there was damage. There was a report earlier this week that the Unit 1 was cooling too rapidly. The isolation condenser was working. The operators turned it off, because they were afraid that it was going -- some kind of thermal transient, thermal shock.

And then, when the tsunami hit, they weren't able to restore the isolation condenser, which part -- you know, we need to confirm all of these things, but it's sort of pointing to why it actually melted down faster than severe accident codes would have said.

MEMBER CORRADINI: That was because the isolation -- it was isolated.

DR. KELLY: Yes. There is one valve that needs to be turned, apparently, and so --

MEMBER STETKAR: John, everybody is -- I have to apologize, because I haven't had a chance to really look at lot of the details, and I'm kind of a detail-oriented guy. But people focus on the tsunami effects on the diesels themselves, which obviously were vulnerable to the flooding.

It's my understanding that a lot of the switchgear was down in the basement of the turbine building. So even if the diesels had survived, would they have been able to provide electrical power to anything? Do you know that?

DR. KELLY: I don't know that, but I've heard that, indeed, you know, it wasn't just the diesels themselves. The diesels might have been many, many, many meters above the tsunami level, but --

MEMBER STETKAR: I don't know how the --

DR. KELLY: -- the actual layout of --

MEMBER STETKAR: -- switchgear itself, emergency power sources are, whether they -- the switchgear --

DR. KELLY: Okay. You don't know.

MEMBER STETKAR: I don't know.

DR. KELLY: I haven't been able to find that --

MEMBER STETKAR: I just don't remember, because the Secretary of Energy and I went up to Millstone a week after the accident, because we thought it would be a good idea to walk around a similar plant that we could walk around in, and so we got a pretty good tour.

You could actually envision how this happened, because the diesel generator room there has, you know, the vent to release combustible gas or the combustion gases afterwards. So up at the top, they have designed it for a very large hurricane tidal swell on Long Island Sound. But if you miss that, you know, there's a clear path for water to go right into the building. And I suspect that water, mixed in with electrical equipment, is, you know, a high probability of failure at that point.

And then, furthermore, the diesel fuel tanks were -- which were outside were also washed away. So even if -- you know, their supply of fuel was gone as well.

Yes.

MEMBER SIEBER: I might comment -- not only the diesels and the switchgear, but also the pumps themselves.

DR. KELLY: Right.

MEMBER SIEBER: In order to get suction head, pumps are usually placed low, and they are driven by electric motors. They are vulnerable to flood. And so if there's more issues than just having the power supply and the switchgear, you have to have the equipment --

DR. KELLY: Right.

MEMBER SIEBER: -- safe, too.

DR. KELLY: So I think we know core overheated, cladding oxidized, melt produced hydrogen. Hydrogen escaped from the containment. There is -- it was either vented or the head seals leaked, or some combination of that. And so Units 1, 2, and 3 all had, you know, explosions or deflagrations, and there was an explosion/deflagration in Unit 4.

And I'll talk -- I heard you speaking earlier about the -- what we know the about spent fuel pool 4, and I have some of -- I'll talk a little bit about the analysis that we did and the conclusions we rely on.

MEMBER CORRADINI: But given the qualitative stepping through, as you have done, there are still large uncertainties as to, was there hardened vents? If the hardened vents failed, if there was a change in procedure, if, if -- there is still a good bit of --

DR. KELLY: I mean, we're sure that they have hardened vents, that they were used. How they were plummed is not, you know, understood, so, you know, there is still --

MEMBER CORRADINI: Okay.

DR. KELLY: But that still needs to be fully verified.

MEMBER ARMIJO: John, would -- these vents would normally not discharge into the refueling floor. So they --

DR. KELLY: No.

MEMBER ARMIJO: So, you know, something --

DR. KELLY: Something else went wrong.

MEMBER ARMIJO: -- went wrong when they were venting or before they went -- were venting.

CHAIRMAN ABDEL-KHALIK: Unless you get connected.

DR. KELLY: So there is some interconnection. That may explain the mystery of Unit 4, so -- but basically, what I wanted to talk about was, you know, what kind of happened in those first days. Of course, you know, we know the NRC stood up their Emergency Operations Center. They deployed people to Japan.

They formed this reactor safety team that was really there to provide advice to the Ambassador and the government as questions came in. And it was principally on the -- managing the reactors and spent fuel pools. I mean, that's what the NRC team was principally focused on.

But they initiated this consortium call that was twice a day, daily, you know, it was very frequent, that it had participation from NRC, INPO, DOE, Naval Reactors, and GE, other industry partners. So there was a call that was discussing basically that the appropriate accident management guidelines, as we are gathering data and looking ahead, as to what was next.

Dr. Lyons, my boss, and Chairman Jaczko got together with INPO and discussed, how are we going to deal with all the industry's interest in assisting Japan? And so INPO agreed to be the coordinating point for that, and they sent -- ended up sending people both to -- to Japan as well as coordinating things here in the U.S.

And so this really was a great idea, because it helped get our capabilities, which are great in terms of many of these areas, channeled in the right direction, so that they could be deployed more rapidly.

MEMBER CORRADINI: So INPO was the point of focus, the point of contact to TEPCO.

DR. KELLY: Yes.

MEMBER CORRADINI: Okay.

DR. KELLY: And for all interesting in assisting, it was -- INPO served as a clearinghouse for that.

Department of Energy -- our responsibility was principally on the -- well, we have our own Operations Center, but principally on the airborne monitoring system that the NNSA maintains for various nuclear disasters in the U.S.

And, you know, this is vital for not only informing the Embassy in Japan about potential dangers to the U.S. citizens, it was also to the military that has naval bases, air base in Japan in close proximity. There were a number of reasons why this was very important for the benefit of U.S. citizens, and, at the same time, it was benefitting the government of Japan.

We also sent representatives from Idaho, PNNL, Sandia, to Japan. We sent additional DOE staff, and then we had the great job of having -- doing shift work, hadn't done that in a while. I got the midnight to 6:00 in the very beginning. Of course, that's when everything was happening, so it was pretty interesting. But even Dr. Lyons was doing shift work when we got the EOC stood up.

MEMBER BANERJEE: Who organized the badges with freshwater and things?

DR. KELLY: That was the Navy that --

MEMBER BANERJEE: Did you guys get involved in that?

DR. KELLY: No. See, the military was also involved, so it was -- I didn't have their activities on here, but --

MEMBER BANERJEE: Nobody coordinated that activity from DOE or NRC.

DR. KELLY: No. There's actually a disaster assistance team -- DART it's called -- and that was the overall coordinating function. But every agency has their roles and responsibilities. We kind of follow down that line.

You know, so during the first several weeks, we did a significant number of analyses -- so that's in my office -- basically asking a lot of the "what-if" questions, because we were trying to anticipate what could go wrong next, and we wanted to be ready to inform the Ambassador about, you know, how much time do you have, and these type of questions.

If the spent fuel pools are dry, how much time do you have? And what would be the signatures? What would we see? And we could look at the very assets the U.S. Government has to give us early warning on -- if the accident --

MEMBER BANERJEE: Were you going directly to the Ambassador or to the Secretary? I mean --

DR. KELLY: Our team -- I have a flow diagram that shows the information flow. It's pretty complex, but I'll get there.

In terms of DOE offices, NE is mine, Nuclear Energy. Science was involved, NNSA. Environment Management, because it's in EM that we have the expertise at Hanford and Savannah River, and a lot of the work in the future is going to be cleaning up contaminated water. And we have built that equipment in the U.S., and we will probably be involved in some role there, had all our labs, universities, consultants.

And then, the Secretary, for the VP disaster, had formed this group of science experts that he brought together to consult with. And so he stood that up within the first week to really help us -- the analysis team with giving us advice, questions, and then asking, you know, pertinent questions that we could then communicate to our colleagues in Japan to get information to help understand.

So there is kind of the information flow. And this is not a complete wiring diagram, but in the middle we stood up this triad they called this, which Steve Binkley in the Office of Science, Steve Aoki in NNSA, and myself, so we were representing the kind of three major elements of the Department.

And then, there was this -- in the U.S., there was this consortium with INPO, industry, DOE, and NRC, that were having their daily phone calls, and we would have people participating on those phone calls. They, in turn, would have phone calls with the Embassy, and there were probably daily meetings with the Embassy and the government of Japan. And you can see the various organizations in Japan.

And, you know, TEPCO and NISA were

interacting with the Embassy, and of course Hosono was the overall integrator in Japan. So that was kind of a lot of back and forth.

But our main connection to getting information to the Embassy was through the consortium, but we also had two DOE people there all the time that we could, you know, call up and talk to.

MEMBER CORRADINI: So, John, I guess I don't recognize what that means. So who is the -- can you explain the integrator's role? I'm sorry. I didn't --

DR. KELLY: He is -- the Prime Minister appointed him as the person in charge.

MEMBER CORRADINI: All right. Thank you.

DR. KELLY: It's all the ministries in Japan that are dealing with this report to him. It's much -- this is just a really small slice of the overall picture.

MEMBER CORRADINI: From the standpoint of command and control, then, information advice would go back to TEPCO from that group also.

DR. KELLY: Yes. And they were coming up with a list of equipment that they wanted, and analysis. So it was equipment and analysis. They wanted stainless steel tanks for water storage, or they wanted robots, or they wanted pumps. And so this was a way of getting the information put together as quickly as possible.

We had the Secretary's -- what we call X1's -- science experts. We were meeting daily with those folks. And then, we had our laboratories where we had -- we brought in some of the -- Harold McFarlane from Idaho fortunately was in Washington at the time, and so we tapped him to kind of be the coordinator of the lab group. So as we got requests for analysis, etcetera, we could give it to Harold, and he would go to the laboratory experts to get the analysis done, and then report it back the next day. So we were pretty busy that first day.

As I mentioned, NNSA had the lead on the radiation monitoring, and they deployed the system. They really -- I think our Emergency Response Centers were stood up sometime 11 or -- 11:00 in the morning or so on that Friday, the 11th, which was I believe nine to ten hours after it had happened, because there was already indications that they had lost cooling.

I think they deployed in the afternoon. Because of the day difference, they arrived very early on the 13th and were flying their first missions on the 13th, which already was after I think Unit 1 had failed.

And then, at the same time, the NARAC group at Lawrence Livermore, they have the plume modeling, and so they were calculating hypothetical source terms, looking at plumes to the U.S., plumes on Japan, and all this was informing EPA in the U.S. and the Embassy in Tokyo.

MEMBER CORRADINI: Was that group also informing NRC?

DR. KELLY: They were working together, so NRC provided the source term.

MEMBER CORRADINI: Oh, NRC provided the source term.

DR. KELLY: NRC provided the source term, and then that was put in the NARAC, and there was lots of interactions with Dr. Holderin at the White House on "what-if" scenarios. So that was pretty interesting.

Very nice, you know, instruments. They did do these flyovers and would -- maybe you've seen these photos, but they've got lots of data now on radiological. They do have gamma specs, so that they can -- they can pick out the cesium-137 or iodine-131, so we have some isotopic information as well. And then, later they did ground sampling. They set up various monitoring there.

And, basically, they are identifying hot zones, and we saw yesterday that there is this kind of plume up to the north and west. And I don't know if it's fortuitous or what, but the plume modeler, if you plug in the weather and sort of a constant release, you get a pattern that kind of looks like this. So that -- it's not exact, but at least it gives you an indication of -- and it's a pretty complicated -- it's probably mostly due to rain, rain at the right time, led to this disposition, rather than in the atmosphere and a lot more dispersion.

MEMBER CORRADINI: And so these are -- what you are showing here are measurements at a particular point in time.

DR. KELLY: Yes. These are dated -- this is April 5th, where they were -- I think the red dot at the bottom is a plant, so then they have a measurement going out. They went over sea, you know, so they did both over the land, over the sea -- a pretty substantial difference. They were running two or three missions a day, so they've run nearly 100 missions now I think they told us.

MEMBER STETKAR: John, was the Japanese government also doing flyovers, taking their own measurements? And were those --

DR. KELLY: Apparently, they didn't have the radiation -- they did not have the radiation monitoring capability.

MEMBER STETKAR: Oh, they did not. Okay.

DR. KELLY: They did not. They had thermal imaging capability, and so that was one way they were trying to measure the temperature of the spent fuel pools.

MEMBER STETKAR: But in terms of -- NNSA was providing --

DR. KELLY: Right.

MEMBER STETKAR: -- this is the only source of this information.

DR. KELLY: And, you know, we -- every time you do this, and especially internationally, it takes a little while to get the protocols all quite right. So initially we were having -- we had the information. We were providing it to our Embassy. We informed the Japanese that we had this data. They had actually asked us to do this. And then, we worked out a way so that we could share it. So it ended up being posted daily on the DOE website.

CHAIRMAN ABDEL-KHALIK: You indicated earlier that the NRC provided the source term for

Livermore --

DR. KELLY: Right.

CHAIRMAN ABDEL-KHALIK: -- to do these plume model calculations. Was there any attempt by the labs to sort of develop a source term estimate for it, an independent --

DR. KELLY: They went -- so they have a code called RASCAL, which I think has the NUREG-1465 source term in it and various modeling. So that was one piece that was used initially. Then, they went to Sandia and asked for, you know, more scenario -- as we learned information, you know, what would this scenario actually give you in terms of fission product release. So we sort of had a best case/worst case -- what would they call it -- it was best estimate bounding source term or something.

CHAIRMAN ABDEL-KHALIK: So that was developed by Sandia.

DR. KELLY: And then, that was put into NARAC. I think we learned -- there was some learning there that NARAC really hadn't been set up for that kind of interface, and so it was kind of cumbersome and took -- and it was difficult to do quick turnaround, because that had not been put together, that interface. With RASCAL, I think it was already in place.

So in terms of our office, we formed something called the Nuclear Energy Response Team. We spent a lot of our time assessing and clarifying information for our leadership, because we're seeing I think a lot of erroneous press reports, and there was a lot of concern about what was going on. And so we were, you know, looking at that trying to rationalize it.

We took the approach that we needed to keep an open mind, that we needed to be able to explain hopefully all of the data, or the majority of the data observations that we were seeing, before you had a theory, so there were multiple theories for the same data sets.

And then, we tried to assign probability such as this is likely, not very likely, you know, to that, and then that helped I think put it in perspective that the data could mean something else. And so we were always trying to envision what could the data actually mean, and the horror stories were kind of coming out.

We supplied watch standards to people on the shift work, and then we organized our response to the questions from the White House, Embassy, and our leadership.

In terms of the way we organized, it was really around these four or -- sorry, five main areas. First, work associated with how to stabilize the reactors and spent fuel pools. That was important to get the stability. We are also concerned that you had to do things to get the radiation levels down, so that the workers could go in and do things, because if the radiation levels were high, they were still not in a very good state.

Because of the high probability of recurring earthquakes, you needed to install some remote operations capability. Over time, they were able to get remote controlled vehicles that could spray water into the spent fuel pools, for instance.

And then, you know, even though the containments may be leaking, we still need to be concerned about their long-term integrity. You know, complete failures of the containment could make this accident become even worse, even today.

And then, if the situation really becomes very worse, we need to plan for that situation, something like Chernobyl sarcophagus type of thing. If the situation were to worsen, this is how we'd frame the problem in the first couple of weeks.

CHAIRMAN ABDEL-KHALIK: So how would you inform that last box?

DR. KELLY: I'll get to what we did on each of these.

So the way we did it is we identified what the potential threats were and what the -- you know, what the mitigation strategies would be. So I don't want to go through all of these in detail, but, you know, we are worried still today about potential core melting to the vessel and backing the containment. That cannot be ruled out until you can manage the decay heat.

Lots of concern about hydrogen explosion and containment, because we didn't know -- we were pretty sure there was still probably hydrogen in the containment, but we didn't know how much oxygen was in the containment. And so if you started various mechanisms that would begin to condense the steam in the containment, and oxygen could come -- the principal source of oxygen was the water we were putting in, we thought.

So we put all of this water -- seawater or even the freshwater had a certain ppm. And if you put enough of it in, you're going to get oxygen concentrations that could take you into the flammable regime.

Spent fuel pool fires, another earthquake, corrosion of the intact fuel, eventually there is zirconium cladding, which would lead them to another release of -- the gap release for those, so those are all things that could happen.

But basically, the idea -- you know, what we wanted -- needed to do was to help inform them about getting more water into it. We eventually -- I think we communicated to them the concern about oxygen, so they ended up treating the water with hydrazine to take the oxygen out before they put it into the system, to try to mitigate that hydrogen threat downstream. But, you know, these were the kinds of things that we thought would be important.

In terms of analysis, as I mentioned, we were doing estimates on oxygen. And I'll talk a little bit more about the next one, which is long-term decay heat removal for a couple of slides. We did a lot of talking and thinking about new sensors. I think that was talked about earlier today -- just simple things, water level, radiation, you know, these type of things. You know, whether -- we looked to see if we, you know, have anything available to send over, but that looked impractical.

We then also looked at, could you restore failed sensors? And these water levels are based on some pressure differential. We think that if you could blow air through it, you might be able to clear the aerosols that have probably plugged it when the core -- when the water level went down. That's our theory at least. And, you know, you may be able to regain that kind of instrument.

Lots of other analysis about mal progression, recriticality, steam explosion potential, boil-down rates, the effect of salt -- and that's still one that we don't fully understand -- mass and energy balance, air ingress, all of these things that were related to potential threats.

Now, this kind of shows schematically all of the analysis that we did. It is dozens of different kind of calculations that were done. Some of these have reached the point where they are written up and we can publicly release them. Not all of them will get to that point, but my goal was to, you know, as we move through this, bring these analyses, as many as we can, to some set of closure, so that we will inform people in the future about what could happen, you know, in this kind of accident, and really gain some insights as we move into the lessons learned phase.

So I think we need to -- we are paying particular attention to documenting what we did, so we don't lose all this valuable information that --

CHAIRMAN ABDEL-KHALIK: And the intent is for all of these documents to be open to the public?

DR. KELLY: I think so. I mean, we are trying to resolve any issues of proprietary data with TEPCO. That will get resolved, I believe, as they are moving toward releasing more and more of their data. And there may be some other -- I don't think there will be any other issues, but we will just see. That would be the only one that I would think we would be concerned about.

One of the things, though, that Japan is conducting an investigation right now on the accident, and we don't want to do anything to prejudice their decisionmaking. So things that we have done are going to lag -- our release of information will lag anything that they do.

CHAIRMAN ABDEL-KHALIK: Okay.

DR. KELLY: One thing that we paid particular attention to -- and it's still a subject for discussion -- is, how do you cool the reactor? It's bottled -- you know, the core is bottled up, and there's no pathway outside of the containment to get the heat out. So they are basically stuck with a feed-and-bleed type of cooling system, which isn't good for a number of reasons.

One is it's difficult to control it exactly. They don't have a lot of instruments to understand how much water to put in. And at the same time, when they -- when they bleed, they are releasing radioactivity to the environment.

MEMBER CORRADINI: And where is the bleed occurring? Is it different for each different unit?

DR. KELLY: I think it's coming out from head seals at this point, so --

MEMBER CORRADINI: The head --

DR. KELLY: Either the -- yes, the drywell seal.

MEMBER POWERS: It's a silicon rubber seal. The Japanese have actually done experiments on it and says that it -- it really cannot stand a prolonged exposure to elevated temperatures and radiation loads for --

MEMBER CORRADINI: So this is a gaseous leakage through the head seals.

DR. KELLY: Yes. Yes, I think the steam will find a way to get out, and so it's not -- I've been informed that it's not deliberate venting, that it's --

MEMBER CORRADINI: Okay.

DR. KELLY: -- just --

MEMBER STETKAR: They're not venting through the drywell head vents or anything like that?

DR. KELLY: Not to my knowledge.

Now, this is recent data from a few days ago of the radiation levels, which are showing ranges of one and a half to four and a half R per hour, and this is on the -- I think the lowest level of the reactor building. And it turns out that this is the level where the RHR pumps are located.

Now, we have information that there was water in this area, so the RHR pumps may be inoperative. There's a high rad level, so it will be difficult to go in there and do things. And the other thing is if you turned them on, you would be pumping contaminated water out of the containment into the -- what is left of the reactor building. That is where the heat exchanger is. That's probably not set up.

And we are -- we had Oak Ridge look at, how long would the pumps work, and it would be a very short period of time before the salty fission product stuff would fail the seals and the pumps wouldn't work anyway. So the recommendation ended up being don't try to start the pumps, because they are not going to be effective, and it could make the situation worse, but --

CHAIRMAN ABDEL-KHALIK: Now, back to the feed-and-bleed situation, are they throttling the feed, so that they -- the bleed is actually just steam?

DR. KELLY: Yes.

CHAIRMAN ABDEL-KHALIK: And the motivation for that, rather than increasing the feed rate, is just to limit --

DR. KELLY: There was some --

CHAIRMAN ABDEL-KHALIK: -- the release?

DR. KELLY: There has been a discussion about trying to fill the vessel up and these type of things. And they're worried that there's -- the vessel is leaking, and they would not be able to fill it. But without water measure, water level measurements, it is hard to tell really what is going on.

So we started looking at -- well, if you have to live with feed-and-bleed, how long is it going to take before you could stop feed-and-bleed? The problem is you have this very thick biological shield outside of the drywell area, and so our -- this work was done at Argonne, started looking at the -- you know, what is the rate-limiting heat transfer step in this process. And it's through that wall, and you don't -- it's something like 250 kilowatts, and they are still in the megawatt range.

So you run this out, and for Unit 1, which is the lowest power, it is about a year before you could stop the feed-and-bleed, and it's even longer for the other units. So this is, you know, a very long period of time to have this kind of situation, which in one of the reasons in TEPCO's road map they are looking at adding a heat exchanger or trying to do some other things to begin to get a cooling system in place.

CHAIRMAN ABDEL-KHALIK: And this is based on flooding of the drywell? I mean, the --

DR. KELLY: The previous one?

CHAIRMAN ABDEL-KHALIK: Yes, that says --

DR. KELLY: This is a convection conduction.

CHAIRMAN ABDEL-KHALIK: This is just convection and --

DR. KELLY: Yes, right. And then, what -- could you get water in -- onto the drywell, and by cooling the drywell improve the heat transfer. This would -- if you could do it, this would be good. At least in terms of time, it would reduce that time down to nine months. But then, you know, there is a lot of issues with this. One is that the shield plugs are there, and we are pretty sure the cranes are inoperable. So getting the shield plugs at the -- the shield plugs being that --

DR. KELLY: These big like multiple concrete structures that would need to be lifted with a crane, which might be difficult to take off.

We looked at drilling technology to see if you could use special drilling technology to drill through those rapidly and not drill through the drywell at the same time, and come up with some ideas. So you'd drill two holes, one where you would inject water, and one for the steam to come out.

Those options are still being evaluated, but we basically did the analysis, wrote it up, sent it to Japan, and it's under consideration right now.

On the spent fuel pool 4, we certainly spent a lot of time looking at this, just because it's outside of containment and a huge source term, if it were to --

MEMBER CORRADINI: Let me go back just --

I guess you don't have to go back in the slides, but just -- may I go back? So, then, the ultimate objective is to bring it to cold shutdown, and a number of -- what I'm hearing you say is a number of options are still under evaluation. Not one option has been chosen to bring it to -- to get into a closed loop cooling of other -- whether it be outside containment or internal. Just a number of options are still on the table.

DR. KELLY: Yes. And I think the engineering challenges are immense. So they have begun, as you saw, to go in and begin to do the radiological survey, because if you're going to do anything else you're going to have to send in people. So I think the plan would be to do those surveys, understand the contamination levels, and then decontaminate, so people could work in there, and then, you know, maybe do the engineering.

So I think this is a long-term process, but I think what they wanted to know was, well, how long do we have to wait? It's a long time. So maybe it makes sense to try to go -- you know, have a plan of attack to go in, clean up, and, you know, engineer some systems for the heat removal.

So on spent fuel pool 4, so the explosion occurred in the morning about 90 hours after the earthquake. We think it's about that time. They -- we had some discussion yesterday about it. It was -- I think it was the beginning of the shift, and they -- somebody noted in the log that there had been this explosion.

Now, we think this -- if it had the explosion that -- and the effects of it, somebody would have heard it, I would have thought.

MEMBER ARMIJO: Hard to miss, yes.

DR. KELLY: But anyway --

MEMBER CORRADINI: But it's not clear that it wasn't coincidence with other things that could have --

DR. KELLY: Yes.

MEMBER CORRADINI: -- that could have masked that one versus something else.

DR. KELLY: Yes. I'll talk about what -- you know, what the likely suspects are here. So it was originally attributed to hydrogen, but, you know, it would not be possible to definitely conclude this. And so the original theory was that it was -- water had boiled down, zirconium had overheated, you had hydrogen and, you know, but there was -- you know, that theory didn't fit for a lot of reasons.

One is they had radiological levels or readings, and, you know, above the pool. And so we had Oak Ridge run shielding calculations, and you could quickly see that, you know, the numbers didn't jive. You must have had water there to get such low levels of radiation at the levels they were at. So if it had boiled down, you would have saw much higher radiation levels.

The fission product assays that were being done, you know, the ratios of iodine and cesium weren't right. There was -- there should have been very little iodine, so you would have not -- you can do this forensics work, but basically it didn't look right from the measurements that were coming out. It looked like fission product release from fuel that had been operated recently.

MEMBER STETKAR: John, in those -- the radiological measurements, there was reasonably high confidence that they were reliable above the pool?

DR. KELLY: Yes, but we -- yes. Well, it was like a -- it would have been two or three orders of magnitude higher had there been no water.

MEMBER STETKAR: Okay.

DR. KELLY: So, yes, I think we were on good ground there.

And zirconium fire, once started, is difficult to put out. So you would have expected to see this linger for days perhaps. At least that's the testing at Sandia -- indicates it just won't go out on its own. So there was a lot of I think conflict on that.

And then, furthermore, the calculations we had indicated it would be 10 days to boil down. And so unless you had a major rupture at the gate, or a slosh, big slosh -- again, the slosh was about a meter is what, you know, we think it might have been. It was hard to conclude that.

MEMBER CORRADINI: So if I might just ask, so you said the Japanese had thermal measurements, mapping. So did they see any unusual heatup of this pool?

DR. KELLY: No. They were reading about 80-some degrees Centigrade. So it was -- the pool was warm.

MEMBER CORRADINI: But not overheated.

DR. KELLY: Not at saturation. Now -- we now know that there's lots of debris, and so they may have been -- their thermal imaging may have been reading debris that could have been colder. So the pool could have been closer to saturation.

So the other theory is that there maybe was flammable materials in Unit 4, because they had just begun work to remove the shroud, and so there may have been equipment that had oil for cooling oil, that as the buildings heated up or something the oil leaked and, you know, then it could vaporize and maybe you'd get a pocket of volatile oil, something like that. That was one thought.

Maybe they had acetylene there. It turns out we -- they have ruled out acetylene, but it would have taken about two bottles of acetylene going off to explain the damage that we saw. But that has been ruled out, so I'm not -- on that.

And third was that perhaps the hydrogen was actually transferred from Unit 3, and this is now believed to be I think the best answer. I think there was -- we discounted radiolysis as a source, and maybe there was some -- a multi-dimensional effect in the pool that led to dryout of a section of it. It's kind of hard to envision that, but because of the channel boxes each -- you know, there is no crossflow between the assemblies in the pool, so you could -- if something was going on in one, others may not be affected by it.

But we did have -- you know, we had from

TEPCO the full layout of the spent fuel pool, every assembly, its date, its burnup, etcetera, so we were able to put together a very good model. And, you know, using that, we then, you know, did the calculations to -- for various initial pool heights and how long it would take.

And it was very difficult to -- unless you were at the bottom of the -- I think the refueling gate there, to start with, that you actually could get to the time when hydrogen production from the spent fuel burning could lead to that explosion. The time would -- the water would have had to have been extremely low at the beginning.

So the evaporation blowoff -- as I said, we were calculating about 10 days, and then you wouldn't expect any hydrogen for about 12 to 14 days. And so the explosion at four days, there had to be some leakage -- massive leakage from the pool, and then those -- you know, the numbers, four to five days, pool liner, etcetera.

Of course, we now have video that shows there was lots of water in there, so --

(Laughter.)

-- all this was overcome by events, so --

MEMBER ARMIJO: But also, the -- you know, it's not just that there's lots of water in there, but if you look you can see the fuel handles, you can see --

DR. KELLY: Yes.

MEMBER ARMIJO: -- tops of vent plugs.

DR. KELLY: Right.

MEMBER ARMIJO: That thing was never on fire.

DR. KELLY: So we had speculated about this vent, because we could see from aerial photographs that there is one -- there is fewer stacks than there are plants, and that's because they connect through the stacks. And so we went back and looked, and it -- after the earthquake, these vent lines were still intact. And even after the tsunami they were still intact.

So we speculated that the hydrogen buildup in Unit 3 was massive, and, you know, some of it was heading out the stack and went through -- through the stack back into Unit 4. And then, some hours later either -- maybe it was a steam hydrogen mix, steam condensed, and it went -- we don't know what happened next, but at least that's the thinking right now is the likely source.

I think this is the more likely. There

still could be -- you know, there still could be combustible material as the source, but that's viewed to be less likely now.

MEMBER ARMIJO: But, John, why wouldn't that hydrogen just go right up the stack? I mean, that's what it is there for. And then, to go into Unit 4, it would have to go past a whole number of valves.

DR. KELLY: Yes. We're going to have to get the details on that and look at that.

So the next section had to do with keeping the radiation levels low. Again, I mentioned that if the levels are too high, the workers may be evacuated. That happened a couple of times.

This is still a problem area we see that, you know, basically isolating and stopping whatever reactor pressure vessel leak -- that has not been done yet. They have begun the cleanup of contaminated water by first pumping it out into various storage tanks, and then they are envisioning building a cleanup system. And I'll talk a little bit more about what we think is going on there.

They definitely need to get more shielding there, because it's still going to be hot for people to work. There is a need to get more data and get the additional sensors and redundant -- you know, pH is important to know in a lot of these chemical processes. And, you know, we have seen -- I don't think we have seen any data on that yet.

CHAIRMAN ABDEL-KHALIK: Do we have any idea about extent of salt deposition within the vessel and how that may impact these mitigation activities?

DR. KELLY: I think I have a slide on corrosion and salt. Yes, I will deal -- I will talk about that --

CHAIRMAN ABDEL-KHALIK: Okay.

DR. KELLY: -- because I -- we aren't worried about that.

So these are -- here is the set of technical studies that we did related to this about getting the radiation levels down.

We had the folks at EM put together a quick report on waste management treatment and storage. And this is where the -- so if you extract the contaminated water, and it has salt in it, and they worry about the efficiency of the cesium extraction, there's the presence of salt. And it's degraded, but they have -- I talked to them yesterday.

They thought that their system would still be effective, because they had lots of salt in the

Hanford K basin residue. So they are pretty sure that in terms of extracting -- you know, separating out the radioactive -- at least the cesium out of the water, that the systems they have will still be effective for that. And so we basically put together our concepts of this and transmitted that to Japan.

MEMBER CORRADINI: So the technique is more what would have occurred in terms of Hanford cleanup than what was done for TMI because of the presence of salt or not -- or just because it is known to be more effective in terms of what was done at Hanford?

DR. KELLY: Looking at the situation, I would say it's, you know, similar to Hanford, although I think some of this was done at TMI. I'm not an expert on that.

But basically, what you needed to do was to, you know, get to -- you need to get the water to some place safer so that it reduces the radiation levels in the turbine building, etcetera, and then set up a system for treatment and disposal.

So they are hopeful that they can clean up the water to the point that they can then use it as cooling water for the reactor, so that they get at least a partially closed system.

Let's see, so there are systems that are skid-mountable and are available dealing with all kinds of things. There is oil in the water, so that was one thing that, you know, was another system that needed to be added to this. And there's lots of expertise in the U.S., so this is one where I see a continuing dialogue with TEPCO and the government of Japan on treating and cleaning up the water.

In terms of establishing remote capabilities, again, I mention that if workers have to evacuate things could get worse. So they needed to be thinking about installing various remote control capability, robotics, spiralis systems, etcetera.

So we did end up sending some robotic equipment with instruments on it. NNSA set up a set of radiation monitors around the plant, in a circumference around it, so that it -- they started to have more release. We'd get more data more quickly. Those were tied into a GPS system and through the internet. Data was being relayed back to Washington. So a number of those things were actually put in place and deployed very quickly.

The other area of big interest was maintaining the integrity of the containment, whether it be due to corrosion or another -- a hydrogen explosion, melt-through, overpressure, failure of these silicon rubber head seals.

The key here we thought was to -- you are going to have to design a system at this point to extract coolant from the primary -- reactor primary vessel, treat it, either store it, and then recycle it in some kind of concept like that.

So, again, we conducted a number of studies looking at oxygen. Again, I mentioned that previously. We did start looking at the corrosion of the reactor pressure vessel and trying to make estimates of how long it would take for the reactor vessel to be corroded through by the saltwater and salt, because we're pretty sure there is significant quantities of salt that have actually precipitated out of the seawater.

And then, we developed a different conceptual model for removing reactor pressure vessel water, so the previous system I talked about was for turbine building, things in the sumps of reactor building that had leaked, it has already leaked out.

This system was to look at, how could you take one of the existing penetrations into the reactor pressure vessel and use that to develop a system to treat the water?

MEMBER STETKAR: John, just before you get too far into the corrosion stuff -- I was just thinking, since several of these systems will need to remain operable for months, if not longer, have the various organizations thought about the possibility of not necessarily a magnitude nine earthquake --

DR. KELLY: Right.

MEMBER STETKAR: -- but, you know, pick a magnitude six earthquake, for example, occurring near the site.

DR. KELLY: Right.

MEMBER STETKAR: Are you thinking about pardoning the equipment at all, or have those thoughts --

DR. KELLY: We have recommended --

MEMBER STETKAR: The good news is you have longer time, because you are much lower --

DR. KELLY: We have certainly recommended --

MEMBER STETKAR: In terms of releases and things like that, it could be --

DR. KELLY: We have recommended that, and we understand that they do have alternate power and heat sink capability now.

MEMBER STETKAR: Okay.

DR. KELLY: We also have set up some ARCOFF analysis to try to understand how things would progress if you had a fault. So we're trying to mock-up what it is just to -- it's more to find out how much time you have to --

MEMBER STETKAR: I mean, that's the key.

DR. KELLY: -- time to recovery. It's not predictive in that sense, but it's to get some time estimates for when it can go.

MEMBER STETKAR: Okay. Thanks.

DR. KELLY: Again, this is for the recovery phase. There is another whole set of calculations that were done, and, you know, we -- yesterday we went through some of these, and it took a whole day. So I would suspect, you know, we could easily put together a multi-day briefing on what -- you know, all the work that DOE collectively did. It's quite interesting.

MEMBER CORRADINI: Can I go back to John's question? Maybe I'm -- so I'm sure there were a bunch of aftershocks. So you know that -- how many aftershocks were there above some magnitude? So to give a feeling -- I would assume a bunch.

DR. KELLY: What was the number, a dozen?

MEMBER REMPE: There were 500 within the

first week. I have seen -- I have a viewgraph that has like maybe 10 of them based on USGS that were above six that were from the day of the event through -- you know, but it -- I can't give you exact numbers here. I haven't counted it.

DR. KELLY: All right. So I think that's -- you know, one of the reasons they are -- because of the explosion in Unit 4, they are I think worried about the integrity of the building, and so that is why they are trying to increase its seismic capability.

So a little bit about corrosion. Our understanding is that they may use this A533B steel, kind of an industry standard. I'm not an expert in this area, but that's what the folks at Oak Ridge -- I believe. They may need to confirm that.

Very little data on this class of steels and salts or concentrated salt solution. And it's not a typical choice for that type of application.

I probably had not really thought about salt and water into -- in the reactors before, although it had happened at Millstone in '72. They had a condenser failure, and they got some salt in and it destroyed a lot of their power detectors, you know, power monitors, and they saw some stress corrosion cracking, things like that. So they had -- that was '72, I think there was a report on that, and --

MEMBER CORRADINI: The Navy has no experience --

DR. KELLY: Well --

MEMBER CORRADINI: The Navy experience doesn't fit into this mold I guess.

DR. KELLY: I think they use cath anode or something. You know, they use systems to --

MEMBER ARMIJO: Cathodic protection and all of that.

DR. KELLY: Cathodic protection is the word.

MEMBER ARMIJO: Are they deaerating the water that is -- the contact?

DR. KELLY: They are deaerating the water now.

MEMBER ARMIJO: Nitrogen sparging or --

DR. KELLY: They are using hydrazine.

MEMBER ARMIJO: Hydrazine.

MEMBER SHACK: It's much more effective, even if it leaked hydrazine.

MEMBER ARMIJO: Well, maybe.

DR. KELLY: But here is the information on Millstone. It was September of '72 and --

MEMBER BANERJEE: Got a lot of hydrogen anyway.

DR. KELLY: So seawater was introduced into full-flow demineralizers, so they got this indication of high conductivity. And, anyway, they started just seeing all of their local power range monitors fail, and so this -- then, they scrammed, and, you know, found out what was happening.

Stress corrosion -- they did a full inspection. Stress corrosion cracking was observed in other reactor components and considered to be superficial. And then, GE followed up with additional tests, found it to be more severe than the actual accident.

So we expect that the stainless steel components will be cracking in this salt solution. Now, you know, if it's the liner and the vessel head, you still have a lot of material before you would corrode through that, so you may have time. But a lot of -- so many penetrations in the bottom of the BWR that it's hard to say that you would -- we would not get some cracking leading to potential penetration.

MEMBER ARMIJO: That's weld overlay. It's duplex microstructure, very resistant to a lot of this cracking. But, you know --

MEMBER SHACK: This is chloride cracking, though, Sam. This isn't our old favorite.

MEMBER ARMIJO: Okay. So it may have some.

DR. KELLY: So we actually don't know for sure, so we -- we are actually putting together a test matrix to try to think about what testing we could do to get our arms -- because we don't know -- we think it's -- I think the data is here, corrosion rates for carbon steel, and there was some limited data on low allow carbon steel. And that was mils per year or a few mils per year, a hundred if there was sulfuric acid present. If it's just eating through the head, that's a long time.

MEMBER CORRADINI: It's more the connections, the weldments.

DR. KELLY: Yes. It's probably the connections and weldments. So we really don't know how long, and so this is still a concern of getting more massive failure of the lower head, in which case, you know, having the containment flooded up if it's capable would help mitigate that.

MEMBER ARMIJO: Is there an assessment of how concentrated the water is in those vessels, what the saltwater concentration -- salt concentration is?

MEMBER POWERS: At least .5 molar.

(Laughter.)

DR. KELLY: We think it's --

MEMBER POWERS: Less than six and more than .5.

DR. KELLY: So seawater is about three percent salt, and the solubility is about 30 percent.

And so when you boil, about 10 -- 10 RPVs full of water out, which they would have had to do, you will get -- the salt will stay and the steam will leave, and so you will easily get up to the precipitation limit. So the estimates were somewhere around 100 to 200 tons of salt, which could significantly fill the lower head.

In terms of the area's emergency response, there wasn't that much done here except we did some work on developing bounding source terms, really to inform -- at this point, it's more to inform evacuation procedures rather than thinking about entombing the reactor. So it was, you know, do you shelter, do you evacuate, and that was a function of, you know, what bounding source term would -- could still be evolved as the accident progresses?

So we have the initial one, but there is -- now out and largely deposited, but if you had another one, what could happen? So this was the -- you know, a second phase of emergency response if something happened again.

MEMBER RYAN: Can you describe that in terms of fraction of intact material in the reactors that would be engaged in that --

DR. KELLY: Yes. So what we were looking at was, you know, where is the cesium, where is the iodine now? How much has already been release? How much is there? And we're using MELCORE to do that partitioning.

You know, the code says most of both the cesium and iodine are still in the water. Less than one percent has actually been released to the atmosphere, and that's -- so they had about 500,000 curies, and that number is somewhat consistent with the radiological measurements. And we haven't pulled all of that together to get the coherent picture, but that number, like one percent-ish or so, of cesium and iodine release is not inconsistent with the --

MEMBER RYAN: Well, I mean, that's -- you've got source term still in the plants and on the ground. They local.

DR. KELLY: Right. And then, you know, we didn't see the strontium yet, so we're not -- we don't think the temperatures were hot long, or it's in solution as well I guess.

MEMBER BANERJEE: Did you see any ruthenium?

DR. KELLY: No. I don't --

MEMBER POWERS: You are never going to see any ruthenium in these kinds of plants.

DR. KELLY: Now, they did see plutonium-238. They are still -- we are still not sure what --

MEMBER POWERS: You will see plutonium --

DR. KELLY: Yes, Unit 3 was running on mixed oxide.

MEMBER POWERS: John, you will see plutonium in Japan anywhere you go. And you will see plutonium in Colorado anywhere you go.

DR. KELLY: Yes. But 238 would be odd to see.

MEMBER RYAN: Did they have any gauges or --

MEMBER POWERS: No, I don't think that's --

MEMBER RYAN: -- because it might have a seal, 238 seal.

DR. KELLY: Yes, so that's another one,

another piece that we'll have to -- yes, did they have sources or something, yes. Anyway --

MEMBER POWERS: But, I mean, the whole thing is quite remarkable, I mean, that you have damage to three units, maybe a couple of spent fuel pools, we've got a megacurie or so of cesium outside the plant.

DR. KELLY: Yes.

MEMBER POWERS: I mean, that just shows you how much defense-in-depth you have, even when things get very, very heavily compromised here. I mean, there is a tremendous -- had you asked me a priori, before the event, you had this sort of event occur, what kind of source term would you expect, I would have written out a much more severe set of numbers for you.

DR. KELLY: So, but you know there's still a lot of work that has to be done. The clean-up as well as stabilization. And so I think we're -- Again another large earthquake could maybe again disable cooling. And our estimates are not that it's on the order of 10 hours. If they lost cooling, it would be 10 hours before they would begin to remelt.

MEMBER BANERJEE: Does the analysis with what measurements you've been making? The plume analysis?

DR. KELLY: Qualitatively. But there is --

MEMBER CORRADINI: You're saying in terms of -- I guess I want to understand. Sanjoy --

MEMBER BANERJEE: I want to actually work backwards and see if the source term is correct or not.

MEMBER REMPE: And that was based on the later melt core source term.

DR. KELLY: Right. There were two things. So the plume analysis is with this NARAC code. They were just doing unit source term.

MEMBER RYAN: There was no exposure measurements. It's hard to calibrate.

DR. KELLY: They weren't doing the detail. But that pattern of having this direction in the northwest, if you put in the weather, the winds and rain, you've got a majority of the deposition along that path. So that's why I say it's qualitative. Qualitatively it was showing that that should have been the highest region and that's what it was.

MEMBER BANERJEE: But you couldn't back out whether your source term was --

DR. KELLY: We're going to try to take a

look at that. But because we had three different source terms kind of overlaid and at different times it's going to be a --

MEMBER BANERJEE: Yes, it's a difficult problem.

DR. KELLY: But that certainly -- The folks at Livermore are very interested in getting that data to help improve the validation of their modeling.

MEMBER RYAN: I'm guessing with the rainfall that occurs fairly routinely in Japan it will be hurt to get enough of that plume measured within a reasonable --

DR. KELLY: Yes. We're going to have to rely on a lot of the data we already have because they're heading into the rainy season pretty soon.

MEMBER RYAN: Right. So it's going to wash away.

DR. KELLY: It's going to wash -- So in terms of -- My last slide and then we can have questions. Next steps. So we're continuing our support for the Government of Japan. We see our role as providing peer review and analysis as requested. So as they move forward with their engineering designs, they've been asking us for our evaluations. We've been giving them feedback. So I think that kind of thing will continue.

We have been collecting data. We've been trying to understand, doing the accident forensics and eventually lessons learned. We see that kind of activity continuing.

And we're staying vigilant on potential accident consequences. So there are questions about evacuation zones. The Ambassador is visiting us in two weeks. And I'm sure we'll have a good session with him to see what's worrying him today and how we can help do analysis and other things, sort through it.

MEMBER RYAN: Has there been any advanced planning on where all the waste material is going to end up?

DR. KELLY: The plan we saw was to basically create an onsite low level waste storage area.

MEMBER RYAN: That's storage. But what's the ultimate call?

DR. KELLY: You know, that may be 30 years or more before they could reuse the site. So maybe almost permanent.

MEMBER POWERS: I'm telling you, Ryan, that we've got the merry, honest French there.

DR. KELLY: You know, they're trying to figure out how this -- It's going to be complicated. They're going to have to bring in vehicles and they want to have a clean path so they can bring in things that don't get radiologically contaminated. So then they're have a cordoned-off area where they'll deal with that.

This was briefed to us -- I don't know if it's a plan. I can't remember who was -- the company that came in. But they had this plan of setting up a region on the site where they would do the storage. And whether then it could be repackaged and transferred later, that was to be determined.

MEMBER RYAN: That raises some interesting questions about do you want to continue on-going activities like that on the coast and then under not ideal conditions. So that's a challenge I think ahead.

CHAIR ABDEL-KHALIK: John, we heard earlier from industry that one of their goals is to be able to handle any nuclear accident in the U.S. and also be able to provide a response overseas. Have you given much thought to DOE's role in such a response capability?

DR. KELLY: Yes. Well, clearly, this lack of instrumentation measurements is really severe. We think that there may be capabilities within our laboratories to invent new instruments that could be deployed. And so that's one area for research.

When I think about it, I kind of put it in a research terminology. Because I think if industry has capabilities DOE doesn't need to do things. Industry can do it. But if there's a new technology that's needed, perhaps.

You know, we have a very good system for responding to other type of nuclear incidents. And so maybe having more capabilities, stage capabilities, these types of things, might be useful. And I think DOE has some of those capabilities. There may be a way to think about how these could be used in the commercial sector.

MEMBER CORRADINI: Maybe just a follow-up then. So are you then discussing it not just within NE but within EM and NNSA?

DR. KELLY: Yes. Because there's much more to DOE than just NE in terms of --

DR. KELLY: Yes. It's more than just NE. So I'm talking more broadly now.

MEMBER CORRADINI: The same triad.

DR. KELLY: We're already doing research

on zirconium-free cladding which would be a big benefit. Silicon carbide cladding. So that's been a research area. And it was really to get over some of the materials issues with high burn-up with zirconium. But there's also always the hydrogen issue if you use that.

CHAIR ABDEL-KHALIK: My question really was aimed at any response activities associated with that "coordinated response" that the industry would provide. Do you foresee a role for DOE?

DR. KELLY: Only if there's technology development needs and perhaps some learning from what we have in terms of the response for like nuclear weapon incident. We have a response time. That capability is in place. It's tested.

So there is certain learning if we wanted to stand up. I think Jim Ellis at INPO has suggested something like this. And I think they're certainly learning from it, the NNSA folks, that could be had from that. And then there may be some capabilities that need to be developed that aren't in the commercial sector. And again there would be a role for DOE there.

CHAIR ABDEL-KHALIK: Okay.

MEMBER BANERJEE: Going back to Unit 4,

the explosion, have there been any observations planned or have there been observations already of the fuel to see if the cladding may have reacted? Because that's one of the scenarios we discussed. Right?

DR. KELLY: Yes. So they have had a camera dangling on this water crane pan over it and you can see things pretty good. You can see the handles. You can see the identification numbers on the assemblies. It certainly doesn't not look like degraded.

Now the best pictures are of unburned fuel. So they had a lot of fresh fuel that was going to be loaded in in there. And there's a region that they just didn't pan over. So that's one of the questions we're going to have.

MEMBER BANERJEE: That's rather unlikely that scenario then.

DR. KELLY: That the zirconium -- Yes.

MEMBER BANERJEE: Yes.

DR. KELLY: I think that's one of the least likely scenarios --

MEMBER BANERJEE: Okay.

DR. KELLY: -- when you have a zirconium fire. And as I mentioned there was a number of other data pieces that did not correlate with that hypothesis.

MEMBER BANERJEE: Thanks.

MEMBER SHACK: Did they have water chemistry samples?

DR. KELLY: The water chemistry is another one that doesn't -- The cesium that they detected is equivalent of the cesium in one -- is less than the cesium in one fuel pin.

MEMBER STETKAR: If there's indications of water, I don't know how their pools are configured, but they typically will have weirs between the different pool sections. If there's indications that water level remained above the sections of those weirs, the entire fuel pool was --

DR. KELLY: You know, these are some of the things you learn is that what they worry about is not overfilling. And so they have measurements close to the top because they probably didn't envision wanting to know where it was when it went down. So they've got --

MEMBER ARMIJO: It was flooded up for this major maintenance.

DR. KELLY: Yes.

MEMBER ARMIJO: So there was plenty of water there. The question, did it leak out through the bottom as a result of the earthquake and then caused a fire? And you know those early thoughts seem not to be supported.

DR. KELLY: Yes, it's hard. If there is a leak, we think it's small. We found out what kind of sealing mechanism they use for the gates. I think it's a seal that seals with hydrostatic pressure. So maybe there could have been something but it would reseal. We think it's unlikely that that's the scenario. The data just doesn't line up to that.

MEMBER BANERJEE: So it's either something was there other than the hydrogen most likely or a hydrogen leak from somewhere.

DR. KELLY: It was either other combustible materials that we haven't discovered. And if they could get into the building they should be able to -- the observation tunnel.

The explosion they thought started lower, too, which was --

MEMBER ARMIJO: You see the building was destroyed at the base.

DR. KELLY: Yes. So it was low which then points to the hydrogen coming from --

MEMBER BANERJEE: Somewhere else.

DR. KELLY: If it was hydrogen from

somewhere else, yes.

CHAIR ABDEL-KHALIK: Are there any additional questions for John?

MEMBER ARMIJO: John, have you communicated directly with the plant designers, the GEs?

DR. KELLY: I was at the GE Emergency Center on like the 13th of March. It turned out the PSA conference was held in Wilmington. So I took the opportunity to go over. I know that was really good. So we've established that liaison, too. So that when we need information on the GE plants we've got that network in place.

MEMBER ARMIJO: And so you feel they're giving you the information you need.

DR. KELLY: Absolutely. Yes. And they've been part of these consortium calls, too. So it's been a real coming together of all the nuclear expertise in the country to help.

MEMBER ARMIJO: Because early in the event there was a lot of uncertainty whether the Japanese plants were very similar to the U.S. BWR4s, Mark I containments or not including hardened vents or not hardened vents. All those sorts of questions. Has GE helped you resolve that since they designed and built at least Fukushima 1.

DR. KELLY: Well, they had some information. They were the builders of the 1 and 2. And then I think it became Hitachi and Toshiba.

MEMBER ARMIJO: Right.

DR. KELLY: And of course they're connected to Hitachi now. So there's information going back and forth on that. But you know unless you get the actual as-built you maybe can never know for sure. The hardened vents would have been an Adder, post TMI.

MEMBER ARMIJO: Yes.

DR. KELLY: I think there are still some questions about getting the details and then really understanding the vent pathways still part of the puzzle on the Unit 4.

CHAIR ABDEL-KHALIK: Joy.

MEMBER REMPE: I want to pick on you with the same questions that we picked on with Tony towards the end. I think there's a lot of key uncertainties and it could help us with our state of knowledge and how we address severe accidents.

And I know it appeared that Tony said, "Yes, we need to go in and see that information." It may be five years or more before we ever do. And industry might be able to throw some support as Dana suggested.

But it's my opinion that would happen at TMI. It was an OECD type of effort and NRC and DOE did it together. Have those kind of discussions been ongoing at DOE?

DR. KELLY: Yes, I think that's one of the areas that we've identified. And at this point it's to understand where we think we would have validation needs for our severe accident modeling capability. Because what we want to do is take whatever information we can gain from this, understand how well our codes predict because we rely on those codes a lot to inform our risk assessments and accident management and all kinds of things. And so we want to know are they valid.

As we go through this we have uncertainties identified in our analysis. Those will point to data needs that could be had when they begin to dissemble the core. So they can -- As they did before, if they take sections so that we can do the metallography, etc. we should be able to go in.

MEMBER REMPE: But as Dana pointed out there may be a lot of push.

DR. KELLY: There will be a need for

expediency now. So I expect -- I mean we already have very strong bilateral relationships with Japan. And I expect that to continue and strengthen as we move forward.

Together we have more of the GE BWRs in the world. So there's a lot of interest in us understanding the implications. I think there will be an even stronger need to collaborate on that. So there may be joint efforts and things like that. If that comes into play, then we will at least encourage data recovery to support code validation.

MEMBER STETKAR: Let me put you on the same point I put Tony. He mentioned the current IAEA teams on the ground collecting information, doing for lack of a better term forensic analysis I guess. Are you plugged into that effort? Or you mentioned bilateral agreements between the U.S. and the Japanese government. How is all this playing out?

DR. KELLY: I'm plugged into some of the IAEA activities. So I'm not exactly sure -- They were over there before. And my understanding was they had some real problems with their data collection previously.

MEMBER STETKAR: Okay.

DR. KELLY: And they were just doing

measurements on the ground. I don't know what the current team is doing other than that they're going over there.

But there's a huge IAEA meeting at the end of June. And we're currently developing an action plan which will be a plan for all the nuclear nations in the world to work through IAEA to do a set of activities. That's currently being developed and will be rolled out in the end of June time frame. And there will be a whole set of meetings over the next year on all of these things.

In terms of collecting data, verifying it, documenting it, these types of things, I think that -- people may differ -- there's merit to having different sets of eyes look at the same thing. And if you can afford to do that and then come together and do the cross-checking, it will hopefully help the whole international community have a set of reliable data.

There were still lots of mysteries with the Three Mile Island data years later. We know a lot more about severe accident phenomenology now. So we're able to more quickly assess things.

But to my knowledge I don't know who the experts are with IAEA, who they've picked up to go over there. But the severe accident expertise is in the DOE National Laboratories in this building. So it's data plus analysis that go together to help you understand what the data is saying at the same time.

I think we have a lot to bring to bear on this problem. Having a data collection, verification, analysis, cross-checking, we'll be doing that ourselves. But then having international community involved I think will be a good thing long term.

MEMBER STETKAR: Thanks.

CHAIR ABDEL-KHALIK: Are there any additional questions for John? Well, let me just on behalf of ACRS say --

MEMBER POWERS: Can I just ask one question?

CHAIR ABDEL-KHALIK: Sure.

MEMBER POWERS: Do you want me to come over and stage your garden?

(Laughter.)

DR. KELLY: Can you stop by once a week? I still have my home in Albuquerque.

CHAIR ABDEL-KHALIK: I may make that assignment later. But on behalf of ACRS, let me just thank you for taking the time from your very busy schedule to brief us.

DR. KELLY: You're welcome.

CHAIR ABDEL-KHALIK: Thank you.

DR. KELLY: Thank you.

CHAIR ABDEL-KHALIK: At this time we will take a roughly 15 minute break. And we'll come back to hear the public comments and have additional discussions amongst ourselves. So let's reconvene at 4:05 p.m. Off the record.

(Whereupon, the above-entitled matter went off the record at 3:52 p.m. and resumed at 4:05 p.m.)

CHAIR ABDEL-KHALIK: On the record. We're back in session. At this time our schedule calls for us to hear from the public. And as I mentioned in the opening remarks, we received a request from Mr. Arnold Gundersen to make a comment. And he has been allotted five minutes to do so.

So I would like to ask the staff to open the bridge line so that Mr. Gundersen (1) can let us know that he's here and (2) make his remarks. Bridge line open.

PARTICIPANT: Yes, the bridge is open.

CHAIR ABDEL-KHALIK: Okay. Mr. Gundersen, are you on the line? Is there anyone else on the line who can let us know?

MEMBER CORRADINI: Now maybe it's open.

PARTICIPANT: Please let us know if you're on the line.

MR. GUNDERSEN: Hi. This is Arnie Gundersen on the line.

CHAIR ABDEL-KHALIK: Yes, Mr. Gundersen you have five minutes.

MR. GUNDERSEN: All right. Thank you very much.

Good afternoon, Mr. Chairman and Members of the Advisory Committee on Reactor Safeguards, I speak to you today as a (telephonic interference) I have not been retained by any group to make a statement at this meeting.

Although there are many issues to resolve as a result of the nuclear accident at Fukushima I want to focus on the single statement of integrity in the brief time you've allotted me.

CHAIR ABDEL-KHALIK: Mr. Gundersen. We're having some difficulty hearing you. So if you try to -- If you're sort of speaking into a microphone, try to minimize any physical contact with the microphone.

MR. GUNDERSEN: I'm sorry. Is this better?

CHAIR ABDEL-KHALIK: Yes.

MR. GUNDERSEN: Okay.

CHAIR ABDEL-KHALIK: Please proceed.

MR. GUNDERSEN: Okay. I first wrote to you, the ACRS, in 2005 to express my concerns on Vermont Yankee and the net positive suction head lever the ACRS had granted to Vermont Yankee.

In 2008, (telephonic interference) was retained by SECAM to analyze the containment.

PARTICIPANT: Excuse me.

MR. GUNDERSEN: I wrote ACRS regarding my belief that the containment volume to power ratio at Millstone was the smallest of any Westinghouse plant. At that meeting the ACRS was told by the NRC that (telephonic interference) analyze the containment system.

In 2009 --

PARTICIPANT: Excuse me. Can I interrupt? I think people either in the room or on the line that need to mute their lines or just stop making noise next to the phone because I don't think that the static is coming from Mr. Gundersen. Thank you.

CHAIR ABDEL-KHALIK: If there are other people on the line if you could please mute your microphones on your end so that we can hear Mr. Gundersen clearly. Thank you very much.

Mr. Gundersen, please proceed.

MR. GUNDERSEN: Thank you, Mr. Chairman.

Did you hear what I had said already or should I start again?

CHAIR ABDEL-KHALIK: No, we have heard up to this point. So please proceed.

MR. GUNDERSEN: Okay. Thank you, Mr. Chairman.

In 2009, Citizens Power retained Fairwinds to analyze a hole found in Beaver Valley containment. My analysis was also provided to the ACRS.

In 2010, I met with you as a candidate for an opening on the ACRS and we discussed positive suction head and its relation to containment integrity. I notice that the Browns Ferry unit had not been allowed the NPSH credit. But the ACRS granted that credit to Vermont Yankee five years earlier. It was illogical for the people of Alabama to have more accident protection than the people of Vermont.

In 2010, at the AP 1000 Oversight Group Fairwinds was retained and in April Fairwinds provided to you a report detailing a long history of containment failures around the country.

In 2010, (telephonic interference) met with you for an hour and half to delineate my concerns reporting doubt of a containment integrity of the AP

1000 design.

In December I wrote you again, notifying you of a significant amount of additional information about containment failure due to flaws. Each time I have contacted you, containment integrity data had been rebuffed and ignored.

The accident at Fukushima has confirmed my belief that the leakage of a nuclear containment cannot be based upon the assumption of a leak rate of zero as used by the NRC. Just this week Tokyo Electric has finally acknowledged that all seals of Mark I containment systems are leaking significant radiation to the environment and at least Units 1 and 2 began leaking on the first day of the accident.

Unfortunately, the possibility of such containment failures to which I alerted you for the last six years has been proven correct. It was no surprise to me that the containment systems have a long history of leaking and have now failed three times at Fukushima. Yet it apparently comes as a major surprise to the NRC.

The ramifications of a nuclear reactor containment leakage and failure of the NRC and its body to consider are: (1) the SAMSA analysis of Westinghouse AP 1000 design (telephonic interference) that there is zero probability of a containment leak of any magnitude. When historical record prior to Fukushima proved this assumption fault and the Fukushima containment failure of the AP 1000 design be analyzed and retrofitted with charcoal filters on top of the shield built.

MR. WARREN: Pardon me. Arnie?

MR. GUNDERSEN: Yes.

MR. WARREN: This is Jim Warren. Can you hear me?

MR. GUNDERSEN: Yes, I do.

MR. WARREN: I apologize for interrupting. But there is so much noise on the phone bridge it's obvious that some people are not listening. And others that are on the phone cannot hear the presentation.

CHAIR ABDEL-KHALIK: Sir, I have asked all others except for Mr. Gundersen to mute their phone so that we can hear him without interruption.

MR. WARREN: Thank you. That's all I'm asking is that we can all hear him and that we all listen. Thank you.

MR. GUNDERSEN: The ACRS has granted net positive suction heads credits to numerous reactors around the country in violation of Regulatory Guide 1.

Today in a simple stroke of the pen the ACRS can acknowledge this erroneous decision by requesting the NRC staff to revise the licenses of reactors so that every reactor is in compliance with Regulatory Guide 1. And with this simple one stroke of a pen you can make all the reactors immediately safer than they are today.

Everyone sitting at the ACRS today knows that the pressure suppression containments on GE BWRs were inadequate when they were first designed. As a result of that design inadequacy, boiling water reactor containment vents were added in 1989 to prevent containment overpressurization. Currently, there are 23 Mark I containment systems in operation. All Mark I have vents that were added as a bandaid fix.

Events at Fukushima show that this fix did not work. I urge the ACRS to evaluate containment venting to determine whether or not any of these reactors --

(Simultaneous speaking.)

-- a single operation.

(4) The ACRS should stop license renewal of any BWR until the Fukushima accidents have been completely analyzed.

For the record and finally, Fairwinds finds it disconcerting that both NEI and DOE have been granted an hour to make a presentation to this body when NEI and DOE have responsibility for promotion of nuclear power. I brought these containment integrity issues to your attention for more than six years.

In closing, I strongly suggest that each of you as members evaluate the bias you bring to the table when listening to experts with whom the nuclear industry disagrees. Thank you for your time, Mr. Chairman. I'll gladly brief you in detail if you choose.

CHAIR ABDEL-KHALIK: Thank you, Mr. Gundersen. We would appreciate it if you provide your comments in a written form just in case we missed.

MR. GUNDERSEN: I will send them to Dr. Hackett this afternoon.

CHAIR ABDEL-KHALIK: Dr. Hackett. Thank you very much.

Okay. At this time, we have sort of concluded all the presentations. Are there any other members of the public who would like to make comments or ask questions?

(No response.)

Is there anybody else on the line? Is

there anybody else here?

Yes, sir. Please come to the microphone, identify yourself.

MR. LEYSE: Yes, this is Robert Leyse. I've talked to you before.

CHAIR ABDEL-KHALIK: Mr. Leyse, please hold off. We have some here in the room who is going to make comments. So I will recognize you later.

MR. LEYSE: I will go to *6.

CHAIR ABDEL-KHALIK: Sir.

MR. KAMPS: Thank you. Hello everyone. My name is Kevin Kamps with Beyond Nuclear. And I'm also on the board of Don't Waste Michigan. We are watchdog groups on the nuclear power industry.

And I just wanted to inform the ACRS if it did not know yet that our organization joined with colleague organizations at the grassroots who live near GE-BWR Mark 1s across the country. We have launched a 2.206 petition to the NRC to immediately suspend the operating licenses of the 21 to 23 BWRs in this country that are very similar design to the Fukushima Units 1 through 4. And this is an important safety step until we learn the lessons from Fukushima so that it doesn't happen here.

Another part of that petition in addition to the reactor risks are the risks of high level radioactive waste storage pools at these reactors. And this would even include shutdown reactors of this design including the Millstone unit that's been mentioned, the pool of which still contains high level radioactive waste.

So I just wanted to inform you of this. We have been granted a petition review board on June 8th that will last for two hours. I'm not sure of the exact time of day. But we have a growing number of groups across the country joining this coalition.

And in addition to this effort there's also a petition drive by another organization, Nuclear Information and Resource Service which is a grassroots petition drive which already has thousands of signatures calling on the NRC to immediately suspend the operating licenses of these reactors in this country.

Thank you very much.

CHAIR ABDEL-KHALIK: Thank you, sir.

Okay. At this time, Mr. Leyse, if you'd like to offer any comments.

MR. LEYSE: Just came back on. Quickly, I want to say DRM 50.93 was around well ahead of Fukushima and a predecessor to that was around since the mid -- around 2002 or 2003. And nothing seems to move.

Now today we heard NEI tell us that while we take this Fukushima act on we don't ignore what else is going on. I would advise ACRS to be get into DRM 50.83 as well as the NRC. NRC once had it as a high priority item until a rather otherwise useless meeting back in October of the Thermohydraulic Subcommittee, the only part really bragging, not bragging.

But it's a fact that made any sense what Mark Leyse and myself discussed. You went through the whole thing and never got into zirconium or how it would react in a loss of coolant accident. Instead you listened to endless presentations from Penn State and others that really don't bear on what's going on today or was potentially going to go on.

CHAIR ABDEL-KHALIK: Mr. Leyse.

MR. LEYSE: End of comments. Thank you.

CHAIR ABDEL-KHALIK: Thank you very much.

Is there anybody else who would like to make comments? Are there any other members of the public who would like to make a comment?

MR. WARREN: This is Jim Warren again. And I like to come back and apologize for having to interrupt Mr. Gundersen's presentation a few minutes earlier. But it was very frustrating that obviously some people in the room were not listening to what he was saying. And it make it possible for others of us not to hear either.

I am concerned that is a reflection of the lack of respect for members outside the nuclear and academic orbit.

CHAIR ABDEL-KHALIK: Sir, excuse me.

MR. WARREN: I want to thank you for holding the meeting and allowing us to listen. Please do respect our ability to listen to these and to participate further. Thank you.

CHAIR ABDEL-KHALIK: Sir, the interruption was not caused by anything that was going on in this room. It may have been caused by others who were connected to the phone line. But I assure you that this committee provides ample opportunity for members of the public and offers them to make comments and treats those comments seriously and with the upmost respect.

MR. WARREN: Okay. Well, I appreciate that. And if I'm mistaken then I do apologize. But when he began his presentation there began an awful lot of conversation. It sounded like it was around the room or near the phone.

CHAIR ABDEL-KHALIK: It was not, sir.

MR. WARREN: Okay. Thank you. Then it was someone else and I apologize.

CHAIR ABDEL-KHALIK: Thank you. All right.

Are there any additional comments that anyone else would like to make?

(No response.)

Hearing none, let me just go around the room and see if members would like to offer any comments or reflections on what we heard today. Let me start with you, Jack.

MEMBER SIEBER: I have no additional comments at this time.

CHAIR ABDEL-KHALIK: Okay. Sanjoy.

MEMBER BANERJEE: None.

CHAIR ABDEL-KHALIK: Harold.

MEMBER RAY: None other than that what I said to NEI on that one point.

CHAIR ABDEL-KHALIK: Dennis.

MEMBER BLEY: No. No additional.

CHAIR ABDEL-KHALIK: Dana.

MEMBER POWERS: What we see is a tremendous amount of interest in the Fukushima accident right now and desperate attempts to try to learn lessons at which is a very premature stage and understanding of this accident. And our experience from previous accidents is it takes quite a while before you can draw conclusions that stand any test of time.

In fact, I think if we go back to our own experiences at TMI we saw an awful lot of prompt steps taken that had to subsequently be reversed. And I grow concerned that we'll be preemptive now when we don't need to be. I'm not sure Mark I BWRs located in the midland of the United States are really susceptible to both tsunamis and earthquakes simultaneously. And so maybe we don't need to address those things right now.

I think we can and maybe this Committee can help define things that can be done at this stage for a time. And I certainly pointed out that potentially one of them was just how the FSARs are done in Japan versus how they're done here in the United States is something that can be done.

Similarly, I think in the area of seismic engineering a lot of plants in Japan were affected by this earthquake and did not sustain damage that shut them down. But they did sustain the earthquake.

And there are opportunities for us to compare our seismic engineering projections against what actually happened at plants other than Fukushima Daiichi. And I think we ought to be encouraging perhaps in our research report for the NRC to take advantage of that. Because at least my looking at things like the IPEEE suggests to me that the rank ordering or vulnerable locations predicted versus those actually observed in Japan may not be entirely coincidental.

Now you can draw -- You cannot from the specific incident draw general conclusions always. But it sure is an opportunity to validate or suggest where more work needs to be done.

CHAIR ABDEL-KHALIK: Thank you.

Sam.

MEMBER ARMIJO: Yes. I'd just like to say that an awful lot of good work has been done by DOE and I appreciate the presentation.

I think the thing that's bothered me from the beginning of this is the mystery of Unit 4 and the spent fuels. I think we've gotten new information that in fact the spent fuel in Unit 4 was in good shape, relatively good shape, compared to the cores in the other reactors.

But we don't know why that plant had an explosion and so much damage. And I think if DOE and others can really study that and find out what happened there because I think that's still a mystery. And I don't think we can really address the U.S. plant safety until we understand what happened in Unit 4. And I think that's a big open issue.

CHAIR ABDEL-KHALIK: Okay. Thank you, Sam.

John.

MEMBER STETKAR: Nothing more. Thanks.

CHAIR ABDEL-KHALIK: Mike.

MEMBER RYAN: No additional comments. Thank you.

CHAIR ABDEL-KHALIK: Bill.

MEMBER SHACK: Nothing.

MEMBER BROWN: Nothing more than what I said.

CHAIR ABDEL-KHALIK: Joy. Mike.

MEMBER CORRADINI: Well, I have a lot of questions. But I guess the only thing that I would suggest is that I don't know about Tony's presentation. But in terms of John's -- I guess in Tony's case I really do think you asked him to get the strategic plan. I don't know the right terminology.

I do think we need that in writing so we understand what are the big pictures things they're looking. Because I know they've allotted a good deal of resources to do this. And I think it's important that we at least understand how they're divvying up relative to the topics.

In John's case, I guess I think Tanny -- I asked Tanny to send everybody electronically the copies of his talk. I think the one thing that I find interesting is that he's trying to get TEPCO to remove the proprietary nature of some of the information. Because I think the more public information that is available is important so we actually can -- everybody can look at the same set of information and its sources. That to me is probably the most important thing.

CHAIR ABDEL-KHALIK: Okay.

MEMBER CORRADINI: But other than that I think it was a very good presentation. I hope we can continue and hear from the staff next month.

CHAIR ABDEL-KHALIK: Yes. That's the plan. The staff will brief us on June 23rd. We have a subcommittee meeting in the afternoon and that is the plan.

Are there any -- Tom.

DR KRESS: Thank you. I don't have any additional comments. I just have been jotting down my reactions in terms of lessons learned. I don't want to bore anybody with them, but I've got about 20 right now. And I think the ACRS should get involved in the NRC's efforts of lessons learned.

But you can be a little premature. These 20 I've got, a lot of them may not prove to be good when we get the real information. That's really my reaction to this.

CHAIR ABDEL-KHALIK: Right. Thank you, Tom.

Are there any additional comments?

PARTICIPANT: If I can.

CHAIR ABDEL-KHALIK: Yes, sir.

PARTICIPANT: Maybe I'm a little bias because I worked on Station Blackout many years ago as one of the first things I did. And now today I think it's going to be very important that the Committee look at that issue and how it evolves now. And I guess there's going to be reg. guides that are going to be updated and a lot of other things related to Station Blackout.

But it might be worthwhile for the Committee to focus on that because that is probably the most important event right now that could occur at a plant. And so whatever the Committee does with respect to Station Blackout I think is going to be very helpful to the Commission.

CHAIR ABDEL-KHALIK: Thank you, John.

PARTICIPANT: Appreciate that.

CHAIR ABDEL-KHALIK: Are there any additional -- Does anybody know what this alarm means?

PARTICIPANT: It's a door alarm. It's okay. We're fine.

CHAIR ABDEL-KHALIK: Okay. At this time, we're adjourned. We're off the record.

(Whereupon, at 4:28 p.m., the above-referenced matter was concluded.)

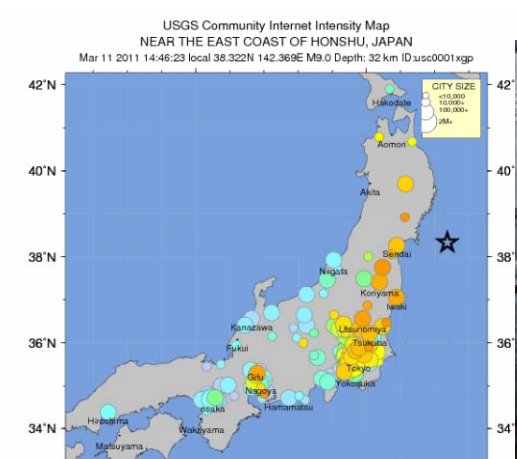
U.S. DEPARTMENT OF ENERGY | Nuclear Energy

DOE Response to Fukushima Dai-ichi Accident

John E. Kelly
Deputy Assistant Secretary for Nuclear Reactor Technologies
Office of Nuclear Energy
U.S. Department of Energy

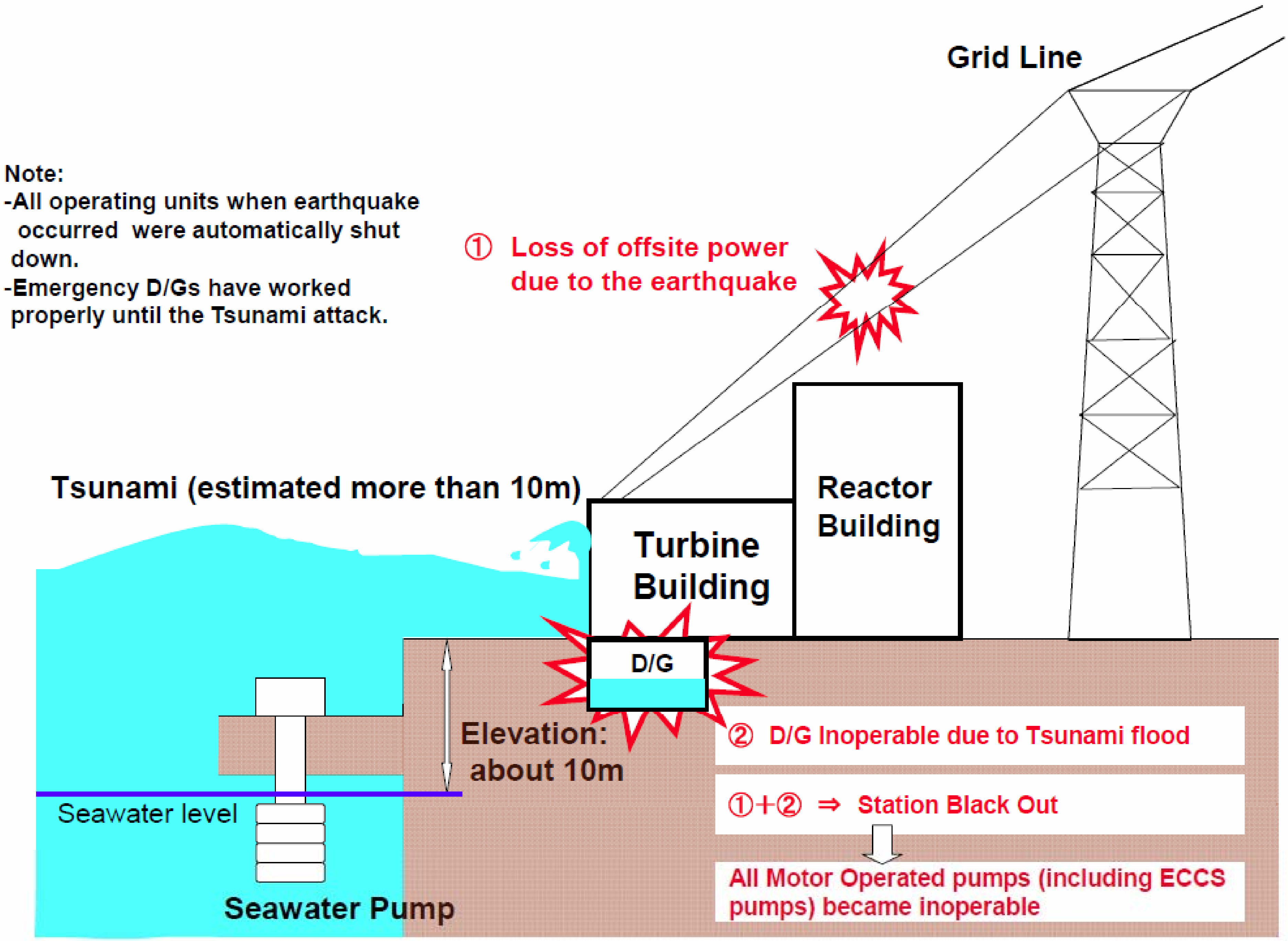
May 26, 2011

Earthquake 3/11



- **14:36 JST Earthquake**
- **15:41 JST Tsunami**
- **Magnitude: 9.0**
- **Generated a 14m Tsunami**
- **Many thousands perished**
- **More that 100 thousand people were homeless without food, water, or heat**

3-2. Major root cause of the damage



Accident Sequence for Fukushima Dai-ichi Reactors

- Station blackout due to the earthquake
- Loss of emergency diesels due to the tsunami (nearly 1 hour later)
- Eventual loss of batteries and cooling to control steam driven emergency pumps
- Core overheats, cladding oxidizes and melts producing hydrogen
- Hydrogen escapes from containment and explodes/deflagrates in reactors 1, 2, & 3
- Explosion/deflagration in reactor 4 building

U.S. DEPARTMENT OF ENERGY

Nuclear Energy

Immediate Response

U.S.NRC

- Activated its Emergency Operations Center
- Immediately deployed personnel to the U.S. Embassy in Japan to support the Reactor Safety Team (RST)
- Provided expert advice to the U.S. Ambassador and Government of Japan ministers
- Set up and coordinated consortium call that involved NRC, INPO, DOE, and Naval Reactors

INPO

- Organized nuclear industry technical response to assist TEPCO

U.S. DEPARTMENT OF ENERGY

- Activated its Emergency Operations Center focused on monitoring radiation release and impact on U.S. citizens (both in Japan and the U.S.)
- Deployed Airborne Monitoring System aircraft and sensors
- Provided additional DOE Embassy reps to the two already assigned to the U.S. Embassy
- Deployed national laboratory reps from INL, PNNL and Sandia to provide technical assistance
- Assigned NE personnel to stand watch in the DOE EOC

U.S. DEPARTMENT OF ENERGY

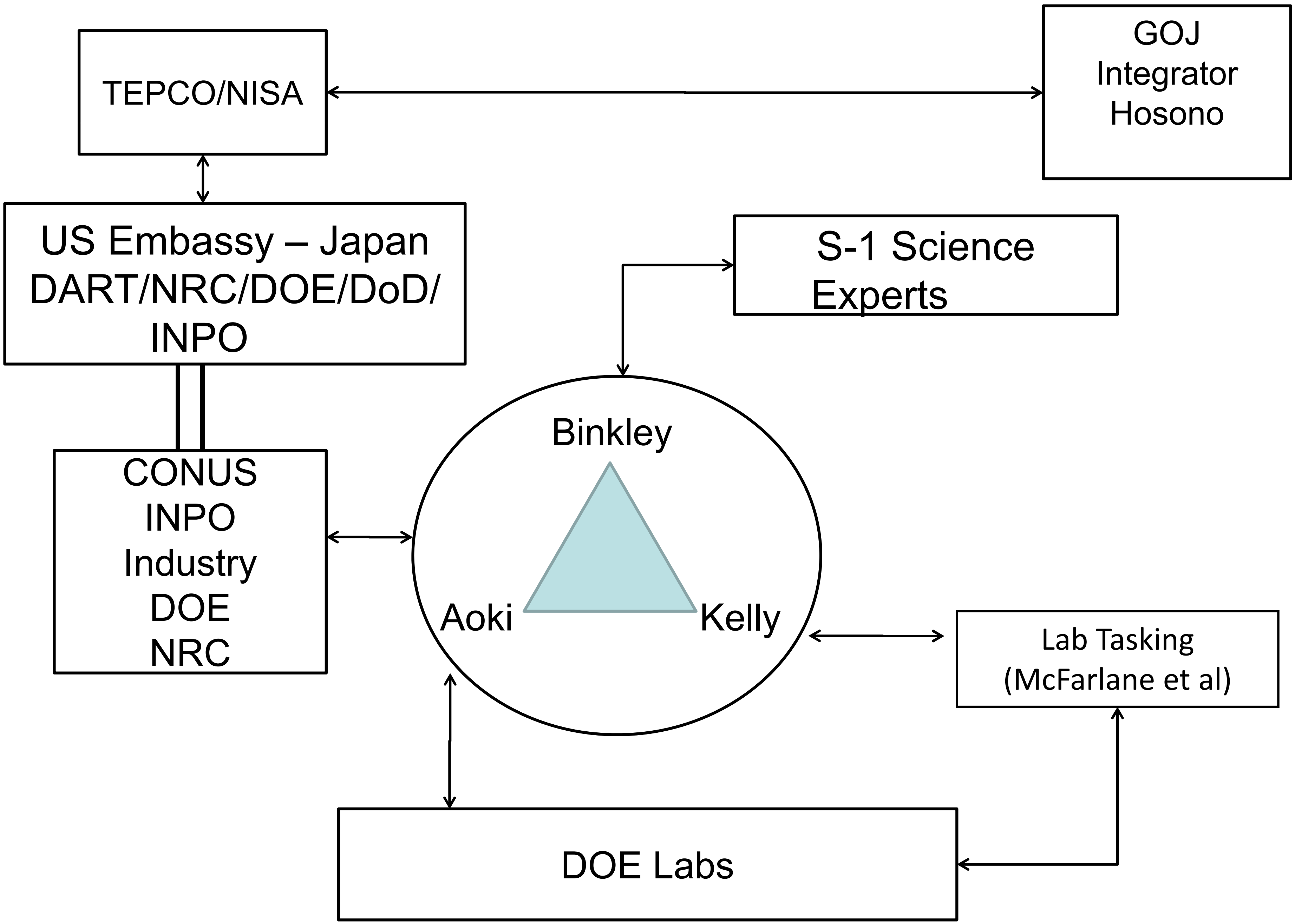
Nuclear Energy

DOE has provided a significant response to the events at Fukushima

- **During the first several weeks after the massive earthquake in Japan, DOE provided a significant and diverse set of analysis to support the events at Fukushima-Daiichi**

- **This response involved a broad set of institutions with over 200 people contributing**
  - DOE: Offices of NE, SC, NNSA, EM
  - Laboratories: ANL, BNL, INL, LANL, ORNL, PNNL, and SNL
  - Numerous universities
  - Individual consultants – Secretary's external science experts

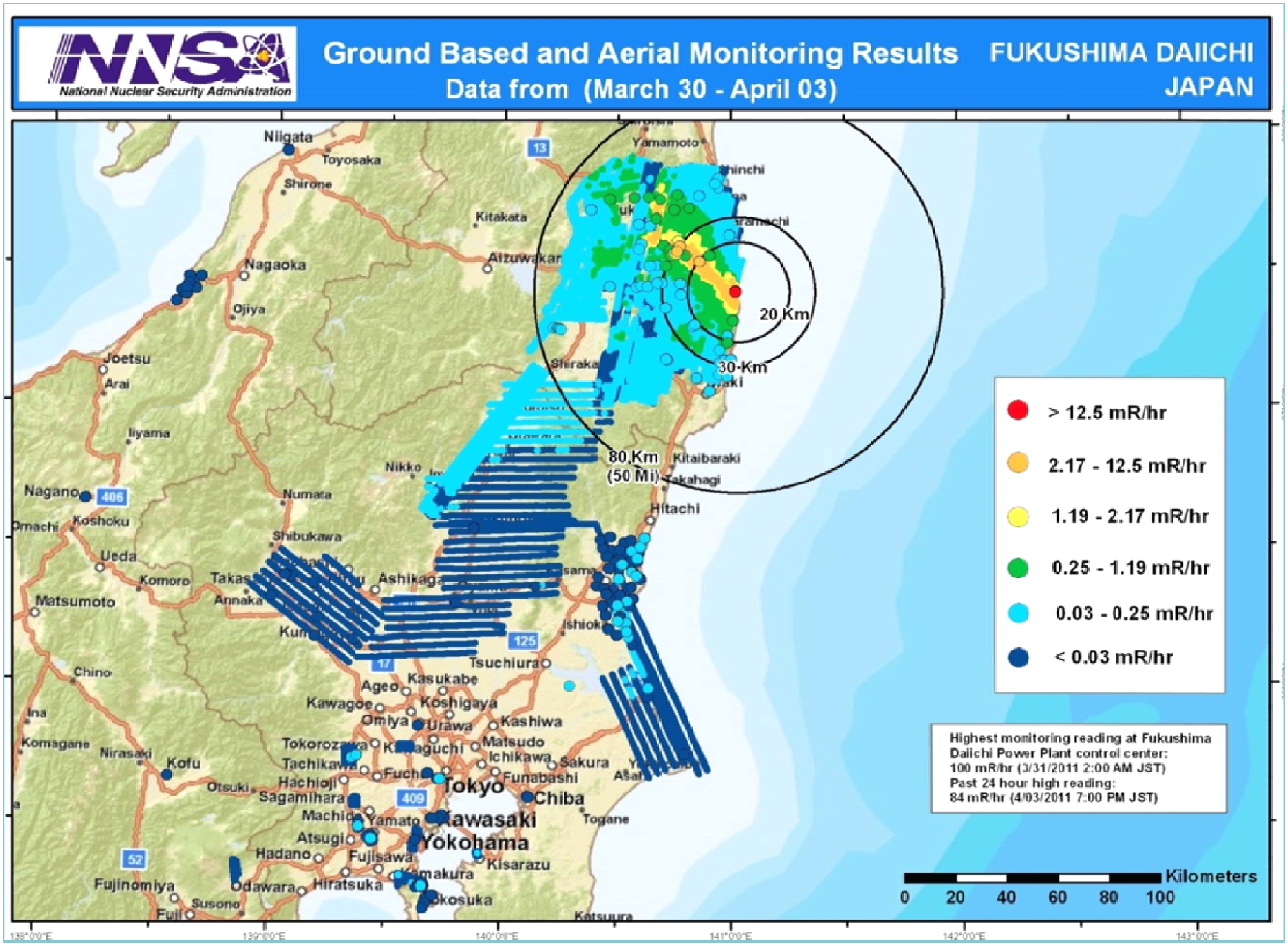
Nuclear Energy Response Team



Airborne Radiation Monitoring

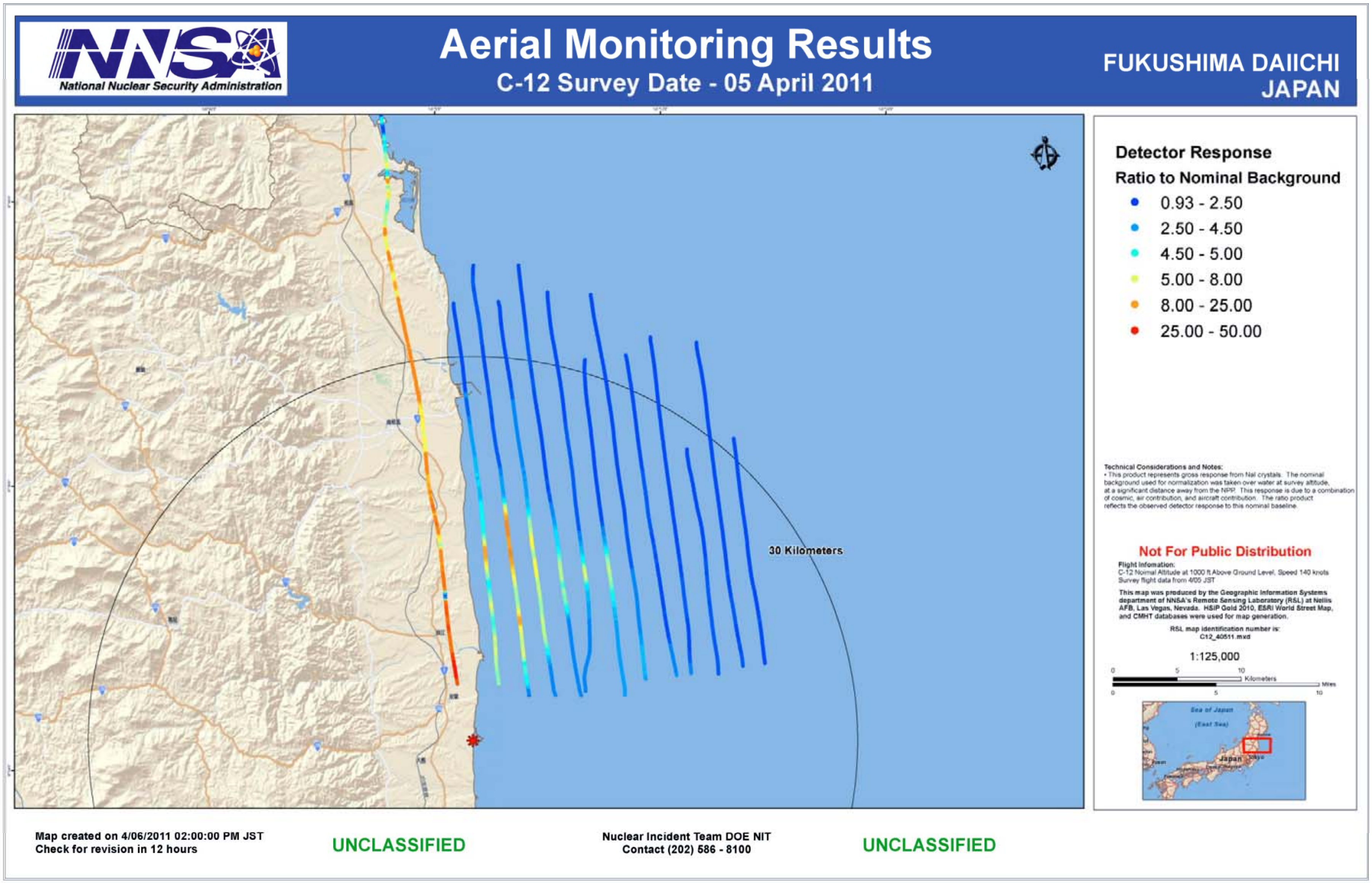
- **NNSA had primary responsibility to monitor and notify U.S. citizens of radiological fallout, including those in Japan**
- **Deployed airborne monitoring systems**
- **Used NARAC code at LLNL to model calculate plume impact on the U.S**

DOE/NNSA Monitoring



This product is an aggregate of data collected from March 30 – April 3, 2011. Monitoring results are derived from aerial measuring platforms and validated where possible by ground survey teams.

DOE/NNSA Monitoring (Over-water)



Office of Nuclear Energy Response Team

- **Primary mission**
  - Assess and clarify information for DOE and NE leadership concerning the status of the Fukushima Dai-ichi reactor situation
  - Provide support to NE EOC watch standers
  - Organized national laboratory analysis activities in support of:
    - *White House and USG*
    - *U.S. Embassy Requests*
    - *DOE and NE Leadership*

Accident Management Strategies

Stabilize reactor and spent fuel pools

Keep radiation levels low so workers can continue to work

Establish remote operations capability

Take measures to maintain long-term integrity of containment

Plan emergency response if situation worsens

Stabilize Reactors and Pools

- **Threats**
  - Reactor core melting thru vessel and attacking containment
  - H2 explosion in containment
  - Spent fuel pool fire
  - Another earthquake
  - Corrosion and gap release of radionuclides episodically from now intact fuel rods

- **Mitigation**
  - Continue to inject water to remove decay heat
  - Inert containment
  - Keep adding water to pools
  - Restore pool cooling
  - Get more data on water level, radiation levels, chemistry
  - Remove spent fuel from pools

NERT Technical Studies related to Reactor & Pool Stabilization

- **Estimation of O2 build up in Containment**
- **Long term decay heat removal**
  - Time to achieve fully passive heat removal
  - Alternative cooling strategies
- **Additional sensors for measuring water level, radiation levels, etc in pools, containment, and RPV**
  - New sensors
  - Restoring failed sensors
- **Melt progression estimates**
- **Potential for recriticality**
- **Potential for steam explosions**
- **Spent fuel pool boil down rate and Zr fire potential**
- **Salt precipitation and effect on cooling**
- **Mass and energy balances**
- **Air ingress analysis**

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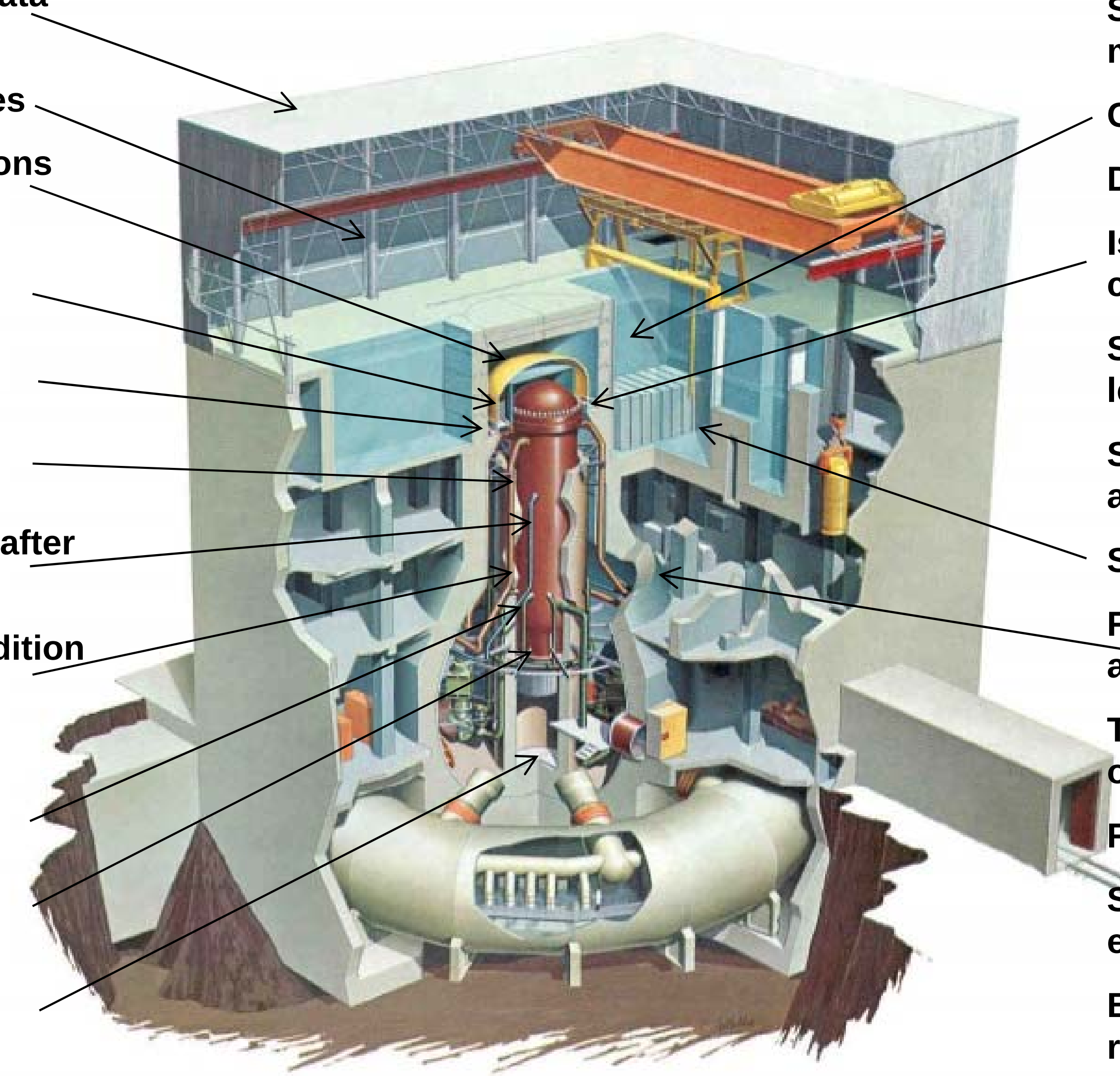
DOE Analysis for Initial and Stabilization Phase

- Collection of daily status data and events
- Isotopic analysis of releases
- H2 production and explosions in reactor buildings
- N2 inerting options and processes
- Gas inventory calculations
- Potential for further H2 production and explosions
- Structural analysis of RPV after pressure spikes
- Core damage and fuel condition
- Sensor data analysis
- Water level calculations
- Corrosion in sea water solutions
- Drywell filling options and water level tracking
- Stabilization criteria



- Severe accident analysis and management
- Criticality determinations
- Decay heat calculations
- Isotope and radionuclide calculations and releases
- Spent Fuel Pool (SFP) water level analysis
- SFP hydrogen production and analysis
- SFP modeling
- Reactor building and SFP dose assessments
- Thermal analysis for SFP fill options
- Robotics tools for stabilization
- Shielding advice for on-site equipment
- Bioaccumulation for water releases

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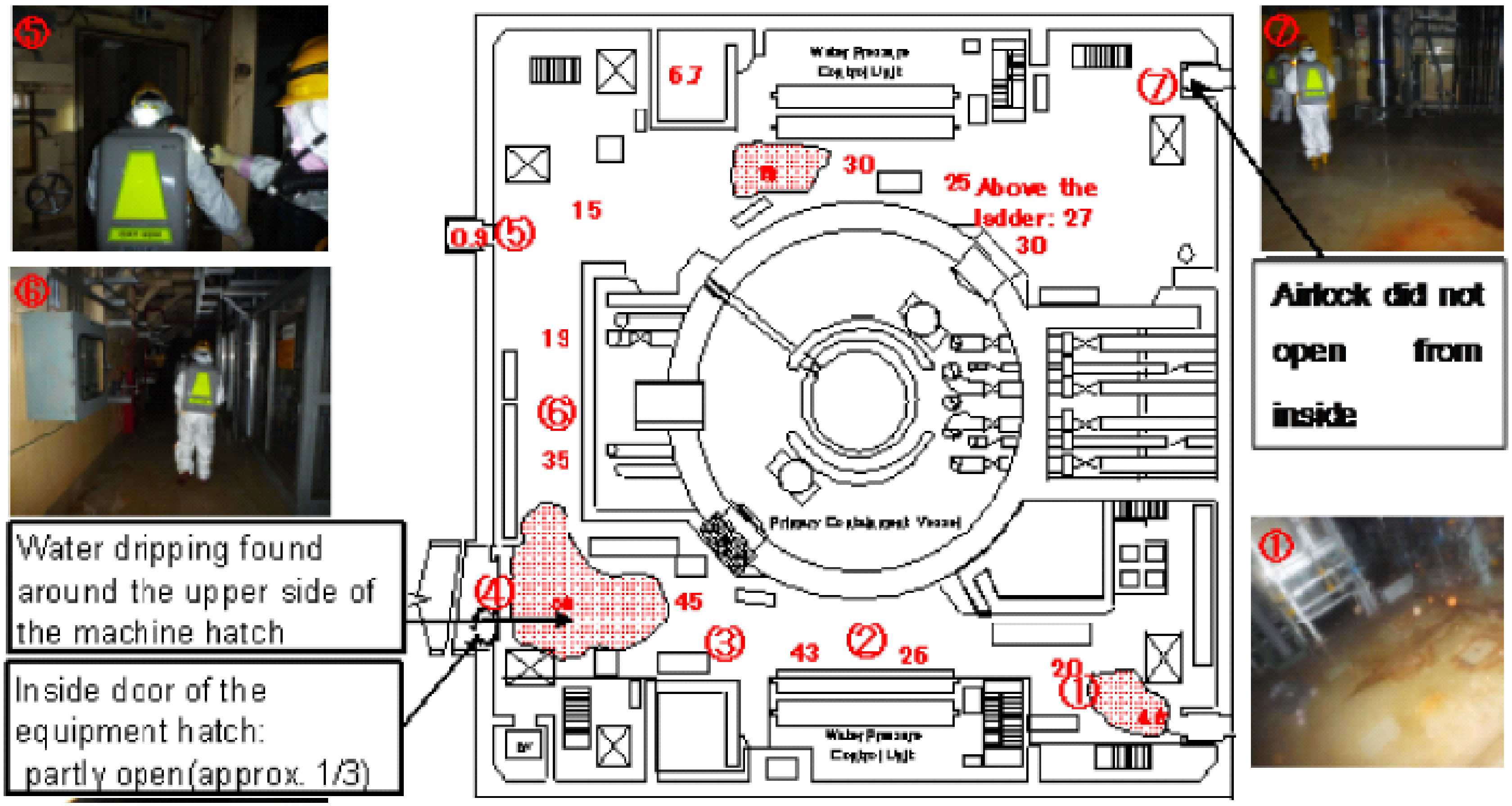
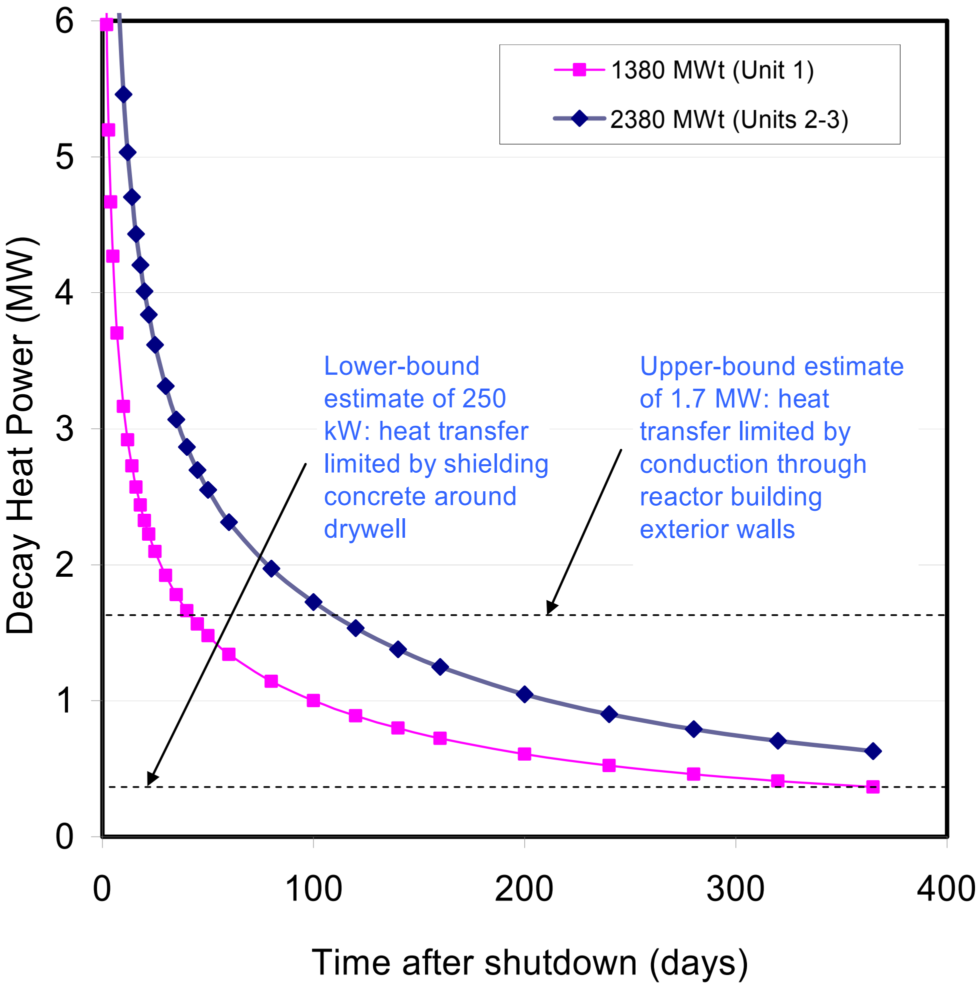
Reactor Building Survey Results for Unit 2

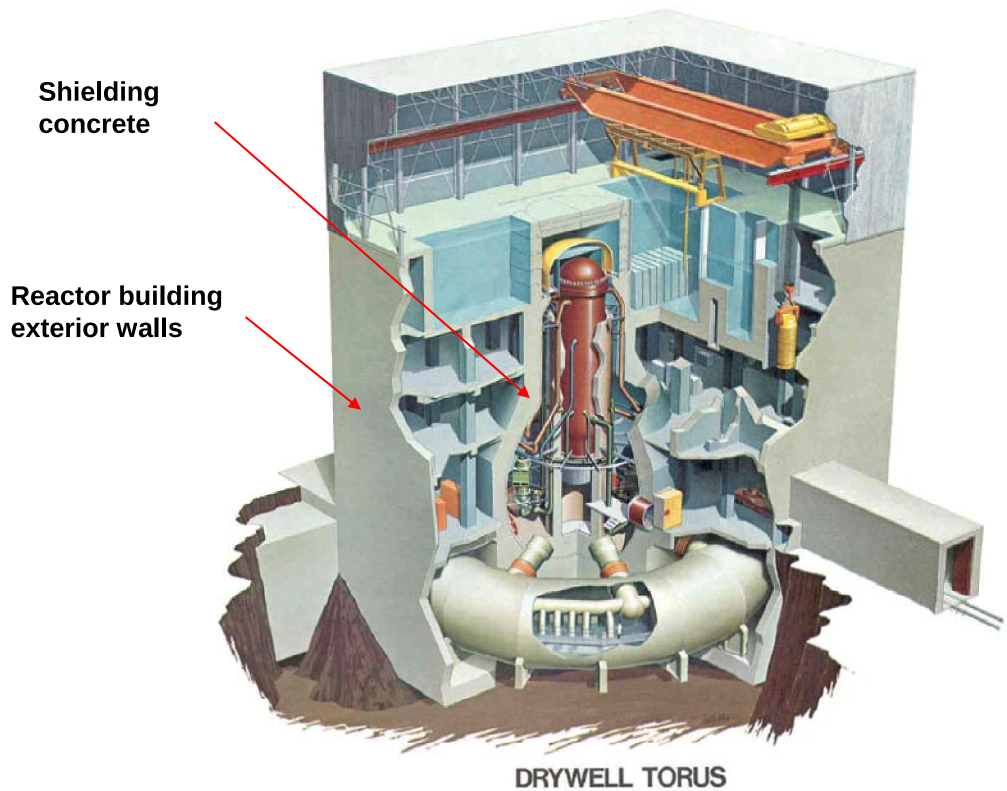
- Recent (19 May) survey results for Unit 2 shown below; dose rates in the range of 15 to 45 mSv/hr (1.5 to 4.5 R/hr)
- Underscores the difficulty in restarting normal RHR equipment.



Passive Cooling Assessment

Calculated containment passive cooling heat removal rates compared with decay heat levels for Units 1-3





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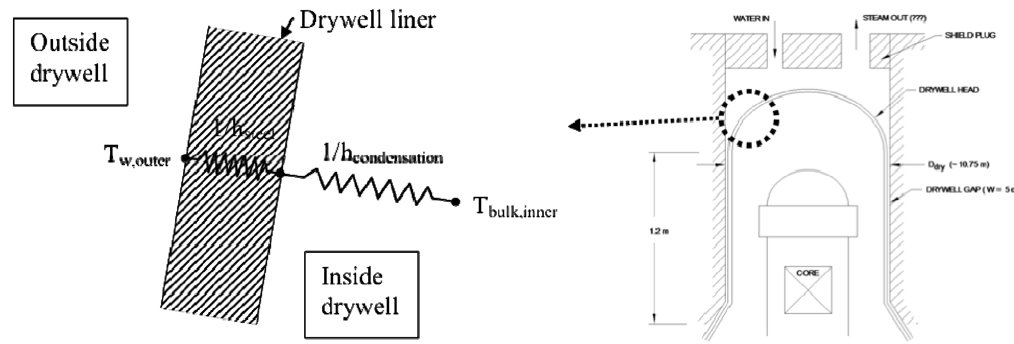
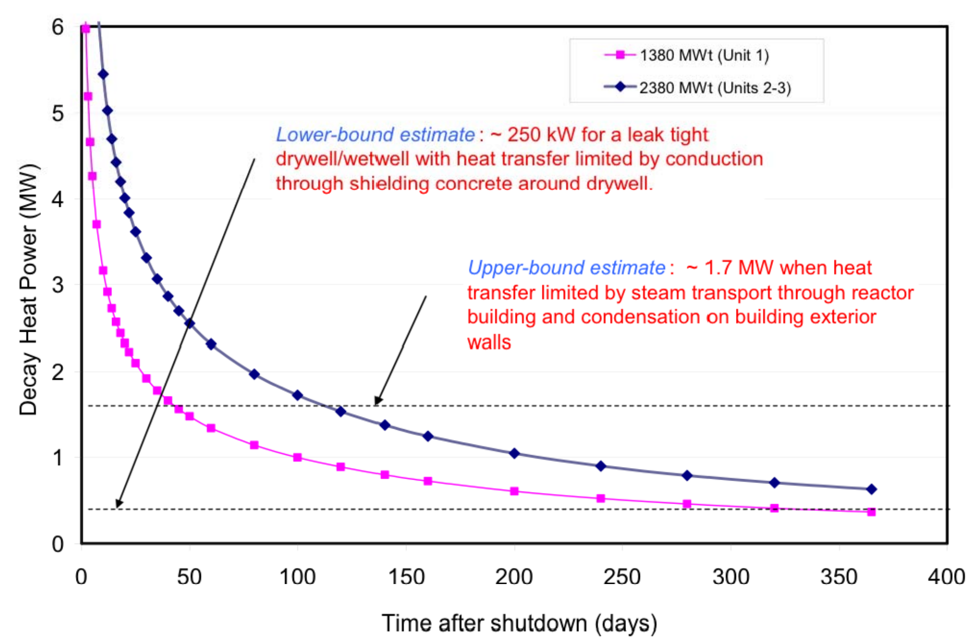
Long-term Decay Heat Removal

- **Decay heat cooling would take about 9 months using of passive cooling**
- **Explored options for accelerated cooling**
  - Capture, treatment and reuse of cooling water
  - Alternate cooling approaches





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Background on Unit SFP 4 Explosion

- **Unit 4 explosion Occurred March 15, 6:00 am – Approximately 90 hours after earthquake (Full core offloaded into pool, high heat load (~2.3 MW))**
- **The Unit 4 Explosion was originally attributed to hydrogen, but it has not be possible to definitively conclude this.**
- **An assessment of possible causes of the explosion was performed resulting three primary causes:**
  - Hydrogen produced from zirconium oxidation from the fuel cladding (or other fuel assembly and storage rack structures) in the fuel storage pool
  - Ignition of other flammable materials in the unit 4 building that were possibly being used for maintenance work (such as acetylene)
  - Hydrogen that was transferred through the stack vent lines from the hydrogen produced in unit 3
- **There were additional possible causes that have been proposed by others, but not analyzed:**
  - Hydrogen production from radiolysis
  - A proposed scenario based on material blockage preventing convective flow coupled with extreme boiling to provide hydrogen production without a low water level.

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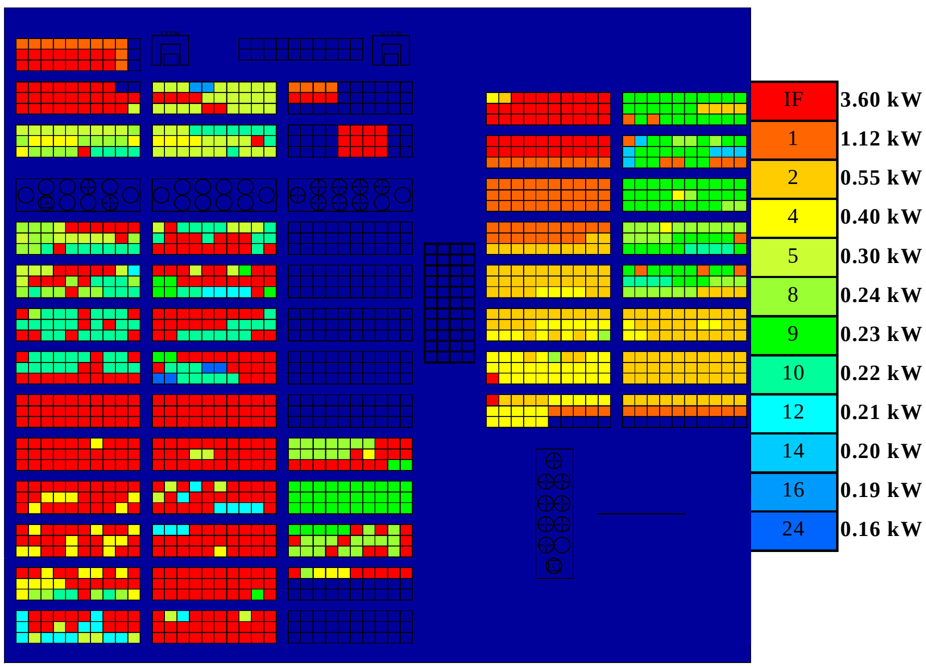
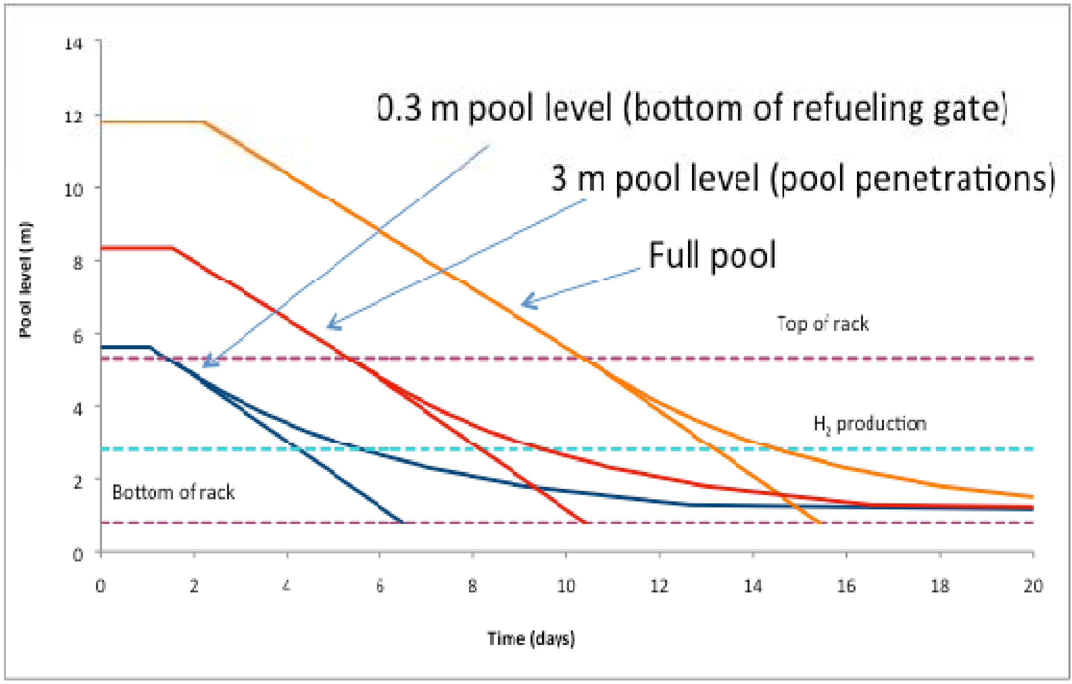
Thermal analysis of pool heatup and boil off

- Models of spent fuel pools developed to predict pool boil off time and to understand hydrogen production
- Used to perform analysis of pool leakage scenarios
- Calculations based on several codes and models to provide range in turn-around time and fidelity

UNIT 4 SFP HEAT GENERATION RATE DISTRIBUTION



POOL LEVEL FOR VARIOUS SCENARIOS FOR UNIT 4

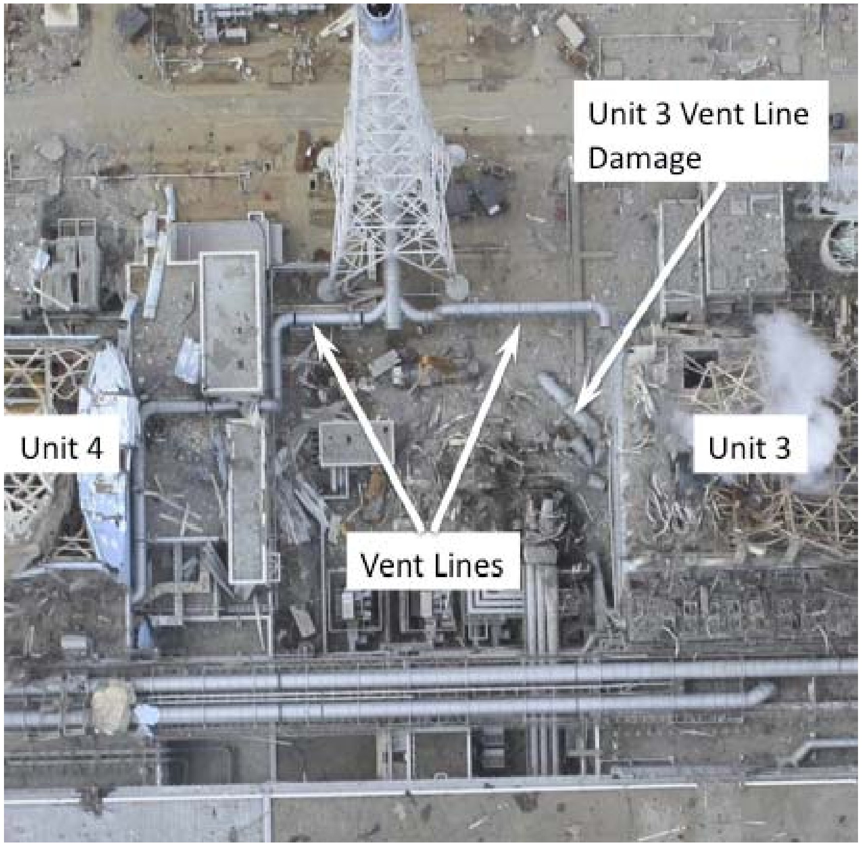


Hydrogen Explosion From Fuel Storage Pool

- **Evaporation and boil off of a the full pool would take ~10 days and significant hydrogen production would not be expected until ~12-14 days after earthquake.**
- **For explosion at <4 days, there would have had to been leakage from pool**
- **Four leakage scenarios**
  - Leakage of refueling pool gate or gate seals (hydrogen production in 4-5 days)
  - Damage to refueling pool penetrations (hydrogen production in 8-9 days)
  - Damage to refueling pool liner (depends on damage, could be ~ 1 day)
  - Failure of two refueling pool cooling system anti-siphon check valves coupled with second failure of refueling pool cleanup system piping
  - Sloshing during earthquake (a few feet)
- **Refueling gate leakage or pool liner damage could result time frame for hydrogen production similar to that which actually occurred**

Hydrogen from Unit 3 Transferred Through Stack Vent Lines

- **The vent lines for Unit 3 and Unit 4 connect to the same stack**
- **A possible source of hydrogen in Unit 4 is leakage from Unit 3 to Unit 4 through this common vent line**



Keep Radiation Levels Low

- **Threat**
  - If radiation levels are too high, workers may be evacuated

- **Mitigation**
  - Isolate and stop RPV leak
  - Clean-up contaminated water
    - *Extract, treat, store*
  - Deliver more shielding
  - Collect more data on chemical composition and radiation levels
  - Deploy additional and redundant sensors

NERT Technical Studies related to Reducing Radiation Levels

- Conceptual design for system to extract, treat, and store contaminated water in turbine building
- Assessment of potential RPV and containment leak pathways
- Characterization on shielding requirements
  - Shielding analysis for RHR pipes and water in turbine building
- Sensors and robotics for radiological surveys
- Venting strategies
- Evaluate containment head seal failure and how to mitigate

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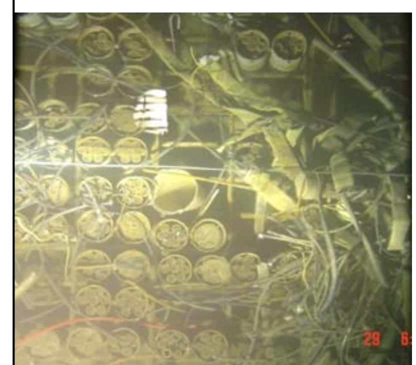
Waste Water Storage & Treatment

- **Significant quantities of water is collecting in the sumps and basements of the reactor and turbine building**

- **Japan government requested U.S. concepts for**
  - Collection
  - Transfer
  - Storage
  - Treatment of waste water


Potential Near-Term Options to Mitigate Contaminated Water in Japan's Fukushima Daiichi Nuclear Plant
April 7, 2011


Hanford Spent Fuel K-Basin


Hanford Spent Fuel K-Basin

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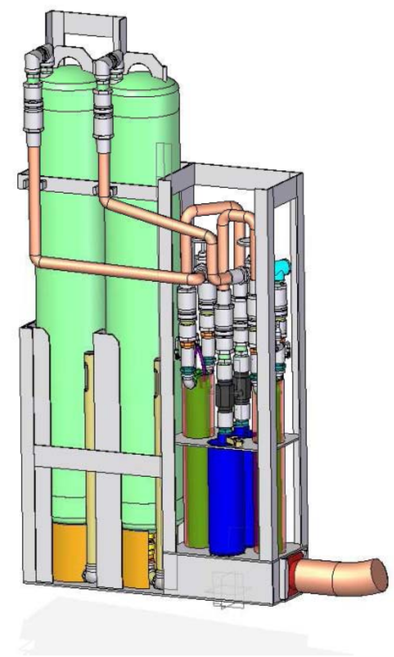
Design Options for Water Retrieval and Treatment

- **Currently accumulated sea water**
  - Pump water from basement, tunnels and other locations
  - Treat water for storage/disposal
- **Cooling water**
  - Pump water from reactor vessels or spent fuel basins
  - Treat water for recirculation
- **Skid mounted systems**
  - Pumping/retrieval technologies for liquids and sludges
  - Pre-filters and filters to remove debris and solids
  - Ion exchange resin columns and sorption systems for removal of radionuclides
  - Evaporation systems
  - Treatment equipment contained in large shielded fuel transport casks
- **Utilize DOE-EM cleanup contractor base for expertise**



Conceptual design of a water treatment system deployed in a spent fuel basin

Establish Remote Operations

- **Threat**
  - If workers evacuate, spent fuel and reactor could resume meltdown

- **Mitigation**
  - Install pumps and systems that can be operated remotely with redundancy
  - Install remote data collection with back-up
  - Install robotic and wireless monitoring system
  - Evaluate fire risks posed by the onsite operations especially electrical fires

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NERT Technical Studies related to Remote Operations

- **Sensors and instruments to characterize site**
  - Emphasis on simple or off-the-shelf

- **Evaluating robots, pumps and equipment that can be operated remotely**

Take Measures to Maintain Long-Term Integrity of Containment

- **Threat**
  - Containment may fail due to corrosion
  - H_2 explosion
  - Melt thru of core
  - Overpressure
  - Failure of silicon rubber head seals
- **Mitigation**
  - Design and install system for extraction, treatment, and storage (or recycle) of corrosive, radioactive liquid waste including heat removal
  - Install additional and redundant data collection for water level, radiation levels, water pH, etc

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NERT Technical Studies related to Maintaining Long-term Integrity of Containment

- **Oxygen level in containment study**
- **Corrosion of RPV and containment by salt water**
  - Test matrix for testing steels
- **Conceptual design of salt/radioactivity removal system from RPV and/or containment**
- **Additional sensors for measuring water level radiation levels, pH, etc**
- **Evaluating use of Millstone I for staging & check-out of new systems**

DOE Analysis for Recovery Phase

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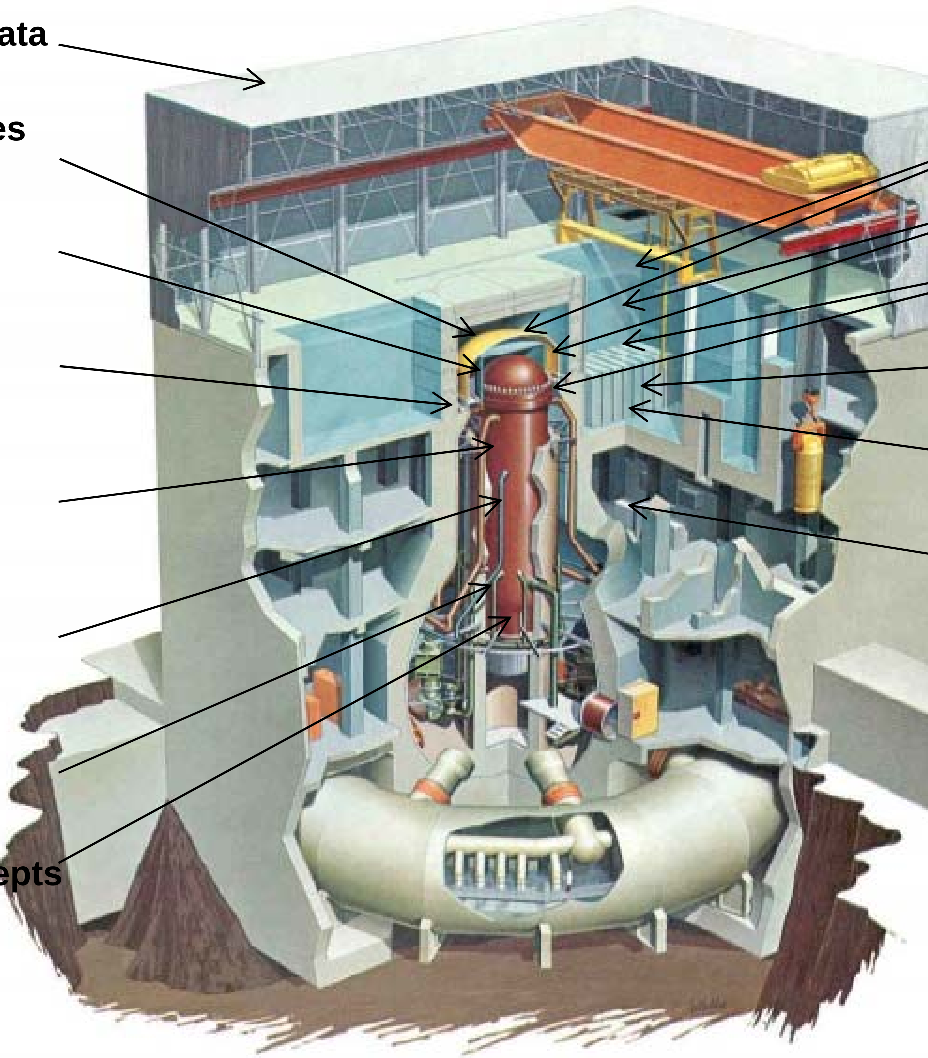

- Collection of daily status data and events
- Isotopic analysis of releases
- Passive cooling options
- Dry-well gap cooling
- Potential for further H2 production and explosions
- Clean-up and recycling of reactor coolant
- Core damage and fuel condition
- Corrosion in sea water solutions
- Corrosion Mitigation Concepts
- Leak management

- Severe accident analysis and management
- Criticality determinations
- Decay heat calculations
- Isotope and radionuclide calculations and releases
- SFP modeling
- Thermal analysis for SFP fill options
- Reactor building and SFP dose assessments
- Robotics tools for stabilization
- Shielding advice for on-site equipment
- Bioaccumulation for water releases
- Water clean-up options

Corrosion rates of RPV steels have been examined in the open literature

- Fukushima-Daiichi plants utilize A533B steel for the pressure vessel (likely based on industry standards, but not confirmed)
- There is little data on this class of steels in salt or concentrated salt solutions as it is not a typical choice for any application
- Some data has been identified (and the search will continue)

Corrosion experience from Millstone unit 1

- **Sept. 1, 1972, the Millstone Unit 1 BWR was undergoing routine startup**
  - sea-water was introduced into full flow demineralizers
  - high conductivity water entered the reactor vessel via the condensate/feedwater system
- **Corrosion effects were observed in a matter of hours**
  - 116/120 of the local power range monitors (with very thin walls) were damaged by cracking
  - Stress corrosion cracking was observed in other reactor components and considered to be "superficial"
  - Subsequent tests at GE found tests produced results more severe than in the actual incident

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Implications from Millstone 1 experience to Fukushima

- Cracking likely occurred in all units very quickly as seawater was introduced

- However, rapid cracking early in the event may not be sustained, consistent with the disposition of cracks that were deemed superficial to subsequent operation in Millstone

- The observations on carbon steel testing are consistent with other literature results from other industries for this class of alloys

Corrosion Rate for Carbon Steel

- **Initial data for low-alloy steels (LAS) and carbon steels (C-steel) in salt-solutions**

Alloy	Temp. (C)	Solution	Concen.	Other factor	Corrosion rate (mm/y)	Corrosion rate (mils per year)
LAS	25	NaCl	3.5%	--	0.025	1
LAS	25	NaCl	3.5%	--	0.38	15
LAS	25	NaCl	3.5%	H_2SO_4	3.8	150
C-steel	150	$MgCl_2$	10%	Irrad.	0.07	27
A533B (Davis Besse)	310	Boric acid	High		64	2500

Davis Besse test data is still most conservative

Plan Emergency Response

- **Threat**
  - Large release could expose large number of people to radiation
- **Mitigation**
  - Develop realistic, bounding source terms
  - Perform radioactivity plume dispersion analysis
  - Develop timeline of precursors and indicators to major event
  - Develop guidelines for shelter vs. evacuate
  - Develop contingency plans for sarcophagus construction

NERT Technical Studies related to Emergency Response

- Plume analysis
- Develop timeline for precursors and indicators to major release
- Scoping study to support permanent stabilization of reactor complex

Next Steps for DOE-NE

- **Continue our Support for the Government of Japan**
  - Peer reviews and analysis as requested
- **Data collection and accident forensics to support lessons learned**
- **Continued vigilance on potential accident consequences**

May 18, 2011

Dr. Edwin Hackett, Designated Federal Official
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Edwin.Hackett@nrc.gov

Dr. Said Abdel-Khalik, Chairman

This letter is in response to the invitation for public comments at the May 26, 2011 meeting of the U.S. Nuclear Regulatory Commission Advisory Committee on Reactor Subcommittee on Fukushima (Federal Register, vol. 76, no. 90, May 10, 2011, Notices, page 27103).

Many U.S. organizations (e.g. U.S. Environmental Protection Agency RadNet, U.S. Department of Energy national laboratories, and various state radiation laboratories) have been making measurements of fission products in environmental media resulting from the Fukushima incident. These measurements are likely being made to understand the resulting dose to the nearby public. I believe that the Nuclear Regulatory Commission in partnership with the U.S. Environmental Protection Agency could play an important role in assisting these many organizations in using their measurement data to convey to the respective publics the resulting exposure risk in a clear and consistent manner. I believe the public is interested in more detail than statements such as “are well below any level of public health concern”.

As with fallout resulting from above ground nuclear testing in the early 1960’s and contamination from the 1986 Chernobyl Unit 4 accident, environmental scientist have made use of the deposited radio-elements to characterize natural processes. The environmental contamination resulting from Fukushima may likewise present such an opportunity even at a much smaller levels. Such applications would likely be assisted with accurate and precise information on the relative isotopic abundances of the fission products, e.g. Cs-134/Cs-137, from each of the several Fukushima units that were compromised.

The International Atomic Energy Agency (IAEA) and the U.S. National Institute of Standards and Technology (NIST) have a number of environmental media standard reference materials, including fish and agricultural products, with low levels of man-made radioactive contaminants such as the following: IAEA-375, “Radionuclides and Trace Elements in Soil”; IAEA-384 , “Fangataufa Sediment”; IAEA-414 , “Fish”; IAEA-372 , “Grass”; NIST 4353A, “Rocky Flats Soil 2”; and NIST 4357, “Ocean Sediment Environmental Radioactivity”. I’m not sure if an equivalent Japanese institution has considered developing similar environmental media standard reference materials with low levels of man-made radioactive contaminants from the Fukushima vicinity. If there is such intent perhaps subject matter experts at the IAEA and/or NIST may wish to assist if so invited.

In closing I would like to extend my thanks to the U.S. Nuclear Regulatory Commission for its timely start to document lessons learned from the Fukushima event. Through such positive actions I believe the U.S. Nuclear Regulatory Commission can assure the safe and productive usage of nuclear energy for the benefit of our nation.

Sincerely yours,

Mr. Donivan R. Porterfield

Fairewinds Associates, Inc
Burlington, VT 05408

Date: May 26, 2011
To: The Advisory Committee on Reactor Safeguards

Good afternoon Mr. Chairman and members of the Advisory Committee on Reactor Safeguards.

I speak to you today as the Chief Engineer of Fairewinds Associates, Inc, and have not been retained by any group to make a statement at this meeting. Although there are many issues that must be resolved as a result of the nuclear accidents at Fukushima, I will focus on the single issue of containment integrity in the brief time you have allotted to me.

I first wrote to you, the ACRS in 2005 to express my concern regarding Vermont Yankee and the net positive suction head (NPSH) waiver that the ACRS granted to Vermont Yankee.

In 2008 Fairewinds was retained by CCAM to analyze the Millstone 3 containment. I spoke twice to the ACRS regarding my belief that the containment volume to power ratio at Millstone 3 is the smallest of any Westinghouse four-loop plant in the world. At that meeting, the ACRS staff acknowledged that it does not have the capability to analyze containment systems.

In 2009 Citizen Power retained Fairewinds to analyze the hole found in the Beaver Valley containment. That analysis was also discussed by the ACRS.

In 2010 when I met with you as a candidate for an opening on the ACRS, we discussed NPSH and its relation to containment integrity. I noted then that the Browns Ferry units had not been allowed the NPSH credit, yet ACRS granted the NPSH credit to Vermont Yankee five years earlier. It is illogical that that the people of Alabama have more accident protection than the people of Vermont.

In 2010 the AP1000 Oversight Group retained Fairewinds, and in April 2010, Fairewinds provided you with a report detailing a long history of containment failures around the country. In June 2010 Attorney Runkle and I met with you for an hour and a half to delineate my concerns regarding doubts about the containment integrity of the AP1000 design. In December of 2010 I wrote to you again notifying you of a significant amount of additional information about containment failures and flaws because at the October 2010 ACRS meeting, the NRC staff informed the ACRS that the NRC's calculations assume that there is zero leakage in the Mark 1 design.

Each time I have contacted you, the containment integrity data has been rebuffed and ignored. The accidents at the Fukushima Mark 1 BWR reactors have confirmed my belief that leakage of a nuclear containment cannot be based upon the assumption of a leakage rate of zero used by the NRC. This week, Tokyo Electric Power Company (TEPCO) has finally acknowledged that all three of the Fukushima Mark 1 containment systems are leaking significant radiation into the environment, and at least Units 1 and 2 began leaking on the first day of the accident. Unfortunately, the possibility of such containment failures, to which I have alerted you for the past six years, have been proven correct.

It is no surprise to me that containment systems have a long history of leaking and have now failed three times at Fukushima, yet it apparently comes as a major surprise to this advisory body and the NRC.

The ramifications of nuclear reactor containment leakage and failure the NRC and this body must consider are:

1. The SAMDA analysis for the Westinghouse AP1000 design is based upon false calculations that there is zero probability of a containment leak of any magnitude. The historical record prior to Fukushima proved this assumption false, and the Fukushima containment failures require that the AP1000 design be reanalyzed and retrofitted with advanced charcoal filters on the top of the shield building.

2. This advisory body has granted NPSH credits to numerous reactors around the country in violation of Regulatory Guide 1. Today, with a simple stroke of a pen, the ACRS can acknowledge its erroneous decision by requesting that the NRC revise the licenses of all reactors so that every reactor is in compliance with Regulatory Guide 1. And, with this one simple pen-stroke you can make all of the reactors applying the NPSH credit immediately safer than they are today.

3. Everyone sitting on the ACRS today knows that the pressure suppression containments on General Electric BWR's were inadequate when they were first designed. As a result of that design inadequacy, boiling water reactor containment vents were added in 1989 to prevent containment over-pressurization. Currently there are 23 Mark 1 containment systems in operation. All 23 Mark 1's have vents that were added as a Band-Aid fix. It is time for the ACRS to evaluate containment venting to determine whether or not it any of these reactors be allowed to continue operation.

4. Moreover, ACRS should stop the license renewals of any BWR until the Fukushima accidents have been completely analyzed.

For the record, Fairewinds finds it disconcerting that both NEI (Nuclear Energy Institute) and DOE (Department of Energy) have been granted one hour each to make presentations to this body, when NEI and DOE are responsible for the promotion of nuclear power. I have brought these containment integrity issues to your attention for more than six years. In closing, I strongly suggest that each of you as members evaluate the bias you bring to the table when listening to experts with whom the nuclear industry disagrees.

Thank you for your time. I will gladly brief you in detail if you so choose.

Arnie Gundersen
Chief Engineer, Fairewinds Associates
Burlington, Vermont