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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
(ACRS)

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SUBCOMMITTEE ON FUKUSHIMA

+ + + + +

THURSDAY

MAY 26, 2011

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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

1 DANA A. POWERS, Member

2 HAROLD B. RAY, Member

3 JOY REMPE, Member

4 MICHAEL T. RYAN, Member

5 WILLIAM J. SHACK, Member

6 JOHN D. SIEBER, Member

7

8 ACRS CONSULTANTS PRESENT:

9 THOMAS S. KRESS

10

11 NRC STAFF PRESENT:

12 EDWIN HACKETT, ACRS Executive Director,
13 Designated Federal Official

14

15 ALSO PRESENT:

16 KEVIN CAMPS, Beyond Nuclear/Don't Waste
17 Michigan

18 ARNOLD GUNDERSEN*

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

22 ROBERT LEYSE*

23 TONY PIETRANGELO, Nuclear Energy Institute

24 JIM WARREN*

25 *Participating via telephone

A G E N D A

OPENING REMARKS BY ACRS CHAIRMAN 5

Dr. Said Abdel-Khalik

NEI PERSPECTIVES 7

Tony Pietrangelo, Senior Vice President

Chief Nuclear Officer

DOE PERSPECTIVES 75

Dr. John Kelly

ADDITIONAL QUESTIONS/GENERAL COMMITTEE

DISCUSSION 146

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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

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1 following the scheduled presentations. The entire
2 meeting will be open to the public.

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

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

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

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

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

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

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

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

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

22 MR. PIETRANGELO: Okay.

23 MEMBER ARMIJO: I have a general question.

24 MR. PIETRANGELO: Sure.

25 MEMBER ARMIJO: The extent to which the

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

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

13 MR. PIETRANGELO: Okay.

14 CHAIR ABDEL-KHALIK: Yes, Mike.

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

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

25 MR. PIETRANGELO: How long do I have?

1 (Laughter.)

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

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

13 MR. PIETRANGELO: Right.

14 CHAIR ABDEL-KHALIK: Perhaps, your
15 perspective on the effectiveness of these processes
16 that had been going on for a while in light of the
17 findings of the recent inspections made by the
18 Resident Inspectors, and whatever industry responses
19 were provided to INPO in response to IER 11-1 and 11-
20 2.

21 MR. PIETRANGELO: Okay.

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

24 (Laughter.)

25 CHAIR ABDEL-KHALIK: And you can address

1 these issues in any logical order you may deem
2 appropriate.

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

7 First of all, the event itself, March
8 11th. We, basically, went into our emergency response
9 mode at NEI as to the NRC and INPO. We were
10 fortunate, I think, as an industry here that following
11 the BP rig explosion, Deepwater Horizon, last year, we
12 kind of did a Lessons Learned on that for how we would
13 apply that to our industry if we had an event like
14 that in our country, and revised our emergency plan
15 and response center, actually did a tabletop last
16 October as a result of that.

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

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

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

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

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

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

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

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

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1 emergency response, et cetera.

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

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

24 There have been many, many observations
25 from those walkdowns of the measures we took. And

1 some of them are, I'll call them some non-compliance
2 issues that the staff in the subsequent Temporary
3 Instruction that was issued, saw the same things that
4 the licensee found in the walkdowns. But I think what
5 a lot of people don't understand is that the measures
6 put in place after 9/11 were specifically targeted at
7 aircraft impact, and large fires and explosions.

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

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

25 So, given -- I think an irrefutable Lesson

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

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

18 Personally, I don't think that makes any
19 sense whatsoever. We built the plant to withstand that
20 natural phenomenon, and the assumption is, is that
21 that phenomena takes out everything at the plant, such
22 that you need these measures. Why would you expect
23 the same kinds of structures that you put in place at
24 the plant to protect your portable? So, that's
25 leading us to consider offsite response strategies

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1 with equipment, perhaps regionally where a lot of
2 plants are located where you'd have that equipment
3 available in a timely way, but not subject to the same
4 natural phenomena and/or terrorist attack that the
5 plant would be subjected to.

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

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

16 MR. PIETRANGELO: You can to a certain
17 extent.

18 MEMBER CORRADINI: Okay.

19 MR. PIETRANGELO: I call it event-inform.

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

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

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1 MEMBER CORRADINI: I'm okay in Wisconsin.

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

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

16 MR. PIETRANGELO: Right.

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

21 MR. PIETRANGELO: Okay.

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

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1 MR. PIETRANGELO: Right.

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

5 MR. PIETRANGELO: Right.

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

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

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

20 A lot of the plants along the Atlantic
21 corridor are relatively close together, and a number
22 of companies could come together and form a regional
23 compact to all use the same equipment. We've done
24 that for transformers and other -- we call it pooled
25 inventory management for long lead time, hard to get

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1 components that you would need to come back from an
2 outage, and so forth. So, there's a lot of thinking
3 in that regard.

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

8 Now, that leads us to questions on our own
9 station blackout implementation here in the country.
10 Based on the plants' configurations, they did coping
11 assessments for two, four, eight hours. You might say
12 well, why the Fukushima? That doesn't even pass the
13 red-face test for being able to cope. But I think you
14 heard at the Commission briefing at the end of March
15 that in the United States, at least, with probably
16 3,500 reactor years of operating experience, we've had
17 one station blackout in 1990 for about 44 minutes at
18 Plant Vogtle during an outage. And it was a truck
19 backed into a transformer in the switchyard. One
20 diesel failed to start, and the other diesel was down
21 for maintenance, station blackout.

22 Now, they were able to restart the diesel
23 that failed to start in 44 minutes, and restored AC
24 power. But that's the only station blackout we've had
25 in the United States. That doesn't mean it can't

1 happen here from some other combination of events.
2 We've had several events, hurricane, Hurricane I
3 believe it was Andrew in Florida, Turkey Point was on
4 diesels for quite some time, a week or two. We just
5 had Browns Ferry go through some very significant
6 tornados, and were on their emergency diesel
7 generators at three units.

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

18 That doesn't say you can't have a common
19 mode failure across all the diesels that potentially
20 could make them non-functional, but I think, and what
21 we've been saying pretty consistently from the get-go
22 is that we cannot say an event like Fukushima could
23 never happen here. It could happen here. It's very,
24 very remote based on the reviews that were done when
25 the plants were licensed, and the subsequent

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1 improvements made over the years, both by requirements
2 imposed by the NRC, as well as initiatives taken by
3 the industry. But it doesn't matter at the end of the
4 day. We have to be prepared for an emergency like
5 this, whether it was tsunami, seismic event, terrorist
6 attack, operator error, manufacturing defect,
7 whatever, we want to keep these symptom-based events
8 that we can respond to no matter what the event.

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

13 MR. PIETRANGELO: Right.

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

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

25 MEMBER RAY: And it's a short one.

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

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

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

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1 loss of all AC power.

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

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

9 MR. PIETRANGELO: Figuring that out now.

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

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

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

25 MR. PIETRANGELO: I haven't heard that

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1 one. Induced station blackout?

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

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

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

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

11 MEMBER POWERS: Non-zero. Oh,
12 interesting.

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

18 MR. PIETRANGELO: In a more holistic look.

19 MEMBER STETKAR: -- view of risk.

20 MR. PIETRANGELO: Right.

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

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

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

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

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

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

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

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

23 And we know we've got the licensed coping
24 duration from the station blackout rule. We know there
25 are certain things we can do to potentially extend

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1 that, and we know we have the B5B measures as another
2 way to expand or extend coping duration.

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

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

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

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1 measures.

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

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

7 (Laughter.)

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

16 MR. PIETRANGELO: Right.

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

21 MR. PIETRANGELO: Right. And both the
22 things I'm talking about, station blackout and B5B
23 54(h) (h) (2) are regulations.

24 CHAIR ABDEL-KHALIK: Right.

25 MR. PIETRANGELO: So, the NRC is,

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

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

19 MEMBER CORRADINI: Right.

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

24 CHAIR ABDEL-KHALIK: But that doesn't
25 preclude sort of the possibility of pre sort of

1 conceptual thinking about --

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

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

6 MR. PIETRANGELO: Right.

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

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

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

23 So, about a month after that, that's kind
24 of where my attention turned. We were lucky,
25 fortunate that we have industry organizations set up

1 to try to fashion a holistic industry response, not
2 just NEI. We've got Institute of Nuclear Power
3 Operations, as well as the Electric Power Research
4 Institute, and there are several activities that we've
5 done over the years with our sister organizations that
6 have been very successful by pulling together an
7 industry response, not just a regulatory response
8 through NEI. So, that's what we set out to do.

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

18 I mean, the charter, there's -- let's see,
19 about 13 people on this group were chartered to
20 develop a strategic plan, articulation of strategic
21 goal, structure, and process for defining the
22 industry's overall response to Fukushima. We want to
23 insure that identified issues are appropriately
24 coordinated between industry organizations, and that
25 lead and supporting roles are established. And I'll

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1 get into how we're going to coordinate that in a
2 moment. And then three, monitor the status of action
3 plans on key issues to insure priorities and schedules
4 are consistent with the strategic plan. And this
5 probably most importantly, and that the overall impact
6 on operating plants is balanced and appropriate to our
7 prime focus, which is excellence in plant operation.

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

18 You see, many of the companies have set up
19 separate groups just to make sure that you don't have
20 a adverse impact on, say plant operations. We've done
21 the same at NEI. I've got a separate group now just
22 devoted to Fukushima-related events. I'll probably
23 matrix across our organization to get the necessary
24 expertise we need. INPO has done the same thing, EPRI
25 has done the same thing. So, I think everyone is kind

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1 of on the same page in terms of there's a lot of work
2 to do, we need to get organized to pull it off, but it
3 cannot be at the expense of the current plants.

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

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

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

19 MR. PIETRANGELO: Oh, sorry. The first
20 goal -- I'll just read you kind of the lead-in. Our
21 primary objective is to improve nuclear safety by
22 learning and applying the lessons from the Fukushima
23 Daiichi nuclear accidents. In response, the U.S.
24 nuclear industry has established the following
25 strategic goals to maintain, and where necessary,

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1 provide added defense-in-depth for critical safety
2 functions of core cooling, spent fuel cooling, and
3 containment integrity.

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

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

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

23 First, the goal -- these are kind of
24 outcomes. Time lines for emergency response
25 capability to insure continued core cooling,

1 containment integrity, and spent fuel pool cooling are
2 synchronized to preclude fission product barrier
3 degradation following station blackout. And all that
4 means is, you've got to have enough coping duration
5 such that you can get your mitigating measures in
6 place before fuel damage. And those have to be
7 synchronized.

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

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

20 MR. PIETRANGELO: Plant-by-plant?

21 MEMBER CORRADINI: Plant-by-plant.

22 MR. PIETRANGELO: Yes.

23 MEMBER CORRADINI: Okay.

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

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

4 CHAIR ABDEL-KHALIK: Before you --

5 MR. PIETRANGELO: Yes?

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

8 (Simultaneous speech.)

9 MR. PIETRANGELO: -- from you, Mike.

10 (Laughter.)

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

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

17 CHAIR ABDEL-KHALIK: Okay.

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

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

1 MR. PIETRANGELO: No.

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

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

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

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

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

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

25 MR. PIETRANGELO: Not yet. There's going

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

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

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

16 CHAIR ABDEL-KHALIK: Training.

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

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1 operator.

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

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

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

14 MR. PIETRANGELO: Yes.

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

19 MR. PIETRANGELO: Right.

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

23 MR. PIETRANGELO: Right. And that's why,
24 when I said before about the assessments one would do
25 whether it's for extended coping duration or emergency

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1 planning, what assumptions do you make to fashion your
2 plan? And I think we've all got to be on the same
3 page with that.

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

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

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

17 MR. PIETRANGELO: Right.

18 MEMBER ARMIJO: -- possibility.

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

24 MEMBER ARMIJO: Flexibility.

25 MR. PIETRANGELO: Right.

1 MEMBER ARMIJO: So, that you can --

2 MR. PIETRANGELO: Yes. Yes.

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

7 MR. PIETRANGELO: Right.

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

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

13 MEMBER POWERS: Okay.

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

17 MEMBER POWERS: Are you going to try to
18 look in -- because it strikes me that that's one area
19 where one could make some progress now, not dependent
20 on understanding the plant, to see if there are any
21 differences. The Japanese system is very similar to
22 our's, that would lead to oversights, perhaps, or
23 probably the most interesting task, especially when we
24 think about all of our plants, is the evolution in
25 knowledge on the vulnerabilities to, or the

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1 frequencies with which natural events of large
2 magnitude might occur, and how one factors that into
3 the updating of the FSAR, which we all know moves
4 about once a year.

5 MR. PIETRANGELO: Right.

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

10 MR. PIETRANGELO: Right.

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

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

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

25 MEMBER POWERS: You say it didn't work,

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

3 MR. PIETRANGELO: Right.

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

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

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

18 MR. PIETRANGELO: Correct.

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

22 MR. PIETRANGELO: Right.

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

25 MR. PIETRANGELO: Right.

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

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

7 MEMBER POWERS: Absolutely. We definitely
8 do that.

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

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

24 And then the last one, primary containment
25 protective strategies can effectively manage and

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1 mitigate post-accident conditions, including pressure
2 and elevated hydrogen concentrations. This one is, I
3 think, one of the ones where we need a lot more
4 information about what happened in Japan. We're
5 seeing a lot of speculation about venting, what they
6 did, what didn't work, what worked, when they did it,
7 et cetera. But it's all speculative at this point.

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

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

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

25 We also put some guiding principles

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

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

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

21 We want to insure response strategies are
22 performance-based, risk-informed, and account for
23 unique site characteristics. This is the one-size
24 doesn't fit all. Maintain a strong interface with our
25 regulators to insure regulatory actions are consistent

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1 with safety significance, and can be complied with in
2 an efficient manner. We want to make sure we can
3 effectively implement any additional regulatory
4 requirements, be that adequate protection, or
5 enhancements.

6 We want to coordinate with federal, state,
7 local government and their emergency response
8 organizations on industry actions to improve overall
9 emergency response effectiveness. This gets to the
10 regional, make sure you're bringing in your partners.
11 And there were, actually, a lot of discussions after
12 9/11. We did comprehensive reviews that were
13 conducted with state and local officials on the
14 plants, the equipment they needed. Did they have
15 familiarity with the site, if they were asked to come
16 in and help, whether it was a terrorist attack, or
17 another event.

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

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1 to. But we want to make sure that we communicate.

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

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

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

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

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1 plans.

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

6 CHAIR ABDEL-KHALIK: Okay. Thank you.

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

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

21 We talked about where we got our info,
22 talked about sources of info from Japan. I don't have
23 a lot on the gaps in worker exposure. I would point
24 you to testimony that Dr. John Boyse gave at the House
25 Science and Technology Committee I think a week or two

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1 ago that's very, very good, puts this in context with
2 respect to worker doses, as well as public exposure
3 from the event.

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

11 MR. PIETRANGELO: Right.

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

24 In some sense no matter how -- you used
25 the term, I can't remember how you said it, but I

1 would call however sketchy what occurred internally of
2 the plant events were.

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

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

7 MR. PIETRANGELO: Sure.

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

21 And I'm not aware of any requirements, I'm
22 saying that in the broad term, of having a limited set
23 of hardened instrumentation which would provide a
24 better feel during these events which would not,
25 necessarily, be reliant on -- it could be electrically

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1 powered if they had their own little --

2 (Simultaneous speech.)

3 MR. PIETRANGELO: -- batteries or
4 something.

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

11 MR. PIETRANGELO: Right.

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

16 MR. PIETRANGELO: Have.

17 MEMBER BROWN: You may not have it any
18 more.

19 MR. PIETRANGELO: Right.

20 MEMBER BROWN: So, that was a thing that
21 struck me, is assumptions were being made, mitigating
22 actions were being taken for the in-plant. Even the
23 knowledge of what the spent fuel pool levels were
24 seemed to be questionable, and that -- I had not seen
25 anybody addressing that, and I didn't hear you say

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1 anything about that during the -- in your all's
2 consideration --

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

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

16 MEMBER BROWN: And/or temperature.

17 MR. PIETRANGELO: Right.

18 MEMBER POWERS: I don't want to deter you
19 in looking for opportunities to improve your
20 instrumentation. I would point out that this is the
21 third major accident I've had the joy of going
22 through, and every one of them people said gee, if we
23 only had better instrumentation of this sort or that
24 sort. And in many cases, we've upgraded the
25 instrumentation, and what I found out subsequently was

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1 not terribly useful to us, and it's not useful for the
2 next accident. I'm not sure we can out-guess the
3 accident when it comes to instrumentation.

4 MR. PIETRANGELO: Yes.

5 MEMBER POWERS: I think it's --

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

8 MEMBER POWERS: I think the --

9 MEMBER BROWN: You have to have something
10 there.

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

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

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

13 MR. PIETRANGELO: I agree.

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

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

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

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

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

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

20 CHAIR ABDEL-KHALIK: Please continue.

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

23 CHAIR ABDEL-KHALIK: Okay. Well, let me
24 just go and see if there are questions posed at the
25 beginning, if Tony had addressed them, or you still

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1 have questions that you would like to pose for him.

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

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

6 MEMBER CORRADINI: Okay.

7 CHAIR ABDEL-KHALIK: So, we have time.

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

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

25 MEMBER CORRADINI: No, I understand that.

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

15 MR. PIETRANGELO: Right.

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

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

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

9 (Simultaneous speech.)

10 MR. PIETRANGELO: Looked like one of our
11 pools.

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

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

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

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

19 MEMBER SHACK: Well --

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

24 MEMBER SHACK: Oh, they did? Okay.

25 MR. PIETRANGELO: And there was a report,

1 there was 36 workers in the reactor building at the
2 time of the earthquake, and they came out of the
3 building drenched. They were at the fuel pool floor
4 and they came out drenched, so that was probably a
5 pretty good splash. I don't know how much inventory
6 they lost as a result of that.

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

19 MEMBER ARMIJO: So, how are you --

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

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

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

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

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

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

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

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1 regard.

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

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

18 The Bulletin, I think, my understanding of
19 it is to make sure that you fix the items or non-
20 compliances that were found in the 30-day time period,
21 or tell us what you're going to do within 30 days. And
22 then I think the 60-day response is more targeted at
23 the controls you have over those extreme -- over those
24 measures for extreme events, what training, what
25 surveillance, what periodicity of maintenance, that

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1 kind of thing, because that was not prescriptive in
2 the requirement.

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

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

19 MR. PIETRANGELO: Yes.

20 MEMBER RAY: One thing that's come up in
21 our discussions here, completely unrelated, has
22 nothing to do with Fukushima. But it does have to do
23 with the intervention of, I'll call it management, and
24 what role they play in a severe accident, and whether
25 they can play any role if they're not licensed to

1 operate the plant, for example. Is any of that kind of
2 discussion taking place?

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

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

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

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

1 too.

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

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

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

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

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

16 (Laughter.)

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

25 I do have another question, though. You

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

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

16 MR. PIETRANGELO: Right.

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

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

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

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

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

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

5 MEMBER SIEBER: Right.

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

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

12 MEMBER SIEBER: Right.

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

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

25 (Laughter.)

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

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

18 CHAIR ABDEL-KHALIK: Right.

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

25 CHAIR ABDEL-KHALIK: Right.

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

3 CHAIR ABDEL-KHALIK: Shared switchyards.

4 MR. PIETRANGELO: Switchyards, right.

5 MEMBER REMPE: Said?

6 CHAIR ABDEL-KHALIK: Yes?

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

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

21 MR. PIETRANGELO: Absolutely. I think
22 that's -- from day one when we all got together to
23 start thinking about what we were going to do, an
24 emphasis on needing a more detailed understanding of
25 precisely what happened, timeline, actions, condition,

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1 as best we can get it. And I think the fuel pools --

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

4 MR. PIETRANGELO: And that's probably
5 years.

6 MEMBER REMPE: Yes.

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

13 CHAIRMAN ABDEL-KHALIK: Go ahead.

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

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

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

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

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

24 MEMBER POWERS: Well, I may --

25 MR. PIETRANGELO: Yes.

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

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

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

13 MR. PIETRANGELO: A plan in advance.

14 MEMBER POWERS: Yes, a plan in advance --

15 MR. PIETRANGELO: Right.

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

19 MR. PIETRANGELO: Right.

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

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1 sympathetic with people.

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

4 MEMBER POWERS: Yes.

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

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

12 MR. PIETRANGELO: Initially at least.

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

17 MR. PIETRANGELO: Right.

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

21 MR. PIETRANGELO: Right.

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

1 MR. PIETRANGELO: Right.

2 MEMBER STETKAR: -- collecting --

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

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

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

17 MEMBER STETKAR: Well, the question is --

18 MR. PIETRANGELO: -- "light on."

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

23 MEMBER CORRADINI: I guess John's question
24 -- I guess more provocatively, so if tomorrow somebody
25 said, "You really shouldn't clean that up. That might

1 be some valuable information there," or could make the
2 final decision to clean it up or to -- or to leave it
3 there for forensics value -- that's what I guess John
4 is asking.

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

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

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

23 But I know if there is any subsequent
24 actions that come out of that I trust that this
25 Committee is going to be engaged in looking at those

1 and providing your expertise to that, because this is
2 something we all need to work on. It's very
3 important.

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

9 CHAIRMAN ABDEL-KHALIK: Thank you very
10 much.

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

13 CHAIRMAN ABDEL-KHALIK: We intend to do
14 that.

15 MR. PIETRANGELO: Okay.

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

18 MR. PIETRANGELO: My pleasure. Thanks.

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

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

25 CHAIRMAN ABDEL-KHALIK: I believe they

1 are. And if you can --

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

4 MEMBER POWERS: Who are you again?

5 (Laughter.)

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

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

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

25 You know, the timeline that we know is the

1 earthquake happened at 2:00 in the afternoon. About
2 an hour later the tsunami hit. It was a magnitude
3 approximate nine on the -- and the tsunami was about
4 14 feet, and their design base I think was about six
5 meters.

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

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

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

24 But we're pretty sure that the grid lines
25 were knocked down by the earthquake. That led to the

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1 loss of offsite power. And then, diesel generators
2 operated, but when the tsunami came in and we have,
3 you know, some simulations now looking at that, the
4 diesel generator rooms were flooded, and this knocked
5 out the diesel generators leading to basically long-
6 term station blackout, without heat sink as well.

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

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

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

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

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

25 DR. KELLY: Still a question mark. But we

1 are pretty sure that there are, you know, various
2 inspections going on to assess earthquake damage. In
3 terms of tsunami damage, that seems like something
4 they would also be interested in.

5 MEMBER CORRADINI: Okay.

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

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

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

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

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

25 DR. KELLY: Right.

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

5 DR. KELLY: Onagawa or --

6 MEMBER CORRADINI: No.

7 DR. KELLY: -- Fukushima 2?

8 MEMBER ARMIJO: Daini.

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

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

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

18 DR. KELLY: I think that was the
19 implication.

20 MEMBER SHACK: Okay.

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

25 Loss of emergency diesels due to the

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

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

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

24 And then, when the tsunami hit, they
25 weren't able to restore the isolation condenser, which

1 part -- you know, we need to confirm all of these
2 things, but it's sort of pointing to why it actually
3 melted down faster than severe accident codes would
4 have said.

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

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

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

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

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

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

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

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

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

5 MEMBER STETKAR: I don't know.

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

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

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

24 And then, furthermore, the diesel fuel
25 tanks were -- which were outside were also washed

1 away. So even if -- you know, their supply of fuel
2 was gone as well.

3 Yes.

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

7 DR. KELLY: Right.

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

14 DR. KELLY: Right.

15 MEMBER SIEBER: -- safe, too.

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

23 And I'll talk -- I heard you speaking
24 earlier about the -- what we know the about spent fuel
25 pool 4, and I have some of -- I'll talk a little bit

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1 about the analysis that we did and the conclusions we
2 rely on.

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

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

13 MEMBER CORRADINI: Okay.

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

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

19 DR. KELLY: No.

20 MEMBER ARMIJO: So, you know, something --

21 DR. KELLY: Something else went wrong.

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

24 CHAIRMAN ABDEL-KHALIK: Unless you get
25 connected.

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

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

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

22 Dr. Lyons, my boss, and Chairman Jaczko
23 got together with INPO and discussed, how are we going
24 to deal with all the industry's interest in assisting
25 Japan? And so INPO agreed to be the coordinating

1 point for that, and they sent -- ended up sending
2 people both to -- to Japan as well as coordinating
3 things here in the U.S.

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

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

11 DR. KELLY: Yes.

12 MEMBER CORRADINI: Okay.

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

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

21 And, you know, this is vital for not only
22 informing the Embassy in Japan about potential dangers
23 to the U.S. citizens, it was also to the military that
24 has naval bases, air base in Japan in close proximity.
25 There were a number of reasons why this was very

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1 important for the benefit of U.S. citizens, and, at
2 the same time, it was benefitting the government of
3 Japan.

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

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

14 DR. KELLY: That was the Navy that --

15 MEMBER BANERJEE: Did you guys get
16 involved in that?

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

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

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

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1 of follow down that line.

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

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

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

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

19 In terms of DOE offices, NE is mine,
20 Nuclear Energy. Science was involved, NNSA.
21 Environment Management, because it's in EM that we
22 have the expertise at Hanford and Savannah River, and
23 a lot of the work in the future is going to be
24 cleaning up contaminated water. And we have built
25 that equipment in the U.S., and we will probably be

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1 involved in some role there, had all our labs,
2 universities, consultants.

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

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

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

25 And, you know, TEPCO and NISA were

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

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

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

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

14 MEMBER CORRADINI: All right. Thank you.

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

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

22 DR. KELLY: Yes. And they were coming up
23 with a list of equipment that they wanted, and
24 analysis. So it was equipment and analysis. They
25 wanted stainless steel tanks for water storage, or

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1 they wanted robots, or they wanted pumps. And so this
2 was a way of getting the information put together as
3 quickly as possible.

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

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

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

1 failed.

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

8 MEMBER CORRADINI: Was that group also
9 informing NRC?

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

12 MEMBER CORRADINI: Oh, NRC provided the
13 source term.

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

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

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1 various monitoring there.

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

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

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

24 MEMBER STETKAR: John, was the Japanese
25 government also doing flyovers, taking their own

1 measurements? And were those --

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

5 MEMBER STETKAR: Oh, they did not. Okay.

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

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

12 DR. KELLY: Right.

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

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

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

1 Livermore --

2 DR. KELLY: Right.

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

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

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

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

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1 in place.

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

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

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

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

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1 leadership.

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

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

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

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

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

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

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

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

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

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1 regime.

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

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

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

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

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

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

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1 phase.

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

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

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

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

21 CHAIRMAN ABDEL-KHALIK: Okay.

22 DR. KELLY: One thing that we paid
23 particular attention to -- and it's still a subject
24 for discussion -- is, how do you cool the reactor?
25 It's bottled -- you know, the core is bottled up, and

1 there's no pathway outside of the containment to get
2 the heat out. So they are basically stuck with a
3 feed-and-bleed type of cooling system, which isn't
4 good for a number of reasons.

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

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

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

14 MEMBER CORRADINI: The head --

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

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

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

24 DR. KELLY: Yes. Yes, I think the steam
25 will find a way to get out, and so it's not -- I've

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1 been informed that it's not deliberate venting, that
2 it's --

3 MEMBER CORRADINI: Okay.

4 DR. KELLY: -- just --

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

7 DR. KELLY: Not to my knowledge.

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

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

22 And we are -- we had Oak Ridge look at,
23 how long would the pumps work, and it would be a very
24 short period of time before the salty fission product
25 stuff would fail the seals and the pumps wouldn't work

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1 anyway. So the recommendation ended up being don't
2 try to start the pumps, because they are not going to
3 be effective, and it could make the situation worse,
4 but --

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

9 DR. KELLY: Yes.

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

13 DR. KELLY: There was some --

14 CHAIRMAN ABDEL-KHALIK: -- the release?

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

22 So we started looking at -- well, if you
23 have to live with feed-and-bleed, how long is it going
24 to take before you could stop feed-and-bleed? The
25 problem is you have this very thick biological shield

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1 outside of the drywell area, and so our -- this work
2 was done at Argonne, started looking at the -- you
3 know, what is the rate-limiting heat transfer step in
4 this process. And it's through that wall, and you
5 don't -- it's something like 250 kilowatts, and they
6 are still in the megawatt range.

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

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

18 DR. KELLY: The previous one?

19 CHAIRMAN ABDEL-KHALIK: Yes, that says --

20 DR. KELLY: This is a convection
21 conduction.

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

24 DR. KELLY: Yes, right. And then, what --
25 could you get water in -- onto the drywell, and by

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1 cooling the drywell improve the heat transfer. This
2 would -- if you could do it, this would be good. At
3 least in terms of time, it would reduce that time down
4 to nine months. But then, you know, there is a lot of
5 issues with this. One is that the shield plugs are
6 there, and we are pretty sure the cranes are
7 inoperable. So getting the shield plugs at the -- the
8 shield plugs being that --

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

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

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

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

25 MEMBER CORRADINI: Let me go back just --

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

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

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

25 So on spent fuel pool 4, so the explosion

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1 occurred in the morning about 90 hours after the
2 earthquake. We think it's about that time. They --
3 we had some discussion yesterday about it. It was --
4 I think it was the beginning of the shift, and they --
5 somebody noted in the log that there had been this
6 explosion.

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

10 MEMBER ARMIJO: Hard to miss, yes.

11 DR. KELLY: But anyway --

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

15 DR. KELLY: Yes.

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

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

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

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

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

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

23 MEMBER STETKAR: Okay.

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

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

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

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

17 DR. KELLY: No. They were reading about
18 80-some degrees Centigrade. So it was -- the pool was
19 warm.

20 MEMBER CORRADINI: But not overheated.

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

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

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

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

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

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

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

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

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

23 (Laughter.)

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

25 MEMBER ARMIJO: But also, the -- you know,

1 it's not just that there's lots of water in there, but
2 if you look you can see the fuel handles, you can
3 see --

4 DR. KELLY: Yes.

5 MEMBER ARMIJO: -- tops of vent plugs.

6 DR. KELLY: Right.

7 MEMBER ARMIJO: That thing was never on
8 fire.

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

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

25 I think this is the more likely. There

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

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

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

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

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

23 They definitely need to get more shielding
24 there, because it's still going to be hot for people
25 to work. There is a need to get more data and get the

1 additional sensors and redundant -- you know, pH is
2 important to know in a lot of these chemical
3 processes. And, you know, we have seen -- I don't
4 think we have seen any data on that yet.

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

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

11 CHAIRMAN ABDEL-KHALIK: Okay.

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

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

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

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

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

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

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

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

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

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

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

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

23 The other area of big interest was
24 maintaining the integrity of the containment, whether
25 it be due to corrosion or another -- a hydrogen

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1 explosion, melt-through, overpressure, failure of
2 these silicon rubber head seals.

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

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

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

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

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

7 DR. KELLY: Right.

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

11 DR. KELLY: Right.

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

15 DR. KELLY: We have recommended --

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

18 DR. KELLY: We have certainly
19 recommended --

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

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

25 MEMBER STETKAR: Okay.

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

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

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

10 MEMBER STETKAR: Okay. Thanks.

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

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

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

25 MEMBER REMPE: There were 500 within the

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

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

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

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

20 I probably had not really thought about
21 salt and water into -- in the reactors before,
22 although it had happened at Millstone in '72. They
23 had a condenser failure, and they got some salt in and
24 it destroyed a lot of their power detectors, you know,
25 power monitors, and they saw some stress corrosion

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1 cracking, things like that. So they had -- that was
2 '72, I think there was a report on that, and --

3 MEMBER CORRADINI: The Navy has no
4 experience --

5 DR. KELLY: Well --

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

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

10 MEMBER ARMIJO: Cathodic protection and
11 all of that.

12 DR. KELLY: Cathodic protection is the
13 word.

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

16 DR. KELLY: They are deaerating the water
17 now.

18 MEMBER ARMIJO: Nitrogen sparging or --

19 DR. KELLY: They are using hydrazine.

20 MEMBER ARMIJO: Hydrazine.

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

23 MEMBER ARMIJO: Well, maybe.

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

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1 MEMBER BANERJEE: Got a lot of hydrogen
2 anyway.

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

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

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

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

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

3 MEMBER ARMIJO: Okay. So it may have
4 some.

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

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

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

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

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1 MEMBER POWERS: At least .5 molar.

2 (Laughter.)

3 DR. KELLY: We think it's --

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

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

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

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

24 So we have the initial one, but there is
25 -- now out and largely deposited, but if you had

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1 another one, what could happen? So this was the --
2 you know, a second phase of emergency response if
3 something happened again.

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

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

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

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

24 DR. KELLY: Right. And then, you know, we
25 didn't see the strontium yet, so we're not -- we don't

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1 think the temperatures were hot long, or it's in
2 solution as well I guess.

3 MEMBER BANERJEE: Did you see any
4 ruthenium?

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

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

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

11 MEMBER POWERS: You will see plutonium --

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

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

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

19 MEMBER RYAN: Did they have any gauges
20 or --

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

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

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

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

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

8 DR. KELLY: Yes.

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

17 DR. KELLY: So, but you know there's still
18 a lot of work that has to be done. The clean-up as
19 well as stabilization. And so I think we're -- Again
20 another large earthquake could maybe again disable
21 cooling. And our estimates are not that it's on the
22 order of 10 hours. If they lost cooling, it would be
23 10 hours before they would begin to remelt.

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

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1 analysis?

2 DR. KELLY: Qualitatively. But there is
3 --

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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1 of thing will continue.

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

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

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

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

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

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

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

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

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

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

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

25 DR. KELLY: Yes. Well, clearly, this lack

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1 of instrumentation measurements is really severe. We
2 think that there may be capabilities within our
3 laboratories to invent new instruments that could be
4 deployed. And so that's one area for research.

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

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

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

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

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

24 MEMBER CORRADINI: The same triad.

25 DR. KELLY: We're already doing research

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

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

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

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

24 CHAIR ABDEL-KHALIK: Okay.

25 MEMBER BANERJEE: Going back to Unit 4,

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

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

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

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

18 DR. KELLY: That the zirconium -- Yes.

19 MEMBER BANERJEE: Yes.

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

22 MEMBER BANERJEE: Okay.

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

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1 hypothesis.

2 MEMBER BANERJEE: Thanks.

3 MEMBER SHACK: Did they have water
4 chemistry samples?

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

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

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

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

23 DR. KELLY: Yes.

24 MEMBER ARMIJO: So there was plenty of
25 water there. The question, did it leak out through

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1 the bottom as a result of the earthquake and then
2 caused a fire? And you know those early thoughts seem
3 not to be supported.

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

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

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

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

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

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

24 MEMBER BANERJEE: Somewhere else.

25 DR. KELLY: If it was hydrogen from

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1 somewhere else, yes.

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

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

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

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

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

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

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1 at least Fukushima 1.

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

5 MEMBER ARMIJO: Right.

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

12 MEMBER ARMIJO: Yes.

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

17 CHAIR ABDEL-KHALIK: Joy.

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

23 And I know it appeared that Tony said,
24 "Yes, we need to go in and see that information." It
25 may be five years or more before we ever do. And

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1 industry might be able to throw some support as Dana
2 suggested.

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

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

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

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

25 DR. KELLY: There will be a need for

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

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

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

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

24 MEMBER STETKAR: Okay.

25 DR. KELLY: And they were just doing

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

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

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

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

23 But to my knowledge I don't know who the
24 experts are with IAEA, who they've picked up to go
25 over there. But the severe accident expertise is in

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1 the DOE National Laboratories in this building. So
2 it's data plus analysis that go together to help you
3 understand what the data is saying at the same time.

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

9 MEMBER STETKAR: Thanks.

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

13 MEMBER POWERS: Can I just ask one
14 question?

15 CHAIR ABDEL-KHALIK: Sure.

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

18 (Laughter.)

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

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

25 DR. KELLY: You're welcome.

1 CHAIR ABDEL-KHALIK: Thank you.

2 DR. KELLY: Thank you.

3 CHAIR ABDEL-KHALIK: At this time we will
4 take a roughly 15 minute break. And we'll come back
5 to hear the public comments and have additional
6 discussions amongst ourselves. So let's reconvene at
7 4:05 p.m. Off the record.

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

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

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

20 PARTICIPANT: Yes, the bridge is open.

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

24 MEMBER CORRADINI: Now maybe it's open.

25 PARTICIPANT: Please let us know if you're

1 on the line.

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

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

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

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

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

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

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

23 CHAIR ABDEL-KHALIK: Yes.

24 MR. GUNDERSEN: Okay.

25 CHAIR ABDEL-KHALIK: Please proceed.

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

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

7 PARTICIPANT: Excuse me.

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

14 In 2009 --

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

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

24 Mr. Gundersen, please proceed.

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

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

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

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

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

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

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

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

1 1000 design.

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

7 The accident at Fukushima has confirmed my
8 belief that the leakage of a nuclear containment
9 cannot be based upon the assumption of a leak rate of
10 zero as used by the NRC. Just this week Tokyo
11 Electric has finally acknowledged that all seals of
12 Mark I containment systems are leaking significant
13 radiation to the environment and at least Units 1 and
14 2 began leaking on the first day of the accident.

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

22 The ramifications of a nuclear reactor
23 containment leakage and failure of the NRC and its
24 body to consider are: (1) the SAMSA analysis of
25 Westinghouse AP 1000 design (telephonic interference)

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1 that there is zero probability of a containment leak
2 of any magnitude. When historical record prior to
3 Fukushima proved this assumption fault and the
4 Fukushima containment failure of the AP 1000 design be
5 analyzed and retrofitted with charcoal filters on top
6 of the shield built.

7 MR. WARREN: Pardon me. Arnie?

8 MR. GUNDERSEN: Yes.

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

11 MR. GUNDERSEN: Yes, I do.

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

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

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

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

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

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

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

21 (Simultaneous speaking.)

22 -- a single operation.

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

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

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

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

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

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

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

24 (No response.)

25 Is there anybody else on the line? Is

1 there anybody else here?

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

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

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

9 MR. LEYSE: I will go to *6.

10 CHAIR ABDEL-KHALIK: Sir.

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

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

25 Another part of that petition in addition

1 to the reactor risks are the risks of high level
2 radioactive waste storage pools at these reactors.
3 And this would even include shutdown reactors of this
4 design including the Millstone unit that's been
5 mentioned, the pool of which still contains high level
6 radioactive waste.

7 So I just wanted to inform you of this.
8 We have been granted a petition review board on June
9 8th that will last for two hours. I'm not sure of the
10 exact time of day. But we have a growing number of
11 groups across the country joining this coalition.

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

19 Thank you very much.

20 CHAIR ABDEL-KHALIK: Thank you, sir.

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

23 MR. LEYSE: Just came back on. Quickly,
24 I want to say DRM 50.93 was around well ahead of
25 Fukushima and a predecessor to that was around since

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1 the mid -- around 2002 or 2003. And nothing seems to
2 move.

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

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

18 CHAIR ABDEL-KHALIK: Mr. Leyse.

19 MR. LEYSE: End of comments. Thank you.

20 CHAIR ABDEL-KHALIK: Thank you very much.

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

24 MR. WARREN: This is Jim Warren again.
25 And I like to come back and apologize for having to

1 interrupt Mr. Gundersen's presentation a few minutes
2 earlier. But it was very frustrating that obviously
3 some people in the room were not listening to what he
4 was saying. And it make it possible for others of us
5 not to hear either.

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

9 CHAIR ABDEL-KHALIK: Sir, excuse me.

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

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

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

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1 the room or near the phone.

2 CHAIR ABDEL-KHALIK: It was not, sir.

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

5 CHAIR ABDEL-KHALIK: Thank you. All
6 right.

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

9 (No response.)

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

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

16 CHAIR ABDEL-KHALIK: Okay. Sanjoy.

17 MEMBER BANERJEE: None.

18 CHAIR ABDEL-KHALIK: Harold.

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

21 CHAIR ABDEL-KHALIK: Dennis.

22 MEMBER BLEY: No. No additional.

23 CHAIR ABDEL-KHALIK: Dana.

24 MEMBER POWERS: What we see is a
25 tremendous amount of interest in the Fukushima

1 accident right now and desperate attempts to try to
2 learn lessons at which is a very premature stage and
3 understanding of this accident. And our experience
4 from previous accidents is it takes quite a while
5 before you can draw conclusions that stand any test of
6 time.

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

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

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

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

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

15 CHAIR ABDEL-KHALIK: Thank you.

16 Sam.

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

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

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

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

10 John.

11 MEMBER STETKAR: Nothing more. Thanks.

12 CHAIR ABDEL-KHALIK: Mike.

13 MEMBER RYAN: No additional comments.

14 Thank you.

15 CHAIR ABDEL-KHALIK: Bill.

16 MEMBER SHACK: Nothing.

17 MEMBER BROWN: Nothing more than what I
18 said.

19 CHAIR ABDEL-KHALIK: Joy. Mike.

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

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

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

17 CHAIR ABDEL-KHALIK: Okay.

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

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

25 Are there any -- Tom.

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

7 But you can be a little premature. These
8 20 I've got, a lot of them may not prove to be good
9 when we get the real information. That's really my
10 reaction to this.

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

13 Are there any additional comments?

14 PARTICIPANT: If I can.

15 CHAIR ABDEL-KHALIK: Yes, sir.

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

24 But it might be worthwhile for the
25 Committee to focus on that because that is probably

1 the most important event right now that could occur at
2 a plant. And so whatever the Committee does with
3 respect to Station Blackout I think is going to be
4 very helpful to the Commission.

5 CHAIR ABDEL-KHALIK: Thank you, John.

6 PARTICIPANT: Appreciate that.

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

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

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

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

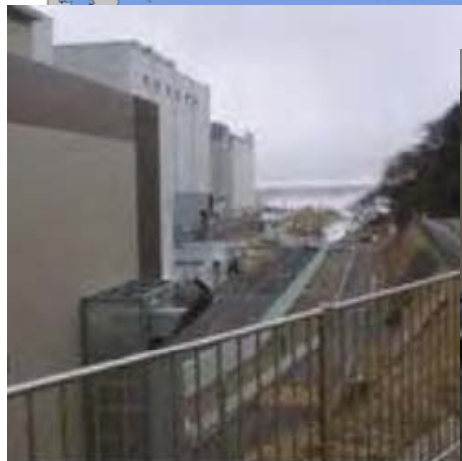
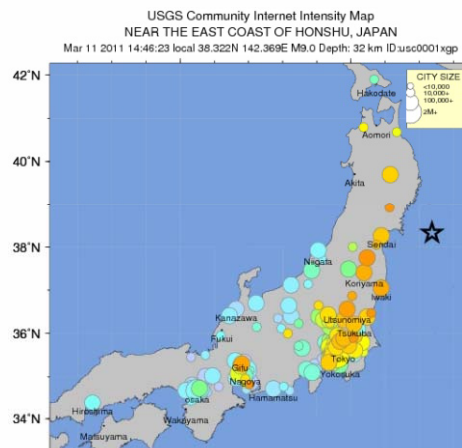
May 26, 2011







Earthquake 3/11

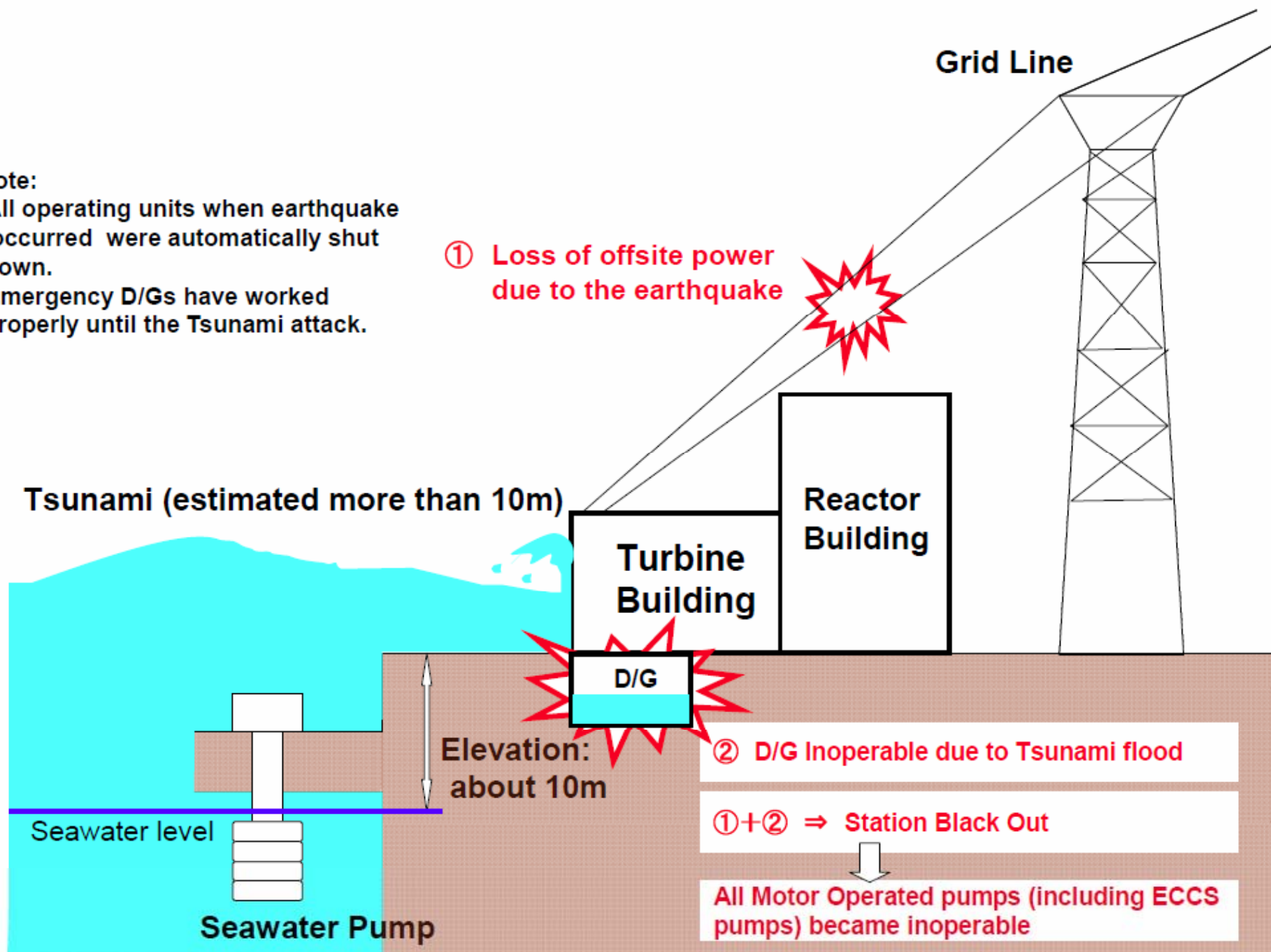


- **14:36 JST Earthquake**
- **15:41 JST Tsunami**
- **Magnitude: 9.0**
- **Generated a 14m Tsunami**
- **Many thousands perished**
- **More that 100 thousand people were homeless without food, water, or heat**

3-2. Major root cause of the damage

Note:

- All operating units when earthquake occurred were automatically shut down.
- Emergency D/Gs have worked properly until the Tsunami attack.





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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



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Immediate Response



- ☐ 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



- ☐ Organized nuclear industry technical response to assist TEPCO



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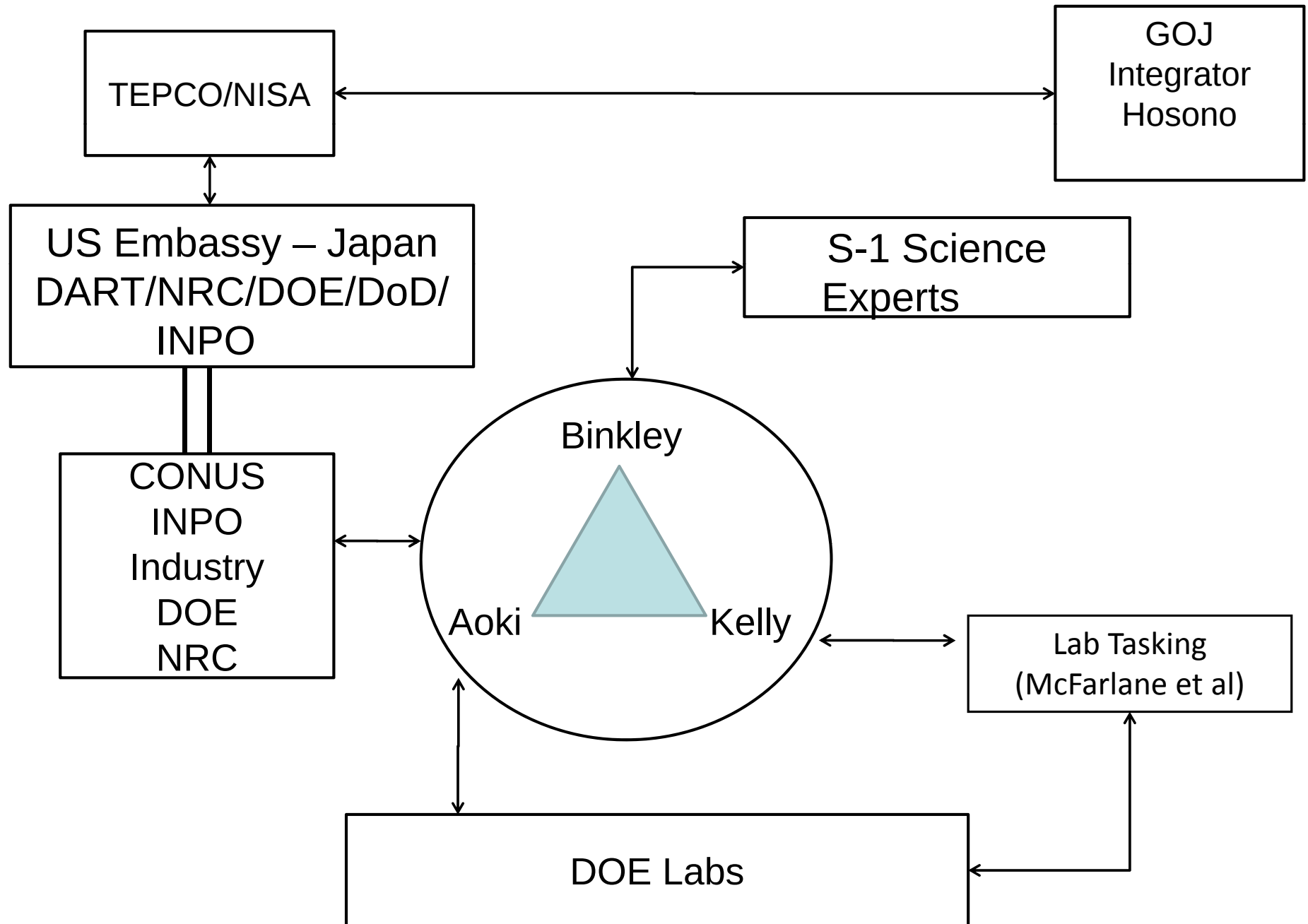
- ☐ Activated its Emergency Operations Center focused on monitoring radiation release and impact on U.S. citizens (both in Japan and the U.S.)
- ☐ Deployed Airborne Monitoring System aircraft and sensors
- ☐ Provided additional DOE Embassy reps to the two already assigned to the U.S. Embassy
- ☐ Deployed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



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





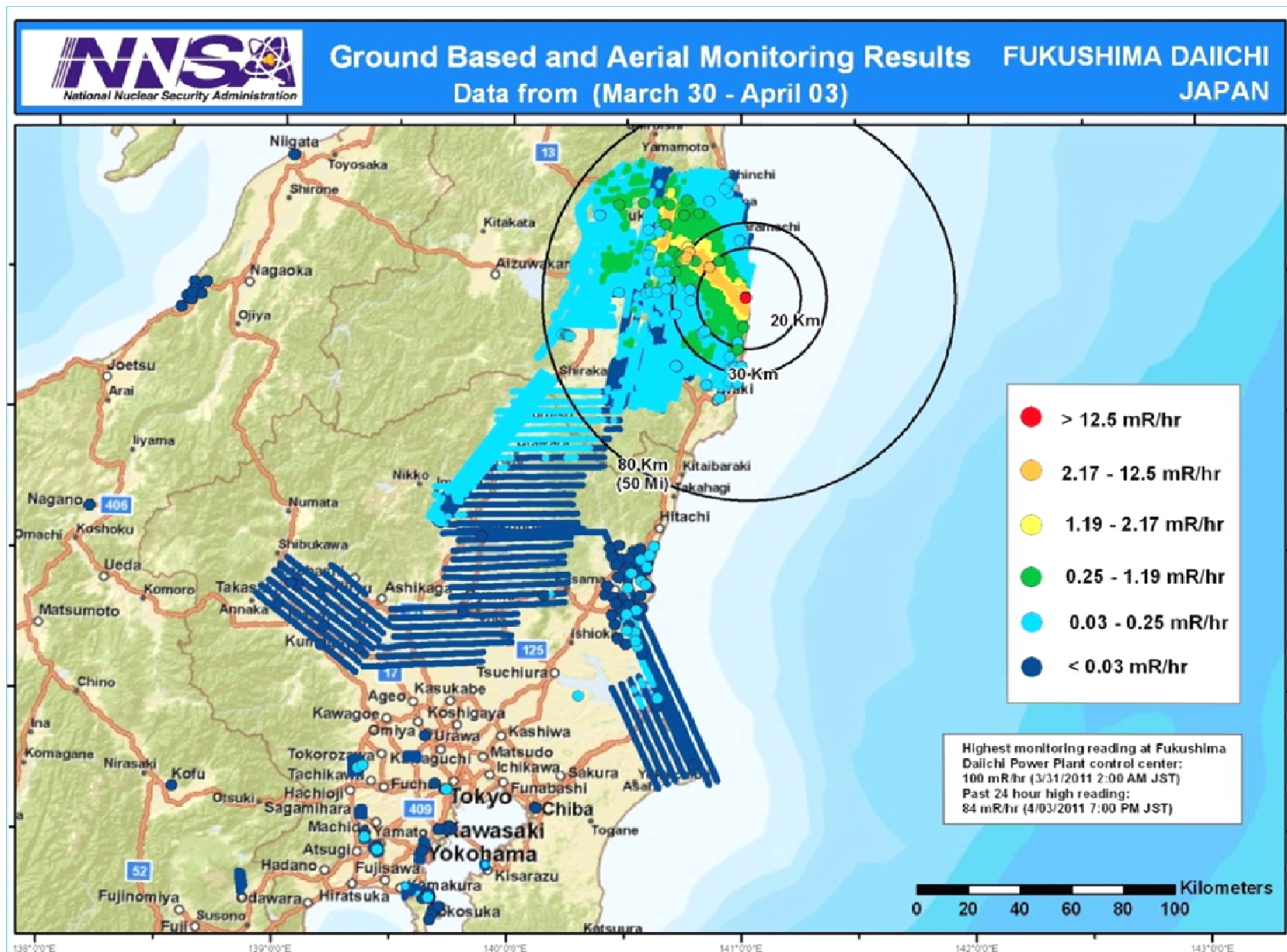
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Airborne Radiation Monitoring

- **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**

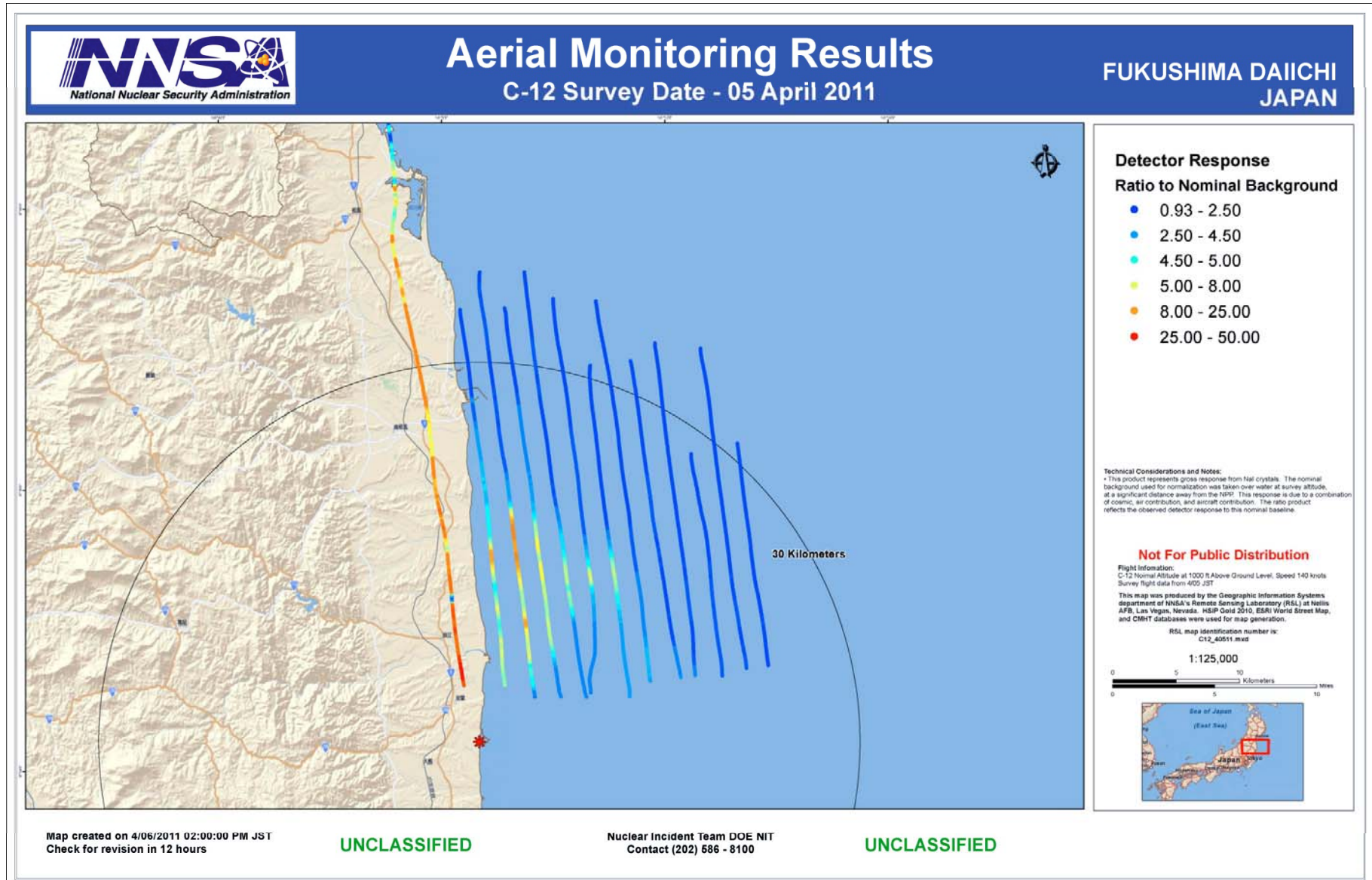


DOE/NNSA Monitoring



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)





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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

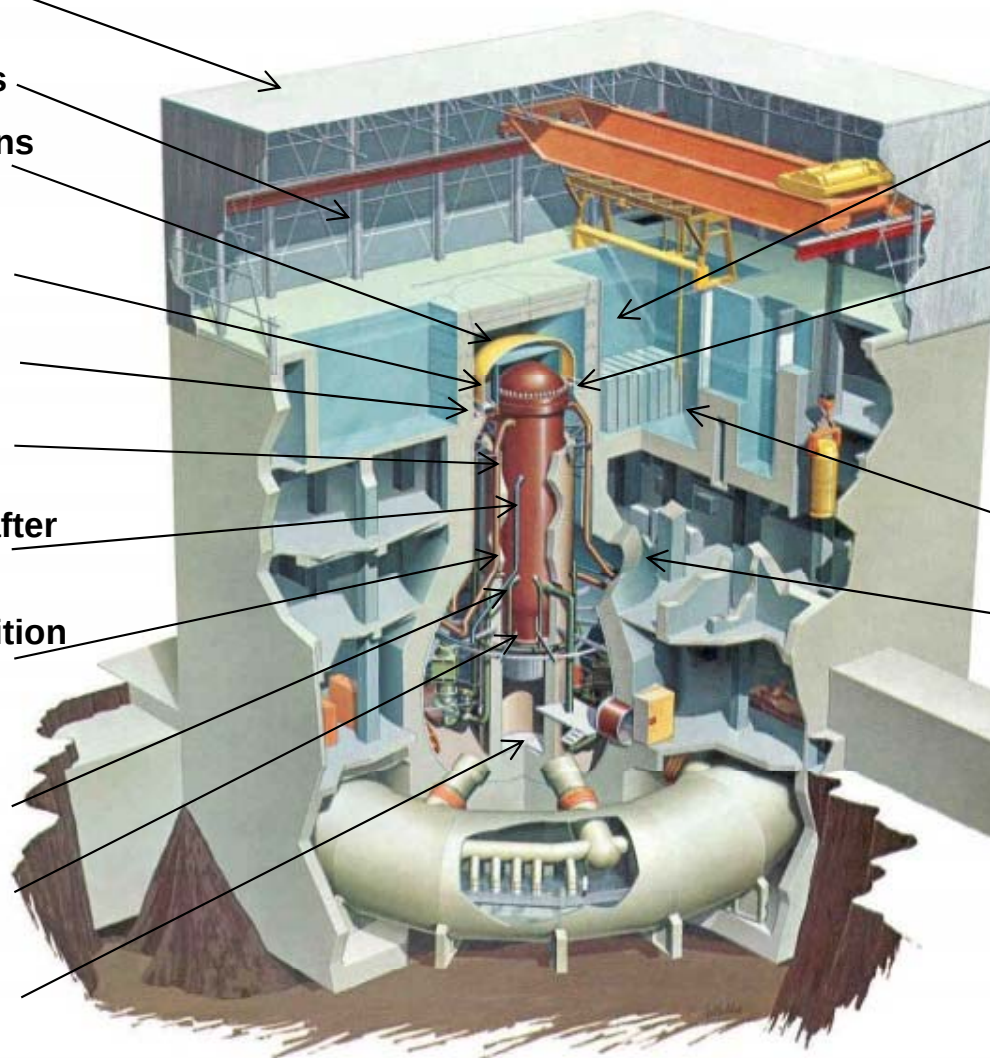
Sensor data analysis

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



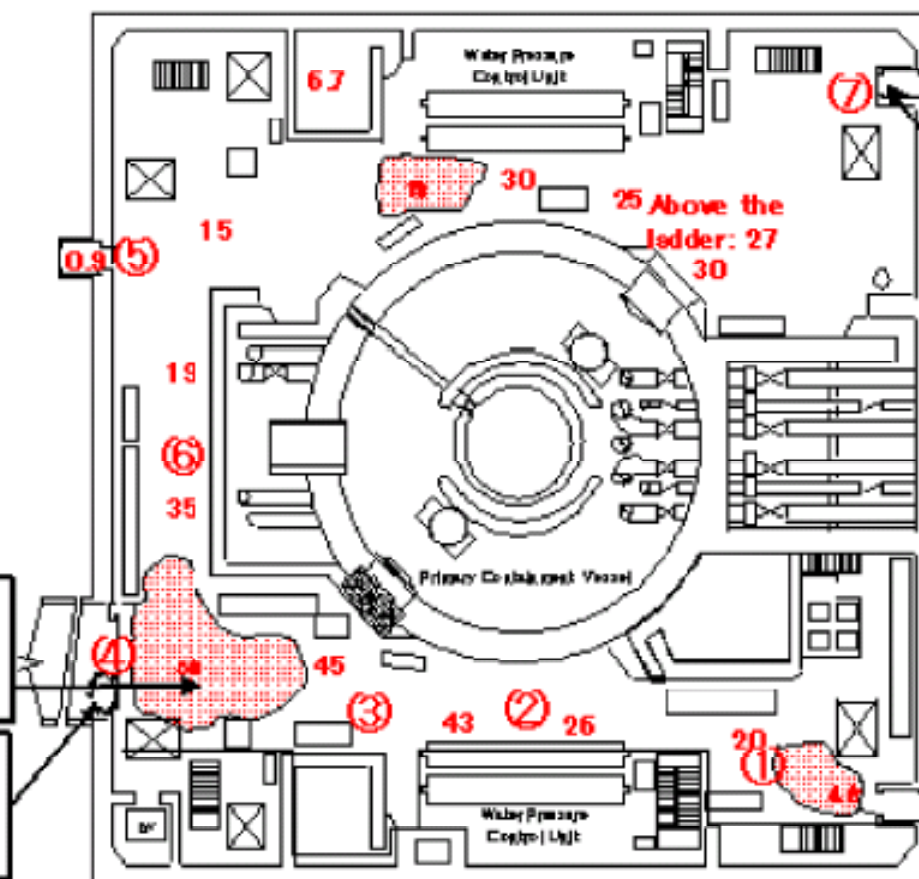
Reactor Building Survey Results for Unit 2

- 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.



Water dripping found around the upper side of the machine hatch

Inside door of the equipment hatch: partly open (approx. 1/3)



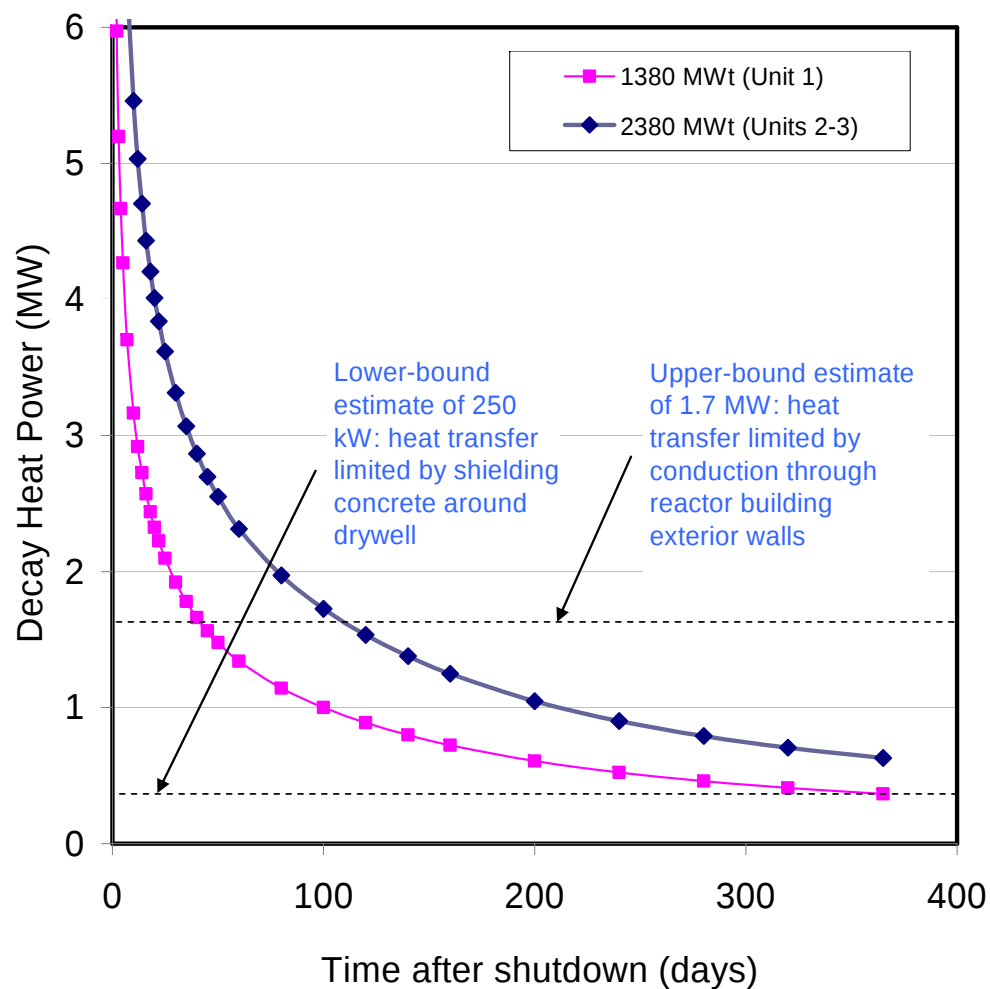
Airlock did not open from inside





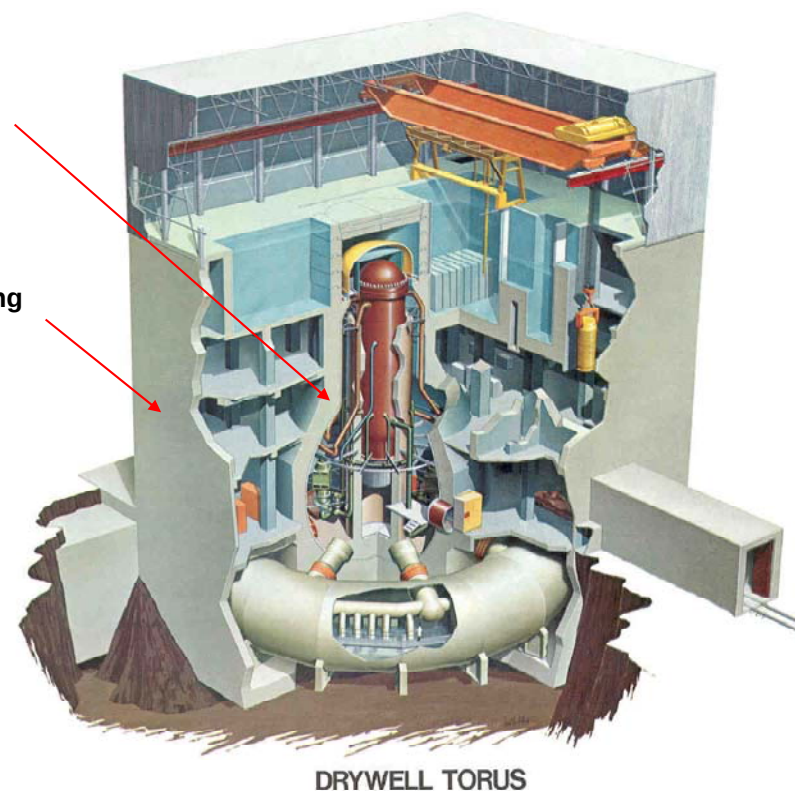
Passive Cooling Assessment

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



Shielding concrete

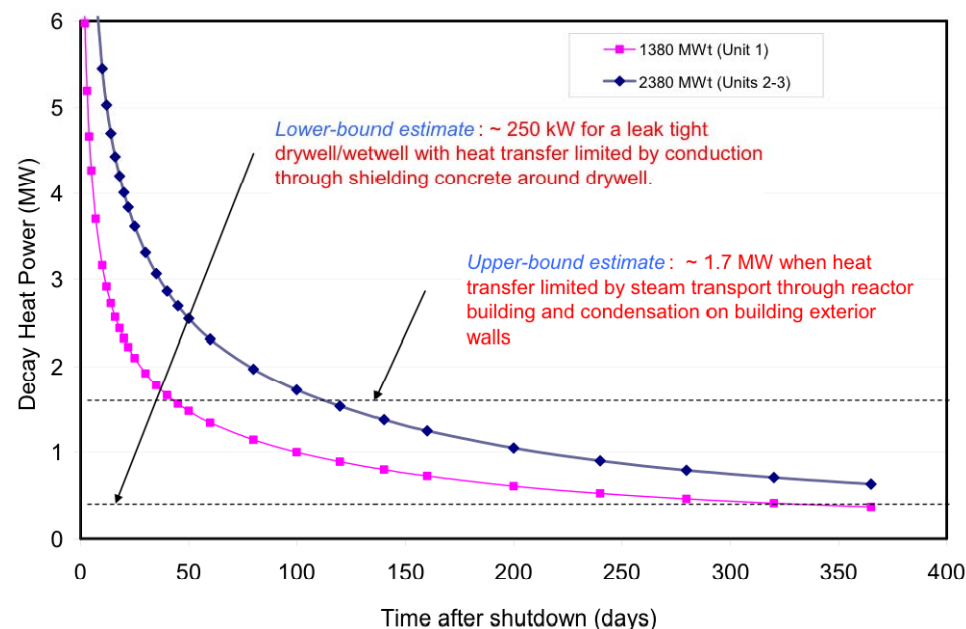
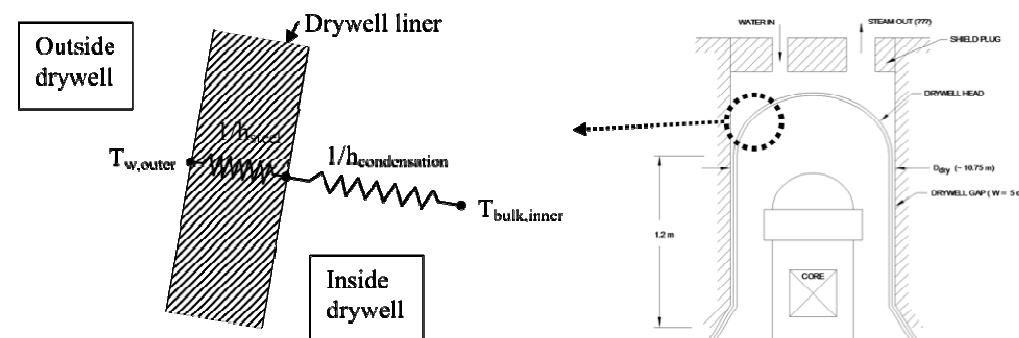
Reactor building exterior walls





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





Background on Unit SFP 4 Explosion

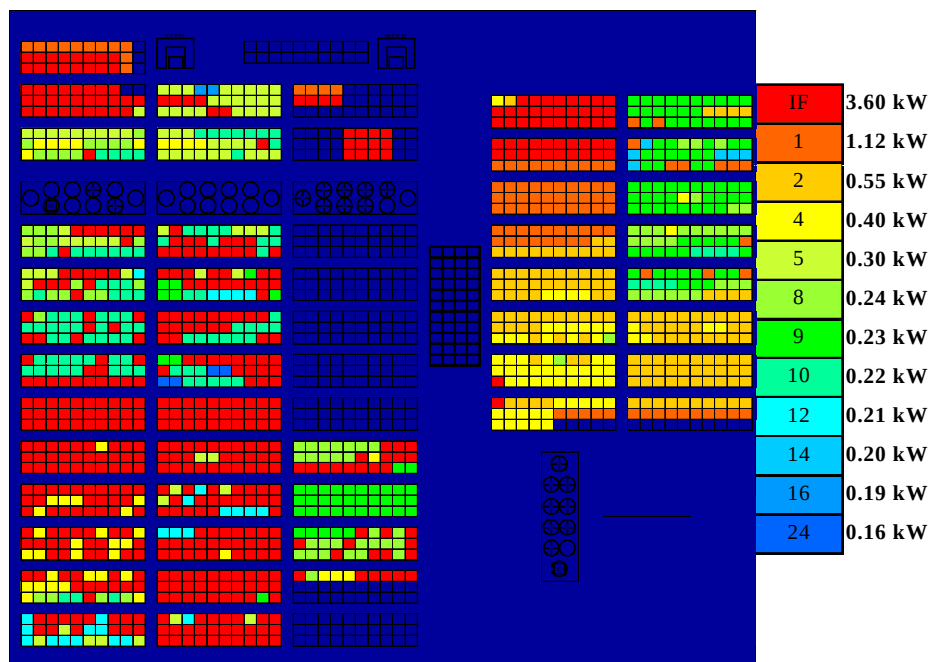
- **Unit 4 explosion Occurred March 15, 6:00 am – Approximately 90 hours after earthquake (Full core offloaded into pool, high heat load (~2.3 MW))**
- **The Unit 4 Explosion was originally attributed to hydrogen, but it has not be possible to definitively conclude this.**
- **An assessment of possible 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.



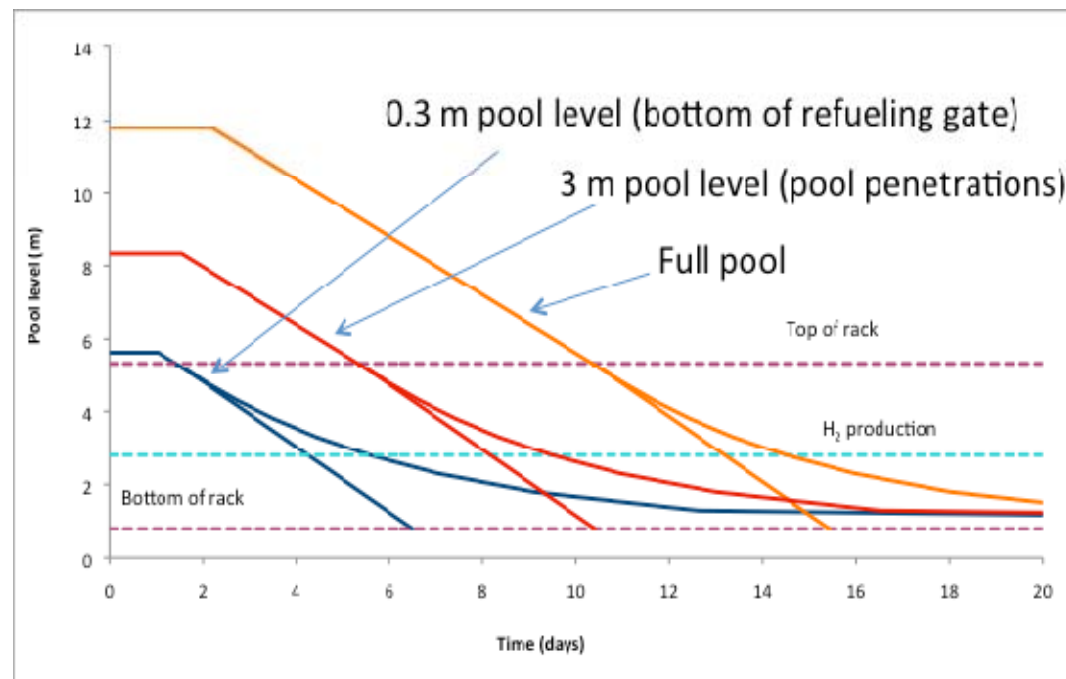
Thermal analysis of pool heatup and boil off

- 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





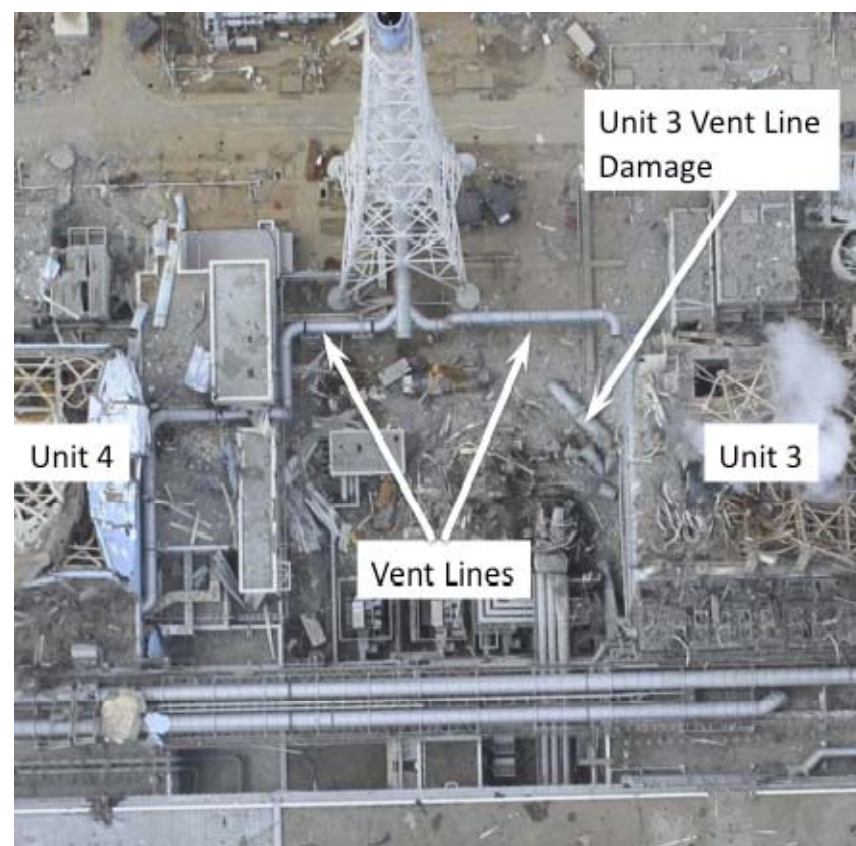
Hydrogen Explosion From Fuel Storage Pool

- **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



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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**



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



Hanford Spent Fuel K-Basin

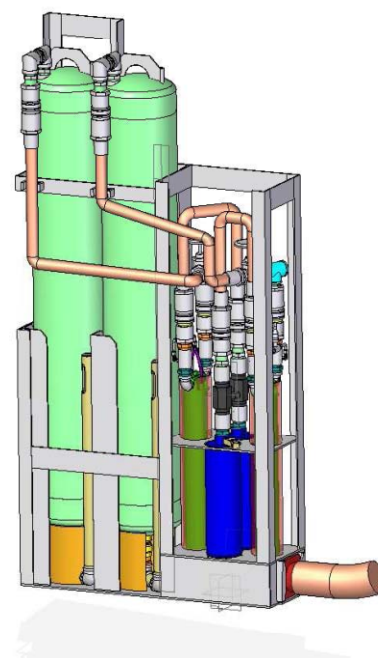


Hanford Spent Fuel K-Basin



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
- H₂ 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

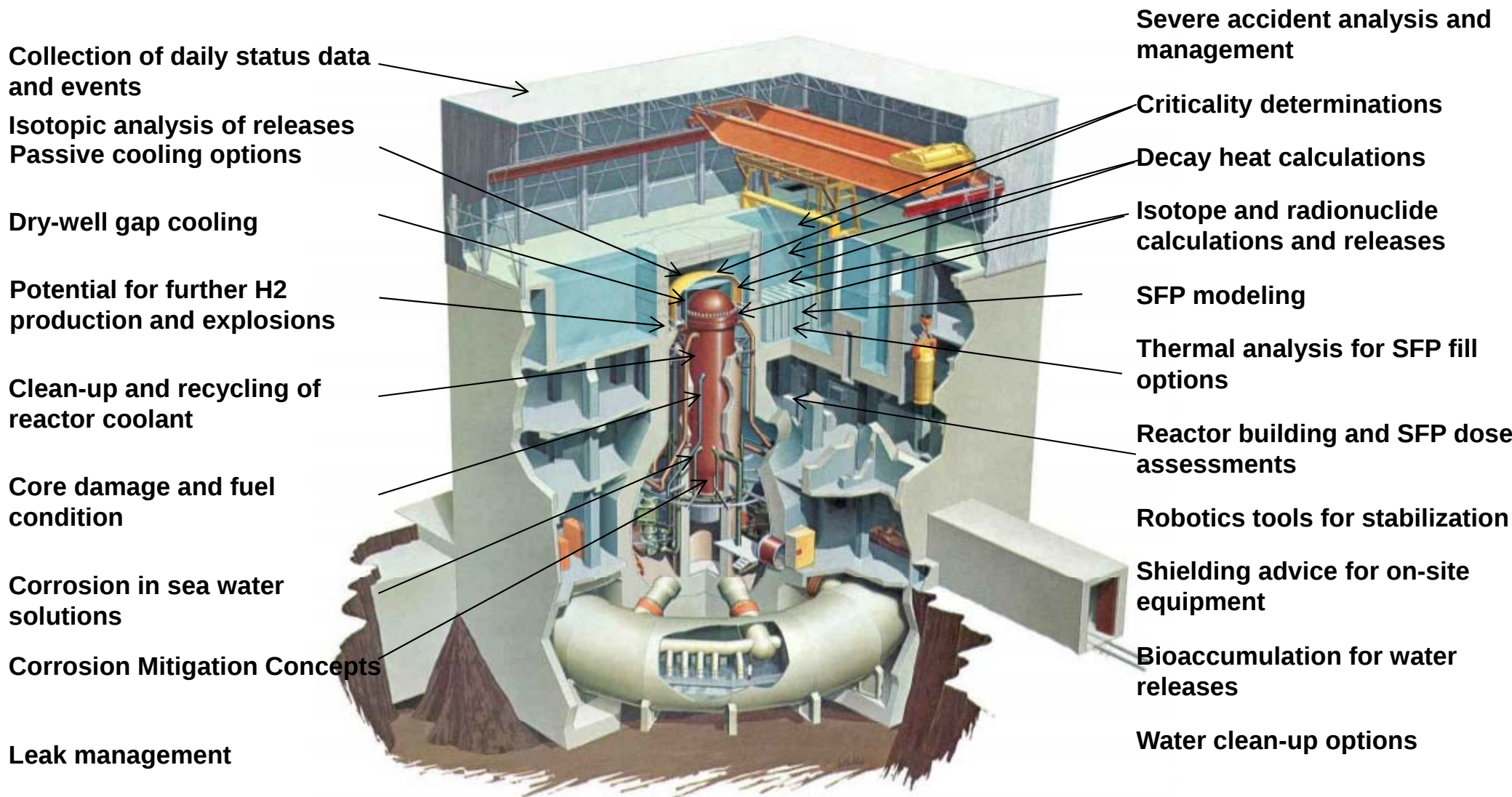


NERT Technical Studies related to Maintaining Long-term Integrity of Containment

- **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





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



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 ₂ SO 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



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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. Donovan 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 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
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