Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
Regulatory Policy and Practices Subcommittee

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Wednesday, October 2, 2013

Work Order No.: NRC-313 Pages 1-178

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

3 + + + + +

4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

5 (ACRS)

6 + + + + +

7 REGULATORY POLICIES AND PRACTICES SUBCOMMITTEE

8 + + + + +

9 WEDNESDAY

10 OCTOBER 2, 2013

11 + + + + +

12 ROCKVILLE, MARYLAND

13 + + + + +

14 The Subcommittee met at the Nuclear

15 Regulatory Commission, Two White Flint North, Room

16 T2B1, 11545 Rockville Pike, at 8:30 a.m., Harold B. Ray,

17 Subcommittee Chairman, presiding.

18 COMMITTEE MEMBERS:

19 HAROLD B. RAY, Subcommittee Chairman

20 J. SAM ARMIJO, Member

21 RONALD G. BALLINGER, Member

22 SANJOY BANERJEE, Member

23 DENNIS C. BLEY, Member

24 CHARLES H. BROWN, JR. Member

25 MICHAEL L. CORRADINI, Member

1 DANA A. POWERS, Member
2 JOY REMPE, Member
3 PETER C. RICCARDELLA, Member
4 MICHAEL T. RYAN, Member
5 STEPHEN P. SCHULTZ, Member
6 GORDON R. SKILLMAN, Member
7 JOHN W. STETKAR, Member
8 WILLIAM J. SHACK, Consultant
9
10 NRC STAFF PRESENT:
11 DEREK WIDMAYER, Designated Federal Official
12 NILESH CHOKSHI, NRO
13 CHRISTOPHER COOK, NRO
14 FERNANDO FERRANTE, NRR
15 JOSEPH KANNEY, RES
16 THOMAS J. NICHOLSON, RES
17 WILLIAM R. OTT, RES
18
19 ALSO PRESENT:
20 HENRY JONES, USGS
21 *Present via telephone
22
23
24
25

1

2 T-A-B-L-E O-F C-O-N-T-E-N-T-S

3 Introduction

4 Harold Ray.....4

5 NRC Staff Introduction and Overview

6 Bill Ott.....7

7 PFHA Workshop: Discussion, Observations and

8 Recommendation

9 Tom Nicholson.....30

10 Motivation for JLD Guidance Development

11 Christopher Cook.....80

12 Insights from the Reactor Oversight Process for Future

13 Activities

14 Fernando Ferrante.....105

15 Development of a Consolidated Hydrology and Meteorology

16 Research Program Plan

17 Joseph Kanney.....143

18 Subcommittee Discussion.....165

19 Adjournment.....178

20

21

22

23

24

25

1

2 P-R-O-C-E-E-D-I-N-G-S

3 8:28 a.m.

4 CHAIRMAN RAY: Meeting will now come to

5 order. This is a meeting of the Advisory Committee on

6 Reactor Safeguards Subcommittee on Reactor Policies and

7 Practices.

8 I'm Harold Ray, Chairman of the

9 Subcommittee. With us this morning we have Pete

10 Riccardella, Dick Skillman -- huh?

11 MEMBER ARMIJO: Steve Schultz.

12 (Laughter.)

13 CHAIRMAN RAY: Yes, what happens is the

14 order on -- yes, I got to decide am I going to look around

15 the table or am I going to read it in the order that it's

16 presented here, and I wind up screwing up.

17 Anyway to resume, Steve Schultz, Dennis,

18 Bley, Dana Powers, Sam Armijo, John Stetkar, Michael

19 Ryan, Ron Ballinger and Joy Rempe. We expect to be

20 joined also by Sanjoy Banerjee, Mike Corradini --

21 MEMBER BALLINGER: Charlie Brown is here.

22 CHAIRMAN RAY: -- and Charlie Brown.

23 MEMBER BROWN: I'm here.

24 CHAIRMAN RAY: With that very

25 unprofessional introduction, let me continue.

1 The purpose of the meeting is to -- oh, and
2 I wanted to mention a very important attendee at our
3 meeting today, a former member and chairman of the ACRS
4 and now consultant to the Subcommittee, Dr. Bill Shack.
5 The purpose of the meeting is to review and
6 discuss first the results of the Workshop on
7 Probabilistic Flood Hazard Assessment sponsored by the
8 NRC's Office of Research. Second, how lessons learned
9 from the workshop and from other work is being used to
10 develop a program plan for needed research. And third,
11 the status of regulatory guidance development in this
12 subject area.
13 There is no subsequent Full Committee
14 session planned at this time and no letter report has been
15 requested by the staff.
16 Derek has provided to all members a
17 comprehensive status report, and I recommend it to you
18 for your review. Bill Shack has followed this area in
19 detail and we're very fortunate, and I'm particularly
20 fortunate to have his input as we go forward.
21 While evaluating what should be
22 requirements for new plants and sites is an important
23 goal, a far more difficult goal is to decide if the
24 licensing basis for any existing plants needs to change
25 and whether the provisions for mitigating beyond design

1 basis flooding events are adequate and credible. It is
2 this more difficult area that I ask members to think about
3 during the meeting today to decide if we're satisfied
4 whether the Agency's on the right track at an acceptable
5 pace or whether we're becoming victims of the paralysis
6 of analysis relative to action that should be taken at
7 specific sites.
8 We absolutely will not discuss specific
9 sites today without licensing engagement, but I suggest
10 that we need to understand when and how they will be
11 addressed.
12 The meeting this morning is open. Rules
13 for the conduct of and participation in the meeting have
14 been published in the *Federal Register* as part of the
15 notice of this meeting.
16 Derek Widmayer is the designated federal
17 official for the meeting.
18 A transcript of the meeting is being kept
19 and will be made available on the ACRS Web page, therefore
20 it is requested that speakers first identify themselves
21 and speak with sufficient clarity and volume so that they
22 can be readily heard.
23 We have not received any request for time
24 to make oral statement from anyone prior to today's
25 meeting, however, there will be time made available at

1 the end of the proceeding for anyone who wishes to make
2 a comment at that time.
3 We will now proceed with the meeting and I
4 call upon Bill Ott, Chief of the Environmental Transport
5 Branch in the Division of Risk Analysis Office of
6 Research to open the proceedings, unless, Nilesh,
7 there's anything you want to say.
8 MR. CHOKSHI: No, I think this is the
9 research shown and Bill will do the introductions.
10 Thank you.
11 CHAIRMAN RAY: Very good.
12 MR. OTT: Thank you. I'll introduce the
13 panel up here as I go through. Basically we tried to put
14 together a program that will tell you where we are from
15 the research perspective, as well as where our colleagues
16 in the licensing offices are. And that's why we're
17 trying to appear for you today together.
18 We last came to you to discuss progress on
19 Regulatory Guide 1.59 almost a year ago. You gave us a
20 letter. We've looked at most of the comments. We sent
21 you a response back with our intent to deal with those
22 comments.
23 Since that particular point in time we have
24 not been able to proceed further because there's been a
25 state of flux with regard to the developing of guidance

1 in the licensing offices with regard to the ISGs, and they
2 would have preferred that we wait until the ISGs were
3 completed before we actually proceeded with the
4 finalization of that draft guide.
5 CHAIRMAN RAY: Will they speak later to the
6 reasons for that preference?
7 MR. OTT: I don't believe they are directly
8 going to address that right now, no.
9 CHAIRMAN RAY: So we'll be in a position of
10 just understanding that they don't want you to proceed,
11 but we won't know why?
12 MR. OTT: Basically they want to make
13 certain that there is consistency between what's in 1.59
14 and what's in the ISGs. So they would like us to take
15 one more flush through it to make certain that there's
16 no disconnect between those documents.
17 MR. CHOKSHI: I think, Dr. Ray, you will see
18 in Chris' presentation there are certain things in the
19 new reactor -- was not, you know, for example sort of a
20 flooding, though, you know, we are very -- all of causal
21 mechanism were not looked at. But as you're looking at
22 2.1 we had to develop some new guidance and we want to
23 make sure that going forward we capture that, because
24 that will be the one we will be using when those
25 situations come up in the new reactor license. And you

1 will see that.

2 CHAIRMAN RAY: I think that helps. It's

3 better if we know why things are where they are than to

4 not. So thank you. Go ahead.

5 MR. OTT: Okay. I will talk a little bit

6 about what we did to try and prepare for Reg Guide 1.59,

7 what we're doing with regard to 1.102, and what the

8 current state of our research program is. Very briefly.

9 Not a lot of detail, just basically the topics of the

10 research that we're going through right now. And then

11 we'll turn it over to Tom Nicholson to talk about the

12 workshop that we conducted January 29 to 31 on moving

13 forward to a probabilistic flood hazard assessment.

14 We know that you're very interested in that

15 workshop and that several of the members attended. Tom

16 will go over that in some detail in terms of the

17 recommendations from each one of the panels.

18 Then we'll turn it over to Chris Cook on my

19 right, who will talk about JLD and the interim guidance,

20 the ISGs that we were talking about a moment ago.

21 Primarily the motivation for those is the probabilistic

22 -- the subject of this discussion.

23 Then we'll turn it over to Fernando

24 Ferrante, who will talk about insights from the

25 significance determination process experience. We're

1 worrying not just about new plants but about existing
2 plants and how to support NRR as well as NRO in this
3 activity right now.
4 And then the last speaker will be Joe
5 Kanney, who will talk about the development of a research
6 plan for development of a probabilistic approach to flood
7 hazard assessment.
8 Next slide, Joe. Another reason for the
9 revision to Regulatory Guide 1.59 is circa 1970s. Since
10 that time there's been a lot of information on storm data.
11 There's tremendous improvement in computational
12 resources, both in data sets and in the ability to
13 manipulate those data sets. There's even been
14 significant improvement in the models that are used to
15 use with that data.
16 In order to support the revision of Reg
17 Guide 1.59, we placed three contracts, one with Pacific
18 Northwest National Laboratory, which basically went
19 through what NRR or NRO had been doing with regard to new
20 sites and tried to capture the current state of the review
21 process. And that was with the PNNL project. It was
22 NUREG-7046, I believe, and has been heavily used in the
23 reviews up to this point.
24 The second contract we placed was with the
25 Corps of Engineers to look at storm surge in the

1 Southeastern U.S. They produced a report which is the
2 basis for more accurate estimates of storm surge and
3 methodology for doing those calculations
4 site-specifically.
5 And then the third contract we placed for
6 that purpose was looking at the estimation of probable
7 maximum precipitation, and that was placed with the
8 Bureau of Reclamation, Dr. John Inglet.
9 CHAIRMAN RAY: Bill, I should have said
10 something about this in the beginning. What is the
11 relationship of a tsunami or a storm, a seiche on what
12 we're looking at here? Is it in-scope or out-of-scope?
13 I notice there's nothing here about it in what you've
14 described so far.
15 MR. OTT: A tsunami is not addressed in a
16 significant way in 1.59. It's addressed in other places
17 in the regulation, in the guidance.
18 CHAIRMAN RAY: Well, in terms of what we're
19 talking about today, is it part of the discussion or not?
20 MR. OTT: No. No, we don't -- at least
21 we --
22 CHAIRMAN RAY: Well, that's an interesting
23 point. Can you just stop and talk about that, or you,
24 Chris?
25 MR. OTT: We'll talk about it a little bit.

1 DR. COOK: Yes, I'll talk about, because
2 certainly for the JLD work that we've doing on
3 Recommendation 2.1, you know, I think we came before you
4 and talked about the tsunami, storm surge and seiche JLD
5 ISG that's there. I'm not quite sure if it's status in
6 getting incorporated in 1.59, but I mean we have that
7 there and I'll certainly be covering it. I mean part of
8 my talk is actually going to be going into motivation
9 about why we needed to, you know, develop these guides
10 in order to complete the Recommendation 2.1 work. And
11 tsunami was a part of that.
12 CHAIRMAN RAY: Well, you know, the site
13 that we've looked at most recently, Levy --
14 DR. COOK: Yes.
15 CHAIRMAN RAY: -- was a significant part of
16 it, and to see us looking at research into precipitation
17 and so on. It all is relevant obviously, but to not say
18 anything about something that's exposed to a large body
19 of water is -- we'll be interested in that.
20 DR. COOK: I think you'll see it in some of
21 my talking points, and you'll be seeing where I talk about
22 it. You'll also be too where I talk a bit about the
23 controlling characteristics of the site and looking at
24 it and looking at you know, for Levy -- well not -- you
25 didn't want to get site-specific.

1 CHAIRMAN RAY: That's right.

2 DR. COOK: But I mean where you have a site

3 let's say where you have a 50-foot storm surge, you know,

4 that's being looked at and then you're able to bound out

5 tsunami, which was a much lower thing with those. But

6 we needed to go through and make sure that we looked at

7 the state-of-the-science. And that's where there were

8 a number of initiatives done through the Office of

9 Research that were their research program to look at

10 tsunamis that triggered from the Indian Ocean event.

11 Then the U.S. had gone through

12 and it started looking at what the potential was. And

13 there were several studies that were completed,

14 NUREG/CRs that were published as well, talking about the

15 potential for tsunami hazards along the Gulf and Atlantic

16 Coast. And we're drawing upon that both for new reactors

17 as well for the 2.1 reviews to look at the operating

18 reactors.

19 MEMBER STETKAR: John, yes, or Bill or

20 somebody, I guess now I'm confused again, because we

21 heard that you're holding up release of Reg Guide 1.59

22 Rev. 3 to make sure that it's consistent within Interim

23 Staff Guidance, or at least that's what I thought I heard.

24 And Interim Staff Guidance 2012-06, about half of it or

25 so deals with tsunami hazard assessment.

1 DR. COOK: Yes, correct.

2 MEMBER STETKAR: And it talks about

3 probabilistic tsunami hazard assessment.

4 DR. COOK: Yes.

5 MEMBER STETKAR: So why is the Agency, you

6 know, continuing with the fragmented approach to

7 flooding? If we have Interim Staff Guidance that

8 addresses tsunamis, why don't we fold that into the

9 Regulatory Guide about external flooding?

10 MR. CHOKSHI: I think that, John, you are

11 right. And I think from what I remember the debate is

12 about do we want to incorporate into 1.59 or have a

13 separate guide? Because, you know, if you look at

14 historically that a lot of guidance for tsunami wasn't

15 actually in the SRPs. So this is sort of a model of

16 administrative-type of issues, this can be broader, you

17 know, on one thing earlier. I think we just need to sit

18 down and talk through this. But you are absolutely

19 right. It's part of a -- you know, that needs to be

20 captured.

21 MEMBER STETKAR: I guess my bigger concern

22 is deviations in sort of the methodology for addressing

23 different sources of flooding. If they're all complied

24 in one Regulatory Guide, there's sort of a forcing

25 function to say here's a general thought process and

1 consistency whether you're dealing with, you know,
2 precipitation-related flooding or tsunamis or storm
3 surge or whatever. If you fragment them, you start
4 developing, well, here's the methodology for this
5 particular flood. Here's a different methodology for
6 another source of flooding. That was more the genesis
7 of my question.
8 DR. COOK: I think part of it also, too,
9 though is you'll see that there's a -- for -- not the steal
10 away and talk about the JLD activities, but there's also
11 -- there was also a large concern and emphasis put on dam
12 failure and the need to look at dam failure and how we're
13 dealing with that. And at least for part of the Office
14 of New Reactors we were there.
15 We felt like some of those discussions with
16 the other federal agencies needed to take place first.
17 And that dam failure guidance was just finished. Joe
18 Kanney is one of the lead authors July. And that was
19 after a year of myself going down personally to talk with
20 the Interagency Committee on Dam Failure and talking with
21 the other dam safety officers from the other federal
22 agencies. And those negotiations needed to take place.
23 I'll be talking on those key points.
24 So we just finished that and now I think it
25 may be right to move forward. But before then -- because

1 we really dam failures.

2 MEMBER STETKAR: No, I understand the need

3 to kind of hold up issuance of regulatory guidance to make

4 sure that you had the benefit from --

5 DR. COOK: Yes.

6 MEMBER STETKAR: -- you know, interagency

7 discussions and a lot more thought about different issues

8 over the last, you know, couple of years or even longer.

9 My point is just when that guidance is issued --

10 DR. COOK: Yes.

11 MEMBER STETKAR: -- you know, be careful

12 about fragmentation of creating, you know, 12 different

13 Reg Guides each of which start to devolve into suddenly

14 different paths of --

15 DR. COOK: Sure.

16 MEMBER STETKAR: -- different ways of

17 assessing a problem.

18 DR. COOK: Sure.

19 MEMBER STETKAR: Anyway, that's --

20 CHAIRMAN RAY: John, I would add to what you

21 said though that, well, what's the Office of Research's

22 view of the state of knowledge on tsunami and so on. So

23 let's resume, please.

24 MR. OTT: Okay. Have we got the next one?

25 Yes, there we are.

1 The next guide that we're working on
2 actively right now is Reg Guide 1.102, which is flood
3 protection issue. It's clear from a lot of the events
4 and the things that have hit the news over the last 15
5 years that there are challenges that we can still address
6 with regard to how we protect against floods. In
7 particular, if you look at that list of items there,
8 Blayais was the plant in France that was severely
9 challenged by a combined event which saw seals fails and
10 doors fail, a number of things which are common to nuclear
11 power plants all over the world.
12 At *Katrina* we had levees fail. There were
13 other engineered barriers at *Katrina* in New Orleans that
14 failed as well. We're all familiar with what happened
15 at Fukushima, but the primary failure may have been
16 failure to anticipate what happened because there was,
17 I think, sufficient information to have appeared ahead
18 of time for a much larger event than the plant was built
19 for. And at Fort Calhoun we learned again that combined
20 events that enormous snow pack plus the spring rains and
21 the early thaw can challenge the designs that we have in
22 place to deal with these.
23 We engaged the U.S. Corps of Engineers.
24 They had been involved heavily in trying to recover from
25 *Katrina* and looking at the failure of a lot of those dams

1 and levees that were affected in that particular case.
2 They have provided us with a final report which is
3 currently under review. Soon as that review is finished
4 and the report published, we'll begin drafting the
5 revision to Reg Guide 1.102.
6 The most significant conclusion or
7 recommendation I would say coming out of it is that
8 they're recommending almost a staged look at flood
9 protection where primary protection would be designed to
10 keep water away from the primary structures so that those
11 doors and seals aren't challenged. And then the doors
12 and the seals would be considered incorporated or
13 temporary barriers and considered secondary protection.
14 Now they would still have a primary role.
15 When you're talking about locally intense precipitation
16 you'd still have to design the site to be able to handle
17 those large volumes of water. That would also include
18 things like drainage and pumps and other aspects like
19 that.
20 The second thing that -- they were very
21 specifically asked to look at reliability data for the
22 secondary protection measures like doors and seals. And
23 what they had found at this point is there's very little
24 data out there that can be used for say a probabilistic
25 analysis on the reliability of seals and doors.

1 Next one, Joe.

2 MEMBER SKILLMAN: Well, before you change
3 the slide, please, where in the Regulatory Guide will
4 there be a hook to how the river is operated? I'll give
5 you an example: Mississippi can be diverted through the
6 Morganza Gates into the Atchafalaya; the Corps of
7 Engineers can open that when the conditions are
8 appropriate, and ultimately lead the Mississippi into
9 Pontchartrain. They can lead the Missouri River above
10 and below Fort Calhoun. And so where in the Regulatory
11 Guide will there be attention given to the river
12 operator?

13 MR. OTT: That's a good question and I'm
14 going to ask Joe if he has specifics on the Guide itself.

15 DR. KANNEY: Well I mean, you know, the
16 operation of dams and reservoirs on the river would
17 really factor more into your assessment of what hazard
18 the plant might see. Reg Guide 1.102 is really looking
19 at flood protection at the plant site, not floor
20 protection that may be in place, you know, and operated
21 by someone other than the licensee. You know, what we're
22 focusing on here is, you know, protection of the plant
23 site and structure, systems and components important to
24 safety at the plants.

25 The way I think of it, you know, if there's

1 a external entity like the Corps or a private industry
2 that's operating a dam or something upstream, that would
3 factor into your assessment of what hazard you might see.
4 Minimally it's a difficult topic whether you're treating
5 it as part of your flood protection or you treat it as
6 part of the hazard, but I would think that would be part
7 of your hazard assessment.
8 MEMBER CORRADINI: So just so I understand
9 in your answer to Dick are you saying that it would appear
10 in 1.59?
11 MR. OTT: No, he said 1.102.
12 MEMBER CORRADINI: No, I understand.
13 Dick's question was about 102, but your answer tells me
14 that if I start worrying about that, that would be a
15 source which there ought to be some discussion and
16 planning in the other Reg Guide. Am I understanding
17 correctly?
18 MR. OTT: Correct.
19 MEMBER SKILLMAN: Maybe in both. Here's
20 where I'm going: If I own the site, I'm the whoever it
21 is on the site and I decide I'm going to apply for a tech
22 permit, and I declare I don't think I can have a flood
23 because I've got people upstream that are going to pledge
24 to empty the river to the east and to the west. So I don't
25 have to design at 305 feet; I can design at 300. Save

1 five meet and I might have saved some construction costs.
2 So if as the owner and intended financier for this thing
3 decide I'm going to take credit for somebody else's
4 behaviors and actions, how do those get blocked in so that
5 my design base is not compromised?
6 DR. KANNEY: At a minimum I think, you know,
7 we would ask that the licensee show some durable
8 agreements, perhaps look at the operating history of the
9 upstream -- say if it's a dam. You know, obviously they
10 have operating rules, they have operating plans. Look
11 at the history. Do they actually follow them in large
12 floods? You know, we would look at those sorts of things
13 I think to get some sort of confidence that we have
14 actually captured the hazard. But at a minimum though
15 it would have to be I think some sort of durable
16 agreement. You couldn't just say, yes, we're going to
17 depend on those guys, because those guys don't know that
18 you're depending on them.
19 MEMBER SKILLMAN: And, Joe, would this be
20 reflected in 1.102 and 1.59?
21 DR. KANNEY: Again, my personal, you know,
22 sense is that it's more appropriate in 1.59.
23 MEMBER SKILLMAN: Okay. Thank you.
24 MEMBER STETKAR: The current interim
25 guidance treats it that way. 2013-01 has a section on

1 doing exactly that.

2 DR. COOK: Exactly. And right now for new

3 reactor reviews we have been dealing with it in -- I mean,

4 it would fall out of 1.59 I think instead of flood

5 protection, which is looking mainly at how you protect

6 the plant site itself and looking at the flood protection

7 that you have, the layered -- you know, whether it would

8 be temporary barriers or permanent barriers in the

9 current guidance. That's 1.102. 1.59 deals with

10 design basis hazard, which would be looking at all

11 potential flood hazard mechanisms. So that would also

12 include say if you were a plant that was surrounded by

13 levies that were owned/operated by the Corps of

14 Engineers.

15 MEMBER SKILLMAN: That will be three weeks,

16 yes.

17 DR. COOK: Exactly. You know, that would

18 be there. You know, that's where we just start, you

19 know, working with them, where we didn't have to work with

20 the Corps of Engineers to discuss with the Corps about

21 their levees, you know, to make sure that we've entered

22 into that arrangement and have those discussions where

23 the Corps would actually tell us. And that's where

24 -- part of the guidance you'll look at at the dam failure

25 ISG that was there, there is a section called dam failure,

1 but levees is also in there. And there was a particular
2 reason for adding that because we realize that there is
3 a potential vulnerability to some sites because of levees
4 and levee failure and the need to look at that and
5 understand how we would treat it.
6 CHAIRMAN RAY: Well, there's a general
7 proposition which is when a safety analysis depends on
8 agreements with entities that are not within the scope
9 of the license, there has to be some recognition. Take
10 off-site power, for example, which is a good operator has
11 to provide. They're not part of the license at all. And
12 so I think what Dick's talking about falls in that same
13 category. When you're relying upon an agreement with
14 some other operating entity, whether it's river level or
15 availability of off-site power, why there's got to be an
16 agreement that's recognized in the licensing basis.
17 DR. COOK: Well, and we're taking it even
18 one step further when we get in -- you'll see me talking
19 about the integrated assessment, because there it's
20 talking about how the site prepares for the oncoming
21 flood. And for some of these ones where you're dealing
22 with dam failure, you usually have a reservoir that has
23 some sort of a storage capacity behind it and through
24 different releases or non-releases from that reservoir
25 the site will have more or less time to prepare for the

1 event.

2 And so we're really getting into, well, how

3 do you know that you have this warning? How do you then

4 take that information? What kind of agreements do you

5 have in place to look at it? And that's certainly -- you

6 know, real life practical operating plants deal with that

7 and have to deal with those issues. And the Missouri

8 River was one that, you know, when that 84-day period went

9 on where they were inundated, there was a lot of

10 communication between the residents and the Corps to

11 actually understand how the upstream operation of the

12 Corps of Engineers dams were going to affect the site.

13 DR. KANNEY: And again, your assessment of

14 the warning time that you can, you know, credibly have,

15 as well as the duration of the flood and those sorts of

16 timing issues would also be considered part of your

17 hazard assessment.

18 DR. COOK: Yes.

19 MEMBER STETKAR: Something you just said;

20 and cut me off, Harold, when I rant too long, struck a

21 chord. You do have this Interim Staff Guidance on the

22 integrated assessment which you just alluded to that

23 touches on this notion that Dick brought up about looking

24 at operation of the river system, if you will, as a source

25 of hazard, but also in part of your flood mitigation or

1 flood preparation, or whatever you want to call it, which
2 is kind of addressed in 1.102. Interim Staff Guidance
3 is not intended to be permanent staff guidance, I've
4 always been told.
5 Now if we have two Reg Guides that cross over
6 this gray area, how do those two Reg Guides now accomplish
7 this notion of an integrated assessment that indeed does
8 rely on elements of both things? In other words, you
9 know, in this Reg Guide 1.102 it strikes me as you ought
10 to address this notion of coordination with the rest of
11 the operator in terms -- river operator under specific
12 flooding conditions that might give you differences in
13 warning time or differences in the potential amount of
14 actions it might need to take.
15 DR. COOK: Well, let me start off and then
16 I'll turn it over to Research to finish, if you don't
17 mind.
18 The JLD ISG was created for a very specific
19 purpose. And we said in the introduction if every single
20 one of them -- as well as numerous meetings, that they
21 were there for the purposes of licensees to respond to
22 the 50.54(f) response. And we wanted to do that
23 realizing that we were developing a lot of guidance that
24 was necessary, say essential to be done, but it was done
25 in a very rapid time frame. We tried to be as complete

1 as -- and, you know, get it as good as we could, right,
2 in that period of time. We also realized it wasn't given
3 the full range of development that normally goes into
4 these, and thought. So we put those caveats in there
5 somewhat intentionally to make sure it really applied
6 specifically to the 50.54(f) response.
7 Personally I'm hoping that a lot of the
8 things that are in there will then get incorporated in
9 these guides, as you said. And that's why I'm sort of
10 turning it over to these guys, because I think they're
11 going to be talking about why these guides are still in
12 development, because I think we are learning things from
13 the application of it that then should go into it.
14 MR. CHOKSHI: I think that's a good
15 question, because to me there are three pieces: One is
16 the hazard, one is the protection in terms of the regular
17 licensing design space, and then looking at the
18 integrated response. So we probably need -- my thought
19 is that -- and this is my own views, that be sure to
20 incorporate as we learn little bit more from the ISG and
21 to like ASME standard and things like that, how you do
22 these in the things go out for new reactors in the Chapter
23 19. So we probably would to have create a new guidance
24 or a new document to capture that part of it, you know,
25 because we -- in my view we need that.

1 MEMBER STETKAR: I'm in favor of less
2 fragmented, more integrated guidance. But anyway,
3 let's go on, otherwise we'll never finish.
4 MR. CHOKSHI: No, but I think that point is
5 well taken.
6 DR. KANNEY: But if you look at the existing
7 revisions of 1.59 and 1.102, when we worked on Revision
8 3 to 1.59 and we talked to you about that -- and if you
9 -- you know, it's been a little while, but if you recall
10 reading through, in Revision 2 of 1.59 there was much more
11 of this blending. There's a whole section in there that
12 actually talks about flood protection. And we made the
13 decision to actually excise that stuff of 1.59, move it
14 over to 1.102 because we were revising it at this time
15 as well. So when the two new revisions, you know, are
16 finalized, I think we will have addressed that particular
17 issue to the best of our ability. I think it will be a
18 major improvement in that regard.
19 My way of thinking of it is that, you know,
20 many of the things you've discussed really are things
21 that should be put in the hazard exception.
22 CHAIRMAN RAY: Okay. I'm watching the
23 clock. It's time for us to move on, I think. We can
24 hopefully have some time to come back to issues that
25 concern members or questions that they have. But we

1 should move on now, I think.

2 MR. OTT: Next one, Joe. Okay. In

3 addition to the work on 1.02 which we've just completed

4 with the Corps of Engineers, we are pursuing four other

5 projects at the current time, one on a more in-depth look

6 at the use of paleoflood information to better

7 characterize flood risk at various sites. Another

8 project with -- that's being done by the U.S. Geological

9 Survey. The probabilistic evaluation of riverine

10 flooding is being done by the same PNNL contractors that

11 did the technical basis work for 1.59. The extension of

12 PMP studies -- the PMP work we did originally was limited

13 in scope just because of our ability and our resources

14 to engage the Bureau of Reclamation.

15 Two key issues that we didn't address were

16 transposition and orographic features. And the

17 orographic features were also not addressed in the

18 original HMRs. We have engaged the Bureau of

19 Reclamation to address these two issues as well.

20 The last is an evaluation of dam breach

21 scenarios. That's also being done by the Bureau of

22 Reclamation and very specifically in support of issues

23 that were raised during the development of the ISG on dam

24 failure.

25 And I think that's the last -- oh, other

1 activities. Ah, I did want to mention we do have a
2 Technical Advisory Committee on flooding. That
3 Technical Advisory Committee is being refocused. The
4 charter has been rewritten. I'll provide a copy of that
5 to Derek after the meeting so that you guys will be able
6 to see that.
7 We have a Probabilistic Flood Hazard
8 Assessment Research Program under development. It's
9 been made clear to us that the licensing offices want to
10 move in the direction of a more risk-informed
11 probabilistic approach when analyzing floods. And we
12 are developing a research plan to deal with that. In our
13 last talk today we'll discuss where we are in the
14 development of that plan.
15 Without doing anything else, we'll turn it
16 over to Tom Nicholson to talk about the workshop on
17 probabilistic flood hazard assessment.
18 MR. NICHOLSON: Thank you very much.
19 While the slides are being brought up I wanted to
20 acknowledge sitting behind Dr. Ray is Dr. Wendy Reed, and
21 she worked with me on the proceedings of the
22 Probabilistic Flood Hazard Assessment Workshop. And so
23 if you want to make any comments, I'll call on you later,
24 Wendy, to add to the information.
25 Okay. Next slide, please? I'm basically

1 going to provide you an overview of why the workshop, the
2 Probabilistic Flood Hazard Assessment Workshop was held.
3 It couldn't have happened without the cooperation of many
4 federal agencies. I'll go through that briefly. How
5 the workshop was organized, a discussion on the
6 presentations and discussions, and its formulation,
7 observations and then recommendations.
8 The workshop happened because we got a user
9 need from NRO and NRR, and basically they ask research
10 to plan, conduct and follow up on a workshop on
11 probabilistic flood hazard assessment. They want us to
12 identify what probabilistic approaches are being used or
13 in development by other federal agencies relevant to
14 flood hazard assessment. The emphasis was on other
15 federal agencies. It was decided early on this would not
16 be an international -- although we did have international
17 participation based upon NOAA recommendations,
18 Deltares, a research institute to the Netherlands, was
19 very much involved in the organization and conduct of the
20 group, based upon their experiences on coastal storms and
21 flooding.
22 Also the user need requested that we
23 recommend to both NRO and NRR what opportunities exist
24 for future cooperation and research with other federal
25 agencies.

1 CHAIRMAN RAY: Just again sort of a
2 pedantic or definitional thing here. At the time of the
3 workshop I understood PFHA to include PTHA.
4 MR. NICHOLSON: Yes.
5 CHAIRMAN RAY: Can we assume that although
6 I, you know, wouldn't hold anybody to that strictly?
7 MR. NICHOLSON: We have a probabilistic
8 flood hazard assess, we have hurricane, we have tsunami.
9 Tsunami was part of the workshop.
10 CHAIRMAN RAY: Okay. Thank you.
11 MR. NICHOLSON: You're welcome. The
12 objectives basically were to identify and solicit
13 presentations on the state-of-the-science-and-practice
14 in extreme flood assessments within a risk context. And
15 I'll emphasize that. Risk context. Facilitate the
16 sharing of information to bridge the current
17 state-of-the-knowledge between extreme flood
18 assessment, sometimes deterministic PMP, PMFs and risk
19 assessments. And Fernando Ferrante who is on the panel
20 here, he'll get into some of the discussions of risk
21 assessments. Seek ideas and insights on possible ways
22 to develop a probabilistic flood hazard assessment for
23 use in probabilistic risk assessments.
24 Next, please? Identify potential
25 components of flood-causing mechanisms that lend

1 themselves to probabilistic analysis and warrant further
2 study. For instance, computer generated storm events is
3 a major issue with regard to probabilistic analysis.
4 Establish realistic plans for coordination of research
5 activities as a follow-up to the workshop. And you'll
6 hear from Joe Kanney on how they're using information
7 from the workshop to develop a research plan. And then
8 finally develop these plans for future a research
9 strategy both within the NRC and in cooperation with our
10 federal partners.
11 Well, the steering committee met on
12 numerous occasions and after much debate we focused on
13 these panel topics: The first one on the list was the
14 panel co-chair of the first one, federal agencies'
15 interests and needs and in probabilistic flood hazard
16 assessment. And then we wanted to focus on
17 state-of-the-practice and identifying quantifying
18 extreme flood hazards. And we looked at the SSHAC
19 process as an example of how we might do that.
20 Then we wanted to look at extreme
21 precipitation events, and the weather bureau and others
22 helped up with that topic. Then to talk about
23 flood-induced dam and levy failures, the Bureau of
24 Reclamation and the Army Corps of Engineers and FERC were
25 involved in that. We brought up earlier, Dr. Ray, the

1 issue of tsunami flooding. It was discussed. The USGS
2 in particular helped us understand tsunami flooding.
3 And then we talked about riverine flooding.
4 Bill brought up NUREG-7046, which kind of describes the
5 present state of the practice within the NRC on riverine
6 flooding. And then we heard from the Corps of Engineers
7 and others, USGS.
8 Then we talked about extreme storm surge for
9 coastal areas. The emphasis there was on the joint
10 probability method developed by the Army Corps of
11 Engineers for the Gulf of Mexico and the Southern
12 Atlantic. This could also be applied to the Great Lakes.
13 And then finally the most difficult of all
14 the panel topics was the combined events flooding, how
15 we put together a combination of floods within a
16 probabilistic approach. And there was a lot of
17 discussion on that.
18 Next? Well, basically after we picked
19 these panel topics we went out and picked experts in those
20 fields from the various federal agencies, academia,
21 Princeton University, Cornell, others, research
22 institutes, Deltares, and then we wanted to we asked for
23 extended abstracts with reference to the Web sites which
24 went into the program. The program was actually
25 published prior to the meeting and posted on the public

1 Web site.

2 After the meeting Wendy Reed and myself, we

3 put together a special Web site, and you can go to it now.

4 It's on the public Web site, in which all the presentation

5 slides and the video of all the presentations, a summary

6 of the meeting and discussions and the program itself is

7 there. And we provide you the link to that Web site. So

8 you can go and read it. We've gotten very good comments

9 back from many people, especially NEI.

10 The presenters were provided an opportunity

11 after the meeting to resubmit their extended abstracts

12 as papers for publication in the proceedings. And then

13 finally the summaries of each panel including the

14 discussions, the presentations, the observations and

15 insights were developed in the proceedings, which I

16 brought a copy along. I talked to Derek yesterday.

17 They're on the SharePoint site, so if you want to look

18 at those. These have not been published yet. They're

19 still in Publications going through final formatting.

20 Next, please? Well, let's go through the

21 observations we received from the various panels. First

22 of all, the keynote address was by Commissioner George

23 Apostolakis, in which he outlined the importance of

24 risk-informed performance-based regulations and

25 highlighting the important interplay between the

1 probabilistic assessments and traditional deterministic
2 methods.
3 What was interesting was is that his talk
4 really motivated the people. We had over 260 people in
5 the audience. The room was packed, the auditorium, and
6 it really had a very strong indication on the people there
7 at the meeting. FERC, the Federal Energy Regulatory
8 Commission, was very impressed by Commissioner
9 Apostolakis' presentation. And they have used that
10 information and they've organized workshops based upon
11 risk-informed performance-based regulations.
12 Well, the first panel, as I mentioned
13 before, was what are of the federal agencies' interests
14 and needs? Risk-informed approaches are being used and
15 incorporated by many agencies and international groups.
16 The French, the Dutch a variety of are using
17 risk-informed approaches. The probabilistic flood
18 hazard assessment methods, most of them, the annual
19 exceedance probability is 10 to the minus 3. In some
20 cases with the Dutch 10 to the minus 4. It was determined
21 and agreed that it was not a question of deterministic
22 versus risk assessment because they are complementary of
23 the processes.
24 Next? Well -- go ahead, Mike.
25 MEMBER CORRADINI: No, you're first.

1 You're the Chair.

2 CHAIRMAN RAY: No, I mean the assertion

3 that they're complementary processes is just -- I was

4 going to say I understand that we're limited here and it's

5 probably a side track we don't want to go off on, but

6 that's a pretty clear statement. It's often they're

7 seen as contrasting. But we can't really explore that

8 now, I don't think.

9 But go ahead, Mike.

10 MEMBER CORRADINI: Your second check mark

11 -- so maybe -- I'm definitely new to all of this. Those

12 seem like relatively high probabilities compared to all

13 the other things that supposedly we worry about in terms

14 of initiating events. Am I off base?

15 MR. NICHOLSON: What we're trying to say is

16 that the present state-of-the-practice is people are

17 looking out to 10 to the minus 3 and 10 to the minus 4.

18 That's what they're looking at right now when those

19 groups such as the Dutch and other people are using

20 probabilistic methods.

21 MEMBER CORRADINI: I understand, but --

22 MR. NICHOLSON: Certainly people want to go

23 beyond that. They'd love to go out to 10 to the minus

24 5 and minus 6, but the present state-of-the-practice is

25 that they only go out to 10 to the minus 3, not 10 to the

1 minus 6.

2 MEMBER CORRADINI: So let me ask --

3 DR. KANNEY: Maybe, could I clarify? The

4 10 to the minus 3, 10 to the minus 4 would probably be

5 better characterized as where most of the community is.

6 There are a significant number of examples in the federal

7 community, specifically the Bureau of Reclamation, who

8 have done numerous studies over the last decade where

9 they have gone out as far as 1 in 100 million years. Now

10 obviously they don't assign a great deal of confidence

11 to things at that return period, but it's true that -- you

12 know, maybe the center or the body of a lot of work,

13 because it's really aimed more at sort of levy failures

14 and things like that, where a lot of the probabilistic

15 work has been done, 10 to the minus 3, 10 to the minus

16 4 is more common. But the idea that people have not gone

17 out to lower probabilities, it's not quite accurate.

18 MR. NICHOLSON: I didn't say that. I think

19 if you look at what NOAA's done with regard to their Atlas

20 14, NOAA Atlas 14, they go out to annual exceedance

21 probabilities of 10 to the minus 3. So we're trying to

22 tell you what the workshop panels --

23 MEMBER STETKAR: It's a difference I think,

24 Mike -- this isn't necessarily 10 to the minus 3 to 10

25 to the minus 4 frequency per year of some devastating

1 flood. It's just the horizons over which people do these
2 analyses.
3 MR. CHOKSHI: I think that's --
4 MEMBER STETKAR: They don't look out for
5 the million-year flood, if you want to characterize it
6 that way.
7 MR. CHOKSHI: You know, I was as a part of
8 this co-chairing of this panel. That was the purpose of
9 this is to explain the news for different agencies. And
10 as I think John described, we are talking about what range
11 of thinking of return figures we are interested in what
12 type of risk criteria or what things we need from that.
13 And what emerge from discussion with different federal
14 agencies that for that needs this is what they have gone
15 up to these explore. And there is also -- there was lot
16 of questions about how far can you go, and I think it will
17 come through when we go through the other sessions some
18 of these. But that was the perspective we wanted to
19 provide, that from our point of view we need to look at
20 local low-probability events.
21 MEMBER CORRADINI: Okay. I understand
22 that. So let me ask my question differently: So I
23 didn't want to start a fight. I just wanted to
24 understand. So John's saying I'm looking at the
25 horizon. So let me put it differently so I see if I ask

it in a better way.

So if I have plant X and plant X is on a lake, and then I have plant Y and plant Y is on a river, then what you're telling is currently plant X or plant Y may have a design basis flood, design basis event that's either due to a variety of ways in which water can get to the site, which is a look back historically over some time span, right?

So now I have the design basis flood. The purpose I'm here today is trying to understand what is the current margin of safety I add to that since the historical time span is so short. I'll use the word "short." Right? If on Lake X or River Y the flood height is 10 feet and I'm the engineer that I've got to do something to build the plant and I say, well, 10 feet sounds good, but I'm uncertain. So I'm going to make it 20 feet. I'm looking for the thinking process that what that 10 feet buys me, right? Am I being too simplified?

MEMBER BLEY: Mike, let me offer something and you guys can correct it from your point of view. One of the things I found in the workshop where there were a couple of talks that really focused on how do we go beyond the history where we've actually measured rainfall, or where we've recorded floods accurately? And they talked about various regimes where you can go

1 back and you can find written records from earlier times
2 that describe things that give you some idea of those
3 kinds of events. And eventually you can go back to paleo
4 information, digging around and seeing the history of the
5 region from what's left in the geology and things. And
6 they talked about ways you can go further and further
7 back.
8 So some people came in thinking, it seemed
9 to me, we're only talking about things we've measured and
10 have measured records of. And others came in talking
11 about ways they can go beyond that. There was a lot of
12 discussion about these things at the meeting.
13 MEMBER CORRADINI: Okay.
14 MEMBER BLEY: But I don't think there's a
15 single answer to what you're trying to get at.
16 MEMBER CORRADINI: Thank you.
17 DR. COOK: Well, Dr. Corradini, if I may,
18 I mean another part, too, is also looking at how we
19 evaluate the plant's response to the events as well,
20 which is where we're getting into the integrated
21 assessment. So it's not just looking at the hazard
22 itself, but it's also looking at then how the plant would
23 respond, both the protection and then mitigation that
24 goes on beyond it that we're looking at when you're
25 starting to figure out about how much goes beyond. I

1 think Dr. Chokshi wanted to --

2 MR. CHOKSHI: Yes, I think your question

3 is, you know, what are the things lot of right now the

4 current flooding hazard criteria deterministic

5 processes? But we have a hierarchial approach that you

6 start with very bounding. I think the way we're just

7 describing the dam core. You know, if I make a extremely

8 conservative assumptions, I want to see what happens at

9 my site. And then if you can show that your side is not

10 affected, you know, then you really don't have to do much

11 more.

12 But then you sort of go down that layer and

13 then try to do much more realistic -- what are the, for

14 example, how do I take into account the drainage or, you

15 know, absorption? What are the realistic criterias?

16 So that's the process currently being used. But this is

17 the motivation for this and again in the future at least

18 to get to a criteria that we can come up with an informed

19 criteria so we can deal with this in an informed way. You

20 know, if you can go to some performance criteria based

21 on probabilistic hazard. Ideally I would like to be in

22 a place where the seismic is currently developed in

23 design basis event. That's the ultimate goal, you know,

24 but it's going to take time before we can --

25 MEMBER CORRADINI: Okay.

1 MR. FERRANTE: I think if I may add to the
2 confusion maybe, but this is Fernando Ferrante in RDRA.
3 But you asked a question of whether those values were
4 high, for example. And they would be high if for example
5 the plant didn't have protection to go along with that.
6 So as a PRA person I'll be looking at what the input is
7 for an annual exceedance probability on how does the
8 plant respond to that. But when I looked at those
9 values; and I attended the workshop myself, I think
10 there's imbedded in that. There's an issue of
11 credibility of extrapolation. Can we extrapolate up to
12 beyond a certain level, the 10 to the minus 4? And U.S.
13 Bureau of Reclamation guidance has certain criteria
14 associated with it. And so there's a lot more than just
15 the perception of how exactly those numbers fit. And I
16 think the workshop tried to address a number of issues
17 regarding the frequency of those phenomenon.
18 CHAIRMAN RAY: All right. Last comment
19 and then I think we should move on, but let me just say
20 we have before us as a committee now a site that has flood
21 exceedance that would be unacceptable but for the fact
22 that the time duration and the ability of the plant to
23 respond, as he was just saying; it's a wet site, in other
24 words, makes the exceedance probability at that site
25 acceptable because the exceedance will only take place

after the plant has had the ability to shut down and institute certain other measures to deal with it. So it's hard to look at a number like that on the screen and say that's high or low because it's a more detailed or complex issue, which is what Fernando just said.

With that, I think we should move on, if we can.

MR. NICHOLSON: Okay. The probabilistic failure hazard assessment obviously wants the probabilities of the initiating events and facilitates uncertainty analysis of these extreme events. And this was common in earlier -- obviously the driving force in many cases obviously is rainfall, and so therefore rainfall has been one of the areas where probabilistic approaches have been pursued.

Another comment from Panel 1 was that the Senior Seismic Hazard Analysis Committee approach is viable and it could be used to develop an expert elicitation. Some people are now using the terminology "expert assessment approach" for flood hazards. That approach would help overcome some of the lack of data for characterizing the extreme events, especially the rainfall; formulation of scenarios; and then hydrometerological model simulations looking at a variety of scenarios, systematic assessment of

1 uncertainties, both the epistemic and aleatory.

2 And then finally, there is a need for

3 multidisciplinary teams when this analysis is done. You

4 want the geomorphologist who would look at paleo flood

5 data, if available, understand the land forms and changes

6 and configuration, hydrometerologist, risk analyst and

7 hydrologist.

8 Panel 2 focused on state-of-the-practice

9 and identifying quantifying extreme flood hazards. It

10 was important to consider the full range of floods out

11 to the extreme events, not just the PMP or the PMF. They

12 also wanted and they focused on black swan events, those

13 events that you didn't realize until after they happened

14 and so therefore an approach that would say let's think

15 about scenarios that may have occurred elsewhere outside

16 the watershed and are they plausible events there?

17 And then finally aleatory, which is random

18 uncertainties, limit the forecast ability. But the more

19 important for the rare events is the epistemic

20 uncertainties in which you are formulating the various

21 scenarios and understanding the conceptual models that

22 formulate the watershed or whatever the area of interest

23 response to the driving force.

24 And then Bayesian modeling is a very good

25 approach to look at these rare events to help quantify

1 and in some cases reduce uncertainties. There's a need
2 to determine the rarity and complexity of natural events
3 including various combined event scenarios. Where
4 available paleoflood information has proven very useful.
5 We heard from the U.S. Geological Survey and they gave
6 us an example. And the current approaches to quantify
7 extreme flood hazards have worked extremely well.
8 MEMBER SKILLMAN: Tom, could you give an
9 example of a black swan event, please?
10 MR. NICHOLSON: Probably the event that
11 just happened in Colorado in which you had about three
12 days of intense rainfall along the whole front range of
13 the Rocky Mountains. The previous event that most
14 people focused on was Big Thompson Canyon flood in 1976,
15 but that was a flash flood that occurred over a much
16 shorter duration. So you can add longer duration. For
17 instance, for Calhoun who would have guessed that that
18 site would have been inundated for 84 days? Those are
19 two examples I can think of that I would call black swan
20 events --
21 MEMBER SKILLMAN: Thank you, Tom.
22 MR. NICHOLSON: -- that people hadn't
23 thought of before.
24 MEMBER SKILLMAN: Thank you.
25 MR. NICHOLSON: Okay. All right. Let's

1 see. Can we go to the next one?

2 MEMBER CORRADINI: And so I'm sorry to come

3 back to this. I'm still struggling. So that means that

4 in somebody's mind there's a picture that says I have a

5 normal day, I have a design basis day and then I have a

6 very bad day, and this is my protocol if I exist in any

7 one of those three regimes. And the plant already has

8 a plan for that. And the NRC has a plan to look at the

9 plant's plan to decide that it's an acceptable plan.

10 That to me is the essence of what I'm looking for here.

11 So does such a thing exist?

12 MR. NICHOLSON: I'm not sure I understand

13 your question.

14 MEMBER CORRADINI: Well, I mean again I'm

15 not an expert in this, but it just seems to me that it

16 kind of falls into three categories: Normal operation

17 where it rains, it snows, the wind blows, and I worry

18 about that plant runs. I have an unusual event where I'm

19 approaching design basis flooding issues and I have

20 certain protocols that I take, which with enough warning

21 I shut the plant down, I do this and that, so I'm in the

22 design basis. But then I have a really very bad day and

23 all of what I designed for isn't there, but I have to have

24 some sort of protocols that even in a very bad day, the

25 black swan, I already have plans in place to do something

1 and I guess that's what I'm looking at, three kind of
2 categories.
3 So my first question is does the third
4 category exist within the owner/operators? If the
5 answer is no, fine. And the 50.54 I assume is going to
6 go towards a discussion that if I have a very bad day,
7 there's got to be a set of protocols developed.
8 MR. FERRANTE: Yes, I mean hopefully the design
9 basis is a really bad day, so that that's already
10 accounted for. I mean right now we're moving to the
11 extent where we get into the third category, which is
12 going beyond that and looking at -- at least for operating
13 plants what equipment can be put to the test beyond that.
14 That's the existing paradigm that we're living under
15 operating --
16 MR. CHOKSHI: Yes, the mitigating
17 strategies for the post-Fukushima, you know, is that part
18 of that third.
19 MEMBER CORRADINI: Well, that's why when
20 you were answering it relative to an integrated plan,
21 that's what I took away.
22 DR. COOK: The one thing I would want to add
23 though just to make sure, Dr. Corradini -- this is Chris
24 Cook -- is just that when we're doing the 50.54(f)
25 flooding response, we're recomputing the design basis,

1 but it's just using present day methods.

2 MEMBER CORRADINI: I understand that.

3 DR. COOK: Everything that we're doing is

4 just to the design basis, but it's just the design basis

5 doing -- a lot of people have said that it's beyond design

6 basis, but it's only beyond design basis because it's

7 really just not their current licensing basis and it's

8 done using present day techniques.

9 MR. FERRANTE: But even to go beyond that

10 there's also flags, this mitigating shows --

11 DR. COOK: Exactly.

12 MR. FERRANTE: There's a lot more going on

13 than just this particular area --

14 DR. COOK: Exactly. And that's the nexus.

15 MR. FERRANTE: -- or category.

16 DR. COOK: Yes.

17 MEMBER CORRADINI: Thank you.

18 MEMBER ARMIJO: I'd like to understand the

19 last bullet on Tom's chart about the current approaches

20 --

21 MR. NICHOLSON: Back on 10?

22 MEMBER ARMIJO: -- yes, on page 10 -- have

23 worked well for these extreme flood hazards. And seems

24 like it's inconsistent with all the prior stuff that

25 says, you know, we've got to do a lot more work. I mean

1 if things are working well, you know, why are we worried?
2 So I think you wanted to convey something else or more
3 than everything's okay.
4 MR. NICHOLSON: Well, everything is not
5 okay if you want to put in the risk context.
6 MEMBER ARMIJO: Yes, okay.
7 MR. NICHOLSON: If you only want to look at
8 what you think is a reasonable extreme value for
9 rainfall, for floods, whatever, people say, well, we
10 design it against those extreme events. When you want
11 to ask somebody what is the probability of the occurrence
12 of those event --
13 MEMBER ARMIJO: That's where you're in
14 trouble.
15 MR. NICHOLSON: -- and what is the
16 uncertainty, you don't have that.
17 MEMBER ARMIJO: Okay.
18 MR. NICHOLSON: So the point the people
19 wanted to make during their workshop was that it is as
20 if we don't know what we're doing with regard to looking
21 at extreme events. We do, but we don't put it in a risk
22 context. And the whole workshop was to organize it and
23 think of that risk context. So I'm sorry for the --
24 MEMBER ARMIJO: No, I understand now.
25 MEMBER SKILLMAN: Let me build on Sam's

1 question. I know of two plants that are riverine plants
2 that have had their design base flood level
3 recommunicated, and they have had to make changes. And
4 so I think what Dr. Armijo is communicating is accurate.
5 Within the fleet, the current fleet in the United States,
6 there are a couple plants where the current approach has
7 not worked well, and the reason is because there is new
8 information, there is new meteorological information and
9 new hydrological information. So if your answer is
10 simply in the context of probabilistic assessment of the
11 events that would give that higher water level, one might
12 say, well, we have a new way to do this. That's dandy,
13 but there are some plants that have been stranded by this.
14 They've had to make modifications.
15 DR. KANNEY: I think the thing you need to
16 keep in mind is, you know, the observations and things
17 that Tom is talking about, you know, these were presented
18 at the workshop. You know, they really pertain to, you
19 know, the hydrology and water resources community in
20 general. Any one of them is not specifically an
21 observation of the current licensing and oversight
22 environment for the NRC. These observations are broader
23 than that. In some cases they certainly apply to the way
24 that we work. In other cases not so much.
25 CHAIRMAN RAY: Okay. I think the point's

1 been made. Tom's less than half way through and I got
2 to get him to the end here in the next 15 minutes.
3 So please resume.
4 MR. NICHOLSON: Okay. With regard to
5 extreme precipitation events, probable maximum
6 precipitation gives you just one point. They want the
7 full range obviously of the curve. And so therefore this
8 information, as you pointed out, there's new information
9 available from the Weather Bureau and elsewhere so we can
10 look at the distribution of rainfall. Opportunities
11 exist to collect these additional data points. Radar
12 distributions have helped dramatically in developing the
13 intensity duration and frequency that was pointed out by
14 our friends from NOAA.
15 NOAA Atlas 14, which I mentioned earlier,
16 provides estimates of precipitation at locations and
17 goes out to an annual exceedance probability of 10 to the
18 minus 3. And they also have a -- you can go to their
19 computer service and identify latitude and longitude.
20 And they'll give you detailed precipitation frequencies
21 with confidence intervals for that location. So you're
22 right, they have come up with much better information
23 over the years. The orographic uplift, the spatial
24 resolution for radar imaging is still a major challenge.
25 Next, please? One of the issues that came

1 up during the workshop was extreme storm catalogues.
2 The Weather Bureau, the Army Corps of Engineers, a
3 gentleman from Princeton University, they all pointed to
4 the fact that if by looking at floods and the storms that
5 caused them, you can learn an awful lot, and especially
6 if you want to transpose a stochastic storm transposition
7 models. Significant progress has been made in physical
8 numerical modeling in these storm events. So there's
9 been very resolution, higher-density rain gauges,
10 satellite data, aircraft observation. So all this
11 information is being brought together, far better
12 information than was available 20 or 30 year ago.
13 The climate community statements on trends
14 in rainfall, though they're interesting they don't
15 provide information on frequency and durations which are
16 needed, and so there is a need for the climate community
17 to thinking those terms. We need better guidance on
18 potential impacts of climate change on these intensity
19 duration frequency curves in the ranges relevant for dams
20 and nuclear power plants.
21 The technical barriers may remain,
22 especially with regard to the technical complexities of
23 the watershed size heterogeneity, how the rainfall
24 occurs over them, how you transpose that information if
25 you want to model it, and then also the combining of

1 rainfall with snowmelt. That's a challenge.

2 Next, please? Now the next panel talked

3 about flood-induced dam and level failures. They

4 recommended that a process similar to the SSHAC be

5 applied for dam and levy failure analysis as well. The

6 PRA analysis should evaluate the comprehensive

7 uncertainties in both the data and the modeling.

8 There seems to be a general lack of

9 information on the reliability of some dams, dam

10 components and operations. It was a topic brought up

11 earlier during the discussion. The Army Corps of

12 Engineers and FERC talked about this at great length.

13 MEMBER POWERS: The whole slide seems to

14 focus on PRA, and the one thing that PRA does not do well

15 for you is to model degradation. And it seems to me

16 degradation is the thing that most afflicts dams, so why

17 the total -- I mean the PRA, probabilistic, SSHAC, all

18 of that is PRA stuff and it doesn't handle the one thing

19 that's important to you for dams.

20 MR. NICHOLSON: People who were the

21 chairmen of this, Tony Wall and Sam Lynn, they focused

22 on that dams generally are safe. Once they get filled,

23 it's the -- filling is the most difficult part of the dam,

24 but once it's filled to a certain point, you're correct,

25 it is the operation of the dam and the maintenance of the

gates and worrying about geotechnical properties.

So the question is is what kinds of information do you have on those? One of the issues is that when you have near failures is that part of the database? And there are universities like Stanford and others who are creating databases talking about the operation and failure of dams. So that topic is part of that discussion. But if you want to look at a risk, what is the probability of a dam failure, it's very complex. It's usually site-specific or dam-specific and it's much more difficult than simply saying I have a distribution of failures. I'm going to come up with a number. Okay?

MEMBER STETKAR: I think in some sense the next to the last bullet there where he talks about fragility and the difficulty in doing that does address your point, because you know, if I do the seismic analogy, you do a seismic walkdown and you see a bunch of --

MEMBER POWERS: He hasn't addressed it at all. I mean the paradigm seems to be --

MEMBER STETKAR: You do a seismic walkdown and you see a bunch of rusted bolts and things like that, you assess a different fragility under given acceleration for that particular component compared to, you know, a newly installed --

MEMBER POWERS: Probably so, but that's not

1 what --

2 MEMBER STETKAR: That's a sense of

3 degradation though.

4 MEMBER POWERS: Yes, and you change things

5 and whatnot. PRA technology is not the thing that seems

6 to fit.

7 MEMBER STETKAR: Okay. I guess I don't

8 quite understand.

9 MEMBER POWERS: I mean it seems to me it's

10 some different type of technology that gets applied here.

11 And I mean it looks like it's all heavily biased toward

12 PRA and PRA's not what leaps to mind when I think about

13 dams.

14 MR. NICHOLSON: I think the conventional

15 view is right now that, yes, in fact they are looking at

16 dams with regard to operations and maintenance and things

17 of that. The problem is if you put damn failure and levy

18 in the context of risk, how do you come up with a

19 probability of the failure modes. How do you come up

20 with information that says given a breach of the dam then

21 what kind of flood may occur below the dam?

22 MEMBER POWERS: Well, let me ask you this

23 question: Does the failure rate on dams writ large

24 -- because you could have -- I mean I can have a dam

25 degrade and discover it and take it out of service and

1 it didn't actually fail.

2 MR. NICHOLSON: Right.

3 MEMBER POWERS: Okay. Does it follow kind

4 of a bathtub curve?

5 MR. NICHOLSON: You'll have to explain what

6 you mean by a "bathtub curve."

7 MEMBER POWERS: You're likely to fail when

8 you load it. So when you first fill the dam -- surely

9 you have a high potential of failure of that. Then

10 there's a long time that the potential failure is just

11 zip. I mean they just don't fail.

12 MR. NICHOLSON: Right.

13 MEMBER POWERS: And then as you go on longer

14 and longer and longer you get this progressive

15 degradation or something happens to it and so the failure

16 rates come back up again.

17 MR. NICHOLSON: Well, that may be true if

18 you're just looking at the operation of the dam and the

19 degradation of the dam, whether the gates fail or

20 whatever the issue, geotechnical heightening, whatever.

21 But there's also things that cause the dam to fail that

22 -- these so-called black swans. What if there's a major

23 landslide above the dam that brings debris into the

24 reservoir and the reservoir then overtops? So when you

25 --

1 MEMBER POWERS: I'm working this thing one
2 at a time.
3 MR. NICHOLSON: Yes.
4 MEMBER POWERS: Does the dam follow a
5 bathtub curve?
6 MR. NICHOLSON: I would think it would be
7 site-specific. I would think it would be dam-specific.
8 I think generally speaking you're correct. I don't know
9 enough about dams to say that's true for all dams.
10 MEMBER POWERS: Okay. So then I can lay
11 over the top of it, of a bathtub failure curve. Then
12 you're more probabilistic events that don't really have
13 anything to do with the dam may have to do with everything
14 with the site.
15 MR. FERRANTE: If I may add something here,
16 at NRR we did look at fatal rates for dams at some point
17 or we had an issue and I'll briefly touch up on that. I
18 wrote information notice on dam failure rates. We did
19 find that it does follow a bathtub curve in the beginning.
20 We did notice that depending on the material of the dam
21 particularly as it ages beyond construction there is an
22 effect there. But we never really found anything at the
23 later curve of the bathtub to indicate there was a
24 phenomenon.
25 Particularly what made that challenging is

1 -- I'm not saying it exists or doesn't exist, is that it's
2 hard to define a failure of a particular dam, for example,
3 from erosion. Is that a degradation or is that something
4 within a particular failure mode that dams can be
5 passive? Is the degradation of a spillway for example
6 a degradation issue? And then ultimately there's not
7 even a lot of detailed description of what the failures
8 were and would those be defined as degradations or not?
9 And so it may be there. We didn't see that on the data.
10 But it might be because of the bias in defining how the
11 dams are.
12 Internal erosion, which might be perceived
13 as a degradation issue in dams is something the Bureau
14 tries to incorporate in their dam risk assessment, but
15 I will agree that it's a very challenging topic because
16 it doesn't lead well to probabilistic treatment. You
17 know, there is an effort to look at the liners on the dams
18 and, you know, is it more or less susceptible? But it's
19 not something that fits very well in PRA and it's
20 something that we encounter ourselves.
21 MEMBER POWERS: Yes, I think it just -- I
22 mean the slide is striking because it seems like it's
23 focused on a technology that just doesn't work.
24 MEMBER BLEY: I guess before we leave this
25 I got to weigh in just --

1 CHAIRMAN RAY: Make it short, Dennis.

2 MEMBER BLEY: If you think -- well, I'll

3 make it shorter than Dana.

4 (Laughter.)

5 MEMBER BLEY: If you think of PRA as being

6 a bunch of fault trees and event trees, yes, I'd probably

7 agree with you. There's a lot of other things here. If

8 you think of the SSHAC process as being a way to bring

9 all the information you have available to the table and

10 evaluate it with the best experts -- you wave your hand

11 at me, but you sit in your lab alone thinking of it.

12 MEMBER POWERS: - of the question.

13 MEMBER BLEY: Yes, I am, Dana. I really

14 am. I think the SSHAC process isn't a PRA thing. It's

15 a way to bring all your information together and organize

16 it and work from there. And I think that's a part of risk

17 assessment. So I think --

18 MR. FERRANTE: Can I add a very brief

19 -- just to address that issue Dr. Powers brought? We

20 looked at how the Bureau tries to implement dam risk

21 assessment. Essentially they're trying to do a PRA-type

22 of approach, or mainly event trees, some fault trees in

23 trying to come up with probabilities. What we learned

24 from that is at least the processes they're trying to

25 develop gives better information than just looking at the

1 dam as a fail/no fail. Is the design up to this level?
2 I mean it really brought to us the understanding of how
3 do you treat the spillways? How do you treat the
4 different components?
5 I mean certainly there's a challenge
6 particularly on a meteorological aspect and putting a
7 hazard curve on that, but I thought it provided better
8 information for us to look at a particular issue that
9 might impact one of our licensees than just looking it
10 does the technology properly fit to give you that final
11 answer or not? And so I will venture that I think PRA
12 has a benefit to issue such as dam and -- I mean it
13 certainly has been a benefit to us in the nuclear arena.
14 And so I just thought there was benefits in there.
15 And I also think the Bureau of Reclamation
16 is trying to implement it judiciously. In fact, I was
17 very impressed that they incorporated very well the
18 philosophy that the number is not really important in
19 PRA. It's really what you learn out of the
20 vulnerabilities that you might bring out and how does the
21 system behave, particularly with respect to
22 combinations.
23 CHAIRMAN RAY: Tom?
24 MR. NICHOLSON: Okay. I think the next
25 slide we've covered all of that information in my

1 comments and other people's comments, so let's go on to
2 the next one.
3 On tsunami flooding, Eric Geist in the USGS
4 and other people, and Henry Jones, who's behind you, they
5 were co-chairs of this and they made some observations.
6 The first one is is that there's a lot more information
7 on storm surge flooding than tsunami events. States
8 except for Alaska and the coast of California, Oregon and
9 Washington, there isn't much information, history of
10 tsunamis, and so therefore some of the information
11 obviously we can relate from storm surge.
12 Most locally cause of tsunami in the United
13 States is submarine landslides off the coast of the
14 United States. This is particularly true for the East
15 Coast of the United States. Distant landslide sources
16 such as the Azores, Iceland and also -- the NRC staff has
17 concluded that they would not be significant causing
18 tsunamis on the East Coast of the United States.
19 MEMBER POWERS: The staff concluded that
20 because of modeling on wave propagation.
21 MR. NICHOLSON: Yes. Yes.
22 MEMBER POWERS: How confident are we in
23 those models of wave propagation?
24 MR. NICHOLSON: Okay. Henry, do you want
25 to answer the question?

1 MR. JONES: This is Henry Jones. We're
2 very confident in the numerical models. Highly
3 confident. The way we do it is actually we go to the
4 implausible. Actually there's been no recorded
5 submarine landslide tsunami on the United States. Only
6 the far field and areas where we do not have any nuclear
7 reactors. Oregon and Hawaii. And those are due, too,
8 from Japan, Alaska or Chile. For the submarine
9 landslide we take the maximum volume. We go into 1D, no
10 friction. And the numerical model has been tested not
11 only by academia, but all the experts internationally,
12 also in the United States. Very confident. We use in
13 most of the sites. And the applicants in their
14 independent research have come to the same conclusion.
15 NRR, actually the flooding from tsunamis
16 was low. In some cases ours exceeded the applicants'
17 by maybe only a couple of feet. But I'm highly confident
18 in our results.
19 MEMBER POWERS: Can your models explain why
20 a tsunami initiated on the West Coast of the United States
21 affected Japan?
22 MR. JONES: Are you saying how one
23 initiated in Japan affected our West Coast?
24 MEMBER POWERS: And roughly; I'm not very
25 sure of the dates, around 800 A.D. there was a large

tsunami --

MR. JONES: Exactly.

MEMBER POWERS: -- in Japan that came out of nowhere.

MR. JONES: We have no paleo results of that.

MEMBER POWERS: And it's been attributed to an event that occurred off the coast of Washington State.

MR. JONES: Where the Cascadia subduction zone -- exactly. We have no -- that's what I'm saying. Most -- any event -- yes.

MEMBER POWERS: I don't care where your reactors are. I'm worried about your model right now. I mean there was an event that took place on one side of the Pacific Ocean --

MR. JONES: Yes.

MEMBER POWERS: -- that affected some place on the other side of the Pacific Ocean.

MR. JONES: Exactly.

MEMBER POWERS: Okay. That strikes me as pertinent. Does the model explain how that could happen?

MR. JONES: Yes.

MEMBER POWERS: Okay. How does it do that? I mean why is that the case and it's not the case that

1 an event in Iceland can affect the East Coast of the
2 United States? That's what I don't understand.
3 MR. JONES: It's all -- there's different
4 mechanisms. It's different how the waves --
5 MEMBER POWERS: Yes, how do the --
6 MR. JONES: -- will disperse. It's going
7 to be different how the continental shelf of the East
8 Coast is different than Japan, which just sticks out of
9 the water, has no continental shelf to affect the wave.
10 There's many multiple reasons which we've explored.
11 DR. COOK: Well, I was just going to
12 say --
13 MR. JONES: Yes.
14 DR. COOK: I mean when -- those conclusions
15 though, when it says NRC staff, when that was being done
16 though a lot of that is based on state-of-the-art
17 numerical models that have been applied by USGS --
18 MR. JONES: Yes.
19 DR. COOK: -- and other agencies. So we're
20 taking that information that was under contract
21 -- because they've developed these numerical models that
22 have been there and have postulated these incredible
23 sources. And then they've routed those to various
24 locations. It's what, NUREG/CR -- sorry to put you on
25 the spot.

1 MR. JONES: I think it's 6666.
2 DR. COOK: Well, we can get it to you.
3 MEMBER POWERS: I would appreciate it.
4 DR. COOK: But I mean it looks through --
5 MEMBER POWERS: Because I mean it strikes
6 me --
7 DR. COOK: Yes, and it looks at that
8 development throughout the whole East Coast where it's
9 looked at all these potential sources where they could
10 be. All of them that could be there from the Puerto Rican
11 Trench to going out to the Azores, going out to Iceland.
12 If they did all those --
13 MEMBER BLEY: I think that maybe, if it's
14 the one I'm remembering, it gives the results of these
15 calculations.
16 DR. COOK: Yes.
17 MEMBER BLEY: It doesn't show how you got
18 there.
19 MR. JONES: Well, actually it shows the
20 sources. Then it shows you how they did the modeling.
21 Matter of fact there's a --
22 MEMBER BLEY: It doesn't? Okay. Then
23 it's not the one I'm thinking about.
24 MR. JONES: And he's address it in his
25 research plan. There is actually another NUREG that

1 just came out that is from NOAA. We worked closely.
2 It's NOAA and USGS. We have the A Team. They're experts
3 here. And they're both in agreement. And we use not
4 only the -- NOAA uses their MOS model. We use the COOLEY
5 model. They are actually in agreement with each other.
6 We have looked all the sources; volcanic, subduction
7 zone, submarine landslide. We did numerous
8 simulations. And this is -- NOAA and also USGS experts
9 have done this. And we've done them -- they've done them
10 for research and actually created NUREGS for us. Every
11 time we go to a site, we redo the modeling all over again.
12 CHAIRMAN RAY: Okay. Wait. Wait a
13 minute. This is -- we don't want too far off track.
14 We're way over, John. We got a long way to go here. And
15 I should have said in the beginning we absolutely
16 positively are going to end on time because of what lies
17 after this meeting.
18 MR. NICHOLSON: Do you want me to skip to
19 the end and --
20 CHAIRMAN RAY: No. No, I don't, because
21 the issues that are being raised are ones that we want
22 to have raised. It's just we can't explore them to the
23 end at everybody's satisfaction in the time available.
24 But I do want -- and I trust Derek is taking note and Bill
25 is observing issues that we don't get closure on here,

1 but I definitely want you to go ahead and go through this
2 material.
3 MR. NICHOLSON: Okay. Let's move on then
4 to riverine flooding. There's a significant amount of
5 experience in riverine flooding. Watershed
6 simulations, the Army Corps of Engineers, especially the
7 Heck models, University of Stanford Watershed models,
8 they have all been doing a lot of modeling over the years.
9 One of the issues is what is the driving crunch in the
10 storm distribution so there have been advances since
11 1998, beginning in 1998 to the present with regard to
12 stochastic storm transposition models in which you look
13 at the history of an area and then the storm -- would then
14 formulate those storms and then bring them into your
15 watershed, route that rainfall and obviously estimate
16 flood levels, discharge and inundation levels.
17 One of the issues that has come up obviously
18 is the size of the watershed and your inability to
19 transpose those storms and account for area reduction
20 factors. So these are kind of piecemeal and people
21 wanting a more continuous event model that would better
22 evaluate the antecedent moisture conditions and initial
23 conditions in the reservoirs.
24 This goes back to your comment earlier and
25 also the discussion of Fort Calhoun and the Missouri

1 River. The argument is it's a highly-regulated river.
2 The rainfall was both snowmelt and rainfall over that
3 spring and that created the condition. And it's a very
4 large watershed. So that was some of the complications.
5 Next one, please? So the joint
6 probability method that was developed for storm surge may
7 be appropriate because you're going to be looking at the
8 probabilities of the initiating events and the
9 information leading into it, the input parameters,
10 especially the antecedent moisture condition, snow pack.
11 One of the recommendations was is to get into a more
12 -- watershed models which use the kinematic wave approach
13 as the Corps does. The relationship between regulated
14 and unregulated flows, the extrapolation of the routing
15 design floods based upon historic flows and then project
16 those out in time may help look at these more severe
17 events.
18 Next, please? All right. So now let's
19 talk about the storm surge for coastal areas. There has
20 been a humongous amount of progress made in the last 10
21 years. A lot of it was motivated because of Hurricane
22 *Katrina* and New Orleans. A team of experts was put
23 together by the Federal Government and they were asked
24 to look at how do you formulate storm surges along the
25 Gulf Coast. And we had research that we are funding.

1 Bill brought it up earlier with the Army Corps of
2 Engineers. Don Rieser was head of a group of experts.
3 And that information led to this joint probability method
4 approach in which they're looking at extreme coastal
5 storms for both hurricanes, extratropical storms,
6 cyclones and winter storms.
7 We think this might have value on the Great Lakes. As
8 a matter of fact the Corps is doing that.
9 Now we are very lucky in that NOAA
10 recommended to us that we contact Deltares. Deltares,
11 beginning in 1953 when they had these horrific storms
12 along the coast of the Netherlands and flooded huge
13 areas, killed many, many people, caused tremendous
14 devastation. The Dutch put in place a very systematic
15 approach to look at flooding, not just storms coming off
16 of the North Sea, but also flooding of Rotterdam and other
17 cities. So they were looking at all sources of flooding
18 and they've come up with a -- we'll call it a hybrid
19 deterministic approach. And they go out to 10 to the
20 minus 4 for annual exceedance probabilities.
21 One of the things that was brought up is if
22 you have paleofloods for riverine, why not
23 paleo-oceanography and other information along the
24 coast? Now the coast as we know is very dynamic and you
25 have lots of erosion and sedimentation, but based upon

1 corings, especially the Dutch think that, yes, in fact
2 that could be valuable information just like paleoflood
3 is for looking at very past storms and watersheds.
4 There was an opportunity that they think if
5 we could bring together the shared codes and modeling
6 capabilities of the Federal Government; FEMA, the Army
7 Corps of Engineers, NOAA, USGS, that we'd be able to do
8 a much better job. So that's one of the recommendations
9 that comes to play there.
10 Next, please?
11 MEMBER BLEY: Before you leave that one,
12 when you bring in the paleo analysis --
13 MR. NICHOLSON: Yes.
14 MEMBER BLEY: -- in the midst of talking
15 about modeling, that's a different kind of record. Do
16 you then try to use the modeling to match that paleo
17 history?
18 MR. NICHOLSON: Yes.
19 MEMBER BLEY: So that's the approach? Now
20 on the previous slide when you talked about watershed
21 models and being able to go beyond the kinds of historic
22 records that we have, did those methods -- have they been
23 applied to the historic record as well to see if they
24 match it well?
25 MR. NICHOLSON: Yes.

1 MEMBER BLEY: And they do?

2 MR. NICHOLSON: Yes.

3 MEMBER BLEY: Okay.

4 MR. NICHOLSON: And it's very -- watershed

5 -- now we're talking about riverine.

6 MEMBER BLEY: Yes, I know we switched here.

7 MR. NICHOLSON: One of the troubles with

8 the paleofloods is even though you may not have a record,

9 you may not have these so-called slackwater deposits and

10 information of previous flood at much higher elevation,

11 but if you do have that information, you still have to

12 ask the question has my watershed changed its character

13 so dramatically that we're dealing with a different

14 population? So is it valid? So there's an awful lot of

15 analysis that has to go into not just finding the

16 slackwater deposits or the debris, the organics that

17 says, yes, in fact I can date it, it goes back 3,000 or

18 4,000 years, has the watershed changed character? And

19 the same thing could be said about the coastal regions.

20 I'd have to understand. That's why you have

21 geomorphologists and oceanographers --

22 MEMBER BLEY: They'd have to bring in the

23 judgemental process --

24 MR. NICHOLSON: Yes, that's why the SSHAC

25 process could be of great benefit, because you bring

1 together these experts saying, yes, you have that
2 evidence, but really it's no longer -- you have a thing
3 called stationarity. It no longer applies because
4 things have changed so dramatically. So you have a
5 different population now.
6 MEMBER BLEY: Okay.
7 MR. NICHOLSON: But that analysis has to go
8 on. It isn't just a matter of I found evidence. Let's
9 plug it in. No, it has to be evaluated.
10 CHAIRMAN RAY: Joy?
11 MEMBER REMPE: So, part of the Dutch
12 process is to do a systematic update every five years?
13 MR. NICHOLSON: Oh, yes.
14 MEMBER REMPE: And are the U.S.
15 organizations going to consider that? I don't see that
16 as one of your observations.
17 MR. NICHOLSON: Well, that observation
18 wasn't made, but I imagine Nilesh and Chris could say that
19 one of the ideas is every 10 years for the United States.
20 Now the Canadians do it every five years. The Dutch do
21 it every five years.
22 MEMBER REMPE: Finances are harder in the
23 U.S., so that's every 10 years.
24 (Laughter.)
25 DR. COOK: Task Force Recommendation 2.2

1 got exactly at that, was looking at going through, in some
2 of a periodic way going through and looking and re-doing
3 that. And so that's still something that's there and is
4 still on the list as the recommendation. I think things
5 are still proceeding to go forward with that. It would
6 need to be a rulemaking change.
7 MR. NICHOLSON: Okay. Let's go to the last
8 panel on combined flooding events. Of all of the
9 panels, this one was probably the most difficult. This
10 one is probably in greatest need of development. The
11 present approach, there's a standard in the ANS Standard
12 2.8 that talks about design basis floods and there's
13 combinations of floods that are provided as examples.
14 When Joe Kanney was here earlier talking to you a couple
15 months ago on Reg Guide 1.59, this topic was brought up.
16 So therefore, we heard from the experts,
17 especially FERC, and they think very strongly that if you
18 can do a risk assessment and you do a combination, then
19 you have to think through what are the relevant
20 combination events for that specific area? Okay. So it
21 isn't -- I can tell you a priori what those scenarios will
22 be. You have to develop those. And they like to say
23 that these -- it's a combination of
24 -- it's an uncommon combination of common events. And
25 so therefore they would like the people who developed the

1 earlier standards, which would be deterministic and to
2 some extent probabilistic, to sit down and come up with
3 these. And Joe is on that group that's hopefully going
4 to come with a new approach for a probabilistic approach
5 towards combined events.
6 Next, please? So what are the final
7 recommendations coming out of the workshop? Well, we've
8 mentioned already many, many times that we think a
9 systematic approach for expert elicitation/expert
10 assessment should be made similar to the SSHAC process.
11 And so the FERC is actually doing this now. Based upon
12 the workshop they're actively moving in that direction
13 and they've contacted us to see if we're willing to work
14 with them on that topic.
15 Next, please? Also the storm catalogues.
16 Extremely valuable. The Army Corps of Engineers is
17 continuing to do this work. They brought it up. They
18 discussed it at the workshop. They are working with the
19 Extreme Storm Event Work Group under the Subcommittee on
20 Hydrology, and they're actually going to do a demo of
21 their system on October 9th if the Government's doing
22 business on that date.
23 So that catalogue could be of great value
24 if you combine it with the SSHAC to say, okay, let's think
25 about all the storms that have occurred in a certain area

1 watershed. What floods did they cause? And then can we
2 model those as recorded and can we take that information
3 and transpose it to other times and other places with
4 regard to defining future flooding conditions?
5 Next, please? We brought up earlier,
6 develop a similar systematic approach for dam and levy
7 failure. That's been a lot of the discussion here, but
8 that's an important topic. The joint probability method
9 for hurricanes, tropical storms and intense winter
10 storms, can we apply those to the Great Lakes? The Great
11 Lakes was not mentioned during the workshop, but we think
12 that that has merit. And sure enough, the Corps of
13 Engineers is doing that. NOAA's Great Lakes
14 Environmental Research Laboratory in Ann Arbor, Michigan
15 and the Army Corps of Engineers' office in Detroit is
16 pursuing that and they're aware of what the Corps has done
17 with regard to the joint probability method.
18 Integrate the risk analysis and storm surge
19 modeling by the Bureau of Reclamation and the Army Corps
20 of Engineers. So how do you build that
21 state-of-the-practice and watershed modeling into a risk
22 analysis? And the Corps is doing that and so is the
23 Bureau. And Joe brought that up earlier with regard to
24 the Bureau of Reclamation.
25 And then finally, we have ongoing

1 relationships with all the agencies that participated.
2 We couldn't have put on the workshop without the
3 cooperation of those agencies. Their logos are the
4 bottom of the proceedings cover. We think this has great
5 merit and we are learning a tremendous amount from the
6 other federal agencies.
7 Before I say I'm done, Wendy, would you like
8 to comment or say anything?
9 DR. REED: No, I think you've touched all
10 of my points.
11 MR. NICHOLSON: Okay. We couldn't have
12 done this without Wendy's help. Wendy was extremely
13 valuable in developing this proceeding. So that's all
14 I have, Dr. Ray.
15 CHAIRMAN RAY: Well, thank you, Tom.
16 We're just 15 minutes behind. We'll take five minutes
17 of the break when it come after the next presentation and
18 five minutes out of the discussion at the end, but I don't
19 want to shorten either of those more than that. So I'll
20 ask the remaining presenters to give me five minutes some
21 how because like I say, I have to end at 12:00.
22 All right. So, Joe?
23 DR. KANNEY: Next on the agenda is Chris.
24 CHAIRMAN RAY: Okay. That's fine. There
25 are two listed here in this block. Chris?

1 DR. COOK: Well, thank you for allowing me
2 to come and talk to you through this. This was actually
3 -- I had prepared the bulk of this for the Commission
4 meeting on the October the 16th, but -- and actually so
5 far as scripting it out and then we sort of cut it out
6 because it was -- there's too much and so other things.
7 So I'm happy to have the opportunity to sort of go
8 through this and to talk about it.
9 As you know, the Japan Lessons Learned
10 Project Directorate has issued numerous Interim Staff
11 Guidances that were there. And this presentation covers
12 those ISGs associated just with Recommendation 2.1,
13 which is the reevaluation of the flood design basis
14 that's there.
15 That particular recommendation deals with
16 the reevaluation of all the potential flood-causing
17 mechanisms. And as we were mentioning before when I was
18 talking with Dr. Corradini, the performance is done using
19 present day methodologies and guidance as was being done
20 for the early site permit and COL reviews. So it's a
21 reevaluation of the design basis through present day
22 methods.
23 So since we're using the ESP and COL
24 guidance, you'd be asking why do we actually, you know,
25 develop this guidance? Why do we need to do that,

1 because we're already going through reviews for ESPs and
2 COLs today. And that's really the purpose of my talk is
3 to talk about the motivation of why we want to develop
4 and get that together, because the motivation actually
5 varies from ISG to ISG.
6 First, a little bit about the process that
7 I've got to go through. All the ISGs are released in
8 draft form via *Federal Register* notice for a 30-day
9 comment period and were discussed at public meetings.
10 The public meetings were coordinated with an NEI Flooding
11 Task Force. Some of our meetings were also attended very
12 heavily, especially the ones on dam failure by other
13 federal agencies. Recommendation 2 --
14 CHAIRMAN RAY: Chris, would you be very
15 clear about what page you're on?
16 DR. COOK: I'm still on slide 2.
17 CHAIRMAN RAY: Yes, I perceived that, but
18 since you're adding to what's on here --
19 DR. COOK; Yes.
20 CHAIRMAN RAY: -- well, just be clear when
21 you turn the page --
22 DR. COOK: I will do that.
23 CHAIRMAN RAY: -- since that's how we're
24 having to follow. Thank you.
25 DR. COOK: Perfect. I'll try to do better

1 with that. Yes, I'm on slide 2.

2 So Recommendation 2.1, sort of in a

3 nutshell. First of all, the licensees need to perform

4 the hazard reevaluation using the present day

5 methodologies and guidance. And you'll see that there

6 are two Interim Staff Guidances that apply to this

7 stage of the hazard reevaluation. If the reevaluated

8 results at the site are greater than the design basis,

9 the licensee then needs to perform an integrated

10 assessment. This is brand new. Okay. So this is new

11 guidance and techniques. And I'll be going through and

12 explaining that.

13 And then in Phase 2, based on the submitted

14 information, the NRC will then determine if a regulatory

15 decision is then necessary, whether that be a safety

16 enhancement, backfit or modifying the plant license

17 that's there.

18 Okay. Next slide, slide 3? So the first

19 ISG that I wanted to discuss is the flood hazards at

20 reactor sites due to dam failure assessment that's there.

21 CHAIRMAN RAY: Okay. So, excuse me.

22 DR. COOK: Yes.

23 CHAIRMAN RAY: Because I was watching

24 Theron over here. I just want to underscore what I said

25 in my introductory comments about the Phase 2 is what I

1 would ask members to bear in mind as something that we
2 need to know, well, how is this going to happen? When
3 do we expect it to happen? That sort of thing. But I'm
4 not asking that as a question to you. DR.
5 COOK: Thank you.
6 CHAIRMAN RAY: I just want to underscore
7 that right now.
8 DR. COOK: Thank you, Dr. Ray. No, but
9 that is a very important part because the whole point of
10 a 50.54(f) letter, as you know, is to request
11 information. And then once this information comes in,
12 the NRC as a body will have to make decisions about what
13 to do next with that. And that's why everything is set
14 up is to help us inform -- and especially with the
15 integrated assessment try to risk inform as much as we
16 can with the decision.
17 MEMBER CORRADINI: Did you say -- is stage
18 1 completed now?
19 DR. COOK: Stage 1 is ongoing. That's the
20 stage we're currently in. And stage 1 itself is where
21 the licensees are submitting the flood hazard reports.
22 We prioritize the 66 different sites that are there into
23 1 of 3 categories, and those 3 categories were set up
24 based on -- you know, the first one submitted this last
25 March, and so they only had a year to get it done. It

1 was primarily sites that already had a review ongoing.
2 You can think of year two sort as being the default year.
3 And then year three that was going out -- so March of 2015
4 were the ones were longest out.
5 And that actually is important for the
6 tsunami and storm surge guidance, because you'll see we
7 intentionally put most of the coastal sites in that so
8 that they could then apply some of the guidance we knew
9 as part of lessons learned from the operating reactor
10 licenses, could actually go through and implement those
11 lessons that we are looking at.
12 So it's ongoing and it will be ongoing until 2015 to -- is
13 the quick answer to your question.
14 MEMBER CORRADINI: Thank you.
15 DR. COOK: So back on slide 3 and dealing
16 with the dam failure Interim Staff Guidance. While all
17 the new reactor reviews considered the potential for dams
18 to fail, none of the completed new reactor sites were
19 flooded due to off-site dam failure.
20 Now many of you were involved in the
21 subcommittee that was dealing with South Texas. So you
22 may be asking since we just came to see you last April
23 how could that be? I just want to recall that that
24 particular one, the MCR that was there, is on site and
25 is controlled by the applicant that was there. So

1 information regarding the construction of the materials
2 of the MCR were readily known and they were also available
3 to the combined license applicant. And that's a key
4 point. There are also no questions about what the
5 appropriate seismic ground motion was to consider at that
6 particular structure.
7 So based on other new reactor applications
8 actually that were stalled, staff and NRO realized and
9 we were aware that the guidance was really out of date
10 and it needed some updating before we go through this,
11 and I wanted to point out a couple examples that were
12 there.
13 First of all, seismic failure dealing with
14 distant dams. If you look at ANS ANSI 2.8, it was unclear
15 if the, you know, SEE or OBE ground motions that were
16 there were at the nuclear power plant site or at the
17 location of a distant dam. And as we all know, those
18 seismic motions will vary. So that part needed to be
19 cleared up. ANSI 2.8 was also framed around
20 deterministic ground motion methods. You know, we're
21 dealing with SSE and OBE, and as you all know, we've
22 progressed more into GMRS. And we needed to update the
23 guidance so that it was clear that we were looking at
24 addressing the probabilistic seismic hazards. I
25 thought, you know, myself personally you could actually,

1 you know, get to it, that we met probabilistic methods
2 by the existing guidance that was there, but in
3 discussions with some of the licensees they didn't get
4 there.
5 (Laughter.)
6 DR. COOK: And so we felt that there was a
7 need to make sure that it was clear, to remove the
8 ambiguity that was there, and to put that out there.
9 Another example that we needed was
10 clarifying our position on the so-called sunny day
11 failure of the dams.
12 And, Dr. Powers, when you were talking about
13 degradation, this was sort of what we were talking about.
14 And because these are failures that are not associated
15 with concurrent floods or seismic events, these are
16 caused by deterioration of method -- or construction
17 methods, hiking, failure of gates and valves.
18 If you look at this Interim Staff Guidance
19 that's there, we put in a staff position based on remember
20 our discussions with the other federal agencies. So
21 this is actually our best interpretation of the current
22 state-of-the- practice. And that staff position
23 states: "Because no widely accepted current
24 engineering practice exists for estimating sunny day
25 failure rates on the order of 10 to the minus 6 per year

1 for dams for sunny day failure, they should be assumed
2 to occur in the consequences estimate."
3 So what we pretty much came out and said is
4 the state-of-the-practice you can't go out to 10 to the
5 minus 6. Don't really try. You have to assume for sunny
6 day failure that it's just going to fail and look at the
7 consequences in the nuclear power plant site.
8 So the final example that I wanted to point
9 out with this guidance was that it was also unclear in
10 some places about the initial reservoir level and the
11 river discharge for several of the failure mechanisms.
12 MEMBER BLEY: Can you tell them how it will
13 fail?
14 DR. COOK: No.
15 MEMBER BLEY: Because that must make a big
16 difference on what happens downstream.
17 DR. COOK: Correct. Whether it's the
18 spillway that goes, whether it's the side embankment that
19 does it, we leave it up to them to go through. And the
20 guidance talks about how to go through looking at the
21 different failure modes that would be there in looking
22 at --
23 MEMBER BLEY: Understand what failure
24 modes would apply and evaluate that?
25 DR. COOK: Exactly. And we're really sort

1 of driving them to then start looking at the potential
2 failure modes analysis. PFMA is sort of the standard
3 practice technique. It's sort of trying to drive them
4 in that direction that would be there. But based on the
5 information notice that Fernando was a part in, you know,
6 Joe Kanney, who's in research, and a number of my staff
7 were all looking at this and we were talking with the
8 federal agencies. We just said that we don't have the
9 confidence that we can say 10 to the minus 6. You could
10 meet with a sunny day failure to try to show it dealing
11 with deterioration and things like that Dr. Powers was
12 talking about. Just assume it fails, but a sunny day
13 failure.
14 DR. KANNEY: But in the guidance we did ask
15 them to do an analysis, to identify, you know,
16 appropriate failure modes that you would consider --
17 DR. COOK: Yes.
18 DR. KANNEY: -- in that sunny day.
19 MEMBER STETKAR: It's a breach flow
20 analysis specifically.
21 DR. COOK: Yes, exactly, to come through.
22 DR. KANNEY: Are we on the right slide,
23 Chris?
24 DR. COOK: Yes, you are on the right slide.
25 Like I said, this is for a Commission slide, so there's

1 a lot more of the sort script. I'm using it so there's
2 -- I'll be talking a lot from my notes that are going
3 through.
4 MEMBER POWERS: That's fine.
5 DR. COOK: Okay.
6 MEMBER POWERS: Lovely. Prefer it.
7 (Laughter.)
8 DR. COOK: So then like I said the final
9 example that was clear were the initial reservoir and
10 river levels that were there and, you know, going
11 through. So for the sunny day failure, just to drive
12 that example all the way, we talked about, you know,
13 talking about being at the maximum, the normal elevation,
14 you know, the top of the active storage pool. Instead
15 of being all the way at the top of the dam, you could
16 assume this type of failure would happen under sunny day,
17 more normal conditions versus a rainfall event.
18 So that was part of what we did is clarify
19 the conditions you needed to assume in your reservoir for
20 hydrologic failure, for sunny day failure and for seismic
21 failure that we thought wasn't clear in the previous
22 guidance.
23 Okay. Next slide, please? Actually, I'm
24 sorry, go back to slide 3 for a second. One more thing.
25 What I also wanted to talk about is what this updated

1 guidance was based on. Much of the new guidance in the
2 ISG was based on published federal guidance. If you
3 review the document you'll see that it contains a
4 sizeable reference list, and as possible we tried to be
5 aligned with guidance from the other federal agencies.
6 However, we did note; and this is important, that federal
7 agencies implement the overarching federal guidance for
8 dams safety differently. They do.
9 Given that, we had to come up with a number
10 of talking points, and I'll read two now, and then there
11 are a couple later. First of all, given the potentially
12 severe consequences associated with flooding of a
13 nuclear power plant site and since nuclear power plant
14 sites should never be evacuated of all staff during a
15 flood event, the NRC continues to make conservative
16 assumptions for predicting maximum flood heights at
17 nuclear power plant sites. These flood heights at the
18 nuclear power plant site may differ from the assumptions
19 made by other federal agencies developing emergency
20 action plans, EAP; these are fairly standard, where
21 evacuation is a useful mitigation strategy for
22 preventing loss of life should an upstream dam fail. So
23 we make certain assumptions such as a sunny day failure
24 that other agencies do not make and we're more
25 conservative in that regard because we do not look at

1 evacuation as an acceptable strategy for us.

2 So the final point that I wanted to make is

3 that the ISG was reviewed by other federal agencies while

4 it was being developed. I briefed the Interagency

5 Committee on Dam Safety; this was ICODS approximately

6 several times while this ISG was being developed. We

7 went to them the first time about nine months before it

8 was finalized. ICODS itself was formed in the 1980s and

9 it serves as the permanent forum for the coordination of

10 federal activities in dam safety and security. And

11 ICODS is chaired by FEMA.

12 The outcome of this meeting was the creation

13 -- the very first meeting that we had was the creation

14 of a special working group just for the purposes of

15 reviewing and commenting on this ISG. So this is

16 separate than our public meetings. These were agency to

17 agency meetings.

18 MEMBER BLEY: I looked at the ISG. This

19 now I think requires looking at all upstream dams, not

20 just the first one.

21 DR. COOK: That's correct. We had assumed

22 before cascading failure was a potential, but some of our

23 assumptions I think in the past have led us to really look

24 at these hazards differently in light of what we know

25 today. And so although cascading failure was there, we

1 have I think better techniques and analysis to look at
2 and realize the serious consequences that could exist
3 from a failure of even a distant dam. So that is included
4 today and that is something that we look at.
5 MEMBER BLEY: Okay. Thanks.
6 DR. COOK: All of the comments from the
7 special working group, which dealt with the Corps of
8 Engineers, FEMA; we talked earlier about FERC and the
9 Bureau of Reclamation, were dispositioned before the
10 document was finalized.
11 There were a number of key points that
12 members of ICODS wanted to put into our talking points
13 and also into the document itself, and I wanted to read
14 two of these.
15 First of all, licensees should interact
16 with federal agencies -- so, let me clarify: These are
17 NRC power plant licensees -- should interact with federal
18 agencies via the NRC, so through us, in order to obtain
19 information on federally-owned, operated or regulated
20 dams.
21 The second one that was there was that we
22 wanted to add a very clear statement into the ISG that
23 the dam owners, operators and regulators are the ones
24 responsible for the safety and performance of the dams
25 and they are the best ones able to answer questions

1 concerning the dam performance of safety for their
2 facilities.
3 And you can imagine the sort of interesting
4 position we are in when we're talking about failure in
5 one of the structures that they own, operate and
6 regulate. And so there's a sensitivity there just
7 between the different agencies that does exist, exists
8 today and it will exist in the future as we go forward.
9 And it's very important to work with them as we talk about
10 that, as well as trying to get information.
11 MEMBER BLEY: ICODS is the group of
12 agencies?
13 DR. COOK: ICODS is a group formed in the
14 1980s that was there after Teton failure. And so
15 President Jimmy Carter was important for setting it up.
16 And it contains the dam safety officer for each agency
17 that's there. And then the main chair is actually -- for
18 us it's the executive director of operations.
19 CHAIRMAN RAY: I assume that the
20 information -- this is from the subject of flooding
21 today, and I don't want to deviate from that, but I assume
22 that the information that you're describing about dam
23 failure would be transferrable to loss of ultimate heat
24 sink issues as well.
25 DR. COOK: Yes.

1 CHAIRMAN RAY: In other words, it's not
2 kept in isolation. Do it all over again for downstream
3 dam failures.
4 DR. COOK: Yes, I mean it's generic for
5 dams. We're looking at dams themselves regardless of
6 construction.
7 MEMBER STETKAR: I think that requires a
8 bit of qualification, Chris.
9 DR. COOK: Sure.
10 MEMBER STETKAR: The ISG addresses
11 flood-induced failures of downstream dams. It doesn't
12 address other failures of downstream dams. As best as
13 I can see, the guidance does not address a seismic failure
14 of only the downstream dam whose sole function is to
15 impound the ultimate heat sink. It addresses cascaded
16 failures.
17 DR. COOK: Right.
18 MEMBER STETKAR: But I think it explicitly
19 excludes that.
20 DR. COOK: The exclusion is one though of
21 essence and purpose for the Recommendation 2.1 flooding
22 hazard, because that is the scope of the 50.54(f) letter
23 that was in there, the methodologies to look at how to
24 evaluate the seismic failure of dam. The ways that you
25 would look at a earthen embankment liquefaction, whether

1 it's upstream or downstream of a plant is really the same
2 mechanisms. But the scope of the 50.54(f) letter -- and
3 hence you're absolutely correct that then the scope of
4 the ISG is for the cases of the upstream dam. It does
5 not include those. But the ways that you'd look at the
6 dam are the same.
7 MEMBER STETKAR: Yes, it's beyond me why if
8 we were looking at dams and a watershed why I wouldn't
9 also look at the same time as the downstream dam just
10 because somebody decides to draw a dotted line.
11 MR. FERRANTE: It has to do with how the
12 agencies --
13 MEMBER STETKAR: I understand. I
14 understand that. Because of time, I just wanted to get
15 on the -- because Harold brought it up, I wanted to get
16 on the record that this ISG is not comprehensive in its
17 scope in terms of looking at all dam failure effects on
18 a nuclear power plant.
19 DR. COOK: True. It does however
20 incorporate Generic Issue 204, GI-204, which was dealing
21 with the loss of upstream dams.
22 MEMBER STETKAR: Yes. Oh, yes.
23 DR. COOK: And but you're correct. I
24 believe that there's actually another potential ISG
25 that's there that's actually dealing with downstream

1 dams.

2 MR. FERRANTE: Or is a Generic Issue 205?

3 DR. COOK: 205 has been issued now?

4 MR. FERRANTE: I don't know if it was

5 published, but it's in the final --

6 DR. COOK: Correct. Okay.

7 MEMBER STETKAR: It's kind of funny because

8 it does address cascaded failures that come -- floods,

9 inundation floods, if you will, that take out a

10 downstream dam with the consequences of, you know, loss

11 of ultimate heat sink.

12 DR. COOK: And if you're interested on the

13 history of how we got there, I was part of that. We can

14 talk about that offline.

15 MR. CHOKSHI: I think and another important

16 point is when question call for a Reg Guide 1.59, that

17 article shows coefficient goes away.

18 (Laughter.)

19 DR. COOK: Exactly. That's the point I was

20 trying to make.

21 Next slide, please, Joe? So now I'd like

22 to move on to the second ISG, which is dealing with

23 tsunami, storm surge or seiche. And as you will see in

24 this ISG it's actually comprised of two separate

25 enclosures that are there. The first enclosure deal

with storm surge and seiche, and the second one deals with tsunami. And I'd like to actually discuss both of those guides separately, or both of those aspects separately as we go through.

Regarding the motivation our updating the storm surge guidance, there were several new reactor sites whose controlling site characteristics were flooding with storm surge. In addition, Hurricane *Katrina* in August of 2005 elevated the potentially destructive power of storm surge associated with hurricanes. In response to both of these drivers, the NRC formed a Storm Surge Research Program to focus on developing modern, risk-informed hazard assessment techniques in cooperation with the National Oceanographic and Atmospheric Administration, NOAA, and the U.S. Army Corps of Engineers. Likewise, other federal agencies in response to Hurricane *Katrina* such as FEMA and he Corps continued to invest in separate programs for developing and applying probabilistic approaches to investigating storm surge.

The motivation for tsunami guidance is actually somewhat similar. Although there aren't any new reactor; emphasis on new reactor sites that have a controlling site characteristic that's from tsunami, there are several proposed new reactor sites along the

1 Gulf and the Atlantic Coast. Therefore, it seemed
2 prudent to the NRC to confirm that storm surge continues
3 to be the controlling characteristics for flooding
4 hazard. And so like storm surge, the 2004 Indian Ocean
5 tsunami raised the global visibility of tsunami hazards
6 worldwide.
7 So these two drivers led the NRC to develop
8 a coordinated tsunami safety study in 2005 with something
9 called the National Tsunami Safety Initiative that the
10 National Oceanographic and Atmospheric Administration
11 conducted, so NOAA conducted. And in 2006 the NRC also
12 initiated a Long-Term Tsunami Research Program. This
13 program includes cooperative work with USGS and NOAA.
14 So the outcomes for both Storm Surge and
15 Tsunami Research Programs have resulted in significant
16 updates to the current knowledge, and these updates are
17 captured in the ISG. And I wanted to highlight a few of
18 the additional items.
19 First of all, probabilistic methods exist
20 today, as we've talked about, for both storm surge and
21 for tsunami, and these methods are both discussed in the
22 ISG. For Atlantic Coast sites we're already seeing
23 applications and new reactor reviews for the use of
24 probabilistic methods for storm surge. So we're already
25 seeing that today that's there. And I also expect that

1 they're going to be used in Recommendation 2.1.
2 However, since the tsunami hazards along the Atlantic and
3 Gulf Coasts are much smaller than storm surge, from what
4 I've seen the use of bounding deterministic models are
5 going to continue to show that tsunami hazards are not
6 the controlling hazard at the site.
7 However, I do suspect that we're probably
8 going to be seeing probabilistic tsunami methods applied
9 to the Pacific Coast that are there as part of
10 Recommendation 2.1. As you know we don't have any new
11 reactor sites that are being proposed along the Pacific
12 Coast. But I do think that we have a good likelihood of
13 seeing them for Recommendation 2.1.
14 I also wanted to note that coastal reactors
15 sites that were not assigned -- that do not already have
16 an ESP or a COL going on were assigned the three years.
17 This was what I was getting at earlier. So they're out,
18 you know, at that year three category, so that gives them
19 more time to actually apply the probabilistic methods
20 that were being discussed in the tsunami and storm surge.
21 The last thing I wanted to hit was the last
22 bullet on the slide, which is long-term sea level rise,
23 which was discussed in the ISG for the purpose of
24 Recommendation 2.1 and the operating reactor fleet. The
25 ISG recommends that long-term sea level rise in operating

1 reactor site be estimated by use of observed data that
2 a tide gauge station is near the site. The staff
3 recommended the use of observed data near the site
4 because it incorporates both the sea level rise that
5 you've been seeing there, as well as vertical land motion
6 such as subsidence and glacial rebound.
7 Staff also realized that practical
8 limitations in the current state of knowledge associated
9 with mechanisms causing long-term sea level rise. And
10 although it's not discussed in the ISG, staff continued
11 to support Near-Term Task Force Recommendation 2.2 that
12 I was talking about earlier, which recommends that hazard
13 reviews be performed at all operating reactors for some
14 set period. These periodic updates allow for more
15 timely mitigation measures to be implemented if a more
16 dramatic sea level rise should occur from what is
17 presented in historical record near the site.
18 The next slide. The March 12th 50.54(f)
19 letter states that NRC staff will develop the
20 implementation details of the integrated assessment.
21 So this guidance was developed by November 30th and we
22 presented details to you around that same time. And I
23 didn't want to go into all those details, but in brief
24 I sort of wanted to walk through the concepts that are
25 captured in the cartoon that you'll see on the left-hand

1 side of the graphic.

2 At the top of the cartoon the outcomes of

3 the hazard reevaluation; that's the blue box at the top,

4 are the input to the integrated assessment. So this

5 where you get into Stage 1 and, you know, Stage 2 that

6 were there at Phase 1.

7 MEMBER CORRADINI: So the blue box is Stage

8 1?

9 DR. COOK: Yes. Yes, so that's the hazard.

10 And so it's very important that as much as we can we try

11 to get finality around that hazard evaluation before they

12 get into the integrated assessment, because those

13 results then come in and then go forward.

14 Upon entering the integrated assessment

15 licensees should evaluate then the capability of the

16 flood protection systems; that's the red boxes you see

17 there, to meet the intended safety functions under the

18 reevaluated hazard. If the licensee can demonstrate

19 that the site's flood protection is reliable and has

20 margin as defined and discussed in the ISG, then the

21 licensee then proceeds down to the purple box to document

22 and justify the results.

23 If the licensee cannot demonstrate that the

24 site's flood protection is reliable and has margin for

25 the methods discussed in the ISG, the licensee then

1 should evaluate the plant's ability to maintain key
2 safety functions during a flood in the event that one or
3 more of the protection systems is compromised.
4 In this ISG this step of the integrated
5 assessment is referred to as evaluation of the
6 mitigation capability that you'll see there. And so
7 that's the green box. So they go from the red box down
8 to the green box to evaluate the mitigation capability.
9 After evaluating the mitigation capabilities, then the
10 licensees should proceed to go forward and to document
11 and justify the results.
12 In lieu of flood protection some sites allow
13 water to enter buildings at some operating reactor sites,
14 and these are structures that, you know, include
15 important safety systems and components such as reactor
16 buildings. And this is done by procedure or design.
17 If the presence of water may affect these
18 SSCs, then the integrated assessment -- what you do is
19 you drop directly down to the green box to evaluate the
20 mitigation capability that's there. And then you would
21 go through and you would evaluate the ability of the site
22 to respond to that.
23 So the ISG describes the items to be
24 included in the integrated assessment report, and these
25 are consistent with the four items that are mentioned in

1 the 50.54(f) letter, and per the 50.54(f) letter the
2 licensees have two years to develop this integrated
3 assessment and send it into us after they've completed
4 the hazard review, so after they've completed that first
5 stage that's there.
6 I believe that's the end of my presentation.
7 CHAIRMAN RAY: Okay. Although I've been
8 trying to expedite our movement forward, and I'll
9 continue to do that, this is an important point. Let me
10 first ask, Joe, in the agenda I got here, you were to make
11 some presentation at this point. Is that correct, or you
12 just got the one at six?
13 MR. FERRANTE: I don't know, I think I'm
14 next.
15 DR. KANNEY: Yes, Fernando is next,
16 insights from reactor oversight process for future --
17 CHAIRMAN RAY: All right. All right. You
18 can see it's got your name in here for some reason.
19 In any event, then I don't have to --
20 DR. KANNEY: No, Chris is giving the
21 presentation.
22 CHAIRMAN RAY: That's fine. But I did want
23 to stop here because of where Chris ended I think is an
24 important point, as I've been saying, and I wanted to see
25 if -- Bill Shack, first of all, do you have a questions

1 that you want to ask at this point in time?

2 CONSULTANT SHACK: No.

3 CHAIRMAN RAY: Okay. Do any of the members

4 have any questions, because we're talking here now about

5 something called results that then get transferred into,

6 well, what do we do about the results at some point in

7 the future? Any questions?

8 (No audible response.)

9 CHAIRMAN RAY: Okay. With that then, let

10 me say that we're at the point here where our break should

11 have ended, but that's not going to be a problem if we

12 can make up some time. I think that item 6 on the agenda

13 we should make sure we allow enough to -- since, Fernando,

14 you have 45 minutes coming up after the break, I'll ask

15 you to shorten it a bit, if you can do that. We'll take

16 a 10-minute break now and please try and get back and

17 resume at 20 minutes to 11:00.

18 (Whereupon, at 10:28 a.m. off the record

19 until 10:38 a.m.)

20 MR. FERRANTE: Okay. All right. I'm

21 Fernando Ferrante. I'm in NRR's Division of Risk

22 Assessment, and basically what I'm here to talk about is

23 insights from the significance determination process

24 regarding experiences on external flooding risk as it

25 pertains to our inspection framework.

1 And so we have a presentation online. I'll
2 get into the material. That way we'll save some time.
3 But in this slide I basically tried to give
4 some sense of the background we're looking at. We're
5 essentially shifting gears a little bit from where we
6 were before. Obviously there is nexus with the
7 Fukushima follow-up activities on what we do in
8 inspection, but what I'm going to talk about, all the next
9 slides are going to be pertaining to a very narrow band
10 of what the Agency does within our oversight process,
11 which is ultimately if you look at a risk-informed way
12 to try to address the risk significance of inspection
13 findings.
14 And so I'm really focusing on this is the
15 effort by which we do risk assessments, as I call them,
16 more than PRAs themselves to try to understand. Every
17 time an issue is brought up, as it was brought by many
18 instances of trying to address the walkdowns for flooding
19 or any other particular violation of our requirements.
20 This is where we come in. We have PRA models. For
21 external flooding we're clearly on a different space.
22 And ultimately the focus here which really addresses the
23 fact that, you know, we're not doing licensing here. We
24 don't have the luxury of sitting and waiting for several
25 years to address an issue.

1 This is again -- the focus is on what does
2 the NRC need to do to follow up on a particular
3 inspection. And that has an implication or the type of
4 information we're willing to look for, how long we wait
5 for, and what decision we make at the end of the day.
6 This is not to say the SDP is a process that relies on
7 lesser quality information. Ultimately I think it
8 reflects the ability of the probabilistic information we
9 have on flooding today.
10 And do really we struggle with where to find
11 information, now reliable it is, what vintage does it
12 have and what's the pedigree and how that information was
13 involved. And ultimately we have discussed with other
14 offices how to go forward in some of this. And so we
15 really have a thorny issue, which is the hazard is on the
16 table, the impacts of the plant from a PRA point of view
17 --
18 CHAIRMAN RAY: Excuse me, Fernando. I'm
19 going to stop you right there because --
20 MR. FERRANTE: Sure.
21 CHAIRMAN RAY: -- the hazard is on the
22 table. Well, what defines the hazard? Is it the
23 licensing basis, or is it the best available information,
24 or what is it?
25 MR. FERRANTE: It's the best available

1 information.

2 CHAIRMAN RAY: Okay. So I can imagine a

3 licensee saying, well, wait a minute, you say this

4 condition is more significant than I do because you're

5 using hazard information that's different than what's in

6 my licensing basis.

7 MR. FERRANTE: That's correct.

8 CHAIRMAN RAY: And how is that gap closed?

9 MR. FERRANTE: Painfully, I'll say.

10 (Laughter.)

11 CHAIRMAN RAY: I would think so. As a

12 former licensee, I can --

13 MR. FERRANTE: I will get to those slides

14 and I'll try to address your point.

15 CHAIRMAN RAY: All right.

16 MR. FERRANTE: If you don't mind.

17 CHAIRMAN RAY: I don't mind.

18 MR. FERRANTE: Okay. And so with that

19 framework in mind we have criteria to define our

20 follow-up actions and what the impact is in the SDP

21 process. It's derived from two metrics: The typical

22 PRA metrics we use, core damage frequency, large area

23 release fraction. What I'll highlight on this slide is

24 every time we have an issue and you might have

25 contribution from a flood that is as low as 10 to the minus

5, if the plant cannot show additional mitigation capabilities, then that number stays within that realm of magnitude, that's still an issue for the SDP to address.

And so we don't have a level of criteria where we say, well, beyond this level we don't care what the flood looks like. There's a range. In theory you could pick 1E minus 6 to be that, but what I'm trying to highlight here is even very extreme -- whatever appropriate word that is used for 1 in 100,000, 1 in a million-type of floods, those have an impact in our inspection and we try to address those in the best manner we can. This will go back to what the credibility is of extrapolating certain information.

We do use quantitative and qualitative. We don't have to be strictly held by the hazard information. We can try to address it from a defense-in-depth and make a determination on what the impact is of that particular finding. We have always considered external flooding a part of the risk contribution to the plants and we have to look at it by our guidance and our processes.

This cartoon is just basically to illustrate the state of affairs as I see it and where we are today. We come essentially in for operating reactors on a deterministic framework. Sometimes we

1 might be able to get 500-year flood information out
2 there. It's not usually included in the license basis.
3 In some cases it might be. But probable maximum
4 characterization is usually what we see regardless of the
5 phenomenon.
6 And so we have to then try to translate some
7 of the information, information that comes around
8 inspections in terms of the protection and the level of
9 mitigation the plant can perform a particular event and
10 then try to put it in our risk-informed framework which
11 may include a PRA model that models how the plant may lose
12 off-site power at a certain point and whether it will go
13 into a station blackout because of the flooding
14 implications and then address what systems are impacted,
15 what recovery actions can be taking place and what kind
16 of operator manual actions are involved.
17 The initiating event frequency, which I
18 marked with a question mark, is certainly one of the
19 biggest challenges we have. This is the framework as it
20 exists today. There isn't a single place where I can go
21 and get probabilistic flooding information for all
22 sites. It just doesn't exist. And every time we have
23 an issue we tend to recycle the wheel and go out there
24 and find information, then eventually get into that
25 discussion with the licensee many times in a public

1 meeting to try to address this.

2 CONSULTANT SHACK: How many plants

3 actually have a probable maximum flood from the 1.59?

4 MR. FERRANTE: I wouldn't be able to tell

5 the exact number, but several of them have one. I mean

6 that was still the framework when licensing.

7 CONSULTANT SHACK: Are most plants -- do

8 the have a -- I was sort of wondering just whether they

9 actually had the PMF.

10 MR. FERRANTE: Oh, whether they actually

11 had the event?

12 CONSULTANT SHACK: And as a --

13 MR. FERRANTE: Not that I'm aware of. I

14 don't know one that actually had it.

15 CONSULTANT SHACK: No, I mean do they

16 follow 1.59 --

17 MR. FERRANTE: Oh, I see.

18 CONSULTANT SHACK: -- for license design

19 basis for it?

20 MR. FERRANTE: Yes. Yes.

21 CONSULTANT SHACK: All of it?

22 MR. FERRANTE: Yes. For the most part.

23 Some of them, because they might have been licensed

24 earlier might have been committed to a particular version

25 of it, but for the most part they follow Reg Guide 1.59.

1 That's the common trend on all of them.

2 PARTICIPANT: What was the year though of

3 1.59?

4 MR. FERRANTE: Late '70s, I believe. Yes.

5 PARTICIPANT: So obviously --

6 MR. FERRANTE: '77.

7 PARTICIPANT: -- three S&E plants did not.

8 MR. FERRANTE: Right.

9 PARTICIPANT: And so there are a number of

10 S&Es.

11 PARTICIPANT: What do they do?

12 DR. COOK: I would say that if you were to

13 look at in a global sense the hazard mechanisms that we're

14 looking at today are the same hazard mechanisms that were

15 looked at then. But there have been definitely changes

16 that have progressed over time as that evolution has

17 taken place. And so it has evolved.

18 MR. FERRANTE: Right. I mean if I can add

19 to that, I know one plant that was licensed before the

20 general design criteria came to be, and they committed

21 to a version that was akin to that one and then put in

22 the licensing basis. That's been my experience.

23 DR. COOK: If you look at Recommendation

24 2.1, I think fleet-wide it's sort of a novelty because

25 this is the first time we're going out. We're going to

1 do it all doing the same way. For flooding.

2 MR. FERRANTE: Okay. And so within the

3 context of inspections I'll try -- you know, this is a

4 long list. I'm not going to go through all of them, but

5 I tried to give you a flavor that flooding has been

6 addressed pre-Fukushima. We have had findings that

7 pertain to flooding protection before and since then with

8 the event of the walkdown in Recommendation 2.3. That

9 has stepped up significantly to the tune that we had

10 several findings, more than 10 certainly, in the last 6

11 to 8 months. And we still have some ongoing issues that

12 came out from the walkdowns that we're still trying to

13 address.

14 As I showed the metrics before, we do try

15 to characterize them and distinguish them and try to be

16 consistent with the way we use the information to the

17 extent it is available.

18 MEMBER SKILLMAN: Let me ask a question,

19 Fernando, if I might.

20 MR. FERRANTE: Sure.

21 MEMBER SKILLMAN: Does the NRC interpret

22 this data as a pattern in terms of inadequacy in the

23 regulations? Here's an example: When a person reads

24 General Design Criteria 2, one doesn't connect that GDC2

25 is much broader than the six or eight sentences that are

1 in 10 CFR 50. And these are old plants. All of these
2 are old plants. Is there a failure in the
3 comprehensiveness of the general design criteria such
4 that -- you know, Oconee, what 1970?
5 MR. FERRANTE: Yes.
6 MEMBER SKILLMAN: Here we are 40 years
7 later. We're finding the SSF is inadequate. We're
8 concerned about Jocassee. Is there more to this than
9 just saying by golly, we had an accident in Japan; we'd
10 better take a look at this? Are there inadequacies in
11 our regulations that need to be addressed at a very
12 front-end level?
13 MR. FERRANTE: Yes, let me characterize a
14 bit more of the complexity, because I think it's not just
15 a generic design criteria issue. A lot of our findings
16 are not -- all of this, for example, certainly is not
17 against, you know, generic design criteria. A lot of
18 them are for example 10 CFR 50, Appendix B and may have
19 to do with correction action plan. Maybe the plant is
20 well protected and the general design criteria is
21 appropriate for the plant, but they had an issue where
22 they did not maintain the flooding protection
23 appropriately.
24 So I can't characterize this as a trend
25 against GDC2 specifically. What I will say from my

1 perspective is we had a number of issues pre-Fukushima
2 and once this walkdown, which is essentially shedding a
3 light in this particular area more brightly, as I see it,
4 a significant number of issues came out. And there are
5 trends in there with respect to where we are in our
6 protection with flooding.
7 Whether that implies the GDC itself is
8 inadequate, I can't really answer that in too much
9 detail. At least I don't have a strong opinion on that.
10 I think it does imply when you compare what we obtained
11 from seismic and flooding that flooding maybe requires
12 looking at it more carefully and certainly looking at the
13 results that come from the Fukushima reassessment in a
14 strong light.
15 MEMBER SKILLMAN: Will there be an
16 assessment of the adequacy of GDC2 as a consequence of
17 what's being found?
18 MR. FERRANTE: Well, I mean to my extent the
19 effort that we're doing with Fukushima is going to be
20 pointing to that, even if it doesn't say that explicitly.
21 We are going to be looking at whether we need to increase
22 the licensing basis of some of these plants and then look
23 at where we were then. I think the paradigm we're
24 dealing with in NRR is that, you know, maybe this is a
25 reevaluation, reassessment issues, but 20-30 years ago

1 the state of knowledge was one. As we move forward that
2 will change, and that has implications for plants that
3 are not dry sites and have included in their procedures
4 actions when this water is on site.
5 And I think it's valid question whether that
6 means we're going to go back and look at GDC 2 and its
7 adequacy. Formally, I don't know, but I think I see the
8 whole effort as going in that direction one way or
9 another.
10 MEMBER SKILLMAN: Thank you.
11 MR. FERRANTE: And so I'll talk a little bit
12 -- I'll try to give you a flavor of where we were and where
13 we are now and how some of these issues are dealt with.
14 I'll try not to go into too much detail to save time.
15 CONSULTANT SHACK: Did I miss it? How did
16 you assign frequencies to get these things in the bins?
17 MR. FERRANTE: I'll get to that question,
18 if you don't mind holding off for a little bit.
19 But in essence, this was one of the first
20 issues I dealt with when I came to the Agency. Oconee
21 Nuclear site in South Carolina had a finding which had
22 to do with CO2 cover in the standby shed on the facility.
23 The standby shed on facility is relied for additional
24 defense-in-depth. It has a number of systems in there
25 that speak to safe shutdown of the facility in events such

1 as fire, floods, ex-control room actions, margins for
2 station blackout coping time. So it's clearly a
3 risk-significant facility. And because this cover was
4 not sealed for over two years, there was a concern with
5 flooding impacts and dam failure upstream of -- Oconee
6 is one of them. And the impact will be to take out
7 several of the mitigation systems that will be relied on
8 to address such an issue.
9 The map on the right-hand side basically
10 shows where the facility is. And up north you can see
11 Lake Jocassee where Jocassee Dam is located. It is 10-11
12 miles upstream of the site, over 1 million acre-feet.
13 And so it's a significant reservoir.
14 We looked at this issue of finding. We
15 tried to put it through our SDP process to the best we
16 could. The licensee appealed this. This actually went
17 beyond SDP. Like I said, SDP is not there to assess the
18 adequacy of the design basis per say, but an effort
19 looking to that was undertaken and is continuing into the
20 Fukushima reassessment now. This also led to the
21 creation of the information notice which I was involved
22 in developing and the generic issue on upstream dam
23 failures. And so this had significant repercussions in
24 how we understood dam failures well before Fukushima.
25 As I said, the information notice was

1 written as an outcome of this. It was coordinated with
2 the release of generic issue and it had to do with
3 basically dealing with some of the dam failure
4 frequencies that we saw articulated by the licensee
5 during the finding. And after that we looked back at the
6 history of where these dam failure frequencies were
7 developed. We came back to this report, NSAC-60, which
8 was an early PRA study for the pre-Oconee units and
9 essentially looked at some of the numbers they had,
10 analyzed where they took the information from, looked at
11 the currently available historical dam information and
12 availability of information such as dam-years from
13 existing dams to try to come up with some reasonable
14 statistics, not to address what the final answer is, but
15 just to inform us where we were. And this
16 actually went a long way. It was referring to one
17 specific NUREG and the Generic Letter 88.20, supplement
18 4, submittals that ended in the IPEEE submittals. And
19 so we had a concern that this was used throughout multiple
20 references. And when we reviewed the databases we had
21 a sense that the dam failure frequencies were, you know,
22 at least closer to the published values which are an order
23 of magnitude higher for dams.
24 And this again was a very specific
25 information notice which was trying to address if you're

1 going to rely on historical dam failures and availability
2 of them as opposed to looking at your dam in a more, you
3 know, PRA base as the Bureau does or maybe as I would like
4 to call it in a more integrated way as opposed to saying
5 here's the number. It tells us this is not an issue. We
6 felt that the numbers will lead to some unconservative
7 results and should be looked at carefully. And we issued
8 this for information and the generic issue was
9 established in part out of this lessons learned because
10 we have addressed some of these issues. And then it was
11 eventually subsumed into the 2.1 recommendation.
12 If you have any questions, let me pause
13 here, since I know this was an item of interest.
14 CHAIRMAN RAY: Well, no, the information
15 notice didn't require any response.
16 MR. FERRANTE: Correct.
17 CHAIRMAN RAY: Which is perhaps puzzling.
18 But in any event it's now, as you say, subsumed into
19 what's ongoing now. If that had not occurred, it would
20 kind of be an open issue that we might be critical about
21 how we addressed it at the time, but that's beside the
22 point now.
23 MR. FERRANTE: Yes, and there was always an
24 intent to not just release this, but address it into the
25 generic issues program and not let this issue fall

1 through the cracks. And of course once we looked at
2 this, we looked at application of other sites, which
3 again we did some pre-analysis before the generic issue
4 was created and that went into the further analysis that
5 was done in the screening report. So it had
6 ramifications beyond just the information notice.
7 CONSULTANT SHACK: You referenced the
8 Bureau of Reclamation report and they seem to have
9 estimated failure probabilities for their dam. Does the
10 Army Corps of Engineers have an equivalent?
11 MR. FERRANTE: Actually, I don't know
12 about the Army Corps. They might have their own
13 assessment of it. But one of the benefits I will say of
14 dealing with some of the flooding issues is we did
15 interface with the U.S. Bureau of Reclamation at length,
16 and we took some of their training and talked to some of
17 the experts in the workshop and well before some of the
18 more recent events. And one of the things that we
19 learned clearly from them is for this particular type of
20 approach, trying to take dam failure information from the
21 historical record, they had clearly come to the
22 conclusion that the number on average was close to what
23 we said, 1E minus 4, and then moved on and said we can't
24 rely on this to make decisions and then moved into a more
25 integrated way of looking at, you know, PRA-type of

1 processes.

2 That's the most important lesson we

3 learned, that they had moved on. And that's the lesson

4 we tried to put here, which is don't put too much emphasis

5 on these numbers to try to screen out things. I don't

6 know if that answered your question, but that's kind of

7 the extent where we went to.

8 DR. KANNEY: The Army Corps has what they

9 call their Risk Management Center. It was set up I guess

10 relatively recently, in the last five years or so. And

11 they are looking at incorporating some of the Bureau of

12 Reclamation's methods and, you know, blending them with

13 some of the methods that they already use. But so the

14 answer is, yes, the Corps also has, you know, a Risk

15 Management Center. They are applying risk-informed

16 methods for dam failure.

17 CONSULTANT SHACK: Just seemed like the

18 dams we were interested in all seem to the Army Corps

19 dams.

20 DR. COOK: Well, and we're working with

21 them. In fact, we've recently let and have them now

22 under contract to help us understand a lot of the dams

23 that are upstream of some of our plants.

24 Regarding the Risk Center, I would also

25 point out though that a lot of these agencies have

1 numerous dams in their portfolio that they need to
2 manage. And so they know from each one of these projects
3 that there are needs and the needs outweigh the amount
4 of budget that they have. And so they then need a way
5 to go through in a risk-informed sense to try to
6 understand how to allocate that money. So a lot of these
7 risk centers, some with the Bureau of the Corps of
8 Engineers, are set up with the purpose of how to allocate
9 funds and how to do that, not necessarily for the purposes
10 perhaps that we're getting to.
11 So there is just a difference in that, and
12 it's some of the differences that we know. And so I think
13 there's a need to look at the information that comes out
14 from some of those studies and try to understand the
15 paradigm under which it was generated to see if actually
16 applicable to what we're using.
17 MR. FERRANTE: Yes. One of the very
18 critical lessons of interfacing with the Bureau and the
19 Corps was I think they certainly move probabilistically
20 in terms of how they treat their hazards. I will
21 characterize that we're trying to make baby steps there.
22 We certainly have developed PRAs in detail for nuclear
23 power plants, and that's an area that they're trying to
24 go more forward into. How do they do that consistently?
25 And, you know, again, it's a risk-ranking-type of

1 approach that they apply to their dam portfolio. And so
2 there's a need to understand, as Chris said, how their
3 values are obtained and to what level they are
4 characterized. But again, I think in my opinion they
5 clearly move on on some of these issues.
6 And I felt like having discussions on, well,
7 if I looked at Teton Dam and I screened that out because
8 my dam is not constructed like them and we have better
9 -- that was a very sterile discussion to have when you're
10 trying to define, you know, the level of safely that
11 particular mitigation equipment provides to a plant.
12 And so the idea was to release the information and kind
13 of move on and have a better discussion.
14 DR. COOK: I think that a key point to
15 follow up with that is that when you're looking at trying
16 to allocate funds for remediation, it's very different
17 than siting a new facility. And to the best of my
18 knowledge the Corps of Engineers when they're siting new
19 facilities is still using deterministic methods. So
20 that's the point more bluntly that I was trying to get
21 to with the differences between, you know, looking at
22 risk. Are you trying to use risk to site a new facility,
23 or are you using that risk to try to manage your portfolio
24 where you have a limited budget? And I think that there
25 are some differences there and we may want to reflect

1 ourselves on that when we deal with operating reactors
2 versus new reactors and how we want to deal with that in
3 our own paradigm and the amount of uncertainty that we're
4 dealing with when we deal with, you know, certain numbers
5 that come out.
6 MR. FERRANTE: Yes. And so to follow up on
7 that very same paradigm, when we also had a finding
8 pre-Fukushima at the Fort Calhoun station. This took
9 place some time in the 2009-2010 time frame. This had
10 to deal essentially with flooding protection, very
11 specifically sandbagging, steel plates against doors of
12 buildings that had to be protected for the safety
13 equipment located inside of it. The particular inside
14 we had here was some of the sandbagging procedures in
15 theory were going to be placed on top of steel plates for
16 which you really didn't have enough room to even credit
17 sufficient watering impounding.
18 And there were issues in terms of
19 implementation. When do the steel plates work? When
20 are the steel plates implemented? You know, if you have
21 to take it or have to take an action that requires taking
22 it out, will that take place before or after the flood?
23 Staging of equipment. Feasibility in terms of the time
24 frames of the flooding event that will anticipate and so
25 forth. So we gave them a yellow within our SDP

1 framework.

2 And then what happened right after that,

3 some time in the 2010 time frame, the reservoirs were

4 actually at a very low level within the river system. As

5 Tom indicated before they had a record snow pack buildup

6 some time throughout the winter. That was followed by

7 a very rapid record snow melt, which combined itself with

8 severe rains within the March-April time frame and then

9 eventually caused very high levels to which the Army

10 Corps had to respond with reactor releases of volume from

11 other impoundments. There are several large dams

12 upstream, both Fort Calhoun and Cooper Nuclear Station.

13 And one of the insights on that is even a heavily

14 regulated river for which the dams have not failed can

15 still result in significant flooding downstream

16 depending on what actions need to be taken, what

17 operations are required.

18 And after that, this is what the plant

19 looked like sometime in July 2011. And as Tom alluded

20 to before, it stayed there for well over two months. And

21 so it was recognized back then that the level never got

22 to the point where some of the performance efficiencies

23 we identified are going to be triggered, but it did cause

24 the licensee to think back in terms of staging equipment,

25 you know, the robustness of some of the mitigation

1 actions and so forth. And so this indicated it was not
2 just a mere exercise and thinking, you know, what does
3 the risk significance mean for that inspection?
4 After Fukushima we had, like I said, a large
5 number of findings that came through with the walkdowns.
6 The TVA, Tennessee Valley Authority, you saw it's had a
7 number of them. Both Sequoyah and Watts Bar. This one
8 did touch on upstream dam issues, in particular the
9 understanding that the licensing basis assumed upstream
10 dams would not fail and the response of the site was
11 measured against that. And information that came out
12 from violations with Bellefonte and follow up from that
13 action well before Fukushima also had impacts on, you
14 know, what that preparation will be if the dams are
15 assumed now that they cool overtop.
16 The other associated finding with this were
17 missing seals. And this is another trend in a lot of
18 these findings which basically for the emergency service
19 water, if I may call it that -- they call it essential
20 raw cooling water. That building was supposed to stay
21 dry in a flood. And because these electrical conduits
22 weren't sealed; they're not only unsealed but the design
23 as it was defined may not have been appropriate enough
24 even to address that particular flooding, will not have
25 prevented that had the flood taken place.

1 And what that means is even though the
2 probable maximum flood level is at 722 feet above mean
3 sea level, you could have this performance of deficiency
4 activate flooding impacts at a much lower. In the case
5 it was around 698. So again, this was a case where we're
6 not dealing -- we're dealing with the effects of not
7 having a risk spectrum, which is we're tied into that
8 probable maximum. And here we have seals, penetrations
9 and then reliance on actions which the flood level will
10 have already achieved that well before getting to the
11 probable maximum level.
12 MEMBER SKILLMAN: Fernando, you mentioned
13 Bellefonte. Did you really mean Sequoyah when you said
14 Bellefonte?
15 MR. FERRANTE: No, I meant Bellefonte.
16 DR. COOK: The Bellefonte COL. Actually
17 in new reactors, when the review had first started, when
18 it initially had come in I was actually involved in going
19 through, and we found some issues with their quality
20 assurance program dealing with their numerical models to
21 simulate the probable maximum flood on the system.
22 MEMBER SKILLMAN: Oh, I understand. Thank
23 you. Thank you.
24 MR. FERRANTE: Okay. And so if I can move
25 on, just to add --

1 CONSULTANT SHACK: I was confused again.
2 It sounded as though their probable maximum flood was
3 high. So they didn't meet their design criteria.
4 MR. FERRANTE: That's right.
5 CONSULTANT SHACK: It's a design
6 deficiency.
7 MR. FERRANTE: Right. Yes, and that's how
8 we learned of the performance deficiencies in our
9 inspection process. Yes, it has to be tied to that.
10 MR. CHOKSHI: Yes, 2.3 walkdowns were to
11 see whether they are in compliance with the current
12 licensing basis.
13 CONSULTANT SHACK: Okay. Thank you.
14 MR. FERRANTE: And so in short Three Mile
15 Island also had a performance deficiency and it followed
16 the trend of the Sequoyah issue I just talked about.
17 Flooding seals missing. And so in this case; I won't go
18 into all the details for the sake of time, but they tried
19 to take credit for fire seals which are not really
20 designed for flooding. And so we developed a logic on
21 how that might impact the different equipment that will
22 be impacted. The timing of the flood, as was mentioned
23 earlier, was critical. More longer floods, longer
24 timing would impact more equipment, and depending on the
25 capacity of sump pumps and other features of the plant

1 to address this.

2 The one issue I will highlight, to try to

3 come back to the frequency question you asked, one of the

4 things we do have available is information on stream

5 gauges in some sites. Not all of them, but some have.

6 Now all these are limited to all the issues we know.

7 Hundred years, 200 years of available information. And

8 I personally know as a risk analyst this is a crude

9 analysis, but we're go in there and we extrapolated, used

10 standard statistical techniques well beyond what they

11 might be recommended for. We are essentially

12 extrapolating limited aleatory uncertainty associated

13 with the stream gauges themselves and not really

14 addressing any of the significant epistemic

15 uncertainties that come in.

16 But what I will say about Three Mile Island,

17 which I think was a distinguishing trait with all the

18 other issues we found, was that we were looking at

19 frequencies and the licensee itself was looking at

20 frequencies that were in the range of the one in 10,000.

21 And so clearly when I look back at all of the guidance

22 that says, well, if you meet these requirements with a

23 probable maximum flood and combinations of certain

24 events, you might assume you have a 1E minus 6, you know,

25 you're meeting a 1E minus 6 flood, it kind of went out

1 the door as far as operating reactors goes. And this was
2 a trend throughout some of the findings.
3 There's a variation here. And different
4 sites -- obviously Three Mile Island is in the middle of
5 an island and it has flooding vulnerabilities which are
6 recognized. I believe the plant also has multiple
7 layers that tried to address this. The CO2 case was one
8 layer that was identified a performance deficiency, but
9 it highlights the difference in information and the
10 difference were that information might point us, even
11 without very sophisticated tools today. Now my goal
12 will be for this to become more sophisticated and us to
13 have better information. But the hazard was bent in the
14 same way that we will be in seismic hazard curve and we
15 put it through the process for the particular elevations
16 of concern.
17 And so here I get to the point of the
18 presentation which I think is more important, which is
19 kind of the insights we had with a lot of these issues.
20 Initiated event frequencies. How do we characterize a
21 hazard? It came time and again and again with the
22 licensee showing us hazard curves saying this is the
23 right answer and us going back to information we had
24 before. I just mentioned they're not all created equal.
25 These are different events for different phenomena with

1 different mechanisms, different timing and so forth.
2 We know the standard methods don't exist
3 today where I can readily take something off the shelf,
4 extrapolate it and feel that I'm comfortable with that
5 frequency if we are in the ranges of one in 100,000 to
6 one in a million, or even lower than that, one in 1,000
7 and beyond.
8 This table pertains to an effort that was
9 done some time in 1997. It basically is not a consensus
10 of any kind, but it involved a workshop of about 20
11 experts, well-known experts in the field of severe
12 flooding hydrology, statistical implementation of, you
13 know, statistics and methods in hydrology, paleoflood
14 experts and so forth. And they got together and tried
15 to make an assessment of what's the best quality data and
16 how credible would an extrapolation be associated with
17 that data?
18 And so this came out in talking to some of
19 our counterparts in other agencies, and clearly what
20 we're dealing with is we don't have a lot more than that
21 site stream flow data at this point. We certainly don't
22 have paleoflood information for a lot of our sites unless
23 it's developed by another agency for other purposes.
24 Even regional analysis might be very limited. And so
25 we're playing with extrapolations well beyond what is

1 credible and optimal.

2 And so the side track of that is for the

3 issues at the TVA plants the left-hand side is the hazard

4 curve they provided us as a counterpoint, which is the

5 issue raised earlier. And so we as in the inspection

6 process are left to grapple with how credible is it for

7 us to believe that some of the issues they're dealing with

8 are really in the 10 to the minus 7 or 10 to the minus

9 8 range.

10 An expert on stochastic flooding methods

11 was contracted by TVA to help them with this issue, and

12 he was present at the regulatory conference where this

13 was presented and we had a very insightful discussion

14 with him. And he came on the presentation and indicated

15 that this is really the best you might be able to do with

16 limited information or limited data. And if you were to

17 develop a more detailed stochastic model where you take

18 all the inputs and treat them as random variables to try

19 to address the issue of how the hydrology might perform

20 in a very sever phenomena, he thinks it will be closer

21 to the 95th curve, which is more or less where we were.

22 And so that gave us at least some sense to move forward

23 with a deficiency as we assess it and come up with a

24 number.

25 We never intended to say that was the right

1 answer or the wrong answer, but again we're trying to
2 assess what resources we assigned to this issue. We
3 clearly believe flooding issues were important at Watts
4 Barr and Sequoyah. And I believe the licensee also
5 understood the message very clearly given the level of
6 additional design and modifications that we're willing
7 to contemplate.
8 CHAIRMAN RAY: Fernando, let me interrupt
9 you here for a second. This is all applicable to the
10 significance of deficiencies. No deficiency, it
11 doesn't apply. Right?
12 MR. FERRANTE: That's right.
13 CHAIRMAN RAY: So it's not -- I didn't want
14 members to get the idea that somehow we were looking at
15 what was being done to assess the adequacy of the
16 licensing basis. This is strictly a matter of if you
17 have a deficiency first, then what is the significance
18 of it?
19 Now having said all of that, is it not
20 applicable to assess the adequacy of the design basis?
21 And is there anything done, or does this feed into some
22 other activity that is being planned or will take place
23 so that we use this same assessment basis that you've been
24 using, quite rightly, to assess, well, is the design
25 basis adequate or not? Is that the case?

1 MR. FERRANTE: Well, the SDP is in essence
2 limited to the finding on -- and we don't have a process
3 within our framework to say what does this imply in terms
4 of licensing basis and address it within that framework.
5 But as I mentioned in the Oconee finding, it did move on
6 to that stage in looking at backfit activities well
7 beyond that.
8 CHAIRMAN RAY: Yes, I think that's the
9 point I want to make is that, you know, this is kind of
10 a legacy of IPEEE. I was in the licensee world at that
11 time, and I'm just going to leave it there. But what
12 Fernando is describing is how do we decide what the
13 significance of some deficiency is? But I think we need
14 to also think about, well, what is this telling us that
15 we're perhaps not yet doing to assess the adequacy of the
16 design or licensing basis?
17 Okay. With that, go ahead.
18 MR. FERRANTE: Okay.
19 MEMBER POWERS: When we think about floods
20 in the distributions you've given us there in the Pearson
21 III distribution there, are these heavy-tailed
22 distributions?
23 MR. FERRANTE: Yes, I mean these
24 are very, very long tails, yes.
25 MEMBER POWERS: Not long, but high, yes.

1 MR. FERRANTE: That's what I implied, yes.
2 And so I -- you know, one of the --
3 MEMBER POWERS: -- variances and things
4 like that.
5 MR. FERRANTE: I'm sorry, say that again?
6 MEMBER POWERS: They don't have variances
7 and things like that.
8 MR. FERRANTE: And so I mean I think one of
9 the things that I learn in talking to other experts is
10 I'm not entirely comfortable that that one curve really
11 is going to give me --
12 MEMBER POWERS: Yes, you can't --
13 MR. FERRANTE: But one point that I think
14 is important is what will help us particularly in the
15 inspection process is maybe we can come to a consensus
16 of where they are. But even an understanding of their
17 spread and where they will be will be good information
18 for us. So looking at --
19 MEMBER POWERS: Well, understanding that
20 there's a spread is the first critical (laughter.)
21 MR. FERRANTE: Yes.
22 MEMBER POWERS: And then I'm delighted that
23 you have considered the possibility of heavy-tailed
24 distributions, because I think at our current state of
25 knowledge we just have to. And they're horrible to deal

1 with, I understand, but that's very good. That's very
2 good.
3 MR. FERRANTE: You know, the Log-Pearson
4 III distribution sort of has been enshrined in a lot of
5 hydrology based upon work done for floods of return
6 periods on the order of just a couple to a few hundred
7 years. So there's obviously some difficulties in just
8 extrapolating that out, period, or assuming that it's
9 still the right distribution for more extreme floods.
10 There are some Bayesian methods out there
11 that allow you to basically do some comparison between
12 different distributions.
13 MR. FERRANTE: And in fact let me follow up
14 on that point. And this is kind of my personal
15 experience since I created this graph. This is not
16 consensus or in anywhere -- but it's kind of the
17 implications of this with different parts of the curve
18 we're dealing with. Because number one, I will prefer
19 to have a curve as opposed to trying to address what that
20 probable maximum flood -- which I believe is a horrible
21 acronym. It's probable. It's not probability. And it
22 might not be a maximum. But in essence what we're
23 dealing with, you know --
24 PARTICIPANT: We're sure it's a flood
25 though.

1 MR. FERRANTE: Yes.

2 (Laughter.)

3 MR. FERRANTE: But we also have ranges, and
4 these are not well defined ranges. They're just my
5 intent to try to characterize different areas where we
6 might be dealing with existing information for which
7 we're still doing with some of the aleatory uncertainty
8 depending on the stream gauge's quality. And then just
9 from the process itself. And then ranges within maybe
10 we can at least inform where that uncertainty is, you
11 know, directing itself to and the ranges that we might
12 use for our understanding of how important a particular
13 issue might be with respect to flood. And then really
14 long ranges where ultimately you have to understand in
15 my mind more of the physical phenomena behind it, and I
16 had better models. Whether that goes through then an
17 expert judgment or the station panel, SSHAC process,
18 whatever it might be, I recognize that that's an area of
19 challenge.

20 And so in my mind the research project and
21 the research plan and all the efforts we're going to try
22 to address these different areas so we can gain benefits
23 in different parts, not just trying to answer what's the
24 right number for --

25 MEMBER POWERS: Yes, the biggest problem

1 you have with experts always is experts think they know
2 more than they really do. But I mean it's just true.
3 (Laughter.)
4 MEMBER POWERS: I mean they're much more
5 confident in their information. And at least in the
6 NUREG-1150 effort we tried to combat that by asking not
7 what they thought, but what they thought the range of
8 technical community opinions would be and whatnot. Here
9 I think you're mitigating it a lot by bringing in these
10 heavy-tailed distributions because that's what they are
11 intended to handle. And I like what you've done with all
12 this but I think it's good.
13 CHAIRMAN RAY: Okay. He's got four slides
14 and we want to give --
15 MEMBER POWERS: Oh, take a powder.
16 (Laughter.)
17 MEMBER POWERS: We're talking about
18 important stuff here.
19 (Laughter.)
20 CHAIRMAN RAY: I understand, Dana, but I
21 want to make sure we get that important stuff noted down
22 for a time when we can have a longer discussion.
23 MR. FERRANTE: Yes, I'll try to go through
24 this very quickly. But this slide goes to another key
25 point. I won't go through the details of the graph, but

1 it's the lack of risk spectrum. If we decide to that
2 probable maximum scenario, there's another range of
3 scenarios that the plant can go through which still can
4 accrue risk and are very important in our inspection.
5 Clearly, like there are some differences here with
6 seismic, but the probable maximum level assumes you will
7 have all those protections working and they'll be robust
8 enough. And every time that turns out not to be true,
9 then we have to deal with it. So moving away from that
10 particular point where we define a single frequency I
11 think is something that is an important highlight of
12 this.
13 And then the other aspect which we've been
14 talking about is this issue of uncertainty. I'm not
15 going to sit here and say it's not an issue. Of course
16 it is an issue. But I'm also trying to move forward in
17 your risk insights and what we can get out of this. And
18 I see when we have large loss of coolant accident
19 frequencies we have these distributions with very wide
20 ranges and seismic. And 95 percentiles have very wide
21 ranges. And we apply them. We put them in our PRA.
22 That's not to say, you know, this is the right answer
23 absolutely, but it's what insights can we get and then
24 what can we put through our inspection process if we
25 indeed find that those things are important given this

1 information?

2 And then dealing with uncertainty we have

3 put several documents. NUREGs. EPRI has put out

4 documents trying to address practical implementation of

5 guidance. It's time we put this to the practice in my

6 mind and try to use them for the benefit of our already

7 existing repeat form process.

8 I don't want to leave you with the

9 impression that the hazard issue, the risk spectrum is

10 the only one. There's a slew of other issues that came

11 out of these findings. Credit for forecasting or

12 warning times, as also was mentioned earlier. Credit

13 for temporary flood barriers, as the Army Corps is

14 developing Reg Guide 1.102 and such for us. Planning

15 procedures and any independence of combination events

16 which tend to always in my mind be assumed as being overly

17 conservation when they may not.

18 And so what I want to leave you with is the

19 idea that for us in NRR and in our inspection framework

20 this is a problem today. It is not really a problem of

21 later down the road. I mean we will continue to receive

22 at a minimum license information challenging requirement

23 with probabilistic information of some kind of another.

24 And so we will like to see this developed, continue to

25 expand and then continue to become, to the extent we can,

1 something that we can at least come to a common
2 understanding of what's acceptable and what's not
3 acceptable to use so that we can at least move forward
4 in more of a single voice in this area. And that's the
5 extent of my presentation, if you have any questions.
6 CHAIRMAN RAY: Well, that's an excellent
7 job. I think that the thing -- I mean Dana was commenting
8 on methodology and the kind of assumptions used and so
9 on. I think this is an application to the determination
10 of the significance of the non-compliance. But the fact
11 that you've got to first have a non-compliance to even
12 put it to work is the thing that I guess I'm wanting to
13 draw attention to.
14 With that, we've got now time I believe,
15 Joe, for you to have 25 minutes, let's say, and leaving
16 us 10 minutes that I'd like to capture the comments of
17 the members before we hit 12:00.
18 DR. KANNEY: No other questions for
19 Fernando?
20 (No audible response.)
21 DR. KANNEY: Okay. I'm going to talk about
22 the work that we have been doing to develop a draft
23 research plan for probabilistic flood hazard assessment.
24 I want to emphasize that we're in the early stages. What
25 we have now is a draft plan. We actually welcome the

1 opportunity to bring it in front of you folks today to
2 get some of your insights at this early stage. I think
3 it should be quite valuable.
4 I'll give a quick overview. You know, the
5 objective in developing this research plan is, you know,
6 to support the staff in developing a more risk-informed
7 licensing and oversight framework with respect to
8 flooding hazards and consequences. The two major
9 applications that we see are the design standards for new
10 facilities, and as you're well acquainted with now from
11 Fernando's presentation about, you know, the use in
12 significance determination processes.
13 CHAIRMAN RAY: Why would you -- you got new
14 facilities. You've got significance of deficiencies.
15 Why not an application that assesses the adequacy of the
16 design basis?
17 DR. KANNEY: I guess my thinking is that
18 would come into the first sub-bullet there, the design
19 standards for new facilities.
20 CHAIRMAN RAY: Well, because it applies
21 only to new facilities I think most people --
22 DR. KANNEY: I see what you're saying.
23 CHAIRMAN RAY: What about existing --
24 DR. KANNEY: -- for existing facilities.
25 Okay. I understand.

1 CHAIRMAN RAY: What about existing
2 facilities?
3 MEMBER BLEY: This is Phase 1.
4 CHAIRMAN RAY: Well, I appreciate that, if
5 that's the answer. Namely it's going to appear some
6 place else. We're just talking now about this research
7 that -- speaking of. But nevertheless, one would think
8 that if we're going to assess deficiencies using this
9 more sophisticated mature appropriate methodology that
10 you wouldn't want for a deficiency to surface to apply
11 it. You'd say, well, does this tell us anything like
12 IPEEE did, or attempted to; that was another story we
13 won't go into, but in any event, about the adequacy of
14 the design basis.
15 MEMBER SKILLMAN: Yes, this is why I raised
16 the issue about GDC2, because it seems to me that these
17 are tied together.
18 CHAIRMAN RAY: All right. Go ahead,
19 Chris.
20 DR. COOK: Well, I was just going to say
21 from a bigger pictures question on that, I mean I think
22 a lot of what you're hearing us talk about with
23 Recommendation 2.1, and in my comments we're talking
24 about; and Dr. Rempe brought it up, too, was the hope
25 perhaps that we'll move forward with Recommendation 2.2

1 where we're looking at things in a periodic basis for the
2 design, or we're looking at, you know, the sites
3 individually as we go through with some sort of a
4 periodicity that would take place. Of course we don't
5 have that right now. And, you know, as you know, when
6 we start looking at the design basis we start bringing
7 up things like backfit, you know, and what --
8 CHAIRMAN RAY: I do know that.
9 DR. COOK: Yes, and --
10 CHAIRMAN RAY: Yes, I understand.
11 DR. COOK: -- so there's a few thorny sort
12 of things that we have to try to understand that are being
13 worked through. But if things become period -- you know,
14 we have some sort of periodicity like other countries do
15 when we go back and we start looking at these things, we
16 can then evolve as we go forward, as we get new
17 information about things like climate change and we start
18 finding about things that we once thought were
19 incredible. You know, you read some of the older FSARs,
20 you know, talking about things that are incredible, but
21 now we're starting to think are sort of credible in our
22 mind set such as upstream dam failures. So that ability
23 to evolve.
24 CHAIRMAN RAY: Okay. Let's -- because I
25 don't want to soak up Joe's time, but it just seems to

me like it's a missing piece here. It appears but then it doesn't appear. It's like we want to shy away from applying what we worked to develop as a methodology for new facilities or the significance of deficiencies and say, well, but I don't want to think about it even in terms of a plant without any deficiencies that has an existing design basis or licensing basis.

MR. CHOKSHI: May I say --

CHAIRMAN RAY: Yes, please speak up, Nilesh.

MR. CHOKSHI: I think that because the -- as the knowledge we get and questions, like for example, the -- I have seen this much in seismic, as we started reviewing the ESPs and COLs we are looking at finding that the new hazard estimates are much greater than -- and so the generic issue was created I think for the operating reactors. Same thing with the dam, you know, I think that Fernando talked about. But I think what Chris talked about 2.2, I think it gives a more structured approach rather than waiting for something to come about or emerge. So I think we are getting there, but you know --

CHAIRMAN RAY: All right. But we fill a role here in this whole agency process, and I'm trying to make sure that the members here appreciate that

1 although we may be creeping toward a point at which we
2 would look at what does this tell us about the existing
3 risk at an existing plant -- I mean the risk at an existing
4 plant, I should say, we're hesitant to ever put that on
5 a slide here anywhere and say that that's what we're going
6 to do and we're going to have it done by some point in
7 time. And I keep referring to IPEEE because we did do
8 that in the past, although it was done under a
9 circumstance in which there wasn't any standard that we
10 were using really, is the way I would put it.
11 Go ahead, Joe.
12 DR. KANNEY: Okay. All right. I think we
13 talked a little bit about sort of the range of annual
14 exceedance probability for rare to extreme floods. You
15 know, we thought about that. And, you know, at this
16 point we're casting the net rather broad, as you can see
17 here. Anything from 10 to the minus 3 to in the
18 neighborhood of 10 to the minus 7. Part of the research
19 here is to really find out how far one could reliably go,
20 what the uncertainty bounds are as you move out to lower
21 and lower probabilities.
22 And I wanted to make the point here that,
23 you know, we're not talking just about, you know, the
24 exceedance probability of just one extreme flood, you
25 know, for a lot of purposes, and Fernando I think

1 illustrated that nicely. We really do need to look at
2 the full hazard curve. Now it may be that in different
3 sections of the hazard curve different methodologies are
4 important so that the methodologies we may use to pin
5 down, you know, the far, far end of the distribution may
6 be different than what we would use for the lower ends
7 of the distribution.
8 Okay. I think I mentioned previously we
9 have a draft plan that we came to talk about today.
10 Obviously, we're going to talk at a high level today. I
11 assume that as we go forward we'll come back and we'll
12 have the opportunity to talk about more details.
13 MEMBER POWERS: Do we have in hand your
14 graph?
15 DR. KANNEY: What's that?
16 MEMBER POWERS: Do we have your graph?
17 DR. KANNEY: It's in this presentation, you
18 know, what we thought we --
19 MEMBER POWERS: It's just that while we're
20 fixing to write a report to the Commission on the research
21 program, then that might be an optimal time to highlight
22 for them your plans here.
23 DR. KANNEY: Okay. We have a draft plan
24 that we went over with the management and NRR and NRO and
25 Research on last week. I guess I'll take my cue from

1 management as to whether you think that's in the state
2 to be shared. What we came with you today is sort of an
3 overview, you know, high-level description of the plan.
4 MEMBER POWERS: Well, yes. But I mean we
5 do write every two years a report to them in which we make
6 recommendations on research that they should be
7 undertaking. And it seems to me that the timing is
8 pretty much optimal here. I mean especially if you're
9 -- the report can say, you know, that they're doing this
10 and they're working out the details, the things we like
11 and the things that they should consider are. And it
12 gives you some visibility to the Commission that way
13 about this. So I mean, we can put all the codicils on
14 it that need to be put on, but it seems to me like now
15 is the time to include that, rather than after the reports
16 come out, because that might close you off to access to
17 funding.
18 MR. OTT: I don't see any reason why we
19 couldn't actually provide you with a draft.
20 MEMBER POWERS: I mean I understand --
21 MR. OTT: But recognize we're still in the
22 process of discussing it.
23 MEMBER POWERS: That's right. And the
24 report doesn't go into such microscopic detail. I mean
25 it's more philosophical. Research this area or don't

1 research this area.

2 MEMBER STETKAR: But it is. If you're not

3 aware, I mean we'll be submitting that report early next

4 year. So as Dana said, it is very timely.

5 MEMBER POWERS: But who is --

6 MEMBER STETKAR: Dr. Corradini.

7 MEMBER POWERS: I mean for the --

8 MEMBER STETKAR: Oh. Oh, I'm sorry. I

9 don't know where this falls. You know, topically I don't

10 know where it falls.

11 MEMBER ARMIJO: We have practices in that

12 area, but we don't have that as a topic.

13 MEMBER STETKAR: Give this information.

14 We'll find a slot to put it in.

15 DR. KANNEY: Okay. I I just want to

16 stress that, you know, we sort of have a small group that

17 we're consulting between right now from the major -- what

18 we anticipate is a major user offices, but that we also

19 realize that we do need to consult with other offices as

20 we proceed.

21 MEMBER POWERS: Joe, I might just go on and

22 point out to the rest of the committee whereas in the past

23 we've often highlighted research programs that have

24 coordinated with foreign entities, this would be an

25 excellent example to show where they can coordinate with

1 other government agencies. I don't think we've ever
2 done that before, but this -- I mean this would be an
3 excellent object lesson in that area.
4 DR. KANNEY: Yes, and I think, you know, as
5 was made very clear from Tom's initial presentation, you
6 know, this is an area that we expect to have a significant
7 amount of collaboration and coordination with other
8 federal agencies. Okay?
9 The main thrusts of the research plan are
10 essentially five: One is to leverage available flood
11 frequency information. I'll go into more detail into
12 each of these, but the idea is that, you know, there is
13 some, you know, flood frequency information out there at
14 our sites. We should look into methods that we could use
15 to leverage that and make that information more useable.
16 Here we're sort of specifically thinking more towards the
17 significance determination process. The folk that do
18 that type of work need to be able to access and synthesize
19 that information on a very short time frame. And right
20 now that's very difficult for them to do because the
21 information is not packaged well in a framework that they
22 can easily use.
23 The second bullet here is, you know, we
24 essentially need to do some work to develop we think a
25 general framework that we can use that would be

1 applicable to a range of flooding scenarios and a range
2 of annual exceedance probabilities. You know, part of
3 that is looking at the uncertainty analysis,
4 understanding the uncertainties inherent in various
5 flood estimation methodologies. You know, thinking
6 hard about the aleatory and epistemic uncertainties.
7 How we would characterize the uncertainties. How we
8 would blend different methods.
9 You've heard a lot of discussion about, you
10 know, potential applications of a SSHAC-like process.
11 You know, we think that would be an appropriate tool to
12 use to get at that assessment of some of the key
13 uncertainties. We recognize that, you know, there have
14 been a lot of advances in modeling techniques associated
15 with the various individual flooding processes and
16 mechanisms that we need to incorporate and provide
17 guidance on.
18 And then on the other side of the equation,
19 on the fragility side, you know, we recognize that there
20 is a lack of information about, you know, basic
21 reliability of flood protections, how one would look at
22 analyzing the plants' response to flooding events. You
23 know, we're sort of dipping our toe in the water here and
24 moving into this with the integrated assessment. We
25 think that the information coming back, the work that's

1 been done on the Integrated Assessment ISG. And the
2 information that we will get back from a lot of the
3 licensees in this area will be very informative and help
4 us in this regard. And then finally, assessing, you
5 know, potential impacts of dynamic and/or non-stationary
6 processes and the flood hazard assessment, and on flood
7 protection. I'll talk a bit more about that later.
8 Okay. With respect to leveraging the
9 available flood frequency information, the point here
10 really is to organize the flooding information that is
11 available. The idea essentially would be to build some
12 sort of a database-type approach with site-specific
13 information or pointers to that information. We realize
14 that, you know, some pieces of information
15 are sort of constantly in flux and new information is
16 constantly being added. We don't want to just have some
17 sort of static snapshot, but more a point or two where
18 information is and guides on how to incorporate it. And
19 obviously we have a lot of plants, a lot of sites that
20 work would have to be prioritized in terms of, you know,
21 anticipated need, anticipated, you know, or perceived
22 risks.
23 And then also Fernando alluded to, you know,
24 there are some existing tools out there that people use,
25 but what we would be looking at is sort of extending some

of those tools, using them in a range where they have typically not been applied. And there is very little guidance and insight into how to do that without getting yourself in trouble.

MEMBER BLEY: Joe?

DR. KANNEY: Yes?

MEMBER BLEY: Following up on what Dana asked you --

DR. KANNEY: Sure.

MEMBER BLEY: -- up front you have a bullet about cooperating with other agencies. Have you given much thought to how you'd weave in those agencies under this plan, or are they involved in your development of the plan? Is it some of it, or parts of it, or a joint plan in principle?

DR. KANNEY: In the draft plan as it stands now, you know, for each of the areas of research that we've identified and discussed in the plan we also have -- at this point it's basically we have a list for potential collaborators for each one of those areas. And but we have not had, you know, formal discussions on the plan, but we do talk to these folks, you know, within ICODS, within the Subcommittee on Hydrology, some of the folks -- we actually have research contracts in the past and ongoing. So there's an ongoing discussion, but as

1 far as, you know, everyone getting together and staring
2 at this plan and talking about, no.
3 MEMBER BLEY: Not yet? Yes.
4 DR. KANNEY: Okay. I think I'm done with
5 that one. So the PFHA framework. What we're looking at
6 is, you know, developing a formal framework that should
7 be applicable to multiple flooding mechanisms. And we
8 think this is important because when it gets down to many
9 scenarios, you know, we are fairly certain that
10 combinations of events may play a key role in the risk
11 profile. And so that having, you know, frameworks that
12 are just aimed at one mechanism versus another mechanism
13 probably wouldn't be very suitable for us.
14 We would like to have a framework that at
15 least at a high level you can look out and you can think
16 of all of the mechanisms in a fairly generic way. And
17 I've given an example of what that might look like here
18 where generically we would talk about sources, pathways,
19 receptors, consequences and then a framework for
20 uncertainty and sensitivity analysis. And
21 then, you know, you might obviously specialize if you go
22 down into the different mechanisms, but you hopefully
23 will be able to roll everything up and think broadly in
24 these terms. And, you know, folks who have looked at the
25 seismic hazard, probabilistic seismic hazard analysis,

1 for example, would recognize this. People in other
2 hazard analysis, probabilistic hazard analyses would
3 probably recognize these same key features.
4 MEMBER STETKAR: Joe, this is just in the
5 -- but because these bullets tend to take on lives of
6 their own, that last bullet where you start to talk about
7 uncertainty learned from what the SOARCA folks learned
8 that you ought to address uncertainty. Uncertainty is
9 an integral part of each one of those things. It's not
10 a separate add on last bullet. Because if you don't
11 think that way, you're going to get in trouble
12 eventually. So just like I said, it sounds like a nit,
13 but unfortunately it's always listed as sort of a last
14 add on afterthought and we're learning that that's not
15 the way it ought to be.
16 MEMBER BLEY: It's really hard to do that.
17 (Laughter.)
18 MEMBER STETKAR: It's really hard to start
19 thinking that way, I think is what Dennis is saying.
20 DR. KANNEY: Yes, I guess I put it last
21 because I --
22 MEMBER STETKAR: Because everybody always
23 does.
24 (Laughter.)
25 DR. KANNEY: I put it last because I thought

it would serve an overarching thing. But your point is well taken.

MEMBER STETKAR: Okay. Just when you're laying it out make sure, you know, you try to think about that.

DR. KANNEY: Okay.

MEMBER BLEY: One more quick one.

DR. KANNEY: Yes?

MEMBER BLEY: On an earlier slide you showed that, you know, you got research and that the two reactor groups involved -- isn't NMSS -- isn't this important for them as well? Have they been watching what you're doing?

DR. KANNEY: Yes, we believe so. That's why, you know, I said that --

MEMBER BLEY: That other agency, other --

DR. KANNEY: Well --

MEMBER BLEY: Other offices.

DR. KANNEY: Yes.

MEMBER BLEY: But it just seems like they might even be a prime piece, but I don't know. I don't know how -- I think that is --

MR. NICHOLSON: Joe, is chairman, co-chair of the TAG and they're on the TAG.

MEMBER BLEY: Okay.

1 MR. NICHOLSON: So they're involved.

2 MEMBER BLEY: That helps.

3 MR. NICHOLSON: Not directly with the first

4 draft of the charter, but Joe is in contact. FSME and

5 NMSS.

6 MEMBER BLEY: Okay.

7 DR. KANNEY: All right. One other part,

8 you know, of developing the framework is coming out of

9 the workshop there's a lot of discussion on this. We've

10 had a lot of discussions on this internally as well.

11 And, you know, one of the things we will look at is, you

12 know, looking at application of I guess what I call

13 SSHAC-like processes. And the point here actually here

14 is to try to do what the SSHAC was meant to do, which is

15 to provide -- you know, when an analysis is done coming

16 out of that, you have confidence that all the technically

17 defensible data sets and models and interpretations, you

18 know, have been given their appropriate consideration

19 and their weighting in the analysis.

20 There's been some discussion about, you

21 know, whether it should be expert elicitations or expert

22 assessment. I think, you know, the folks in the

23 probabilistic seismic hazard analysis, their

24 application of SSHAC, you know, focused more on expert

25 assessment as opposed to expert elicitation. I think,

1 you know, we've taken on those concerns.

2 Other ideas, you know, in terms of peer

3 review. We think it's important that, you know, peer

4 reviews be participatory peer reviews. I think this was

5 another development that the SSHAC process highlighted.

6 And also we need to sort of think about the appropriate

7 hierarchy of approaches given. You know, for example,

8 if you're doing a detailed analysis versus a screening

9 analysis, your treatment of the uncertainties would be

10 somewhat different.

11 And so that one might have for -- you know,

12 develop something like the different levels in the SSHAC

13 process depending upon, you know, what the particular

14 goal of the analysis might be and the complexity of that

15 analysis. And then, you know, the level at which -- you

16 know, the way in which you would use expert assessment

17 and participatory peer review might differ depending

18 upon the different levels of analysis that you're engaged

19 in.

20 And in respect to looking at the SSHAC-like

21 process, Tom mentioned that FERC has an initiative to

22 look into this for their purposes and we have been

23 discussing with them for the joint workshop with respect

24 to that.

25 John was developing -- do you have any new

1 information on that, John?

2 PARTICIPANT: Not at this juncture.

3 DR. KANNEY: Okay. So we are in

4 discussions with FERC about that.

5 Okay. And then finally we think that, you

6 know, there is I think a tremendous number of lessons

7 learned in applying the SSHAC sort of framework and the

8 basic analysis framework in other natural hazards

9 assessment examples, you know, when they actually got to

10 do it. So that, you know, part of developing the

11 framework we would have to be looking at some set of

12 example applications and really bang on this to make sure

13 it works.

14 And we've identified sort of three key areas

15 that we would want to look at in terms of -- and we're

16 thinking in terms of different types of sites. One would

17 be a riverine-type site. Make sure that the framework

18 works in that setting. Coastal sites would be sometimes

19 a very different set of hazards. And the combinations

20 of events that you might see there would be different from

21 a riverine site. And then there's this very sort of

22 special case of local intense precipitation. For

23 example, if we have a so-called dry site, you would still

24 have this particular hazard to look at, whereas you might

25 not have any of the other hazards really to consider

1 except maybe you have some sort of
2 high-level-screening-type approach.
3 Okay. Improved modeling techniques. You
4 know this is again very high-level, but essentially in
5 each of the areas, you know, that are important to
6 flooding estimation, you know, the last 10 to 20 years
7 there have been a number of improvements in terms of
8 analytical capabilities, in terms of data sets which are
9 available, computational resources, understanding of
10 some of the key uncertainties. And in each of these
11 areas, you know, the main thing I think we would look at
12 here is making sure that we can incorporate the
13 state-of-the-science or state-of-the-art. And
14 specifically with respect to examining each of these in
15 terms of the key uncertainties and sensitivities.
16 That's I think what really, you know, we need to
17 understand in terms of doing the probabilistic
18 assessment is are we characterizing the uncertainties
19 appropriately and do we understand the sensitivities so
20 that our model is giving us, you know, faithful results?
21 MEMBER SCHULTZ: And, Joe, the conference
22 that was held, did that capture these improvements? If
23 we review that in some level of detail, will we take from
24 that the improvements in the analysis techniques and the
25 understanding of uncertainty that you've described?

1 DR. KANNEY: Yes, you know, one of the key
2 points of the Probabilistic Flood Hazard Workshop was to
3 identify in many different areas, you know, what is the
4 state-of-practice, what is the state-of-science, where
5 are gaps where more research is needed?
6 MEMBER SCHULTZ: Okay. Thank you.
7 DR. KANNEY: I think the results of the
8 workshop will be very valuable in this regard.
9 And then finally we'll go to what I call
10 dynamic and non-stationary processes. You know, we know
11 that we have certain non-stationarity in flood hazard
12 assessment. Obviously the one that gets the most talk
13 these days is climate. What would be the impact of
14 changes in climate upon flooding?
15 There are also non-stationary impacts when
16 you're talking about flooding analysis. For example,
17 you may have changes in the watershed. Land use, land
18 cover changes happen. And these are the sorts of things
19 that we would want to make sure that get incorporated in
20 the flooding analysis.
21 CHAIRMAN RAY: What flooding analysis?
22 I'm sorry. I can't help ask. What flooding analysis
23 are you talking about? For a new site or to evaluate the
24 significance of a deficiency, or what?
25 DR. KANNEY: Both.

1 CHAIRMAN RAY: All right. Those two
2 things? Anything else?
3 DR. KANNEY: (No audible response.)
4 CHAIRMAN RAY: In other words, to be simple
5 about it, is there any analysis foreseen to evaluate the
6 adequacy of the existing design basis? Yes or no?
7 DR. KANNEY: I am not aware of a --
8 CHAIRMAN RAY: I'm not aware of it either.
9 So that's all I wanted to establish. Okay. Go ahead.
10 Finish up.
11 DR. KANNEY: Specifically, you know, with
12 respect to these areas, I think, you know, our focus would
13 be again understanding the state-of-the-state,
14 following recent advances to the point where we can
15 assess identified trends and look and assess their impact
16 on our licensed facilities.
17 Next steps. Obviously what I've presented
18 you is a high-level description. You know, we have a
19 draft plan that we need to finalize. We need to continue
20 identifying the resource requirements. We have, you
21 know, some very rough ideas of that right now in terms
22 of the staffing, contact with contract support, maybe
23 infrastructure that would be needed. We need to
24 continue with consultations with other offices and
25 divisions. We will bring this in front of the Flooding

1 Issues Technical Advisory Group that was mentioned
2 earlier. And then of course, you know, it's a last
3 bullet, but it's not a small thing, you know, is to try
4 to coordinate this with our other federal partners.
5 The time frame that we're thinking about is
6 about a five-year time frame for implementation. You
7 know, obviously subject to available funding and staff.
8 CHAIRMAN RAY: Okay. Any questions for
9 Joe specifically on what he's just discussed other than
10 my ranting?
11 MEMBER CORRADINI: Repeat your ranting so
12 I understand it.
13 CHAIRMAN RAY: This very comprehensive and
14 sophisticated update of our modeling and analysis
15 capability is only applied to two things: New sites and
16 the significance of deficiencies in existing sites,
17 period.
18 MEMBER CORRADINI: Well, but I thought you
19 asked something further.
20 CHAIRMAN RAY: Was there any current
21 commitment to apply it to the adequacy of existing design
22 basis.
23 Okay. I think it's very important now, so
24 I'm going to take off the time constraint. I'm going to
25 lean on my Chairman over here for running over if that's

1 what has to happen because --

2 MEMBER ARMIJO: Yes, we can give you five

3 minutes, because I want to make a comment, too.

4 (Laughter.)

5 CHAIRMAN RAY: We've been looking forward

6 to this, as you can tell by having a complete attendance

7 here, and I want to make sure that the comments are

8 captured.

9 Derek, you have your pencil out, I trust.

10 And we'll start with Bill Shack.

11 CONSULTANT SHACK: Well, PMP and PMF have

12 been useful concepts, I think. You know, there are

13 numbers that you give to engineers to design things with.

14 It's been helpful. You know, I really think it's time

15 to move on. We've talked about the Pearson III. Well,

16 that's been around since 1924. You know, it's been there

17 a long time. To extrapolate out to the frequencies that

18 we're interested I think will require a considerable

19 better understanding of technology.

20 It's unfortunate that it took Fukushima to

21 kind of galvanize us into this effort, but I think, you

22 know, there is a need to bring this external event

23 understanding up to something comparable that we have for

24 seismic. And I think, you know, the workshop shows that

25 other people are thinking this way. I'm still a little

1 skeptical about how many of these approaches which are
2 really designed for frequencies that are not quite
3 adequate for our purposes are going to be extrapolated
4 out to our purposes.
5 So I think you will need the research. You
6 know, I think you will have to go to these stochastic
7 modeling-type things. You know, you're just not going
8 to be able to extrapolate statistical curves after that.
9 You really do need physical models and real
10 physically-based models to do this. And that seems to
11 be there.
12 So and I think we will find uses for this,
13 Harold. You know, coming out of 2.1 we'll have a better
14 understanding of what the impacts might be. And, you
15 know, there is a process for raising generic issues if
16 you think things come up, and you know, we'll go through
17 it. But I think we have to have the tools in order to
18 be able to carry out those analyses, and the workshop and
19 the research plans seem to be a good step forward.
20 CHAIRMAN RAY: And I certainly endorse
21 that, too, although I know I've been challenging in my
22 comments. Certainly need the tools.
23 MEMBER POWERS: The fact that the
24 distribution was discovered in 1924 --
25 CONSULTANT SHACK: No, no, it was applied

1 to flood frequencies.

2 MEMBER POWER: Oh.

3 (Laughter.)

4 CONSULTANT SHACK: No, that didn't make it

5 bad.

6 (Laughter.)

7 MEMBER POWERS: No, that doesn't make it

8 bad.

9 CONSULTANT SHACK: I think it sort of

10 indicates maybe that it's taken us a long time to get

11 around to looking at it, but that's okay, too.

12 MEMBER POWERS: I mean I think the

13 delightful thing is that they're not enslaving

14 themselves to constraining distributions. That's the

15 step. And so when he tells me he brought in experts, I

16 think he did bring in experts who have actually thought

17 about it.

18 MR. FERRANTE: Yes, I mean there's

19 certainly studies looking at different distributions.

20 That's where we need to go.

21 MEMBER POWERS: There are lots of them.

22 MR. FERRANTE: Right. Right.

23 MEMBER POWERS: And lots of them have been

24 applied to floods, but the fact that you're not -- you

25 know, if you put the law of normal distribution, you and

I'd still be talking.

MR. FERRANTE: That's right.

CHAIRMAN RAY: Okay. Pete?

MEMBER RICCARDELLA: Well, you know, I'm certainly no expert on this topic, but I was a little surprised that I didn't hear the word "climate change" until almost the last slide. It seems as if if you're going to be evaluating probabilities based on frequencies of past events, but if the climate change affects that, then obviously the probabilities make a difference.

MR. NICHOLSON: Panel 3 did talk about that, and Jeff Bonham from NOAA commented on that. And we need more information from them to understand the frequency and the uncertainty associated with those climate change scenarios.

CHAIRMAN RAY: I don't want to reestablish back and forth here. Just because of time I want to capture the comments of the members. And you guys can certainly be a part of that, but I can't restart discussions again.

Okay. Dick?

MEMBER SKILLMAN: Three brief items: Number one, it seems to me that there's enough data here to suggest that at least one output should be a revision

1 to GDC2, as painful as that might be. Present Part 52
2 and Part 50, new plant build to Part 50 are going to draw
3 on Appendix A in CFR 50 and are going to draw on 52, and
4 those who design read those design requirements very
5 carefully. So that is one observation I'd make.
6 The second is I think in the comment
7 combining of events is the real trigger here to make sure
8 that events are combined properly, particularly under a
9 probabilistic assessment. You didn't speak much about
10 seismic dam failure. And maybe the probabilities are so
11 low that disappears, but that certainly seems to me to
12 be something that ought to be at the top of the hit parade.
13 And the third item I'm stealing from John
14 Stetkar, but I believe he's right on the money. Whatever
15 is codified ought to be put in one document. And I
16 suggest it should be Reg Guide 1.59 so it's in one place
17 and so there isn't this fractioning of requirements.
18 Thank you.
19 MEMBER SCHULTZ: Dick and I are on the same
20 page with those last two comments, so I'll pass.
21 CHAIRMAN RAY: Dennis?
22 MEMBER BLEY: Well, it's kind of like
23 drinking from a fire hose today. I appreciate all of
24 this. Each topic could have been a whole meeting.
25 CHAIRMAN RAY: Well, that's why I had to

keep pressing. I apologize to everybody.

MEMBER BLEY: Right. I'm really pleased to see we're moving away from just trying to look at this statistically with some things we didn't completely understand to trying to get to causes in the physical world. And I applaud what you've done and where you're headed.

CHAIRMAN RAY: Dana?

MEMBER POWERS: Yes, there's a tremendous amount of work that you've done here with not very much as far as resources, and admirable. And I can see that we're getting a tremendous change in mind set over what we had during the period of time when I was doing the early site permits. And I just applaud that.

I would like to see the details of the tsunami analysis that can explain simultaneously long-range Pacific transmission of seismic waves and the interference. That is very, very critical to us and you need to get that out, peer reviewed, flagged, because we're going to use that to draw circles around how far we have to consider this for sites. And I would like to see that in detail. And then I would encourage you to publish that further.

I'm really delighted with the kinds of things you're thinking about on extrapolation. I

1 understand it's just preliminary thinking. And I'm
2 delighted that, Joe, seeing your mapping out, the way
3 you're going on the research program. That's going to
4 change our technology.
5 And let me point out that you face a real,
6 real management challenge here, because you're going to
7 have people that want to change specific things in the
8 regulation right in the middle of your research and
9 that's going to get in the way of a systematic development
10 of a new technology. And you're going to have to kind
11 of stiff-arm some of the immediate applications of
12 nascent developments in order to give them a chance to
13 develop that technology in a robust fashion.
14 So there are some real challenges to
15 managing the research program that you're undertaking
16 here because you're trying to take something that's
17 developed for one purpose, repackage and reconfigure it
18 so that you can use it for an entirely different purpose.
19 That's going to be a big management challenge for you.
20 Other than that, wonderful presentations,
21 guys.
22 CHAIRMAN RAY: Thank you, Dana. Sam?
23 MEMBER ARMIJO: Yes, I share my colleagues'
24 views. I think the staff has done an excellent job in
25 both the presentation -- and the plan is a comprehensive

1 plan addressing the issues that we're facing.

2 The only concern I have is prioritization

3 of work, and that is that we not lose focus on events that

4 have the characteristics of Fukushima. And by that I

5 mean an event, a flooding event in which you have little

6 or no warning. Covers a huge area. Large magnitude.

7 Probably of long duration, or possibly of long duration.

8 And may be combined with some other triggering event like

9 a seismic. Those are the things that really can catch

10 us flat-footed.

11 And, you know, I do not share much concern

12 at all about the rate of change of the climate. That's

13 a very, very slow process compared to one of these huge

14 surprises. So, you know, the more focus that can be put

15 on that so that we aren't caught flat-footed with

16 something that we can't handle or haven't tried to

17 anticipate better and modify the plants if necessary,

18 whatever we can do. But that's really an issue of

19 prioritization and focus of the work as opposed to the

20 very orderly and systematic technically very sound

21 approach to the entire range of floods. I'm worried

22 about the big monster that just catches us flat-footed.

23 But other than that, I really appreciate the

24 presentations.

25 CHAIRMAN RAY: John?

1 MEMBER STETKAR: I don't have anything to
2 add, but thanks for packing a lot of information into
3 three-and-a-half hours.
4 CHAIRMAN RAY: Thirty-five minutes at this
5 point.
6 (Laughter.)
7 MEMBER STETKAR: And 18 seconds.
8 CHAIRMAN RAY: Mike?
9 MEMBER RYAN: I too would add to the quality
10 of the briefings and the quality of the information and
11 your plan for moving forward. So with that, I'll stop.
12 Thank you.
13 CHAIRMAN RAY: Ron?
14 MEMBER BALLINGER: Same here with the
15 quality of the presentations. This is the first time
16 I've heard any of this, and so it's really great. But
17 I'm curious as to somewhere in between infinity, which
18 would be climate change, and black swan, which would be
19 combined everything, everything all of a sudden, can the
20 results of this analysis end up with a tool that a plant
21 could use to estimate its own hazard in real time? I
22 don't know what the plants do.
23 So for example, at Fort Calhoun, were they
24 surprised by the flood? Okay. Well, they shouldn't
25 have been surprised by the flood. If there's a decent

1 overarching model that says, you know, if you got this
2 kind of watershed problem here and there -- is there some
3 kind of fire hazard index kind of thing that you can come
4 up with for plants that are in places where you're likely
5 to get a flood more than infrequently? You know, like
6 Phoenix, some place like that. Salt River, you never
7 know what's going to happen, right? So that's the kind
8 of -- I'm curious as to whether a tool like that could
9 be sort of an outcome of this.
10 CHAIRMAN RAY: I'm not going to answer that
11 because that will take us way too long, but it's a
12 question that we'll capture.
13 Charlie?
14 MEMBER BROWN: In fewer words I echo the
15 previous statements.
16 CHAIRMAN RAY: Okay. Joy?
17 MEMBER REMPE: I also appreciate the
18 update. I hope we have periodic updates as we go
19 forward, too, on this topic.
20 CHAIRMAN RAY: Mike?
21 MEMBER CORRADINI: I'm at the end of the
22 line so I don't have anything to really add of value, but
23 I want to go back to one thing that Ron said and say it
24 a bit differently. So eventually I'd like to know what
25 the owner/operators do to decide if they should worry or

1 not worry.

2 CHAIRMAN RAY: And when they should worry.

3 MEMBER CORRADINI: And when they should

4 worry. I think that's the essence of what I took away

5 from Ron's point, which I think is something that I can't

6 capture. This looks complicated enough that I can't

7 imagine them doing this, so what do they do to decide?

8 So that's my end game. And I'm sure Harold wrote it down.

9 CHAIRMAN RAY: I have. And not only that,

10 I'll just say obviously the answer to that is not

11 something that we want to include in this record, so it's

12 going to be a matter of people's opinion more than it is

13 anything else.

14 MEMBER CORRADINI: I'm sure it will.

15 CHAIRMAN RAY: Okay. Anything else?

16 Yes, Tom?

17 MR. NICHOLSON: You may be interested, on

18 November the 12th from 7:30 to 9:00 at the ANS meeting

19 being held at the Shoreham Hotel we'll have both a panel

20 of people like here, as well as industry, and they'll be

21 discussing this topic.

22 CHAIRMAN RAY: 7:30 to 9:00 did you say?

23 MR. NICHOLSON: Yes.

24 CHAIRMAN RAY: What the hell? Is that in

25 the morning or in the evening?

1 MR. NICHOLSON: In the evening.

2 (Laughter.)

3 CHAIRMAN RAY: What date?

4 MR. NICHOLSON: November the 12th. That's

5 a Tuesday.

6 MEMBER BLEY: When is Veteran's Day?

7 MR. NICHOLSON: Eleventh.

8 CHAIRMAN RAY: All right. Thank you for

9 that, Tom. Chris?

10 DR. COOK: Really quickly, the one thing I

11 just wanted to say was I wanted to say thank you, and I

12 mean this sincerely. Dr. Stetkar, or Ray, one of you

13 when we were coming before you for the lock-downs

14 mentioned NUREG-1852 that was there that was looking at

15 -- for fire and how to use performance shaping. We

16 incorporated that into our walkdowns. That has bore a

17 tremendous amount of fruit. So I just wanted to say

18 those nuggets you guys give us -- I just want to pass

19 along, thank you, because they actually are useful.

20 CHAIRMAN RAY: Okay. With that we will

21 adjourn. Those of us who have a 12:00 meeting will be

22 late. They're next door. And Full Committee begins at

23 1:00.

24 (Whereupon, the meeting was adjourned at

25 12:07 p.m.)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Progress on Flood Assessment

William R. Ott, Chief

Environmental Transport Branch

Office of Nuclear Regulatory Research

STATUS

- **Progress on Guidance**
- **Probabilistic Flood Hazard Assessment Workshop 1/29-31/13 – Tom Nicholson**
- **JLD Interim Guidance Development – Chris Cook**
- **Insights from Significance Determination Process Experience – Fernando Ferante**
- **Development of Research Plan for Probabilistic Flood Hazard Assessment – Joe Kanney**

Regulatory Guidance

- **Regulatory Guide 1.59 "Design Basis Floods for Nuclear Power Plants"**
  - **Issue: Substantial improvement in technology (storm data, computational resources, models)**
  - **Research support on**
    - **Design basis flood estimation**
    - **Storm surge in southeastern US (Fla and the Gulf Coast) – built on US Army Corps of Engineers experiences following Katrina**
    - **Estimation of probable maximum precipitation (PMP) (Phase I)**

Regulatory Guidance (cont'd)

- **Regulatory Guide 1.102 "Flood Protection for Nuclear Power Plants"**
  - **Issue: Blayais, Katrina, Fukushima and Fort Calhoun lessons learned**
  - **Research support for flood protection**
    - **Engaged US Army Corps of Engineers**
    - **Primary protection (new reactors)**
    - **Secondary protection ("Incorporated" and temporary barriers)**
    - **Reliability data for secondary protection sparse**

Research to Improve Analyses

- **Pursuing a more risk-informed framework**
  - **Use of paleoflood information to assess flooding risks at nuclear power plants**
  - **Probabilistic evaluation of riverine flooding**
  - **Extension of PMP studies (Phase II) to include transposition and orographic features**
  - **Evaluation of dam-breach scenarios**

Other Activities

- **Technical Advisory Group re-focused**
- **Probabilistic Flood Hazard Assessment Research Program Plan under development**
- **Continuing to pursue interaction with potential partners in domestic and international research and regulatory communities.**

PFHA Workshop: Discussion, Observations and Recommendations

Thomas J. Nicholson
NRC/RES/DRA
(301-251-7498, Thomas.Nicholson@nrc.gov)

ACRS/ Regulatory Policies and Practices Subcommittee Meeting
October 2, 2013

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Overview

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Motivation for Convening PFHA Workshop
- Cooperation of Federal Agencies
- Workshop Organization
- Presentations and Discussions
- Observations
- Recommendations

Motivation for Workshop

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Address User Need from NRO and NRR dated June 27, 2012 requesting RES to plan, conduct, and follow-up on a Workshop on Probabilistic Flood Hazard Assessment (PFHA)
- Identify what probabilistic approaches are being used, or are in development by other Federal Agencies relevant to flood hazard assessments
- Recommend to NRO and NRR what opportunities exist for PFHA cooperation and research with other Federal Agencies

Workshop Organization

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

PFHA Workshop Objectives

- Identify and solicit presentations on the state-of-the-science in extreme flood assessments within a risk context
- Facilitate the sharing of information to bridge the current state-of-knowledge between extreme flood assessments and risk assessments
- Seek ideas and insights on possible ways to develop a PFHA for use in probabilistic risk assessments

Workshop Organization

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

PFHA Workshop Objectives (continued)

- Identify potential components of flood-causing mechanisms that lend themselves to probabilistic analysis and warrant further study (i.e., computer-generated storm events)
- Establish realistic plans for coordination of PFHA research studies as the follow-up to the workshop observations and insights, and
- Develop plans for a cooperative research strategy on PFHA for the NRC and the workshop partners

Workshop Organization

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Identified PFHA Workshop Panel Topics

- Federal Agencies' Interests and Needs in PFHA
- State-of-the-Practice in Identifying and Quantifying Extreme Flood Hazards
- Extreme Precipitation Events
- Flood-Induced Dam and Levee Failures
- Tsunami Flooding
- Riverine Flooding
- Extreme Storm Surge for Coastal Areas
- Combined Events Flooding

Presentations and Discussions

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- **Speakers with expertise in the Panel Topics were invited from Federal Agencies, academia, research institutes and industry**
- **Extended abstract with references and website links requested**
- **Information published in Workshop Program prior to workshop**
- **Presentation slides and video of presentations and panel discussions posted on NRC Public Website Archives:**

http://www.nrc.gov/public-involve/public-meetings/meeting-archives/research-wkshps.html

- **Presenters provided opportunity to submit papers for Proceedings**
- **Summaries of each Panel including overview of presentations, summary of discussions and observations and insights developed for the Proceedings**

Observations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Commissioner Apostolakis provided keynote address outlining importance of risk-informed, performance-based regulations and highlighting the important interplay between probabilistic assessments and traditional deterministic methods.

Panel 1 Federal Agencies' Needs

- ✓ **Risk-informed approaches are being used and incorporated in safety assessments and decision-making by several Federal agencies and international groups.**
- ✓ **PFHA methods' Annual Exceedance Probability (AEP) 10^{-3} and 10^{-4}**
- ✓ **It is not a question of deterministic versus risk assessment because they are complementary processes.**

Observations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Panel 1 Federal Agencies' Needs (continued)

- ✓ **PFHA requires probabilities of initiating events and facilitates uncertainty analyses for extreme events.**
- ✓ **Senior Seismic Hazard Analysis Committee (SSHAC) approach is viable; it can be used to develop an Expert Elicitation approach for flood hazards which would help address:**
  - **paucity of data for characterizing extreme events,**
  - **formulation of scenarios in hydrometeorologic model simulations**
  - **systematic assessment of uncertainties (epistemic and aleatory).**
- ✓ **Need for multidisciplinary teams of hydrometeorologists, risk analysts, hydrologists and geomorphologists to develop and implement PFHA.**

Observations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Panel 2 State-of-the-Practice in Identifying and Quantifying Extreme Flood Hazards

- ✓ Important to consider the full range of floods out to extreme events AEP of 10^{-4} or less, including "black swan" events.
- ✓ Aleatory uncertainties (randomness) limit our forecast ability.
- ✓ For rare events, epistemic uncertainties are more important.
- ✓ Bayesian modeling may be needed for more rare events to help quantify, and in some cases reduce, uncertainties.
- ✓ Need to determine the rarity and complexity of natural events, including various combined-event scenarios.
- ✓ Where available, paleoflood information has proven useful.
- ✓ Current approaches to quantify extreme flood hazards have worked well.

Observations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Panel 3 Extreme Precipitation Events

- ✓ **Although Probable Maximum Precipitation is simply one point on a curve, such design-basis events can provide useful information for assessing the potential for flooding.**
- ✓ **Opportunities exist to collect additional point data to fully characterize the time series of the precipitation distribution.**
- ✓ **NOAA Atlas 14 provides estimates of point precipitation estimates out to 10^{-3} for the AEP for most of the U.S. NOAA's Precipitation Frequency Data Server provides detailed precipitation frequency estimates with confidence intervals.**
- ✓ **Use of radar data provides better spatial and temporal correlations of rainfall where rain gauges are not present.**
- ✓ **Orographic uplift and spatial resolution for radar imaging are major challenges.**

Observations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Panel 3 Extreme Precipitation Events (continued)

- ✓ **Need to develop and document a U.S. Extreme Storm Catalogue.**
- ✓ **Significant progress in physical and numerical modeling of storm events, namely better resolution combined with more modern datasets, higher-density rain gauges, satellite data and aircraft observations have contributed to improved modeling.**
- ✓ **Climate community statements on trends in rainfall intensity do not address frequencies and durations required for civil infrastructures.**
- ✓ **Need better guidance on potential impact of climate change on intensity-duration-frequency (IDF) curves in range relevant to civil infrastructures.**
- ✓ **Technical barriers involve technical complexities of watershed size and heterogeneity, different storm mechanisms and combining storm rainfall with snowmelt.**

Observations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Panel 4 Flood-Induced Dam and Levee Failures

- ✓ PFHA for flooding due to dam and levee failure needs a structured evaluation process like SSHAC to fully assess uncertainties.
- ✓ PRA analysis should evaluate the comprehensive uncertainties in both data and modeling.
- ✓ Reliable data on dams, dam components, and operations are generally not available to meet specific needs of risk assessments for individual dams or event components of dam systems.
- ✓ History shows that large dams seldom fail by flooding alone, rather by a combination of factors as a system.
- ✓ Estimation of dam and levee failures (fragility) is difficult, often subject to bias and limited engineering tools.
- ✓ Dams are generally safe but failures do occur, often the result of "uncommon combination of not uncommon events."

Observations

Panel 4 Flood-Induced Dam and Levee Failures (continued)

- ✓ Lack of information on near-failure incidents which are needed to support risk analysis.
- ✓ Major advances in collecting data and archiving dam failures and reliability of dam components and operations thru government, university and industry sources.
- ✓ Tools have recently become available, and continue to be developed that will enable probability and uncertainty in the event trees describing the sequence of events that lead to dam and levee failure (e.g., process-based erosion and breach models).
- ✓ State of PRA in dam and levee safety is relatively new compared to nuclear reactor safety.
- ✓ Need to consider improved guidance on dam and levee PRAs for tolerable risk limits.

Observations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Panel 5 Tsunami Flooding

- ✓ Probabilistic Tsunamis Hazard Analysis derived from SSHAC.
- ✓ Lack of data in the U.S. stems from infrequency of tsunami compared to storm surge flooding.
- ✓ Most likely cause of tsunamis in U.S. due to submarine landslides.
- ✓ Many numerical tsunami models have been developed dealing with wave generation and migration.
- ✓ Landslide tsunami models are not as developed.
- ✓ Wave effects on structures are not well researched.
- ✓ Questions remain as to the effect of tsunamis waves versus storm surges on structures due to frequency, velocity, or other physical attributes.
- ✓ NRC staff has determined that tsunamis caused by distant landslide sources (e.g., Azores, Iceland, etc.) would not be significant on the U.S. East Coast.

Observations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Panel 6 Riverine Flooding

- ✓ **Watershed simulation models used to route runoff from extreme precipitation events are routinely being used.**
- ✓ **Technical complexities exist in incorporating antecedent storm conditions such as snowpack releases.**
- ✓ **Stochastic event flood models may be limited by watershed size due to the inability to transpose storm data and account for the areal reduction factor (ARF) (not a continuous event model).**
- ✓ **A continuous event model would be better at evaluating antecedent moisture and initial conditions in reservoirs.**
- ✓ **Sequences of floods should be considered with better communication between modelers and reservoir owners when performing watershed modeling with many reservoirs.**

Observations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Panel 6 Riverine Flooding (continued)

- ✓ The joint probability method used for estimating storm surge may be a better approach for evaluating uncertainty since it enables obtaining probability distributions for all input parameters.
- ✓ It is time to move away from the Unit Hydrograph Method in favor of watershed models which use the kinematic wave approach.
- ✓ The relation between regulated and unregulated flows can be extrapolated by routing design floods that are extrapolations of historic flows.
- ✓ This approach enables the estimation of exceedance probabilities of extreme floods beyond those observed in the historic record.

Observations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Panel 7 Extreme Storm Surge for Coastal Areas

- ✓ **Significant progress has been made in the past 10 years regarding probability analysis in storm surges (e.g. hurricanes, extratropical cyclones and intense winter storms).**
- ✓ **Following coastal storms and flooding in 1953, the Dutch developed a very systematic approach to storm surge research particularly in monitoring, modeling and protection. Their tools and data are both deterministic and probabilistic.**
- ✓ **Coastal evolution is dynamic and, when combined with sea level rise, requires design and development of coastal facilities which can be constantly adapted.**
- ✓ **Paleo-analysis should be pursued even though coastal environments are constantly changing.**
- ✓ **Database, shared codes and modeling capabilities could be created to facilitate the sharing of information between agencies.**

Observations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Panel 8 Combined Flooding Events

- ✓ Site-specific flood hazards can derive from combinations of flood-causing mechanisms, therefore no single prescriptive set of scenarios is adequate as the design basis flood.
- ✓ Although previous standards on combined events were deterministic, development of probabilistic flood scenario combinations would benefit from insights of earlier standards developers.
- ✓ It is often the combination of common events, rather than the one extreme rare event, that is the driver for risk.
- ✓ Uncertainties should not be ignored or double-counted, even if they cannot be specifically quantified in the analysis.
- ✓ Focus resources on significant processes and events that matter.

Recommendations

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- ✓ **Develop a systematic process of expert elicitation for flood hazard assessment (EEFHA).**
  - **EEFHA would address information gaps in flood event scenarios. It would assist in estimating probabilistic flood hazard magnitudes, durations, and frequencies.**
  - **EEFHA process should include uncertainty assessments of the flood scenarios, past histories of floods including paleofloods and regional storm events, and related storm-event parameters.**

Recommendations (continued)

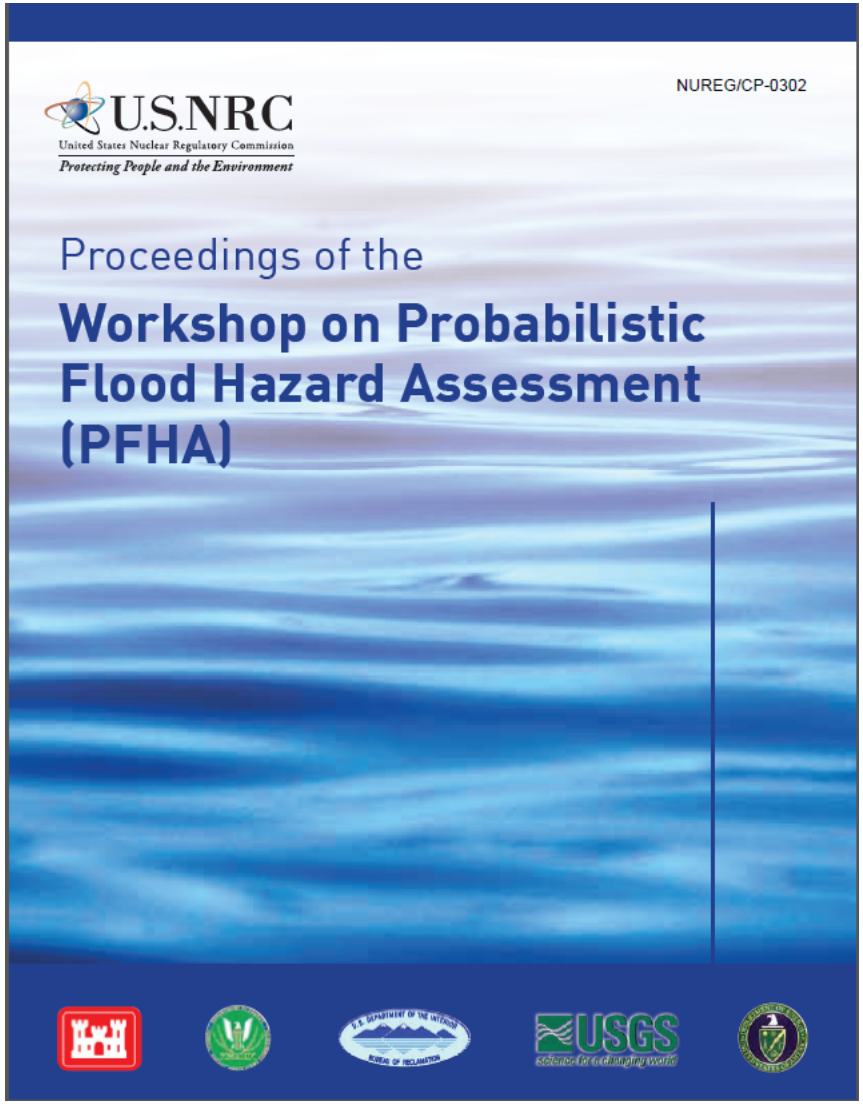
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- ✓ **Support ongoing development of the USACE's Storm Catalogue for analyzing floods in the U.S.**
  - **The catalogue relates extreme storms to flood events, and includes both point measurements and radar data for spatial and temporal distribution of the precipitation.**
  - **This information will support both the expert elicitation process, and site-specific stochastic modeling of extreme floods (e.g., Stochastic Event Flood Model).**

Recommendations (continued)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- ✓ Develop a structured evaluation process for dam and levee failures to examine comprehensive uncertainties in data and modeling of potential failure mode scenarios.
- ✓ Further develop and apply the USACE's joint probability method for storm and hurricane surge analyses along the Gulf and Atlantic coasts with possible application to the Great Lakes.
- ✓ Integrate risk analysis into the state-of-the-practice of watershed and coastal-storm surge modeling as presented by the Bureau of Reclamation and USACE.
- ✓ Support ongoing interagency committee activities such as the Subcommittee on Hydrology's working groups on hydrologic frequency analysis and extreme storm events.



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Questions???

United States Nuclear Regulatory Commission

Protecting People and the Environment

Motivation for JLD Guidance Development

Christopher Cook, Ph.D.
Office of New Reactors
Chief, Hydrology and Meteorology Branch
October 2, 2013

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Overview

- The Japan Lessons Learned Directorate (JLD) issued several interim staff guidance (ISG) documents.
- This presentation covers ISGs associated with Recommendation 2.1 (Enclosure 2) of the March 12, 2012, 50.54(f) letter sent to all power reactor licensees and construction permit holders.
- All ISGs were released in draft form via a FRN for a 30-d comment period and were discussed at public meetings.
- Recommendation 2.1 in a nut-shell:
  - Phase 1, Stage 1: Licensees perform hazard reevaluation using present-day methodologies and regulatory guidance.
  - P1, Stage 2: If reevaluated results are greater than the design basis, the licensee should perform an Integrated Assessment.
  - Phase 2: Based on the submitted information, the NRC will determine if a regulatory decision (safety enhancement, backfit, modify plant license, etc.) is necessary.

Dam Failure ISG
[JLD-ISG-2013-1]

Purpose

- Assess flooding hazards due to dam failure(s)

Motivation

- Flooding from off-site dam failures were not a controlling site characteristic of completed new reactor reviews.

Additional Items

- Based on published federal guidance, while consistent with NRC regulations and guidance.
- Reviewed and edited by specially-created ICODS working group.

TSS ISG
[JLD-ISG-2012-06]

Purpose

- Assess flooding hazards at a site due to tsunami, storm surge, and seiche (TSS).

Motivation

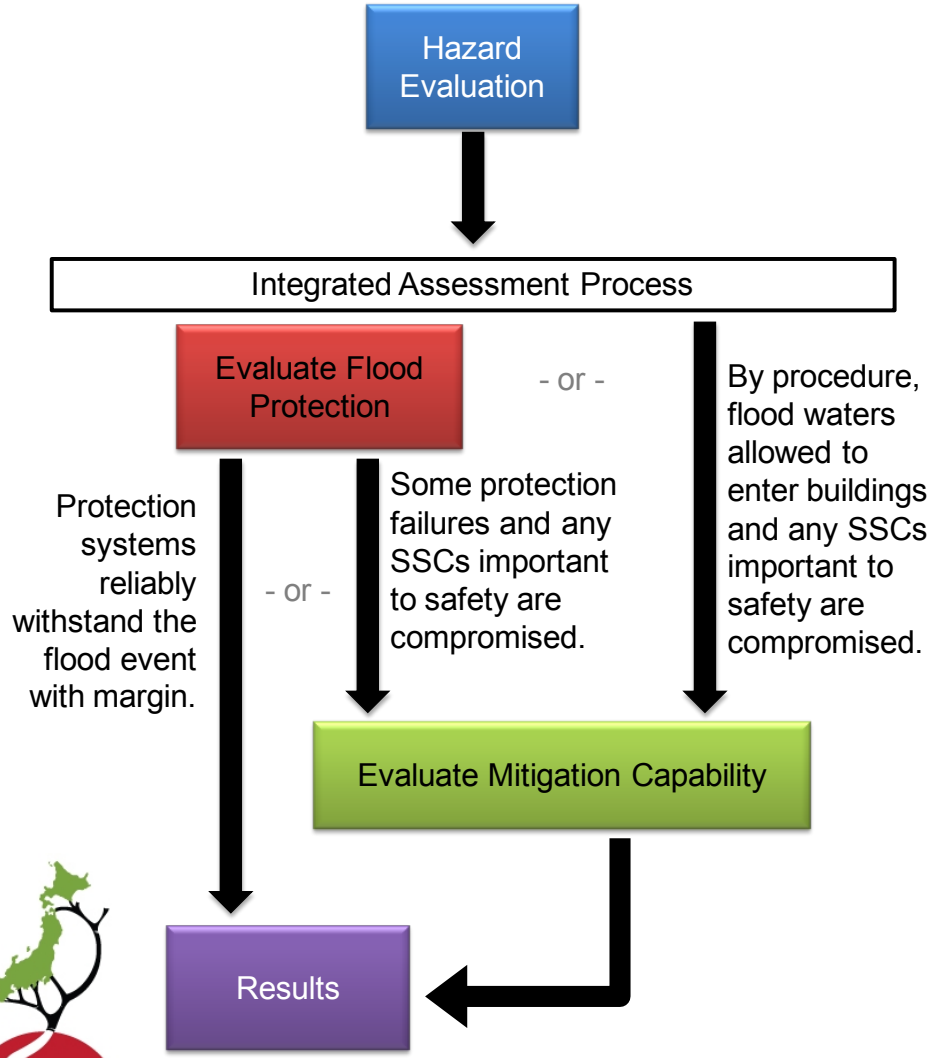
- Based on lessons-learned from new reactor reviews and RES funded programs.

Additional Items

- Discusses application of probabilistic and probabilistic-deterministic methods.
- Discusses estimation of sea level rise.

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Integrated Assessment [JLD-ISG-2012-05]



Purpose:

Evaluate the total plant response (protection and mitigation) to the reevaluated flooding hazard.

Motivation:

Risk-inform regulatory decisions (Phase 2) for operating plants with increased flooding hazards.

U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Insights from the Significance Determination Process (SDP) Experience on External Flooding Risk

Fernando Ferrante, USNRC
Office of Nuclear Reactor Regulation (NRR)
Division of Risk Assessment (DRA)
PRA Operational Branch (APOB)

ACRS Subcommittee Meeting on Probabilistic Flood Hazard Assessment (PFHA), October 2nd, 2013

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Presentation Outline

- Provide a very brief overview of the Significance Determination Process (SDP) within the Reactor Oversight Process (ROP) and its relevance to external flooding issues
- Discuss an overview of relevant SDP analyses related to external flooding issues
- Discuss available (and unavailable) risk information and insights gained from currently available sources
- Share overall insights and challenges gained from the SDP experience with respect to potential PFHA activities

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Reactor Oversight and SDP

- ROP is the USNRC's process used to inspect, measure, and assess the safety performance of operating nuclear power plants in the US
- SDP supports the determination of the safety significance of inspection findings
- SDP includes risk-informed screening and, if needed, detailed risk assessments
- Outcome of SDP reviews is the determination of additional NRC inspection actions

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Significance Determination Process and Risk Criteria

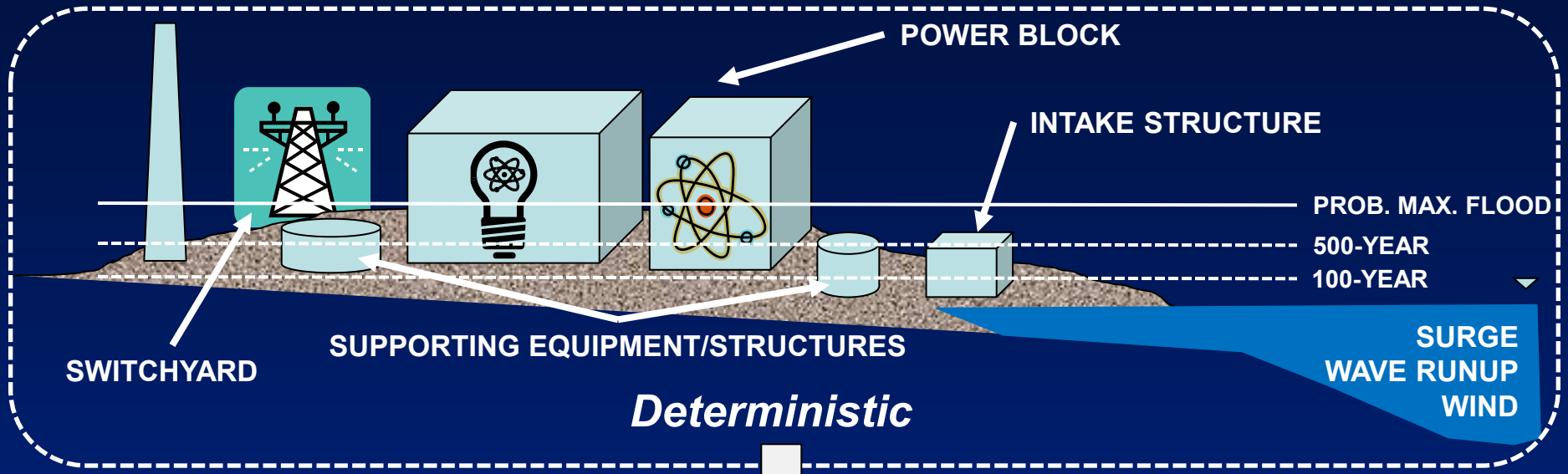
Significance Determination Process (IMC0609): Estimated CDF (per year)			
CDF < 1E-6	1E-6 ↔ 1E-5	1E-5 ↔ 1E-4	CDF > 1E-4
GREEN			
VERY LOW	WHITE		
	LOW TO MODERATE	YELLOW	
		SUBSTANTIAL	RED
			HIGH

Significance Determination Process (IMC0609): Estimated LERF (per year)			
LERF < 1E-7	1E-7 ↔ 1E-6	1E-6 ↔ 1E-5	LERF > 1E-5
GREEN			
VERY LOW	WHITE		
	LOW TO MODERATE	YELLOW	
		SUBSTANTIAL	RED
			HIGH

- SDP allows for both quantitative and qualitative assessments to be performed against risk criteria
- Both internal and external event risk contributions need to be considered for SDP analysis

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Available Flood Information

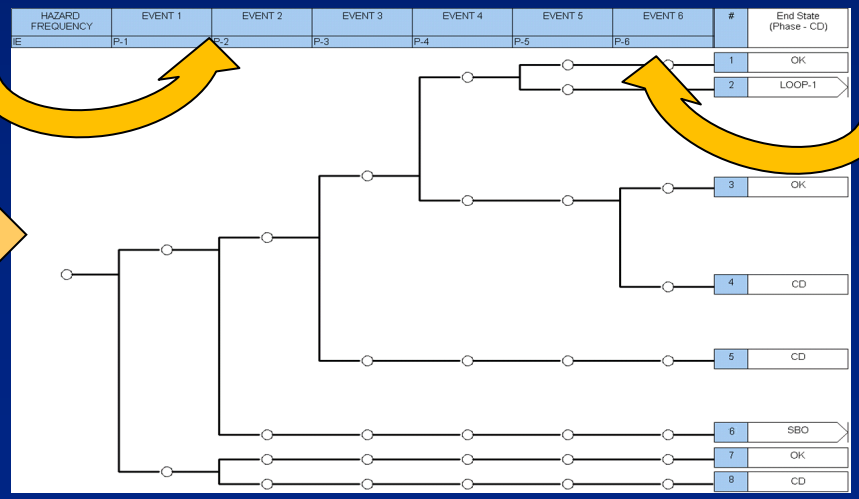


Deterministic

Risk-Informed

SYSTEM/FUNCTIONS AFFECTED

INITIATING EVENT FREQUENCY (?)



COMPONENTS AFFECTED

OTHER EFFECTS

- OFFSITE POWER
- SERVICE WATER
- ACCESSIBILITY

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

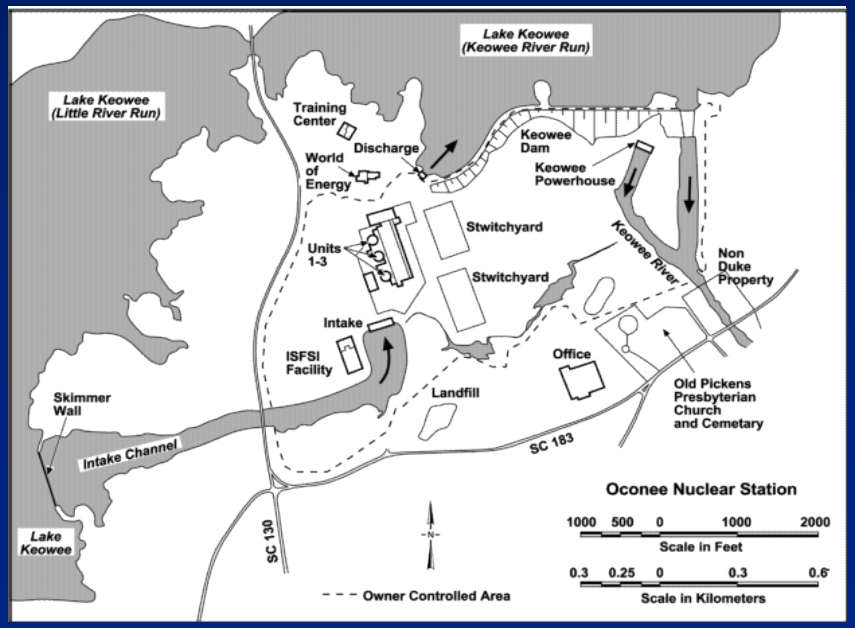
External Flood-related SDPs

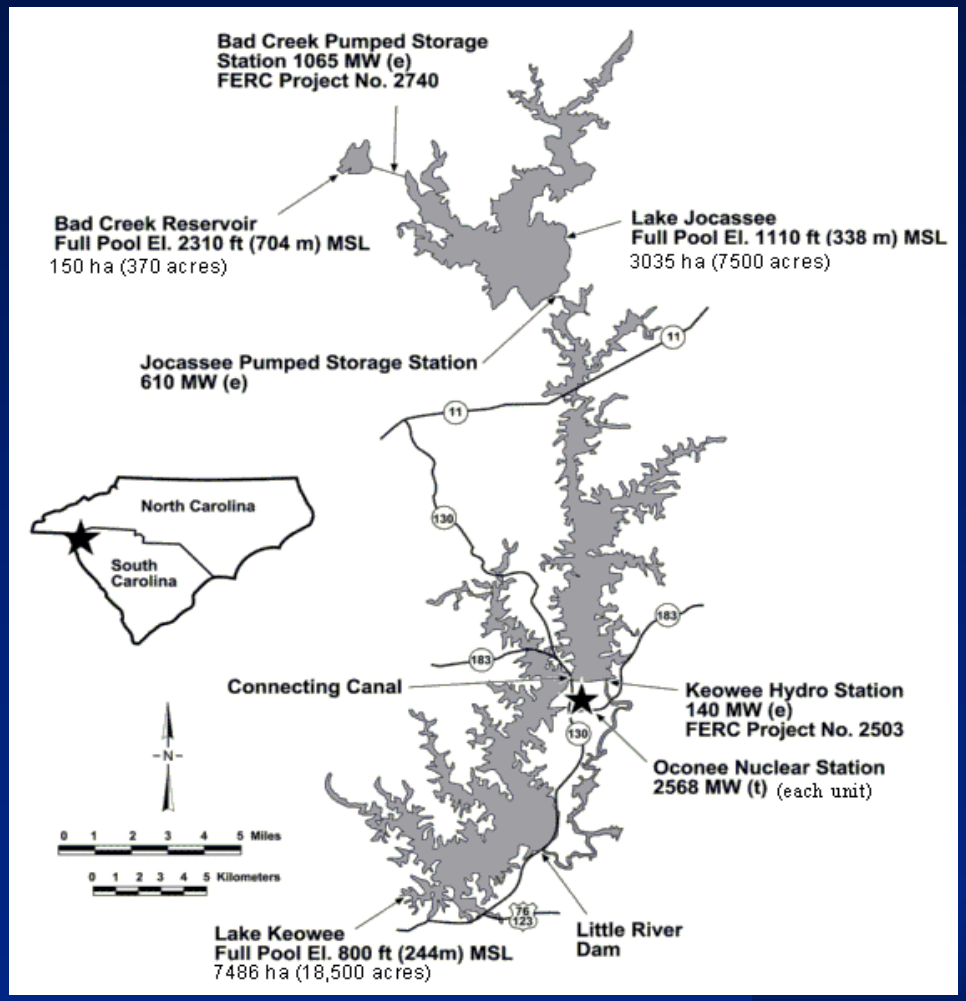
- **PAST SDP EXPERIENCE (PRE-FUKUSHIMA)**
  - Oconee Standby Shutdown Facility (SSF) openings **(WHITE)**
  - Fort Calhoun flood protection **(YELLOW)**
  - Brunswick EDG fuel oil tank room openings **(WHITE)**
  - Robinson localized flooding, ponding **(GREEN)**
- **RECENTLY COMPLETED (FUKUSHIMA FLOODING WALKDOWN)**
  - Sequoyah, Watts Bar findings **(GREEN, WHITE, YELLOW)**
  - TMI missing flooding seals **(WHITE)**
  - Dresden inadequate flood procedure **(WHITE)**
  - Monticello flood protection plan **(YELLOW)**
  - Point Beach sandbagging protection **(WHITE)**
  - VC Summer localized flooding, ponding **(GREEN)**
- **CURRENTLY ON-GOING SDPs**
  - Millstone unsealed conduit banks

Past SDP Experience (1)

Oconee SSF Openings (2006) (WHITE)

- CO2 access cover removal in the south wall of the SSF
- Loss of all mitigation systems in a flood scenario
- Licensee appealed finding





Source: NUREG-1437, Supplement 2, Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Oconee Nuclear Station, Units 1, 2 & 3 - Final Report

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Information Notice 2010-02

POTENTIALLY NONCONSERVATIVE SCREENING VALUE FOR DAM FAILURE FREQUENCY IN PROBABILISTIC RISK ASSESSMENTS

- Alert addressees of a potentially nonconservative screening value for dam failure frequency
- Based on analysis performed in Nuclear Safety Analysis Center (NSAC) report NSAC-60, "A Probabilistic Risk Assessment of Oconee Unit 3," issued June 1984.
  - Estimated values between 1.4×10^{-5}/year and 2.3×10^{-5}/year
- Analysis was based on historical dam failure information which was strongly dependent on data availability and criteria applied
- Estimate was referenced in NUREG/CR-5042 and referenced by other licensees in Generic Letter 88-20 submittals
- NRC staff reviewed currently available databases and obtained values closer to results in available literature

Example SDP Experience (2)

Ft. Calhoun Flood Plan (2010) (YELLOW)

- Failure to maintain adequate procedures to protect Intake Structure Building and Auxiliary building
- Sandbagging flooding protection above flood level and portable pumps to feed steam generators critical

Source: OPPD Public Presentation (April 4, 2012)

Source: DEMIS Mapserver and USGS data

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Missouri River Flood 2011

Source: OPPD Public Presentation (April 4, 2012)

Recently Completed SDPs (2)

Sequoyah Multiple Flood-related Findings (2013)

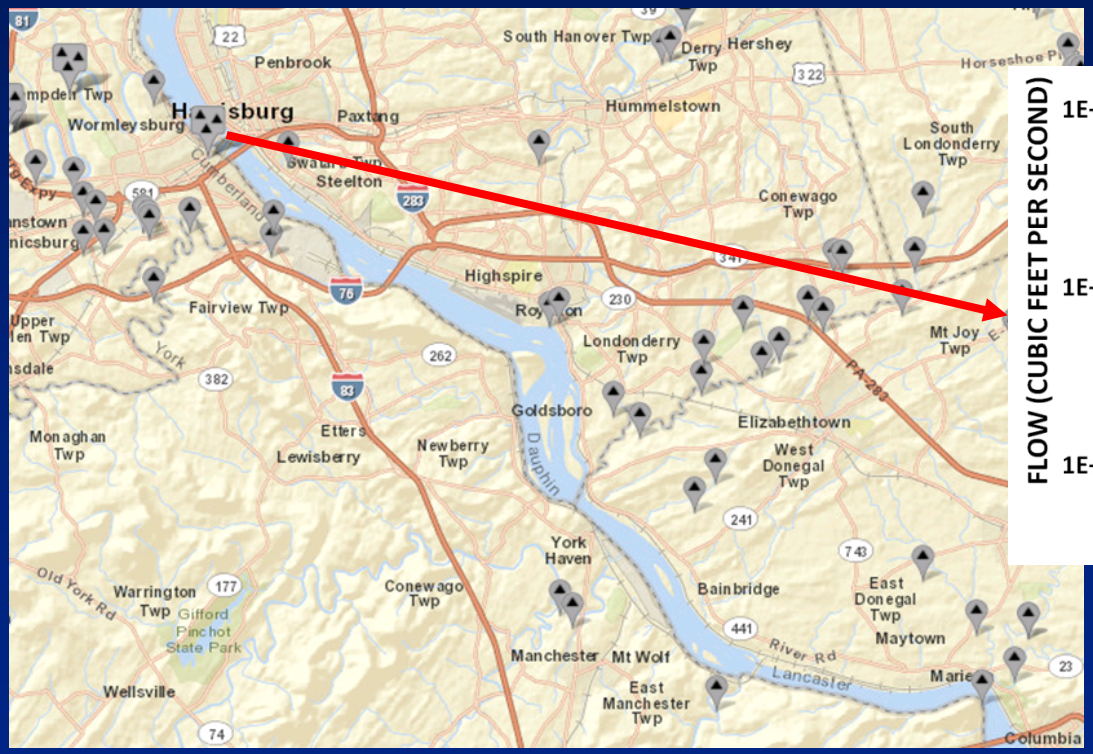
- Potential for upstream dam overtopping prior to 2009 **(WHITE)**
- Missing seals in electric conduits violated dry design of Essential Raw Cooling Water (ERCW) building **(WHITE)**
  - Flooding ERCW building would cause loss of ERCW strainers and traveling water screens, loss of safety function and EDGs

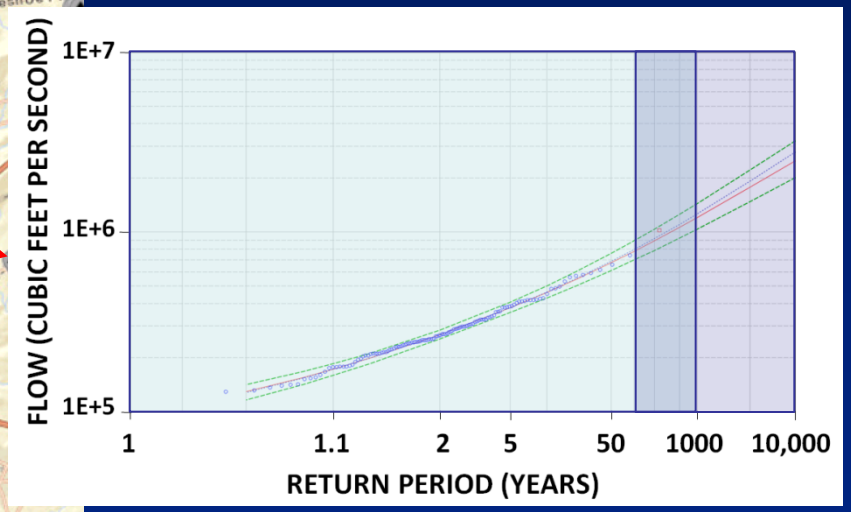
Source: Applicant's Environmental Report Operating License Renewal Stage

Recently Completed SDPs (3)

TMI Missing Flooding Seals (2013) (WHITE)

- Multiple deficient conduit couplings that also perform as flood seals at the Air Intake Tunnel (AIT)
  - Could impact Decay Heat Removal and RCP seal integrity, longer lasting floods would threaten Emergency Feedwater





Source: USGS – National Water Information System (NWIS) Mapper

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

SDP Insights - Flood Frequency

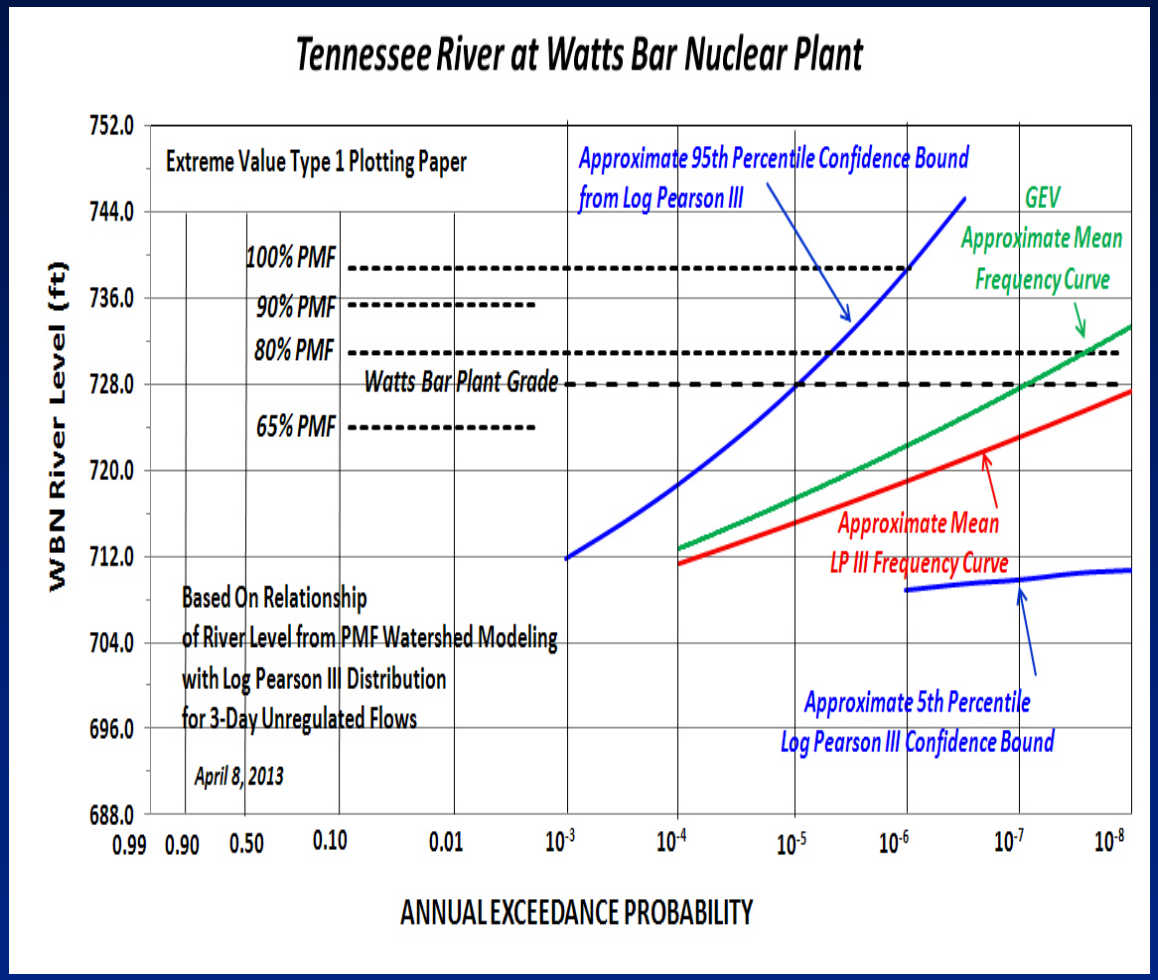
INITIATING EVENT FREQUENCIES

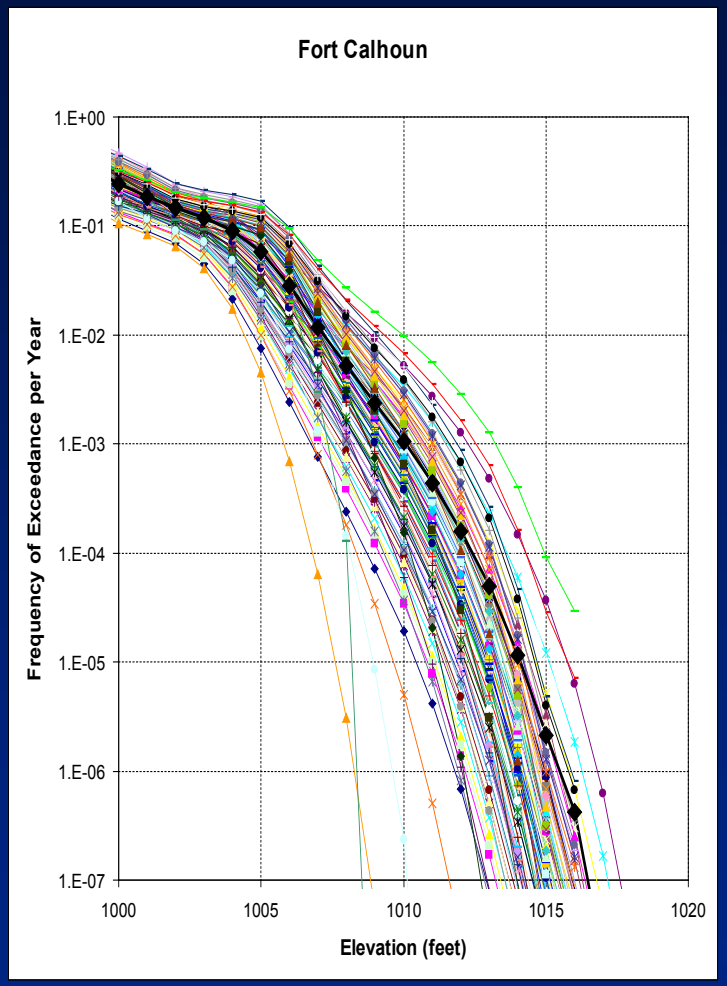
- Significant lack of consensus on extreme extrapolation or its application within hydrologic community
- Standard methods usually not intended for values beyond 500-year return periods
- Probable maximum events are not created equal !!!

	LIMIT OF CREDIBLE EXTRAPOLATION FOR ANNUAL EXCEEDANCE PROBABILITY	
TYPE OF DATA	TYPICAL	OPTIMAL
AT-SITE STREAMFLOW DATA	1 in 100	1 in 200
REGIONAL STREAMFLOW DATA	1 in 500	1 in 1,000
AT-SITE STREAMFLOW + AT-SITE PALEOFLOOD DATA	1 in 4,000	1 in 10,000
REGIONAL PRECIPITATION DATA	1 in 2,000	1 in 10,000
REGIONAL STREAMFLOW + REGIONAL PALEOFLOOD DATA	1 in 15,000	1 in 40,000
COMBINATIONS OF REGIONAL DATA SETS + EXTRAPOLATION	1 in 40,000	1 in 100,000

USBR "A Framework for Characterizing Extreme Floods for Dam Safety Risk Assessment" (1999)

SDP Insights - Flood Frequency





Source: TVA public presentation (April 22, 2013)

Source: OPPD news presentation (August 18, 2010)

SDP Insights - Flood Frequency

LIMIT OF HISTORICAL FLOOD RECORDS

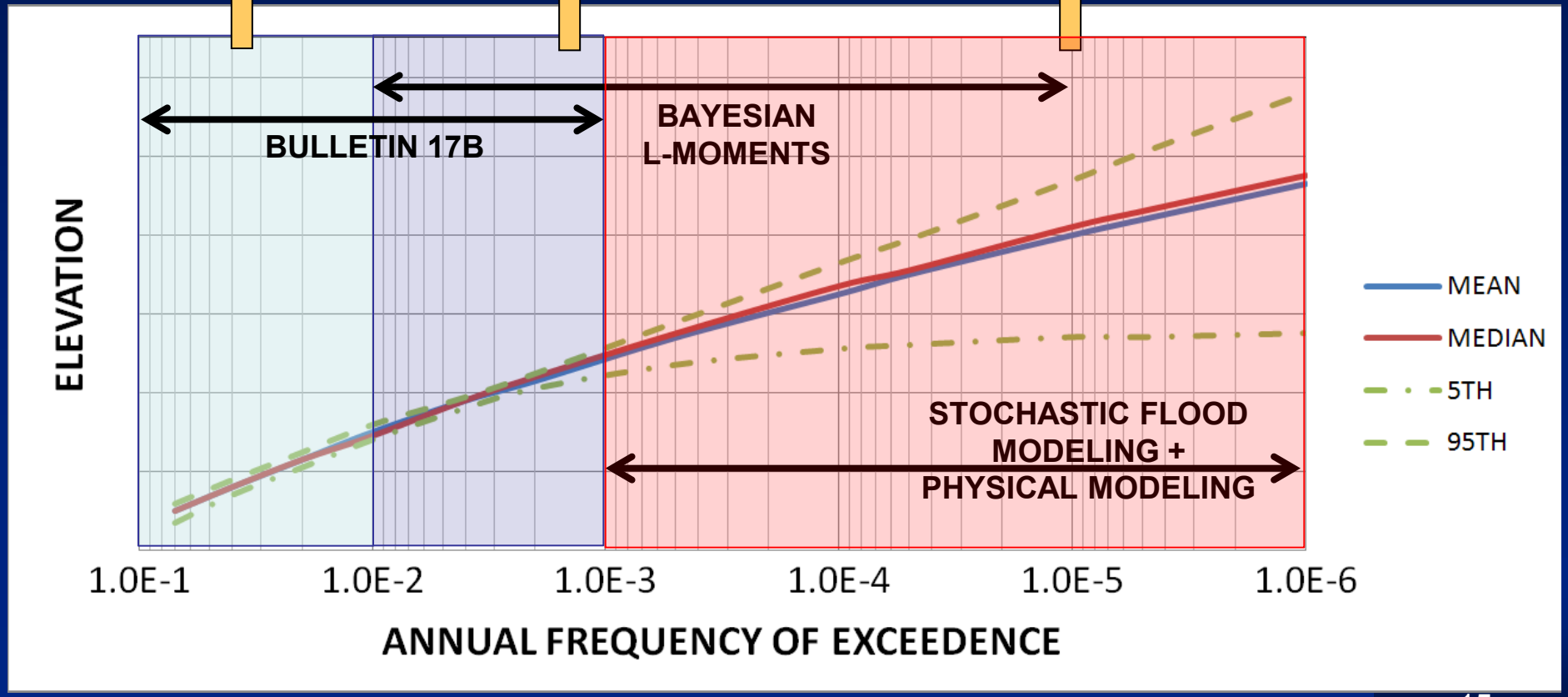
(Less Uncertainty/ Established Methods)

LIMITS OF CREDIBLE FLOOD EXTRAPOLATION

(More Uncertainty/ Extrapolation Methods)

EXCEEDS CREDIBLE FLOOD EXTRAPOLATION

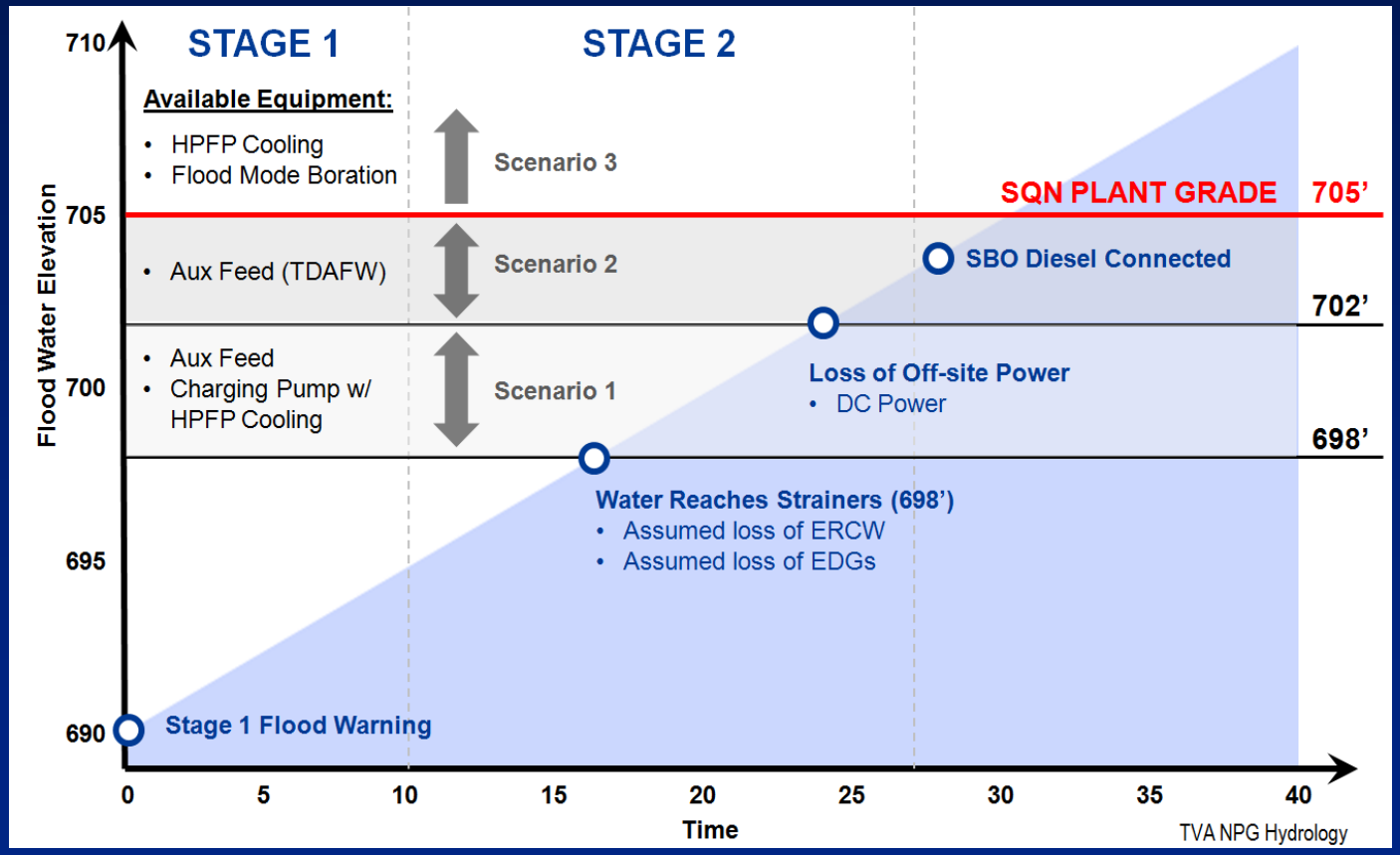
(Significant Uncertainty/ Stochastic Methods)



SDP Insights – Risk Spectrum

LACK OF RISK SPECTRUM (i.e., "Probable Maximum Event" Bias)

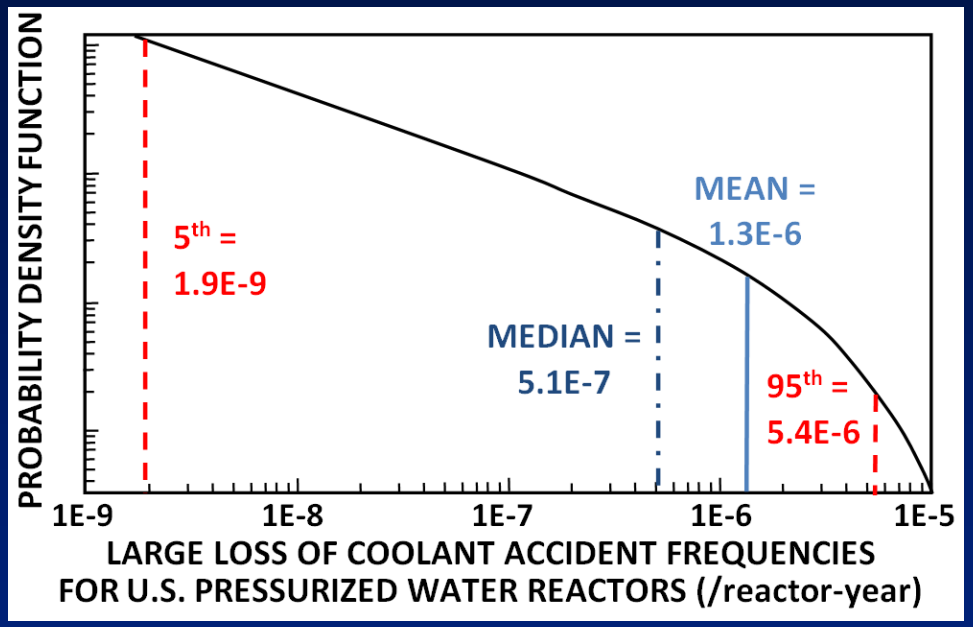
- Translation from precipitation to rainfall-runoff to elevation lacking
- Less intense events than PMP/PMF may be much more critical



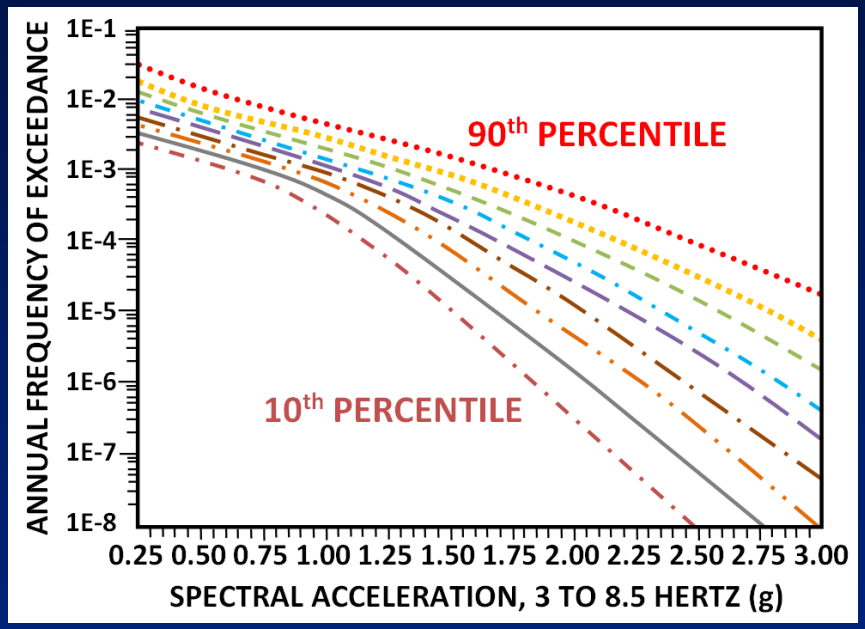
Sources: Tennessee Valley Authority news release/public presentation (April 22, 2013)

SDP Insights – Uncertainty

Large LOCA Source: NRC – INL Reactor Operational Experience



Seismic Hazard Source: PG&E – Diablo Canyon LTSP



LARGE UNCERTAINTY IN PRACTICE (NUREG-1855, EPRI-1026511)

- Insights gained from plant response rather than numerical results are most valuable
- Significance can be most acute with the presence of cliff-edge effects
- Mean values may not be enough, perform sensitivity analysis

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Additional SDP Insights

- **FORECASTING/WARNING TIME/PLANT STATUS**
  - Heavy reliance on external entities (e.g., river operations)
  - Affects assumptions about plant status (e.g., early/late shutdown)
- **CREDIT FOR TEMPORARY FLOOD BARRIERS**
  - Traditionally, very small credit provided (e.g., sandbagging)
- **EXISTING FLOOD SEALING PROTECTION**
  - Lack of appropriate design consideration/control
  - Protection missing altogether
- **FLOOD PROTECTION PLANNING PROCEDURES**
  - Heavy reliance on availability of equipment/material/time/offsite aid
  - Feasibility/reliability of specific actions may be questionable
  - “Backwards” assessment tend to be optimistic
- **INDEPENDENCE BETWEEN COMBINATION EVENTS**
  - Inappropriate bias estimates towards extremely low probabilities

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Conclusions

- There is an immediate need for probabilistic flood hazard information for reactor oversight purposes
- Existing NRC PRA models can be used to obtain insights for flood risk with enhanced frequency estimation (i.e., similar to seismic risk)
- Additional engagement with other entities performing probabilistic flood hazard assessments should be performed to enhance state-of-practice

United States Nuclear Regulatory Commission

Protecting People and the Environment

Development of Probabilistic Flood Hazard Assessment Research Plan

Joseph Kanney, Ph.D.
Hydrologist, Environmental Transport Branch
Division of Risk Analysis
Office of Nuclear Regulatory Research

October 2, 2013

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Overview

- Objective is to support NRC staff in the development of a risk-informed licensing and oversight framework for assessing flooding hazards and consequences
  - Design standards for new facilities
  - Significance determination tools for evaluating deficiencies related to flood protection at operating facilities
- Main (but not exclusive) interest is in range of annual exceedance probabilities (AEPs), including rare to extreme floods with probabilities (AEPs) in the range of 10^{-3} to 10^{-7}
  - Full hazard curves needed

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Overview (Cont.)

- **<u>Draft</u>** Probabilistic Flood Hazard Assessment (PFHA) Research Plan has been developed
  - Joint RES/NRO/NRR effort
    - RES/DRA: Joseph Kanney, Elena Yegorova
    - NRO/DSEA: Kenneth See, Nebiyu Tiruneh
    - NRR/DRA: Fernando Ferrante
  - Other offices/divisions will be formally consulted as plan progresses
  - Preliminary estimate for time-frame: 5 years
- Implementation will involve significant collaboration with other federal agencies

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Main Thrusts of PFHA Research Plan

- Leverage available flood frequency information
- Develop PFHA framework for range of flooding scenarios and range of AEPs
- Application of improved modeling techniques for processes and mechanisms associated with flooding
- Investigate reliability of flood protection and plant response to flooding events
- Assess potential impacts of dynamic and nonstationary processes on flood hazard assessments and flood protection

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Leverage Available Frequency Information

- Leverage Available Frequency Information on Flooding Hazards at Operating Nuclear Facilities
  - Organize flooding information and build database of currently available site-specific flood hazard frequency information, prioritized according to anticipated need and level of perceived flooding risk.
  - Develop guidance on use of currently accepted extrapolation methods for river flooding hazard information
  - Develop guidance on use of currently available extrapolation methods beyond the current consensus limits

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

PFHA Framework

- Develop PFHA Framework for range of flooding scenarios and AEPs
  - Formal framework that should be applicable to multiple flooding mechanisms as well as combined events
  - Likely component models include
    - Source
    - Pathway
    - Receptor(s)
    - Consequences
    - Uncertainty and sensitivity analysis

PFHA Framework (Cont.)

- Investigate use of “SSHAC-like” processes to provide confidence that all technically defensible data sets, models and interpretations have been given appropriate consideration and weighting in the analysis
  - Expert assessment vs. expert elicitation
  - Participatory peer review
  - Appropriate hierarchy of approaches (similar to levels of SSHAC process)
  - Systematic uncertainty and sensitivity analysis
  - Joint NRC-FERC Workshop/Course

PFHA Framework (Cont.)

- Develop example applications of framework (with cooperation of stakeholders where feasible)
  - Riverine site
  - Coastal site
  - Local intense precipitation

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Improved Modeling Techniques

- Investigate application of improved deterministic and probabilistic modeling techniques for processes and mechanisms associated with flooding
  - Extreme precipitation
  - Rainfall-runoff
  - Dam failure
  - Storm surge, tsunami, and seiche
  - Combined events

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Dynamic and Nonstationary Processes

- Assess potential impacts of dynamic and nonstationary processes on flood hazard assessments and flood protection at nuclear facilities
- Focus will be on understanding the state of the science, following recent advances, and assessing the potential for identified trends to impact NRC licensing and oversight activities
  - Climate change impacts on intensity and variability of precipitation events, changes to timing of snowmelt, relative sea level rise, etc.
  - Land use and land cover change impacts on watershed response to precipitation events

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Next Steps

- Finalize PFHA Research Plan
  - Identify resource requirements
    - Staff
    - Contract support
    - Infrastructure
  - Consultations
    - Flooding Issues Technical Advisory Group (FITAG)
    - Management in other offices
    - Other federal agencies
- Implement over 5-Year timeframe subject to availability of staff and funding