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Subcommittee

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UNITED STATES NUCLEAR REGULATORY COMMISSION'S
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

April 21, 2006

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, taken on April 21, 2006, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

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

1 UNITED STATES OF AMERICA
2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

5 (ACRS)

6 SUBCOMMITTEE ON RELIABILITY AND PROBABILISTIC
7 RISK ASSESSMENT

8 + + + + +

9 FRIDAY, APRIL 21, 2006

10 + + + + +

11 ROCKVILLE, MARYLAND

12 The Subcommittee met at the
13 Nuclear Regulatory Commission, Two White Flint North,
14 Room T-2B1, 11545 Rockville Pike, at 8:30 a.m., George
15 E. Apostolakis, Chairman, presiding.

16 COMMITTEE MEMBERS:

17	GEORGE E. APOSTOLAKIS	Chairman
18	J. SAM ARMIJO	Member
19	MARIO V. BONACA	Member
20	RICHARD S. DENNING	Member
21	THOMAS S. KRESS	Member
22	OTTO L. MAYNARD	Member
23	WILLIAM J. SHACK	Member
24	JOHN D. SIEBER	Member
25	GRAHAM B. WALLIS	Member

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1 NRC STAFF PRESENT:

2 Sud Basu, RES/DRASP

3 Amy Cubbage, NRR

4 Jim Gaslevic, NRR/DNRL

5 Bob Palla, NRR/DNA

6 Marie Pohida, NRR/DRA/APOB

7 Larry Rossbach, NRR/DNRL/NESB

8 Nick Saltos, NRR/DNA

9 See Meng Wong, NRR/DRA/APOB

10

11 ALSO PRESENT:

12 David Hinds, GE

13 Mohsen Khatib-Rahbar

14 Theo Theofanous, GE

15 Rick Wachowiak, GE

16 Zhe Yuan, REI

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P R O C E E D I N G S

Time: 8:33 a.m.

CHAIRMAN APOSTOLAKIS: The meeting will now come to order. This is the second day of the meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Probabilistic Risk Assessment. I am George Apostolakis, Chairman of the Subcommittee.

Members in attendance are Graham Wallis, William Shack, Sam Armijo, Mario Bonaca, Rich Denning, Tom Kress, Otto Maynard, and Jack Sieber.

The purpose of the meeting is to begin our review of the ESBWR probabilistic risk assessment. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Eric Thornsbury is the designated Federal official for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting, previously published in the Federal Register on April 4, 2006.

A transcript of the meeting is being kept and will be made available, as stated in the Federal

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1 Register notice. It is requested that speakers first
2 identify themselves and speak with sufficient clarity
3 and volume so that they can be readily heard.

4 We have received no written comments or
5 requests for time to make oral statements from members
6 of the public regarding today's meeting.

7 We will now proceed with the meeting, and
8 I call upon Mr. Rick Wachowiak to begin the
9 presentations. Rick.

10 MR. WACHOWIAK: All right. I would like
11 also to say that from GE this morning, we have David
12 Hinds and Sid Bhatt in attendance also.

13 Well, this morning we are going to talk
14 about a couple of things. We are going to talk about
15 external events in the DCD PRA, and then a little
16 later on this morning we are going to talk about the
17 shutdown PRA.

18 Now these are kind of intermingled,
19 because in our -- the way that we are writing the
20 document now in the fire and flood analysis we've got
21 the fire and the shutdown fire in the same chapter,
22 and then the flood and the shutdown flood in the same
23 chapter. So it may seem like I am jumping around a
24 little bit, but I am trying to keep it in the spirit
25 of how we arranged the presentation here.

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1 So let's start out with the probabilistic
2 fire analysis. We have done a screening analysis to
3 show that the contribution of risk due to fire is
4 going to be not significant in the ESBWR design. We
5 chose the five methodologies to provide the basis for
6 identifying the fire compartments, defining the fire
7 ignition frequencies. Those are consistent with what
8 we have done in the rest of the PRA where we used
9 generic --

10 MR. WALLIS: Well, you don't explain how
11 you reached this conclusion, because in existing
12 plants fire risk is often comparable with the regular
13 risks, and I'm not sure why your plant is any
14 different. What is it that makes it different was not
15 clear to me.

16 CHAIRMAN APOSTOLAKIS: Not only that, but
17 to find something insignificant when your base is 10^{-8}
18 ⁸. This is now, what, 10^{-11} .

19 MR. WACHOWIAK: Well, we are going to
20 cover exactly those things.

21 One of the things that, and it probably
22 prompts your question, is this definition here. Risk
23 of core damage due to fire in each of the area groups
24 -- and we will talk about area groups in a minute --
25 should be lower than the risk of core damage due to

1 internal events.

2 Now thinking about that, is that the right
3 way to pose that? I would say that, no, we didn't
4 pose that quite right. What we should have said here
5 was that either the total of the fire risk in the
6 screening analysis needs to be much less than the
7 internal event CDF or each individual group, using
8 this conservative screening analysis, needs to be
9 much, much less than.

10 In Rev-0 it turned out that each
11 individual group was much, much less, and we will talk
12 about one sequence in Rev-1 that doesn't come out
13 quite that way, and we can explain why.

14 So this was in Rev-0 of the document. We
15 will be changing that to be the correct one. Now when
16 we come into how does the ESBWR get to have a lower
17 fire risk or a lower contribution than existing
18 plants, there's a couple of different things that play
19 into this.

20 Number one, at the design phase it is
21 pretty easy to say that everything is separated, and
22 it was easy to say that in the existing plants when
23 they were at the design phase. Right? And it was
24 when they actually pulled the cables and set things
25 out in the actual field that caused some of the

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1 problems that are associated with fire risk.

2 We understand that now in the industry.
3 that is a well known issue. So as part of the
4 detailed design of the ESBWR, we are saying you don't
5 get to field route stuff the way you did before. It's
6 got to match the fire hazards analysis and the routing
7 that we put into the design. That is a criteria that
8 we have to meet. It can't be deviated, and it leads
9 to being able to preserve the types of risk levels
10 that we are going to see here.

11 The other thing is that many of the -- The
12 instrument control system that we are using in this
13 plant, the digital instrument control system connected
14 by fiber optics, is not subject to the same kind of
15 failure modes and adverse actions that the actual
16 cable connections do.

17 Now there's some other issues with what
18 happens to printed circuit cards and things like that,
19 but we think that we are less susceptible to things
20 like hot shorts and other things that cause actions
21 that you wouldn't necessarily consider. So that's
22 some of the reasons.

23 CHAIRMAN APOSTOLAKIS: You show here that
24 fire is indeed a negligible contributor. That means
25 that at the COL stage they will not have to worry

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1 about fire? If the design is certified, fires are
2 out.

3 MR. WACHOWIAK: That would help me out.

4 CHAIRMAN APOSTOLAKIS: Sorry?

5 MR. WACHOWIAK: That would help me out in
6 meeting the schedule, but I expect that we will have
7 to provide a similar sort of analysis at the COL stage
8 to show that it remains negligible, and I would expect
9 as we go forward and build the plant, we will continue
10 to have to show that it remains negligible or include
11 it, if for some reason there is some component that we
12 actually have to buy, implement something that has a
13 failure mode that we never thought of before.

14 CHAIRMAN APOSTOLAKIS: I understand that.
15 The question is more from the legal side. When you
16 set the fire down, then I guess you are not allowed to
17 revisit certain issues. That's the whole idea.
18 Otherwise, you start everything from scratch.

19 So I am wondering, if you have a situation
20 like this, is it -- Yes, Amy, please?

21 DR. DENNING: She is afraid to get up.

22 MS. CUBBAGE: Well, this would be more in
23 the mode of verification through the ITAAC that they
24 have implemented the design as certified.

25 DR. KRESS: Well, it would have to show up

1 in an ITAAC.

2 MS. CUBBAGE: We would have to have
3 sufficient ITAACs that we could verify that the as-
4 built plan conforms to the regulations and the
5 license.

6 DR. WALLIS: Now you said that you got
7 this low risk by using fiber optics instead of copper,
8 but I believe your PRA assumes copper. It says you
9 are not taking credit for fiber optics.

10 MR. WACHOWIAK: Well, what we said -- What
11 I believe we said was that --

12 DR. WALLIS: It assumes copper conductors
13 is what I read, instead of fiber optics.

14 MR. WACHOWIAK: In Revision 0 we did say
15 that we assumed copper.

16 DR. WALLIS: But you are not assuming
17 fiber optics?

18 MR. WACHOWIAK: What we are assuming is
19 that, even though we have fiber optics, we are going
20 to include a -- what we will call bounding or worst
21 case spurious actuation due to some unknown means.

22 DR. DENNING: Now is that only the
23 actuation of one SRV? Is that the only actuation,
24 spurious actuation, you are saying?

25 MR. WACHOWIAK: It's a spurious actuation

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1 of a relief valve. It doesn't necessarily have to be
2 an SRV. It can be an SRV or a DPV, but the reason
3 that one is more remedying than, let's say, all is
4 that one is sufficient to remove the isolation
5 condenser as a viable heat removal source; or that is
6 also not sufficient to depressurize the plant so that
7 GDS can come in without further depressurization.

8 So if we assume one, it gets us into a
9 situation where it is essentially the worst case. If
10 we assume a whole bunch, then GDCS can come on all by
11 itself, and we don't have to worry about the passive
12 syndrome. If we assume none, then isolation
13 condensers work just fine.

14 So we chose to use limited
15 depressurization in this, just for that purpose.

16 DR. DENNING: As far as the controlling of
17 cables and things like that in isolation, does that
18 only relate to the passive safety systems? It isn't
19 clear to me. What happens to those active systems
20 that you use for asset protection? Are they trained
21 in the same sense and do they have separation or is
22 that not relevant to that?

23 MR. WACHOWIAK: It is relevant, and we
24 will see through some of these analyses where it can
25 make a difference. It determines how much credit we

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1 can get for some of these things.

2 In our composite spec for the plant, which
3 is the like overarching design spec, it's got some
4 things that we need to meet. There is a list of
5 systems in there that we call the plant asset
6 protection systems, and what we specified is that, to
7 the degree possible, we will provide electrical
8 separation, physical separation, purchased to seismic
9 pipe specifications for those pieces of equipment to
10 provide reasonable assurance that we are not going to
11 have a single fire event or flood event that is going
12 to take out all those pieces of equipment.

13 So -- and the list of equipment is, in
14 general, the stuff that, if we had the active systems,
15 that are modeled in the PRA. So we do have separation
16 of the nondivisional side for those.

17 So far, the design implements that. Now
18 once again, this is where we are early in the design
19 phase, and I guess I understand now that this is
20 something that is -- we have to deal with as we add
21 the detail to the design, and everything on the
22 drawing board now shows that they are separated, and
23 I guess we need to maintain that.

24 DR. BONACA: I have a question regarding
25 the ITAAC, just to understand it. You cannot impose

1 on GE more than the Code of Regulations protections
2 applies. So if GE comes in with an analysis and the
3 fire risk of, we could say, two percent for CDF, and
4 then later on it goes out to five percent or eight
5 percent --

6 MS. CUBBAGE: We would be in the position
7 of verifying that they are in conformance with the
8 regulations.

9 DR. BONACA: That's right. So they still
10 really can change the results quite significantly and
11 still be in conformance with the regulations. So I
12 can't understand --

13 MS. CUBBAGE: Nick Saltos, come on up
14 here, Nick, to the mike, please.

15 MR. SALTOS: This is Nick Saltos from NRR.
16 What we do at this stage, we identify those design
17 features. For example, separation, diversity,
18 redundancy are the features that make the risk be so
19 low, as they said, and those become part of the ITAAC
20 or become action items.

21 So the plant has to meet these
22 requirements.

23 CHAIRMAN APOSTOLAKIS: But if it does,
24 then there is a presumption that the results of this
25 preliminary analysis are correct, and how do we know

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1 that, if they do a fire assessment, risk assessment of
2 the plant as it is being built will actually conform
3 with this.

4 MR. SALTOS: The fire analysis right now
5 should be conservative. Yes.

6 CHAIRMAN APOSTOLAKIS: So we are not going
7 back to it. That's the thing. As long as they meet
8 what they are saying --

9 MR. SALTOS: Well, there are many uses to
10 address before these numbers stay the way they are.
11 There is propagation of fire in the adjacent fire
12 areas which have not been addressed. There is smoke.
13 It can propagate also in the back, in the front.

14 MS. CUBBAGE: Those issues will be
15 reviewed -

16 MR. SALTOS: There are several arteries.
17 There is regulatory treatment of non-safety system,
18 doing the fire PRA without the non-safety systems. So
19 out of all these exercises they are going through,
20 this risk might increase; but in any case, we are
21 going to capture all these features that make this
22 risk be gone.

23 Now, hell, no, we are not speaking to a
24 number like that. What is important is for the fire,
25 the design features that make these number low, but

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1 how low we don't know yet.

2 MS. CUBBAGE: All of that happens as part
3 of the certification process.

4 CHAIRMAN APOSTOLAKIS: Well, it's Part 52
5 that applies here. Right? All it says is that they
6 have to cut a PRA. Isn't that what it says?

7 MS. CUBBAGE: Right, but all it says --

8 CHAIRMAN APOSTOLAKIS: It doesn't say
9 anything else.

10 MR. SALTOS: It says that they have to
11 have a PRA, 35 important -- But also we use the PRA to
12 identify requirements for the design.

13 CHAIRMAN APOSTOLAKIS: I understand that.

14 MR. SALTOS: All the assumptions that are
15 made in the PRA are important assumptions that make
16 the risk be low. We are making sure that they go into
17 the ITAAC, all serial action items or liabilities to
18 a problem or tech specs. So when they identify them,
19 it will be according to those requirements -- will
20 meet those requirements.

21 MS. CUBBAGE: And don't forget, this is
22 the risk aspect of your review. We also have the fire
23 protection engineering review.

24 CHAIRMAN APOSTOLAKIS: I understand. I
25 guess it is not very clear to me. You certify the

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1 design, that you are not allowed -- I mean, the whole
2 idea of the certification process is not to start the
3 process all over again when an applicant comes with a
4 real application, but is the PRA part of that or
5 should you say, yes, the design has been certified,
6 but we would like the PRA to be really updated as we
7 move on?

8 MR. SALTOS: The PRA is part of it.

9 CHAIRMAN APOSTOLAKIS: Part of that
10 certification?

11 MR. SALTOS: Yes, because ensuring that
12 all the design features wanted in the PRA that make
13 the risk -- the applicant below. They are going to be
14 there, and the design is -- The plant is going to be
15 built according to those requirements.

16 CHAIRMAN APOSTOLAKIS: Fine. That's one
17 part. The other part is, yeah, you have built it that
18 way, but update your PRA to take into account now
19 details that were not in the original design
20 certification phase, because we didn't have all that
21 information.

22 MR. SALTOS: Oh, yes.

23 MS. CUBBAGE: I think we are still working
24 through the issues of what would be reviewed at the
25 COL stage of our NPRA, and I think that is kind of

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1 offline.

2 MR. SALTOS; Yes, but the PRA also makes
3 assumptions, for example, about if there is some
4 failure caused by cables being close together, we come
5 up with requirements that the cables have to be
6 separated up to a certain distance or in different
7 fire areas.

8 So all this information goes in there.
9 Now unless we miss something, the PRA is high, top
10 level assumptions that make the PRA conservative,
11 bounding, so in an average sense at least.

12 DR. SHACK: A licensee, if he is coming in
13 for a 1174 action, he is going to have his own PRA.
14 Now presumably, it is going to be built on this PRA,
15 but it is going to have to be verified that it is
16 plant specific and been reviewed.

17 MS. CUBBAGE: Right. I think the issue
18 you are getting to is what will change at the COL
19 stage, and I think Rick was speaking more to the fact
20 that this PRA is going to have to evolve with this as-
21 built plan so that it can be a tool used by the
22 licensee. But whether we get it back into the review
23 again at the COL stage, I think, in general is no.

24 MR. SALTOS: Well, it has to meet the
25 requirements.

1 MS. CUBBAGE: Right, and that's --

2 MR. SALTOS: That's what we said. Now if
3 they want to argue the case about how they route some
4 cables or some other design details, but they still
5 will have to meet those requirements, high level
6 requirements.

7 MS. CUBBAGE: But the question is an
8 updated PRA.

9 MR. SALTOS: They may choose not to update
10 it.

11 CHAIRMAN APOSTOLAKIS: That is what
12 worries me.

13 MR. SIEBER: Well, there is no rule that
14 makes anybody do that.

15 CHAIRMAN APOSTOLAKIS: Or not do that.
16 See, that's the point. The rule is not specific.

17 MR. SIEBER: That's right. You can do it
18 if you wanted to or --

19 CHAIRMAN APOSTOLAKIS: Well, the question
20 is -- Rick showed yesterday a very nice slide where
21 you had five or six columns, the evolution of the
22 design. right? You start with a very conceptual
23 stage, and then you move on.

24 As you move on, then, obviously, the PRA
25 changes, too, because you have more information. So

1 what is it -- My question is: Let's say we all
2 certify this. You guys agree, and your SER, the ACRS
3 agrees with the letter and so on.

4 That means then that at a later stage, if
5 we raise a question about, say, common cause failure,
6 you can come back and say, wait a minute now, you
7 reviewed that last time and you have certified it;
8 don't even raise questions anymore.

9 MR. SIEBER: I don't think that's right,
10 John.

11 CHAIRMAN APOSTOLAKIS: Well, I don't
12 understand. That's what I am trying to understand.

13 MR. SIEBER: Well, the NRC is going to
14 certify a design. They are not going to certify the
15 PRA.

16 CHAIRMAN APOSTOLAKIS: Well, that's
17 exactly the question.

18 MR. SIEBER: Okay.

19 CHAIRMAN APOSTOLAKIS: Is the PRA part of
20 the certification?

21 MR. SIEBER: No, only in how it resulted
22 in design of the thing. That's what we certify, is
23 the design. The PRA is just a tool they use with
24 designing. We aren't going to certify that.

25 CHAIRMAN APOSTOLAKIS: But what if, in the

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1 COL things, they don't even submit a PRA?

2 MR. SIEBER: Well, they don't have to, but
3 if there is something that shows up --

4 MS. CUBBAGE: I think it is a
5 requirement.

6 MR. SIEBER: Well, maybe.

7 CHAIRMAN APOSTOLAKIS: It is a
8 requirement. Why do you say it is not?

9 MR. WACHOWIAK: It is on the list of
10 documents to be provided by the applicant.

11 CHAIRMAN APOSTOLAKIS: That's right. The
12 question is how up to date should it be? I'm sorry,
13 go ahead.

14 MS. CUBBAGE: Yes, there is a whole other
15 effort going on to look at what would need to be
16 submitted in the COL.

17 CHAIRMAN APOSTOLAKIS: Okay. So it is
18 kind of open right now.

19 MS. CUBBAGE: Yes. That's why I'm kind --
20 and they are still -- We are in the process of a Part
21 52 rulemaking right now, and we are in the comment
22 period.

23 CHAIRMAN APOSTOLAKIS: Well, that is the
24 one where -- Sorry, Nick. go ahead.

25 MR. SIEBER It's a good question.

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1 MR. SALTOS: Any difference that exists
2 between the specification, the PRA and the actual
3 plant here -- it has to be submitted, site specific
4 characteristics. So any design changes, more details
5 about the route of cabling and the piping and things
6 like that have to be submitted at the COL stage. But
7 it does not mean that they have to be updated for
8 everything. If there is no PRA at the certification
9 period, it is bounding.

10 MS. CUBBAGE: And you are saying, if you
11 identified a common cause of failure that was not
12 reviewed as part of the certification, if it rose to
13 the level of an adequate protection issue or a
14 compliance issue, we would have the forms back that
15 certify the design.

16 CHAIRMAN APOSTOLAKIS: Well, let's say
17 that it is not an issue of adequate protection. I
18 mean, to reach that level is really hard. But suppose
19 that we look more carefully. We have a plant specific
20 PRA, and the core damage frequency now is 10^{-7} . Okay?
21 An order of magnitude greater, still very low but --

22 MS. CUBBAGE: That's an issue, a
23 compliance issue, and they have met the ITAAC. We're
24 done.

25 CHAIRMAN APOSTOLAKIS: So the only chance

1 in the future will be if the licensee wants to come
2 back and invoke Regulatory Guide 1174, in which case,
3 of course, they have to have a good PRA.

4 MR. SIEBER: That's a choice.

5 MR. SALTOS: But they can demonstrate,
6 though -- They can demonstrate that the assumptions
7 they were making in the certification PRA, they were
8 bounding, and any details having to do with -- about
9 piping and cabling and things like that, and site
10 characteristics, they are in the law by the
11 assumptions they are making in the certification PRA,
12 and the only way there is to go is down, not up. Then
13 they conclude not to make changes to the PRA.

14 CHAIRMAN APOSTOLAKIS: Well, yes, what you
15 are saying is that, even if they do all these things,
16 and even if they update it, it would be the same.
17 That's really what you are saying.

18 DR. WALLIS: Well, this may be true of
19 fires, but I am not at all sure that the assumption
20 that this core capture works with 99 percent
21 efficiency is bounding. You keep using the word
22 bounding, but I mean --

23 DR. BONACA: That opens up the issue of,
24 again, what is within the licensing basis and even
25 beyond the licensing basis. Are they bound, you know,

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1 in the results for --

2 MS. CUBBAGE: If the design feature is a
3 BiMAC, they would be bound to that. That was provided
4 in the whole document, and they would have to.

5 DR. BONACA: Yes, and I understand that.
6 Of course, they wrote that. But the results of
7 whatever they configure, I mean they vary once you
8 begin to do more accurate calculations. So --

9 MS. CUBBAGE: That's a regulatory issue we
10 will have to deal with during the review, and you will
11 be hearing about it then.

12 MR. WACHOWIAK: One of the things that I
13 had to save for my second or third to last slide for
14 the day -- One of the things that is difficult with
15 using the PRA in this manner or including it in the
16 submittal at this point in the design is that the PRA
17 is a little bit of a different animal than the design
18 basis analysis.

19 In the design basis analysis, you say what
20 has to happen, and you impose on that nonmechanistic
21 failures of a limited manner and you say, okay, if you
22 have any one failure -- And so it is easy going from
23 a preliminary design to a final design and keep that
24 framework intact.

25 CHAIRMAN APOSTOLAKIS: That's correct.

1 MR. WACHOWIAK: In the PRA, though, we are
2 trying to figure out -- We know what is supposed to
3 happen, but what we also try to figure out is what can
4 go wrong, and changing the details can change what can
5 go wrong.

6 So if we, for example, which we may talk
7 about later, we have our turbine building, and we had
8 everything laid out. We looked at what the worst case
9 flood scenario is, and on paper originally it looked
10 like it was a circ water line break -- okay? --
11 because so much water can get to anything. But now we
12 see as they are building the actual rooms and things
13 inside the building design, we find out that that
14 flood has been isolated and ported to the outside.

15 This interior wall that wasn't originally
16 part of the design now greatly affects in this
17 particular one in a good direction what is in the PRA.

18 DR. SHACK: Was that wall added to address
19 that?

20 MR. WACHOWIAK: No, no. It was added,
21 because they were putting the walls in the building
22 now. We didn't have that at the original. We are
23 finishing in the details on the picture.

24 Then there are other places where we may
25 find that there is some failure mode inherent to

1 equipment that is able to be purchased that we didn't
2 think about before. So this failure mode would have
3 to go in, and it could take us the other direction.

4 Now what we have tried to do in these
5 uncertain things with external events -- Let me back
6 up. With internal events, I think we have been
7 working with PRA internal events on the mechanical
8 systems and these electrical systems for -- I don't
9 know. I've been messing with it for almost 20 years,
10 and people have been working on it for a long time,
11 and we think we know what we are going to see when we
12 go and actually put equipment in.

13 On some of these new systems like the
14 digital I&C and things like that, we are not quite
15 sure what is going to happen. So we try to do things
16 like this where we bound it.

17 We say, we will use what we think are
18 bounding assumptions and come up with values that are
19 low using bounding assumptions, so that later when we
20 rough in the details or fill in the details from our
21 rough idea that, yeah, maybe we have to refine some of
22 this. We can't just use five. Maybe we have to do
23 some fire propagation modeling or something, but in
24 the end the conclusion still comes out to be the same.

25 Your point is a good one, though. If we

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1 do this certification using this method and then, to
2 get to the final answer we have to use a different
3 method, where does that put Nick, the reviewer, in
4 this then?

5 MR. SALTOS: Well, you still have to meet
6 the assumptions. You are going to meet the
7 assumptions that you make in the certification. You
8 will not change this afterward.

9 CHAIRMAN APOSTOLAKIS: No, but they will
10 make a difference, because --

11 MR. SALTOS: We might have to make some
12 different assumptions.

13 CHAIRMAN APOSTOLAKIS: Then you review it
14 again.

15 MR. SALTOS: We will come up with some
16 additional requirements at the COL stage.

17 DR. BONACA: I need to understand better.
18 You said something about the core capture now, and
19 there will be commitments based on that, because they
20 put it in their design. So now there is another
21 manufacturer that comes in tomorrow and has a design
22 that still has a core damage frequency of 10^{-8} and has
23 no core capture. Okay, are you certifying that
24 design?

25 MS. CUBBAGE: Do you mean different plant

1 altogether?

2 DR. BONACA: Say there is another BWR
3 designer that comes in with a design, and there is no
4 core capture, but -- What is the regulation? I mean,
5 you probably would certify that, too, because I mean,
6 if you can convince yourself that there is such a low
7 risk.

8 So I am trying to understand, you know.
9 Until now, it seems to me, the regulation was very
10 specific on what you had to do, and what you do beyond
11 that was like out of the -- discretionary. But it
12 seems to me now that the process we are using to
13 define different requirements is based on what the
14 promise from the designer is.

15 I can't understand. What is the
16 requirement for a core capture?

17 MS. CUBBAGE: Well, I guess Rick is going
18 to speak to -- maybe not today, but at some point in
19 the future, what happens if the core capture doesn't
20 work, and what would happen to the PRA results, the
21 Level II results. I don't know.

22 MR. SIEBER: What does the NRC require?
23 I guess -- I think that's the question Mario is
24 asking.

25 MS. CUBBAGE: We can do this later when --

1 Let Rick get through this. We will come back to this.

2 DR. KRESS: It seems to me, though, it is
3 something akin to ice condenser or suppression tube.
4 They are not required, but if a designer chooses to
5 come in with them, the staff will evaluate it and see
6 if it meets the design basis.

7 DR. BONACA: Well, I heard something
8 different here. I heard that the core capture, which
9 we have seen, was not required for -- really is not
10 required for the criteria we use to license plants
11 today, because you have a core value --

12 DR. KRESS: Why wouldn't that invoke
13 defensiveness?

14 MS. CUBBAGE: At Part 52, there are
15 requirements to address failure accidents. So it has
16 to address it, and the manner in which they do it is
17 up to the choice of the designer.

18 MR. WACHOWIAK: There is all sorts of
19 interesting questions associated with that now. Let's
20 say, hypothetically, we come up with a way between now
21 and when we build the plant to eliminate that 90
22 percent of the CDF that is associated with those low
23 pressure events, and all the ones that we remove,
24 though, are the ones that have low water level in the
25 drywell, and all that's left are the ones with high

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1 water level in the drywell. What does that mean?

2 We have improved the plant, but we have
3 challenged one of the acceptance criteria of a
4 conditional containment failure probability. So how
5 does that play into any of this?

6 DR. DENNING: Although, we don't really
7 have a conditional -- I mean, people have talked about
8 it, but we don't really have a conditional. We have
9 an absolute at the moment. So you haven't made it
10 worse in that respect.

11 CHAIRMAN APOSTOLAKIS: So why don't we go
12 ahead now, and maybe we can come back to this.

13 MR. WACHOWIAK: The scope of the analysis
14 that we have included basically are these particular
15 buildings, and the reason that we picked these
16 buildings are these are the buildings that contain the
17 equipment that is modeled in the PRA. So we assume
18 that any other buildings that are out there, they can
19 burn.

20 One thing that is maybe a little different
21 than that is where the diesel driven firewater pump
22 is. We did screen that one out based on that not
23 causing an initiating event. So even though it is in
24 the PRA, it could give us a degraded state, it doesn't
25 lead to any sort of challenge to the plant, and in the

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1 end that would be something like an A4 evaluation
2 would need to deal with, with the operation.

3 CHAIRMAN APOSTOLAKIS: Let me understand
4 that. It doesn't lead to any sort of initiating
5 event?

6 MR. WACHOWIAK: The diesel driven fire
7 pump is used as a backup to the backup to injection
8 into the vessel and into the pools up on top. If we
9 have a fire in that room, we may lose that level of
10 redundancy, but it doesn't affect anything to do with
11 the operation of the plant. So there is no
12 perturbation there.

13 CHAIRMAN APOSTOLAKIS: The plant would not
14 be shut down?

15 MR. WACHOWIAK: The plant would not be
16 shut down. They would probably go into an LCO based
17 on some fire protection thing, and they would have to
18 get that repaired based on fire protection rules. We
19 might go into a manual shutdown if they can't get it
20 repaired in 30 days or something like that.

21 CHAIRMAN APOSTOLAKIS: But that's when you
22 would do an A4 analysis.

23 MR. WACHOWIAK: We may do an A4 analysis.
24 That would be -- I believe that is required of the
25 Part 52 plans. I don't think 50-69 goes away, or does

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1 it?

2 In Rev. 1 they are including full power
3 and shutdown modes, plant operation. We have added
4 the shutdown -- or are in the process of adding the
5 shutdown in response to an REI. it was pointed out,
6 and I believe correctly, that we should have
7 considered the shutdown mode for fire and flood, and
8 that is ongoing.

9 We use bounding assumptions here. Now we
10 are trying to compensate for the level of design
11 detail where we are not really sure where things are,
12 but we know in the design from the fire hazards
13 analysis where they are supposed to go. So we don't
14 know if a cable goes through this Div. 1 chase or this
15 Div. 1 chase, but we know it is in one of those Div.
16 1 chases.

17 So what we did was we said that let's
18 start with the fire. We will use a fire ignition
19 frequency. We are not going to do any fire modeling
20 at the first cut. Any fire that starts in any fire
21 zone is going to cover everything in that fire zone.
22 But then to cover the uncertainty of what is in each
23 particular room in those zones, we are just going to
24 say it gets everything in that division.

25 So even though the division may be on this

1 corner, this corner or this corner -- they are not
2 really like that, but even if it was like that, we
3 would say it gets all of those, mainly because we
4 don't really know the routing. So that is a bounding
5 assumption that we have there.

6 We also didn't credit the fire protection
7 system for suppressing the fire at this point. That
8 is a detail that is unknown and, as we mentioned
9 earlier, we postulated our worst case spurious
10 actuation, which in the reactor building is the
11 inadvertent open relief valve. In the -- trying to
12 remember if there are any other buildings that have
13 those. I don't believe -- Now in the control room we
14 also postulated the inadvertent open relief valve.

15 DR. DENNING: What happens if you activate
16 the squib that drains the gravitational -- the water
17 pool?

18 MR. WACHOWIAK: Actuate the squib that
19 drains the pool to actuate the BiMAC?

20 DR. DENNING: Yes.

21 MR. WACHOWIAK: That's a good question.

22 DR. WALLIS: It drains.

23 MR. WACHOWIAK: It would drain, and I
24 think we would have to look at that, and we will have
25 to look at how we protect against that. Right now,

1 that is kind of covered under our blanket design
2 assumption that it's got to be reliable under all
3 credible sequences to actuate and to not spuriously
4 actuate. So we would have to address that in the
5 design and how that -- Maybe that equipment needs to
6 be in separate special fire zones. I don't know.

7 DR. WALLIS: Does the explosive ignite in
8 the scope valve in a fire?

9 MR. WACHOWIAK: Not necessarily. It
10 depends on how the control system is set up.

11 MR. SIEBER: No, he is talking about the
12 heat on the explosive.

13 MR. WACHOWIAK: Oh, the explosive is
14 inside the drywell, inside the containment. The fire
15 wouldn't be there, because that is a nitrogen
16 environment. The fires are in other buildings outside
17 your --

18 DR. WALLIS: So they don't affect the
19 valving?

20 MR. WACHOWIAK: They don't affect the
21 squib itself. it affects the control system.

22 DR. ARMIJO: The control system could
23 activate the squib. Right?

24 MR. WACHOWIAK: The control system could
25 activate the squib, and that is why that it needs to

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1 be diverse; because otherwise we would have a
2 potentially greater impact if we, let's say, hook
3 these squib valves into the normal ECCS digital
4 control system. Then maybe some of those fires could
5 cause activation of the deluge system, but the current
6 thinking is that we are probably not going to be able
7 to meet our goals if we connect it into the existing
8 ECCS digital control system.

9 DR. DENNING: Now your assumption is the
10 fire barriers are perfect. There is no -- You don't
11 have any probability of failure or fault in a --

12 MR. WACHOWIAK: Let me put up this slide.
13 In Revision 0, that was correct. We asserted that
14 this assumption was bounding, and we didn't need to go
15 there.

16 Now the question is, though, is there a
17 worse case if the fire goes from this one compartment
18 of Div. 1 to this other compartment of Div. 2? Is
19 that worse than all of Div. 1 together going?

20 So in this current revision what we have
21 done is we have postulated the failure of one fire
22 barrier, and we have given a probability based on the
23 latest EPRI fire PRA methodology. There is a table of
24 data for fire barriers. We included that for the
25 failure probability, and looked at propagating.

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1 Now we also -- and this is probably
2 overkill, I think, but we used the same assumption.
3 if it propagated from 1 to 2, then we lose everything
4 in 2, when in fact, it really would be a subset that
5 I am not sure how we define at this point.

6 So we start getting into a place where we
7 do that. Yeah, I understand that it is a realistic
8 concern, but we made -- The conservative assumption
9 here may be a little too conservative by the time we
10 get to that point. So we got to figure out how to
11 deal with that.

12 What we find in -- and I think in our
13 results -- in the reactor building, for example, where
14 we would have thought that that was the biggest
15 concern, it didn't cause us a problem. All of these
16 fire scenarios -- in all but one place, they are all
17 3 times 10^{-10} , 2 times 10^{-10} , -11, 12, truncated. they
18 are all very small things except for one, the fire in
19 the turbine building.

20 The fire in the turbine building is an
21 interesting thing. the turbine building is huge. It
22 contains a lot of equipment that can initiate fire.
23 So it has a fairly high initiating frequency, but as
24 we said before, we didn't have a lot of details on
25 what was there.

1 So we said, okay, we will apply our
2 assumptions: Fire in the turbine building gets
3 everything. If that happens, what would that act
4 like? The loss of feedwater. What was our highest or
5 one of our highest core damage events? Loss of
6 feedwater. And basically, what this does is, using
7 all those assumptions, we end up with this sequence
8 here that basically is a ratio of the loss of
9 feedwater initiating event to the fire ignition in the
10 turbine building initiating event. It is basically
11 that same thing.

12 So we are trying to figure out what we
13 need to do with this under that original statement
14 there that the sum of all these needs to be less than
15 the internal events CDF. It meant we didn't have to
16 deal with this.

17 DR. WALLIS; I'm puzzled by this. I read
18 the document. I felt the control room was the -9
19 event. I don't understand why all the fire scenarios
20 have the lower than 3 and 10^{-10} .

21 MR. WACHOWIAK: We've looked at the fire
22 in the control room event.

23 DR. WALLIS: Something changed since --

24 MR. WACHOWIAK: And it has changed since
25 then.

1 DR. WALLIS: It's changed since the
2 document I read. Okay.

3 MR. WACHOWIAK: Right. And unfortunately,
4 that is one of the documents that we are still working
5 on.

6 DR. WALLIS: So this is clearly a
7 preliminary meeting.

8 MR. WACHOWIAK: For the most part, yes.

9 DR. WALLIS: We are going through the
10 details.

11 MR. WACHOWIAK: And for us, this --

12 DR. WALLIS: It would be better if I
13 hadn't read it at all, I think.

14 MS. CUBBAGE: Well, it is preliminary,
15 because the staff hasn't reviewed it. There may be a
16 lot of changes that may come from this, additionally.

17 MR. DENNING: But it is still worthwhile.

18 MS. CUBBAGE: So this was supposed to be
19 an introductory.

20 MR. WACHOWIAK: We went through it in Rev.
21 0. We have got some feedback from the staff. As we
22 were implementing this feedback, we made some changes
23 to the model, and the changes that we made during that
24 time frame affected the fire in the control room.

25 DR. WALLIS: If you have a fire in the

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1 turbine building, it affects the entire building?
2 I don't see how that can happen.

3 MR. WACHOWIAK: It can't. It can't. This
4 is bounding assumption here. In this particular
5 scenario, that bounding assumption is not appropriate.
6 So we know it is lower than that. How much lower is
7 something that we haven't gotten into yet, and that is
8 part of the issue with trying to do these things in a
9 bounding manner and trying to go through these with as
10 little perturbation on the people who are adding in
11 the detailed design of things. We don't want to have
12 to force things to happen inside that building that
13 really aren't going to -- we don't want to be a
14 requirement later on.

15 We tried the bounding assumption. Maybe
16 we will keep the bounding assumption. We don't know,
17 and maybe we will keep it going on at 4 times 10^{-8} for
18 CDF. That could be okay.

19 DR. DENNING: But if there is anyplace you
20 can have a huge fire, that's where it is.

21 MR. WACHOWIAK: If there is anyplace for
22 one, that's where it is. The question, though, is:
23 Is a huge fire a sudden loss of feedwater? So there
24 may be some small subset of fires that become a loss
25 of feedwater, and the others are a loss of condenser.

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1 Loss of condenser is clearly a more benign accident.

2 That's the kind of thing we would want to
3 look at, but once again, the question is do we need to
4 pursue it or is there some reason that we would want
5 to look at that for optics? You know, let's say we
6 get rid of all the internal events things, and now
7 we've got fire. CDF is 10 times the internal events,
8 CDF again and, you know, what does that do to what we
9 -- It's really a balancing act to try to figure out
10 how to do things with these external events at this
11 stage.

12 DR. WALLIS: So you redesign the turbine
13 building.

14 MR. SIEBER: It's pretty tough.

15 DR. WALLIS: Put another wall in there.

16 MR. WACHOWIAK: Maybe.

17 MR. SIEBER: You could have a lot of
18 little turbines.

19 MR. WACHOWIAK: Well, but what we could do
20 in that case is do a better separation of the
21 feedwater room from the turbine building. That could
22 be done, and maybe it is being done. We just don't
23 know.

24 MR. SIEBER: It still comes from the hot
25 well, which is connected to the turbines. That's

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1 where all the oil is.

2 MR. WACHOWIAK: Well, the issue that we
3 have with the loss of feedwater isn't just because we
4 lose feedwater. It's the sudden loss of feedwater
5 that causes the problem in the PRA -- or that causes
6 the scenario that leads to the numbers in the PRA.

7 So if we could somehow delay the total
8 loss of feedwater, make it a staged loss of feedwater,
9 we could make it better, too.

10 CHAIRMAN APOSTOLAKIS: What happens in the
11 scenario that you are preventing -- with the squib
12 valves? Did you dismiss that or you said you are
13 going to look into it?

14 MR. WACHOWIAK: We are going to look into
15 it. We don't -- didn't have any information yet on
16 where any of that control equipment was. So now we've
17 got the design requirement that it's got to be
18 reliable to actuate and reliable to not actuate when
19 it is not supposed to, and that would clearly fall
20 into this fire category, not actuating when it is not
21 supposed to.

22 The shutdown results: These are still for
23 fire. They are still too preliminary for me to
24 present at this point. We do have one insight from
25 that that I will present in the shutdown -- as much as

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1 people don't like the word insight, but it --

2 MR. MAYNARD: Some of us don't like it.

3 MR. WACHOWIAK: Okay, but we think we have
4 learned something from what we have done so far in the
5 fire -- shutdown fire PRA.

6 MS. CUBBAGE: That's coming later today?

7 MR. WACHOWIAK: Later today? No, the
8 shutdown discussion is coming later.

9 MS. CUBBAGE: Yes, okay.

10 MR. WACHOWIAK: Yes, and I put the insight
11 from the fire during shutdown in the shutdown
12 discussion.

13 CHAIRMAN APOSTOLAKIS: So but you are
14 still doing this analysis?

15 MR. WACHOWIAK: We are still doing this
16 analysis.

17 CHAIRMAN APOSTOLAKIS: So you are using
18 the word insight correct. That means we are not done.

19 MR. WACHOWIAK: That's right. We are not
20 done.

21 CHAIRMAN APOSTOLAKIS: It isn't real yet.

22 MR. WACHOWIAK: Okay. So let me move on
23 to the probabilistic flooding analysis. Once again,
24 we don't know a real lot about where everything goes
25 in the building. So we had to make some sort of

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1 estimates, and we used experience with flooding in
2 existing BWRs.

3 So there's data on there about how often
4 there is a fire main break. There is data on there
5 how often there is a circ water line break, and we
6 applied those to our different buildings.

7 This is a little bounding here where the
8 data says that the probability of a fire main break is
9 -- I'm trying to remember the numbers -- somewhere
10 around 3 times 10^{-3} per year, and what we did was we
11 applied that 3 times 10^{-3} to every building. So we
12 didn't try to apportion it, like you would if you
13 tried to say what is the total.

14 CHAIRMAN APOSTOLAKIS: Let me raise
15 another question here regarding the fire before we go
16 on.

17 You said that a fire in the turbine
18 building basically will cause loss of feedwater flow
19 and that you go to that event tree.

20 MR. WACHOWIAK: It is that event tree with
21 some other effects in there, too.

22 CHAIRMAN APOSTOLAKIS: Oh, that was the
23 adjustments to the other --

24 MR. WACHOWIAK: Yes, there are other.

25 CHAIRMAN APOSTOLAKIS: -- and may be

1 possibly affected by the fire. Right?

2 MR. WACHOWIAK: Right. The reactor closed
3 cooling water system is in there. So that system
4 would be affected. The instrument air system is in
5 there. So that system would be affected.

6 CHAIRMAN APOSTOLAKIS: Okay, because I was
7 looking at the sequence. So you did that, and even if
8 you do that, it's still 10^{-8} ?

9 MR. WACHOWIAK: Yes. There are really
10 secondary effects. It's the things that are contained
11 in the reactor building are what are providing our
12 protection in that scenario.

13 CHAIRMAN APOSTOLAKIS: Okay.

14 MR. WACHOWIAK: Okay. So the initiator
15 for this is somewhat bounding, because now, instead of
16 using the industry experience, we are using one, two,
17 three, four, five, six times the industry experience,
18 in effect. But we don't know where to apply all those
19 things. So we just did them all and let it go at
20 that.

21 We did include full power in shutdown
22 modes for this, and we will talk about both of those
23 modes here. We are far enough along in the shutdown
24 to talk about it, at least.

25 MR. DENNING: What about design

1 principles? I mean, that's what is so great about the
2 fire analysis, is that it tells you what design
3 principle should I use. I mean other than separation,
4 but are there design principles to minimize the impact
5 of floods on risk that you are taking into account?

6 MR. WACHOWIAK: Yes, and I'm not sure
7 exactly where I got to this on the slide, but for
8 example, one of the things that we found is that the
9 fire code is not necessarily helpful to us in
10 preventing floods.

11 It is there looking at one specific thing,
12 and when they make the regulations for the one
13 specific thing, they tend to affect other things in a
14 way we don't like.

15 In our control building, which is mostly
16 underground, we have to have a fire protection system.
17 Now the equipment that is in there we have minimized -
18 - or we have eliminated anything that needs sprinklers
19 or anything like that, but the code still says you
20 have to have hose stations, and the typical design is
21 you go into your stairwells and you run your fire main
22 through the stairwell, and you have hose stations at
23 the various things that nobody is ever going to use.

24 When we looked at that, we said, well,
25 wait a minute. If you have a break of one of these

1 fire mains and you fill up the stairwell, you exceed
2 the capacity of your flood doors if you put those down
3 in there. They will open, and that will affect
4 everything in that building. What can we do? What
5 can we do to fix this?

6 Well, after some discussions with the
7 designers, we said, well, let's not put the fire main
8 inside the building. Let's put the fire main outside
9 the building in its own chase, and then we just have
10 a little two-inch stub tube that comes through the
11 wall.

12 So we have effectively minimized the
13 probability that we are going to have a large fire
14 main break in that control building, because we were
15 able to take our insight and move the pipe outside.
16 So that is one of the cases where we --

17 DR. WALLIS: As long as the pipe breaks
18 and not the stub connection.

19 MR. WACHOWIAK: The stub connection --
20 One, it is very short. So we were able to reduce the
21 probability there, and that's what we did, was by
22 reducing the frequency.

23 DR. WALLIS: Usually, it's a break from an
24 inadvertent water hammer. That can pop the stub off
25 or it could break the pipe.

1 MR. SIEBER: Or a seismic event.

2 MR. WACHOWIAK: Cause a seismic event?

3 MR. SIEBER: Differential movement between
4 the pipes.

5 DR. WALLIS: The things that have happened
6 in plants have usually been water hammer related, I
7 think.

8 MR. WACHOWIAK: Right.

9 DR. WALLIS: Someone inadvertently drained
10 the main and then turned the water on.

11 MR. SIEBER: Pressure is pretty low.

12 MR. WACHOWIAK: Some of the things that
13 mitigate those, though, are that there are sumps
14 there, and there are ways to get the water out. If it
15 is a two-inch line, we can get the water out with
16 ease. If it is a six-inch line, we would have a
17 pretty hard time with that.

18 So we have tried to look at these things
19 and make it reasonable. We are not trying to impose
20 requirements that could never be met. So anyway --
21 So that is one of the ways that we have addressed some
22 of those.

23 Other ways are that cables have to come
24 from the control building or connections have to come
25 from the control building into the reactor building.

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1 We don't want to have a flood that can affect both of
2 those buildings. We would like it to be confined to
3 one or the other.

4 So as part of the PRA, we are specifying
5 the minimum height that that connection can be, and we
6 don't have water sources on site that can flood up to
7 that level. So there are several places where we are
8 folding what we know from the flood PRA back into the
9 design.

10 MR. SIEBER: I have a question. If you
11 look at this picture, which is on the cover, most of
12 this is underground?

13 MR. WACHOWIAK: Much of that is
14 underground.

15 MR. SIEBER: So how do you get the water
16 out of a flooded compartment? You have sump pumps?

17 MR. WACHOWIAK: There are sump pumps.

18 CHAIRMAN APOSTOLAKIS: Which part is
19 underground, Jack?

20 MR. SIEBER: If you look at where the
21 steam piping comes out, right below -- It's right
22 below where those pipes run.

23 MR. WACHOWIAK: The core is underground.
24 Right?

25 MR. SIEBER: Most of what is on this

1 picture is underground. So you have to have sump
2 pumps, which means that you are dependent in the flood
3 scenario on providing electric power to operate the
4 sump pumps. Otherwise, everything will flood up.
5 Right?

6 MR. WACHOWIAK: Right. Now what we did in
7 the flood PRA is we didn't -- Other than places like
8 where we looked at that in the control building, for
9 the reactor building we didn't take credit for the
10 sump pumps. What we looked at was, if you had a pipe
11 break and you put all the water from that pipe break
12 in there, where does it go? And we failed the
13 equipment that is associated with those levels.

14 Now what we did look at is, if you have
15 flood doors -- let's say they are rated for some
16 elevation of water, and we greatly exceed that
17 elevation of water. We'll say that the door will open
18 to allow it to spread to the different rooms, but we
19 didn't take credit for the sump pumps.

20 MR. SIEBER: Have you analyzed to see the
21 extent to which you can flood a room to the point
22 where everything becomes inoperable, since you don't
23 have gravity drains?

24 MR. WACHOWIAK: In the PRA our assumption
25 is that, if the room is flooded, the equipment will

1 fail.

2 MR. SIEBER: Right.

3 MR. WACHOWIAK: Okay. That's our
4 assumption. In the deterministic flood analysis, they
5 look at whether the equipment will fail due to
6 specific things like water being sprayed on it or
7 other things. But the deterministic flood analysis
8 really has some different set of ground rules applied
9 to it.

10 For example, a fire main can't break in
11 that analysis. It can only leak, and there's various
12 other things in the rules for that. So that we didn't
13 try to take credit for it here.

14 CHAIRMAN APOSTOLAKIS: Let's go on.

15 MR. WACHOWIAK: Okay. Once again, I
16 explained, I think, where I got the number for at
17 power. For shutdown, we had to look around for that.
18 We didn't really have a flood during shutdown
19 reference that we could use.

20 We found some operating experience for
21 BWRs in a NUREG, and we looked through the different
22 flooding events and came up with a flooding
23 probability based on those.

24 CHAIRMAN APOSTOLAKIS: Maybe you said it,
25 Rick, and I missed it. But based on the general

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1 information contained in these reports, these reports
2 presumably have flooding frequencies for existing
3 BWRs. Correct?

4 MR. WACHOWIAK: Yes.

5 CHAIRMAN APOSTOLAKIS: These plants don't
6 have gravity driven pools and so on. So I mean, I
7 wonder whether these frequencies are applicable.

8 MR. WACHOWIAK: We don't have gravity
9 driven pools in any of the buildings that we are
10 looking at here either. Those are in the -- Those are
11 all in the reactor building.

12 CHAIRMAN APOSTOLAKIS: Right. So I mean,
13 shouldn't you be doing something about the flooding
14 frequencies, since you got so much water now all over
15 the place?

16 MR. WACHOWIAK: The water that we have all
17 over the place is inside the containment. We will
18 talk about that during shutdown. That's the time when
19 the water can get out of the containment and into the
20 reactor building. But in general, though, the water
21 sources are the same as existing plants. We've got --

22 CHAIRMAN APOSTOLAKIS: It comes back to
23 the question from Rich. What if these squib valves
24 are actuated?

25 MR. WACHOWIAK: That's all inside the

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1 containment.

2 DR. WALLIS: It's just all the water in
3 the sump. That's all. That's all there is.

4 MR. SIEBER: Yes. You've got to have
5 water in containment someplace. You can have it
6 anywhere.

7 CHAIRMAN APOSTOLAKIS: All right.

8 MR. WACHOWIAK: But we do have other
9 gravity driven -- or gravity draining things that we
10 looked at. If we break off a CRD suction line inside
11 the reactor building, our assumption is that the whole
12 CST goes into the reactor building. Okay? That's
13 pretty much a bounding assumption there.

14 MR. SIEBER: And how big is the CST for
15 this plant?

16 MR. WACHOWIAK: Oh, that's a question I
17 wasn't prepare to answer. It floods --

18 MR. SIEBER: A quarter million gallons?

19 MR. WACHOWIAK: It's a substantial flood
20 in the reactor building. Matter of fact, it moves all
21 the way to the --

22 CHAIRMAN APOSTOLAKIS: Rick, can I show my
23 ignorance here. You guys dismissed it, you know. The
24 water goes down the sump. Big deal. I mean, don't you
25 have anything there? Where are the control rod

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1 drives? Or is it too high? You said yesterday it is
2 what, several meters?

3 MR. WACHOWIAK: If we -- If two of the
4 GDCS pools are drained into the lower dry well, we do
5 know that it will flood up above the core inside the
6 dry well.

7 CHAIRMAN APOSTOLAKIS: Okay. So there is
8 no --

9 MR. WACHOWIAK: We might lose the fine
10 motion control rod drives, but the hydraulic actuation
11 of the control rods would not be affected by that.

12 DR. WALLIS: That's water on water.

13 MR. SIEBER: Yes.

14 MR. WACHOWIAK: So it is not discounted.
15 It is just not specifically there yet.

16 CHAIRMAN APOSTOLAKIS: Oh, it will be?

17 MR. WACHOWIAK: Yes. I think we have to
18 look at the spurious operation of those, and what we
19 would do once we got to the spurious -- Maybe the
20 answer is nothing, but it's still something that --

21 I hit the wrong key. There we go.

22 The major water sources that we -- We went
23 through, and we looked at the water sources in the
24 different buildings. We've got the fuel and aux. pool
25 cooling system that is connected to various pools

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1 there.

2 That actually is one way that you might be
3 able to get water from one of these pools outside of
4 the dry well and into the reactor building, if there
5 is a break and we turn that system on. But once
6 again, that would be something where it would be an
7 infrequent event, and it would be an event that was
8 being controlled by the operators during that time,
9 and isolable. So it's recoverable.

10 Reactor water cleanup and shutdown
11 cooling: That is operating all the time. Once again,
12 that is provided with safety related automatic
13 isolations there. So there would be a limited water
14 source from that.

15 Reactor component cooling water system:
16 It is a closed cooling water system. It's got a
17 limited inventory. We have taken a look at what kind
18 of floods we can get from that, and that is included
19 in the analysis.

20 Fire protection system is also a fairly
21 large source, and in the various places we looked at
22 what was specified, whether it was wet pipe, dry pipe,
23 what kind of alarms and isolations we would get to see
24 where they would be effective. But those are included
25 in the analysis.

1 Feedwater system: If we have a feedwater
2 pipe break, what does that do to these various
3 scenarios? The feedwater pipe break outside
4 containment -- or in the steam tunnel would not be
5 much different from what we have seen in the rest of
6 our analysis, but once again we are looking into what
7 those different feedwater pipe breaks might mean to
8 the different scenarios.

9 Again, the feedwater pipe break, we don't
10 think, will cause a total loss of feedwater, because
11 we will lose that one train. The other train comes up
12 to speed with our aux. -- our adjustable speed drives
13 very quickly. That is what they are designed to do,
14 to make up for that before we would get any flooding
15 from this feedwater system that would affect multiple
16 trains.

17 In the control building, our major water
18 source --

19 DR. WALLIS: What do you use for frequency
20 of feedwater pipe breaks? Where do you get that from?
21 Get it from a NUREG? Just count all the -- or only
22 for BWRs? Do you just count all the PWR line breaks?

23 MR. WACHOWIAK: The way we did the
24 feedwater line break was we got the number from our
25 LOCA analysis from internal events for the feedwater.

1 From the NUREG we got things like fire pipe breaks and
2 service water pipe breaks and circ water pipe breaks.

3 DR. WALLIS: Your feedwater design is the
4 same as it would be for existing BWRs?

5 MR. WACHOWIAK: No. It is much better.

6 DR. WALLIS: It's much better? You know,
7 in feedwater design you got to be careful about water
8 hammer when you are putting cold water into the steam
9 area. I assume that you have done it right, but who
10 knows? I'm a bit concerned about applying sort of
11 existing old data to a new design.

12 MR. WACHOWIAK: In the control building
13 we've got a chilled water system, very limited amount
14 of water there, potable water, small; fire protection
15 system, and we talked about that earlier, how we
16 arranged that so that the big pipes are outside the
17 building.

18 Fuel building: Once again, we can go
19 through these. I don't know if we need to go in
20 detail through each of the different areas.

21 DR. WALLIS: No, we don't.

22 MR. WACHOWIAK: The turbine building here
23 -- the circ water that we think may have already been
24 addressed in the detailed design.

25 Service water building: We looked at that

1 as a separate area, and kind of determined that that
2 really acts like a loss of service water. So we
3 didn't model it further.

4 The way we did these were we identified
5 all these various scenarios that could potentially
6 have floods and damage equipment. So for each given
7 building, we applied the total flood frequency and
8 calculated each of those three scenarios, and then we
9 took the maximum of those three scenarios and said
10 this is the reactor building flooding core damage
11 frequency. We didn't try to split things apart for
12 those different buildings.

13 So it is kind of a maximum type analysis
14 where we had multiple for different -- for the same
15 building.

16 Shutdown flooding scenarios: Once again
17 we looked at different things, applied basically the
18 same type of parameters -- or same type of method.

19 So what did we come up with? Internal
20 flooding: It is not a dominant feature or factor in
21 overall plant risk. Contribution is an order of
22 magnitude less. So maybe you want to say this is, you
23 know, 3.4 now or whatever.

24 CHAIRMAN APOSTOLAKIS: When did the events
25 become 2.9? It was 3.1.

1 MR. WACHOWIAK: Rev. 0, it was 3.1.

2 CHAIRMAN APOSTOLAKIS: And meanwhile it
3 was 8. The trend is right. Right? It's probably an
4 earlier version I have.

5 MR. WACHOWIAK: It is.

6 DR. WALLIS: Now what I read -- again, I
7 must have the earlier version. Was I --

8 MR. WACHOWIAK: This one went up. Right?

9 DR. WALLIS: Two orders of magnitude since
10 I read it.

11 MR. WACHOWIAK: Okay. Now this is what
12 happened since you read it. I'm thinking that the
13 number that you have is probably better.

14 DR. WALLIS: And it might go up two orders
15 of magnitude again.

16 MR. WACHOWIAK: Since you -- When you --
17 or we created the document that you have, we didn't
18 recognize what the -- We did not recognize that
19 scenario with the loss of feedwater as having the
20 sequence of events that it did, when we did the
21 flooding analysis early on.

22 Later in the -- I guess this is the PRA
23 phase -- we recognized that change to the loss of
24 feedwater event and, when we got to Rev. 1, we had not
25 gone back and fed that back in.

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1 DR. WALLIS: That overwhelms my thought,
2 all the other events.

3 MR. WACHOWIAK: That's right. Just like
4 fire, that is where the most of the flood probability
5 comes from, is from that turbine building.

6 DR. WALLIS: So you got an insight from
7 that, that maybe you should do something about the
8 design.

9 MR. WACHOWIAK: And the designers, we
10 think, may have already taken care of it for us before
11 we even got it.

12 DR. WALLIS: Now I would not go into the
13 details here, but when I looked at the event tree, I
14 found that you had sort of had numbers that $1E^{-2}$ for
15 drains not obstructed, just appeared, $1E^{-3}$ for water
16 type drains intact, which means presumably someone
17 didn't leave them open.

18 These numbers look to me like engineering
19 guesses.

20 MR. WACHOWIAK: We have removed those from
21 Rev. 1.

22 DR. WALLIS: You removed all that stuff?

23 MR. WACHOWIAK: Right. We just looked at
24 what the total flooding volume would be.

25 DR. WALLIS: Oh, you took out all the

1 stuff I read.

2 CHAIRMAN APOSTOLAKIS: Well, it seems to
3 me they are going to have to revisit this.

4 MR. WACHOWIAK: I think so, and especially
5 after the staff reviews what we have.

6 CHAIRMAN APOSTOLAKIS: We understand. Is
7 there going to be a Rev. 2?

8 MS. CUBBAGE: Oh, yes.

9 DR. WALLIS: So we shouldn't read anything
10 until we get to Rev. 10 or something?

11 CHAIRMAN APOSTOLAKIS: What should we
12 review?

13 MS. CUBBAGE: AP1000, which was a delta
14 above AP600. In AP1000 there are 15 revisions of the
15 design control document and eight or 10 revs of the
16 PRA.

17 DR. WALLIS: So what do we read?

18 CHAIRMAN APOSTOLAKIS: Well, there is an
19 issue here, because we cannot have 10 supplementary
20 meetings.

21 MS. CUBBAGE: This is an introductory
22 meeting and --

23 CHAIRMAN APOSTOLAKIS: I understand that,
24 but --

25 MS. CUBBAGE: -- when we get to the point

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1 of the staff has completed their evaluation, that is
2 when we are asking for your --

3 DR. WALLIS: Well, but then why did you
4 give us something to read, assuming we wouldn't read
5 it? We read it intelligently.

6 MS. CUBBAGE: If we hadn't given you
7 something to read, then you would have --

8 DR. WALLIS: For the moment, we are asking
9 about the details.

10 CHAIRMAN APOSTOLAKIS: But they are sure
11 it is going to be a BWR. Right? Well, let me ask
12 something I have here. When should the subcommittee
13 meet again? I mean, we were thinking originally late
14 September/early October. Now Rev. 1 will be ready by
15 then. Right?

16 MS. CUBBAGE: We will have all of Rev. 1
17 of the PRA within two weeks.

18 CHAIRMAN APOSTOLAKIS: No. We don't need
19 it in two weeks. The question is: The document we
20 will be reviewing in October is subject to more
21 changes. I mean, should we postpone the subcommittee
22 meeting then?

23 MS. CUBBAGE: I think it is beneficial to
24 have the committee identify issues as early as
25 possible, but there is also the risk of wasting time

1 with cycling through. So I think we will have to take
2 a look at our review schedule for this area, see when
3 it is convenient and the staff has maybe developed
4 their FTR with open item input.

5 CHAIRMAN APOSTOLAKIS: Yes, but on the
6 other hand, Rick also said yesterday that he is not in
7 a position to change the PRA anytime we find
8 something. I mean, we have to do our reviews in a
9 relatively timely manner. Right?

10 MR. WACHOWIAK: Yes. I would like to have
11 still in September the discussion on the methods for
12 HRA and the methods for common cause, things that we
13 think methodologically that you may want to see
14 different in the PRA.

15 MS. CUBBAGE: Right.

16 MR. WACHOWIAK: But discussing which
17 particular sequence happens to be the dominant
18 sequence today may not be the most productive thing.

19 DR. WALLIS: I find a difficulty with
20 that, because very often you get credibility by doing
21 the details right. The devil often is in the details,
22 and if your details keep changing or just being
23 whisked away, then what do we review? How do you gain
24 -- You are not going to gain credibility with an
25 overview of stuff. We've got to be able to dig into

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1 some examples in enough detail to be sure you've done
2 a good job, and if those examples keep changing all
3 the time, what are we going to review?

4 MS. CUBBAGE: Graham, I think -- Rick,
5 correct me if I am wrong, but we are hoping that the
6 delta from Rev. 0 to Rev. 1 will be the most
7 significant one, and the increment will be smaller as
8 we go on. And if now, we've got a big problem.

9 DR. WALLIS: Well, someday we are going to
10 review something and then say yes or no, and we can't
11 review it and you say, oh, but it's changed. That's
12 no good. We are going to say no in that case. You
13 will bring us something, and we are going to say yes
14 or no. We are going to say yes or no on what we see,
15 not on something that is going to be changed. Someday
16 we are going to do that.

17 CHAIRMAN APOSTOLAKIS: I think what they
18 are implying is that we may have to meet again more
19 than once. I thought we were going to meet only once.

20 MS. CUBBAGE: I think we need an interim
21 meeting to talk about methodologies, I think, would be
22 useful. But when we get down to the point where the
23 staff has an SER with open items, there will be the
24 details and PRA that that is based on. So we will be
25 looking to get feedback in a more concrete form at

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1 that time.

2 CHAIRMAN APOSTOLAKIS: Okay. So we will
3 probably have more than one supplementary meeting. So
4 we will schedule one for sometime September/October.

5 DR. WALLIS: Well, I guess when you've
6 got a committee letter, a committee letter will
7 probably be based on something that is not going to
8 whimsically change.

9 CHAIRMAN APOSTOLAKIS: That will be again
10 informational.

11 DR. BONACA: But it seems to me that, you
12 know, my expectation at this stage was, you know, how
13 did the PRA lead you to certain things, and here we
14 are interactively working design.

15 DR. WALLIS: That's good.

16 DR. BONACA: In October, it will be
17 interesting to know -- to have some perspective of how
18 you -- I think you gave it to us already today, but in
19 part you just came in and you described the results of
20 a configuration you have analyzed which is still up
21 there. It will be interesting to see how you went
22 into that, particularly with the design process, to
23 get these results.

24 Yes, you did some of that today and
25 yesterday, but --

1 DR. ARMIJO: I don't think that the
2 details are changing whimsically at all. I believe it
3 is part of the process. As they go through, they
4 learn more. They make some changes, and I think it's
5 all part of the process for where the design stands
6 right now, and I don't think there is anything
7 whimsical about it.

8 DR. WALLIS: When the numbers are changed
9 by over two orders of magnitude -- there is a new
10 event appears which wasn't there before. This seems
11 to me a significant change, whether it is whimsical or
12 not. It's something that might appear whimsical,
13 since we didn't know it was going to happen.

14 DR. ARMIJO: But I would -- The fact that
15 they have a few significant changes doesn't surprise
16 me at this stage of the design and the stage of going
17 through it.

18 CHAIRMAN APOSTOLAKIS: I think another way
19 of looking at it is that we got involved too early,
20 but we are learning.

21 MS. CUBBAGE: Well, I don't believe -- I
22 think in the near future I need to meet with Eric and
23 all of the other ACRS staff members and plot out more
24 of a complete plan for interaction.

25 Just as a matter of reference, on AP600

1 there were six full Committee meetings, 37
2 subcommittee meetings.

3 CHAIRMAN APOSTOLAKIS: Yes, but 36 of them
4 were thermodynamics.

5 MS. CUBBAGE: And AP1000, 8 full
6 committee, nine sub, again heavily weighted on the
7 thermal hydraulics. So --

8 CHAIRMAN APOSTOLAKIS: No, I don't mind
9 having more subcommittee meetings, because it really
10 helps us.

11 DR. WALLIS: Well, we are going to apply
12 thermal hydraulic standards to the PRA now.

13 MS. CUBBAGE: Oh, we are looking at it.

14 DR. WALLIS: When the things change by two
15 orders of magnitude from one day to another --

16 MS. WACHOWIAK: I also want to say, yes,
17 once again we didn't change -- we are not changing
18 things whimsically. It's like they were saying. As
19 we learn more, we incorporate it in. We are hoping
20 that we won't see anymore two order of magnitude
21 increases on anything. However, remember, we are
22 playing around down here in the 10^{-8} - 10^{-10} range, and
23 you know, you can hiccough and you can move to 10^{-10} .

24 CHAIRMAN APOSTOLAKIS: I repeat what I
25 said yesterday. The age of the earth's crust is 3^{10} ,

1 10⁹ years. So you know, maybe we should stop a little
2 bit and --

3 DR. WALLIS: If you were a creationist,
4 you would say it was a lot less than that.

5 DR. ARMIJO: Just a quick question. Is
6 there a chance as the design progresses that that 3 x
7 10⁻⁹ might flip back to the 10⁻¹¹?

8 MR. WACHOWIAK: What I have seen is it is
9 very likely that that will happen. As they added
10 detail to the turbine building, it looks like -- for
11 other reasons than the PRA, it looks like they have
12 addressed the particular circ water pipe break that
13 caused us to get that two order magnitude change.

14 So that one, I may expect to go down.

15 CHAIRMAN APOSTOLAKIS: Rick, what is wrong
16 with having the external events contribute to core
17 damage frequency? The attitude here, it seems to me:
18 No, we must dismiss that. I don't understand that.
19 You are down to the 3 times 10⁻⁸ or 7, whatever it is.
20 I don't see any problem saying, yes, and 10 percent,
21 30 percent of that is due to fire. Why go out of your
22 way to dismiss those?

23 MR. WACHOWIAK: The main reason is that
24 the analysis isn't really on the same footing as what
25 we have done with the internal events.

1 CHAIRMAN APOSTOLAKIS: Well, if you do the
2 bounding analysis, then it's not.

3 MR. WACHOWIAK: Right. So that -- What we
4 are trying to avoid is, if we have these numbers close
5 to each other, then some people may tend to forget
6 that this is our best estimate number, albeit with
7 uncertainties, but this is a bounding number, and this
8 number really isn't 4 times 10^{-9} . It is something
9 different from that.

10 Then when we go back in, and if we just
11 say, well, then let's put it altogether in one big
12 model and solve everything in our one big model like
13 some plants have done, now you get a different --
14 maybe a different maintenance rule, risk significant
15 list than if you had kept them separate, or maybe you
16 get a different --

17 CHAIRMAN APOSTOLAKIS: But they do take
18 into account these things when they establish the
19 maintenance rule, the criteria and so on.

20 MR. WACHOWIAK: Right.

21 CHAIRMAN APOSTOLAKIS: So I don't think
22 that is a problem. In fact, I remember even in the
23 case of special treatment requirements, they kept
24 external events separate, see what kinds of insights
25 we can get from those.

1 MR. WACHOWIAK: That's right. But then we
2 run into the problems with having to have all the
3 expert panels and having to have the separate rules
4 and move things into one bin or the other. So we
5 think that it might be cleaner if could just show that
6 it is not going to be --

7 CHAIRMAN APOSTOLAKIS: I understand that,
8 but I mean, thinking of a little higher plane, you are
9 down to such incredibly low numbers, and to say that
10 the events that cause dependencies are dismissed, and
11 then there are other failures that dominate, it
12 doesn't gel. Right? I mean, you are down to very
13 insignificant --

14 DR. WALLIS: What is most likely to happen
15 in terms of event is something that isn't in this
16 picture at all.

17 CHAIRMAN APOSTOLAKIS: Oh, no. This does
18 not include acts of God.

19 DR. WALLIS: No, it doesn't include
20 something like the Davis-Besse. If anything does
21 happen, it is going to be probably of that type.

22 CHAIRMAN APOSTOLAKIS: But as Rick said --
23 you put it very nicely yesterday, that you are
24 addressing in this design things that have happened
25 before, we can think of. You are not getting into

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1 things that are outside. I mean, whether the safety
2 culture of the plant is good or not is way beyond your
3 capability to control it. Right?

4 MR. WACHOWIAK: At least now, yes.

5 CHAIRMAN APOSTOLAKIS: Anyway, are you
6 done?

7 MR. WACHOWIAK: Quickly, I think we have
8 talked about all these different things here at one
9 point or another. From the flooding, we looked at
10 layout of where things should be.

11 Safety redundancy and separation: We want
12 to try to move things around. Just like in fire, we
13 used our best principles to put things where the
14 floods won't interact so much between different
15 systems.

16 DR. WALLIS: Someday we are going to get
17 to the point where you are going to explain how you
18 predict the probability of a full drain getting
19 blocked. You are going to get to that detail someday?

20 MR. WACHOWIAK: No. I don't think we are
21 going to include the floor drains.

22 DR. WALLIS: Well, it is a 10^{-2} event.
23 According to you, you could easily get a factor of 10
24 out of that one, and you get a few more factors of 10,
25 then things stop being so insignificant.

1 MR. SIEBER: I think the floor drains are
2 important.

3 DR. DENNING: Well, I guess how you treat
4 them. Are you saying that you will assume that the
5 drains don't work and that you will plug them stably
6 or are you assuming that they always work?

7 DR. WALLIS: They have a 10^{-2} .

8 MR. WACHOWIAK: In Revision 1 we have
9 assumed that they don't work.

10 DR. DENNING: They don't work? So it is
11 a conservative assumption.

12 MR. WACHOWIAK: It's conservative.

13 DR. DENNING: In substance.

14 MR. WACHOWIAK: Yes. The only place where
15 it would be nonconservative is if we have a floor
16 drain here where the flood is in this room, and there
17 is nothing bad in that room, but it can go down into
18 the room where there is something that could be a
19 problem. We looked at those. In that case, the floor
20 drain always works.

21 MR. SIEBER: The drains communicate with
22 one another, too.

23 MR. WACHOWIAK: That's right. So I
24 believe we've got backflow devices and things.

25 MR. SIEBER: That's an opportunity plug.

1 Any device you put the drain is an opportunity plug.

2 MR. WACHOWIAK: I will move on to the last
3 couple of slides here before, I think, we might be at
4 a break.

5 The high wind risk is basically our
6 tornado analysis. We treat it as a loss of preferred
7 power with no recovery in the first 24 hours, and we
8 also assume that the condensate storage tank would
9 fail. So that wouldn't be there as a water source.

10 Initiating frequency, though, turns out to
11 be much, much lower than what we have already assumed
12 in the loss of preferred power.

13 CHAIRMAN APOSTOLAKIS: Why this
14 assumption, Rick?

15 MR. WACHOWIAK: Why? Because the tank
16 itself is subject to tornado missiles.

17 CHAIRMAN APOSTOLAKIS: It's outside?

18 MR. WACHOWIAK: It's outside, and we could
19 potentially drain that tank.

20 We treat it this way. When we run through
21 the calculation for it, though, it turned out to be
22 rather small. We will be readdressing that again when
23 we update through, but we think it is still going to
24 be small. the initiating frequency is not --

25 DR. WALLIS: It makes a bit of difference

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1 where you put the plant, doesn't it? High wind risks
2 are certainly much greater in certain parts of the
3 country than others.

4 MR. WACHOWIAK: High wind or tornado?

5 DR. WALLIS: Or both.

6 MR. WACHOWIAK: There's little difference.
7 The highest rate winds are already built into the loss
8 of preferred power scenario. So that's already in
9 there. But if we are talking about tornadoes, things
10 that can have this other effect on top of it, those
11 tend to be a much lower probability than a loss of
12 off-site power, which is in the one in five years.

13 DR. WALLIS: It makes a difference where
14 you put the plant. For a plant in Oklahoma, it is
15 very different from putting it in Alaska.

16 DR. DENNING: For your initiator
17 frequency, what was your assumption on the tornado?

18 DR. WACHOWIAK: I'd have to look at that.
19 I don't remember. It probably came from URD, which
20 was drawn from industry averages. I would be
21 surprised if it came from anywhere other than the URD.

22 MR. SIEBER: You can actually construct a
23 plant so that it won't receive damage.

24 DR. BONACA: Why is the plant designed to
25 be so much underground?

1 MR. WACHOWIAK: Why is it designed to be
2 underground?

3 DR. BONACA: Yes.

4 MR. SIEBER: It's a good idea. Don't
5 change that.

6 MR. WACHOWIAK: There may be several
7 reasons. I'm not sure that I know.

8 MR. SIEBER: It's easier to build.

9 MR. WACHOWIAK: There are probably many
10 thoughts that went into that. The PRA was not one of
11 them.

12 DR. DENNING: Continue.

13 MR. WACHOWIAK: Okay. We did do a seismic
14 margins analysis to address the capability of the
15 safety systems. Now this is safety systems only where
16 we've looked here. We looked at the design fragility
17 for these systems. Once again, those things would
18 have to be confirmed when the plant was built.

19 We have an entry for the sequence of
20 events. It looks kind of like a loss of off-site
21 power type of event. We assigned the safety systems
22 onto there. Non-safety systems, basically, are
23 assumed to fail in this scenario, and then we looked
24 at along every success path -- or along every path in
25 the sequence what has to fail -- what do we have in

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1 each of those sequences that can prevent the core from
2 being damaged and the minimum -- the maximum fragility
3 for that -- for anything in the path is the fragility
4 for the sequence, and then the minimum fragility for
5 all the sequences, the fragility for the plant. It is
6 not an overly detailed or overly complicated thing.

7 It turns out that all the sequences are at
8 least two times the safe shutdown earthquake. I think
9 it is a little higher than that, 2-point-something.
10 We looked at it for both full power and shutdown, and
11 because of this, we are asserting that it is unlikely
12 that seismic will be a vulnerability.

13 Now will that mean that -- What will it
14 mean for overall risk numbers if we ever do a seismic
15 PRA? That's uncertain at this point. We can't say.

16 MR. SIEBER: Well, it gets some insights.
17 It's all you can do.

18 MR. WACHOWIAK: We can probably get
19 insights.

20 DR. DENNING: So you have no intent to do
21 seismic -- to take a couple of sites and to do a real
22 seismic PRA? Because I think that you are headed
23 toward -- When we wind up with an operating plant,
24 then this is the risk dominant for many plants. This
25 is dominaturist. Am I wrong? Because there is

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1 implicit risk associated with the seismic margins
2 analysis that is more like the traditional risks we
3 have had.

4 Now here you are designing a plant to be
5 a 10^{-7} , 10^{08} plant, but you are using more the
6 historical seismic logic here. Am I wrong?

7 MR. WACHOWIAK: I wouldn't say that you
8 are wrong. At this point, though, from my
9 understanding of DCD and what goes into a COL
10 application, PRA is at seismic margins would be what
11 we have.

12 CHAIRMAN APOSTOLAKIS: I still have a
13 problem -- what I said earlier. You have a plan that
14 has internally been core analysis frequency way down
15 there, 10^{-6} , and the major common cause failures have
16 dismissed as being insignificant compared to this
17 insignificant number. I have a problem with
18 understanding that.

19 I mean, you could have a strong
20 earthquake. It is going to shake the whole thing, and
21 yet we are saying, oh, no, no, the sequence -- and
22 also preferred power is still dominating, and that
23 involves random failures. That's a little hard to
24 digest. But maybe at another subcommittee meeting we
25 can go more deeply into it.

1 You are already way down there at 10^{-6} ,
2 and you are saying there is a strong earthquake, and
3 that is insignificant compared to the random failure
4 of components. How can that be? There is a reason
5 why earthquakes and fires are usually significant
6 contributors to risk for existing LWRs. The reason is
7 they are contributing events, and the plants are so
8 redundant that, unless you have these big sources of
9 dependency, you don't see much action. But here it
10 seems to be the other way. I am still bothered.

11 I don't have a specific comment that says,
12 hey, guys, here you really overdid it, but I sure
13 would like to have a subcommittee meeting going into
14 this more carefully, and see whether you -- Maybe your
15 results are fine. I don't know, but geez, it just
16 doesn't make sense to me, you know, without getting
17 into the details.

18 I don't know how all the other members
19 feel about it.

20 DR. DENNING: Well, the fire I understand.
21 Fire is a different animal in that you really can
22 design a plant with true separation. Seismic is a
23 different animal.

24 CHAIRMAN APOSTOLAKIS: It's just shaking
25 the whole thing.

1 MS. CUBBAGE: You are talking about an
2 earthquake of a lower probability than the SSE, which
3 could be dominant, because --

4 CHAIRMAN APOSTOLAKIS: Yes, because we are
5 already down to 10^{-6} .

6 MS. CUBBAGE: You could have a 10^{-8}
7 earthquake that would be different than anything they
8 have analyzed.

9 CHAIRMAN APOSTOLAKIS: Yes. Just kills
10 everything.

11 MS. CUBBAGE: So something like that could
12 be dominant.

13 CHAIRMAN APOSTOLAKIS: It could be. Well,
14 it doesn't have to be the dominant in the sense that
15 it would come out 10^{-7} , but to actually say that it's
16 dismissed, compared to $3 \cdot 10^{-8}$ -- I mean, wow.

17 DR. DENNING: I'm not sure it's exactly
18 said that it was. But that's okay.

19 CHAIRMAN APOSTOLAKIS: Are you there,
20 Rick?

21 MR. WACHOWIAK: This one, I did not say
22 that it was dismissed. I said we don't expect it to
23 be a vulnerability. Now how you define a
24 vulnerability is in the details.

25 CHAIRMAN APOSTOLAKIS: We are very clever.

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1 MR. WACHOWIAK: I think that's it for
2 break time.

3 CHAIRMAN APOSTOLAKIS: We still have your
4 shutdown management.

5 MR. WACHOWIAK: That will be short.

6 CHAIRMAN APOSTOLAKIS: Because members
7 will start disappearing -- In fact, everybody will
8 leave at twelve. All right?

9 DR. DENNING: Well, Graham is actually
10 about to leave. Is that true, Graham?

11 CHAIRMAN APOSTOLAKIS: Graham is leaving
12 a little earlier.

13 DR. WALLIS: After the break.

14 CHAIRMAN APOSTOLAKIS: After the break?
15 You are here for the break?

16 DR. DENNING: The alternative would be to
17 do the shutdown now, and then Graham can take off.

18 CHAIRMAN APOSTOLAKIS: You guys, you are
19 asking me to violate my principles.

20 DR. WALLIS: It's supposed to be at 10:30.
21 the break is on the schedule for 10:30.

22 (Whereupon, the foregoing matter went off
23 the record at 10:03 a.m. and went back on the record
24 at 10:17 a.m.)

25 CHAIRMAN APOSTOLAKIS: The next

1 presentation is on the shutdown events, and I noticed
2 that you never use the word risk assessment. You
3 always say risk management. Is that a conscious
4 decision or it just happened?

5 MR. WACHOWIAK: Yes, it is. It's a
6 conscious decision.

7 CHAIRMAN APOSTOLAKIS: It's a conscious
8 decision. Okay.

9 MR. WACHOWIAK: In the process where we
10 are in the design, at least we have the great
11 opportunity that we can manage the risk.

12 MR. SIEBER: So you haven't built anything
13 yet. So you can change the plant to manage the risk.

14 MR. WACHOWIAK: David has a couple of
15 answers to some questions that came up previously.
16 Been doing some research here.

17 MR. HINDS: This is David Hinds with GE.
18 Just a couple of quick answers to the questions that
19 came up, at least a couple of them that we had to
20 table. In fact, one of them is an actual correction.

21 The question related to grade elevation
22 and what is below grade elevation. If you look at
23 those cutaways -- I think they are on your handouts --
24 the grade elevation is approximately equal to the
25 bottom of the suppression pool, similar to the bottom

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1 of the core. So the bottom of the suppression pool is
2 equivalent with grade elevation, as per the plan.

3 Now there will be slight -- potentially
4 slight differences on site specifics, but that's the
5 approximate grade elevation right now, at the bottom
6 of the suppression pool. Okay.

7 Additionally -- it's actually a correction
8 from one of the questions that was asked, and we made
9 a quick answer to, and I need to correct a little bit,
10 in that it wasn't exactly correct. We have also a
11 question that you had related to quickly do we
12 depressurize when we get an actuation signal or SRD.

13 We do not depressurize that quickly. Our
14 design is that, if we get an actuation signal to
15 depressurize, there is a time sequence such that all
16 valves do not open immediately. First the SRVs, the
17 ADS valves -- the SRVs that are ADS valves, five of
18 them open immediately, and then five additional ones
19 open 10 seconds later, and then 50 seconds within the
20 event three of the depressurization valves will open.

21 So there is a time delay such that the
22 initial depressurization begins with SRVs to the
23 suppression pool, and then the complete
24 depressurization begins with the DPVs,
25 depressurization valves, 50 seconds into the event.

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1 It begins with three opening, and then a
2 sequence continues on with two more opening at 100
3 seconds, two more opening at 150 and one more opening
4 at 200, eight total DPVs, but they are staggered in
5 50-second increments to bring pressure down totally.

6 I looked at one of the loss of feedwater
7 sequence, and at approximately 280 seconds into the
8 event pressure is low enough for the gravity driven
9 system to eject the vessel. So we were incorrect on
10 our timing sequence.

11 CHAIRMAN APOSTOLAKIS: Okay.

12 MR. HINDS: Thank you.

13 MR. WACHOWIAK: Okay. I want to talk
14 about shutdown. The scope of our shutdown analysis --
15 and once again, this is in Rev. 1. You have Rev. 0
16 now. We don't have all of this in there. In Rev. 0
17 it's there.

18 Internal events, external events: We
19 talked about some of the external events earlier.
20 Seismic margins we talked about.

21 The scope is that we included Mode 5,
22 which is called Shutdown, Mode 6 which is refueling.
23 there are two modes that -- and the power operation is
24 clearly Mode 1. So what happens to Modes 3 and 4, Hot
25 Shutdown and Safe Shutdown?

1 We have taken a look at those two modes
2 and decided that they really are enveloped by what we
3 did in the Mode 1 PRA, and didn't elaborate on these
4 in detail anymore.

5 We will probably, before we are completely
6 done, readdress that to look at specific things like
7 what is the actual sequence during a shutdown for
8 refueling, and also our other colleagues are working
9 on tech specs, and they have a question for us about
10 end stage: Should you have to go to cold shutdown all
11 the time? I think we are going to have to look at
12 that to answer some of their questions.

13 Timing of when those questions will be
14 answered, I'm just not sure. But our scope now is
15 Mode 5, Cold Shutdown; Mode 6, Refueling, and Mode 6
16 is really split into with the cavity flooded and the
17 cavity unflooded, different responses there.

18 Pretty much you have the same level of
19 detail in the shutdown model as we did in the power
20 operation model. We've got event trees. The system
21 models are nearly the same with just some tweaks on
22 them. So it's the same kind of level of detail.

23 I kind of went through which events we are
24 going to look at. Manual shutdown -- there is an
25 event for manual shutdown there. LOCAs, we only

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1 considered in Mode 6. Once again, we are saying that
2 the Mode 5 LOCAs are probably enveloped by or bounded
3 by what we did in the at-power scenarios.

4 Now these other ones, loss of power, loss
5 of shutdown cooling, fires and floods -- we didn't
6 look at those in Mode 6 with the reactor cavity
7 flooded. The main reason is before -- if we are
8 flooded, we've got 72 hours or more before we have to
9 regain the shutdown cooling function.

10 So with that long period of time,
11 something can be done, and from the data that we have
12 seen from plants, existing plants, three days
13 certainly would be an adequate amount of time to do
14 something about recovering that function.

15 One of the things that we did differently
16 for the three models during the shutdown are in the
17 area of the maintenance activities. What did we
18 assume different from the configuration of the plant
19 for the Mode 1 operation?

20 Multiple pumps and trains of feedwater and
21 condensate can be unavailable when we are in shutdown,
22 and that is factored in for all the modes of the
23 shutdown evaluations.

24 A question came up: What about flood and
25 fire barriers? Could any of those be disabled during

1 shutdown? Typically, we see some of that in the
2 existing plants, and how do we want to address that?

3 So as part of our shutdown external events
4 analysis, we looked at the effect of having those
5 barriers disabled. In Mode 6 we assumed that
6 isolation condensers have been taken out of service
7 for maintenance.

8 We allow one GDCS pool to be out of
9 service for maintenance of its valves during Mode 6.
10 PCCS is unavailable in Mode 6, mainly because the
11 containment is open at that point, and it wouldn't do
12 us any good. SRVs and DPVs are assumed to be
13 undergoing maintenance in Mode 6. Therefore, they
14 will be -- Well, the lines to those will probably be
15 blocked off after the event -- or after the flood-up
16 occurs.

17 Now we did look at recovery actions in
18 Mode 6. Shutdown events tend to move slower than the
19 power events, mainly because we are starting from a
20 lower decay heat level, got more time to recover the
21 initiating event.

22 So what we looked at were industry data on
23 loss of shutdown cooling events, loss of offsite power
24 events, loss of service water events, and created a
25 nonrecovery curve similar to what's been published for

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1 loss of offsite power for these other systems, and
2 applied a five-hour recovery to our initiating events.

3 So we will just right now jump over to the
4 results. The manual shutdown is very low. Loss of
5 decay heat removal is very low, and we looked into
6 whether adding that recovery factor is what is driving
7 this; because if the recovery factor is driving it,
8 then I'm not sure we want to -- We will at least want
9 to put that into our sensitivity analysis, but that is
10 not doing it.

11 It would only come up to something times
12 10^{-12} if we removed the recovery factor. So that is
13 not what is driving that there. I think it is just
14 the overall time to respond.

15 Loss of service water is also low. Loss
16 of preferred power is getting into the -- or we are
17 starting to see some things in the scenario, and LOCAs
18 tend to be the highest. We will talk about the LOCAs.
19 It is two specific LOCA scenarios that are the
20 dominant factors here.

21 DR. KRESS: Is there something on how long
22 you will be in shutdown mode?

23 MR. WACHOWIAK: Yes. These are all
24 weighted for the two-year refueling cycle with the
25 refueling outage link that we have stated to the

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1 customers that they would have. So it is weighted to
2 that -- another reason why it is low.

3 In our containment we got all these pools
4 of water here. For now, assume that there is a head
5 up on top of that. But in the shutdown events, we
6 still can flood the reactor up from these other pools.
7 Now the breaks that are giving us most of the risk in
8 shutdown are the breaks that would occur in instrument
9 lines and the reactor water cleanup lines down low on
10 the vessel, these lines that come out underneath the
11 core.

12 If those lines break, then all the water
13 we've got in here comes out and, if it gets down too
14 low, it shuts off shutdown cooling. We lose decay
15 heat. If the lower drywell is intact or these hatches
16 aren't open, we've got enough water in the GDCS pools
17 and every place else to keep this all flooded up so
18 that the decay heat removal can keep on operating.
19 That is not a problem, if we've got this cup here to
20 contain all the water.

21 Certainly, if we've got the refueling pool
22 open up on top, there is enough water there without
23 activating any of the GDCS pools, once again to keep
24 the core covered and keep the shutdown cooling system
25 operating.

1 The problem with that is one of the things
2 we do in the refueling is get under here to maintain
3 the control rod drive mechanisms that are in here.
4 Historically, what plants do is they will open up
5 these hatches. They will run cables through there and
6 airhoses through there and all sorts of things through
7 that, and if this door is open, it doesn't matter what
8 happens with the rest of these things.

9 The water comes out, goes out through the
10 reactor building, floods up everything in the reactor
11 building, and there is not enough left there for the
12 core, even to potentially affect the equipment that
13 could -- like FAPCS that we could be using to pump
14 water back in, that magnitude of flood would affect
15 the FAPCS. So we really don't have any recovery from
16 that event other than getting out and closing the
17 doors.

18 DR. WALLIS: With the water pouring
19 through?

20 MR. WACHOWIAK: Well, yes, and depending
21 on the size, it's anywhere from about an hour and a
22 half to about three hours before the water starts
23 pouring out. So anybody working in there is going to
24 recognize that this is happening. It is going to be
25 a dramatic event for them, and they are going to be

1 out, and people will know about it, and you could get
2 the hatch back on.

3 The problem is all of this stuff that is
4 running through the doors that you have to disconnect
5 before you can get the hatch back on.

6 DR. WALLIS: Well, they may have to walk
7 through some hot water and steam to get to the door.

8 MR. WACHOWIAK: This would be refueling.
9 So it would be warm water. Like I said, it would be
10 a dramatic event for anyone who is in there.

11 In our number that we have there, we have
12 taken credit for the operators and the crew that's out
13 there being able to get that door closed in some --

14 DR. WALLIS: Does the water come down in
15 a way that it would cascade down past the hatch or is
16 it somewhere else? If there is a break, is it going
17 to come --

18 MR. WACHOWIAK: Oh, is it going to come
19 out here? Is it going to come out there?

20 DR. WALLIS: Near the hatch. Is it going
21 to impede the sort of action of shutting the hatch?

22 MR. WACHOWIAK: We don't know that right
23 now, because those pipes have not necessarily been
24 routed. So we wouldn't know. But once again, that's
25 a good question, and we have a new insight now that we

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1 can write down and say don't put the pipes over there
2 so that it would cascade.

3 So that is an issue that goes into that.
4 And here is one of our examples of a PRA as a design
5 tool in process. We've noticed that we could live
6 with a 10^{-9} CDF -- an addition to CDF 10^{-9} CDF, but you
7 know, the thing is that is one of these things where
8 it's a containment bypass also, and do we want to live
9 with a 10^{-9} containment bypass? I don't think that
10 that's someplace where we are going to want to end up.

11 So we are looking at various options.
12 What do we do -- I think I talked about that. What do
13 we do to address this? And we've got several things,
14 brainstorming ideas that we are running past the
15 designer, and we are coming up with an optimized way
16 of making the -- either making it so that that hatch
17 doesn't have to be open. If it's already closed, what
18 do you about the people inside? There's also sorts of
19 different considerations there.

20 Well, and there's ways to address that,
21 too. That's not just a given there, but there's
22 things to do with the hatch. There's things to do
23 with maybe providing service penetrations or maybe a
24 special hatch that goes on during outage that has the
25 service penetrations. We don't really know yet. We

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1 are in the process of determining what we can do.

2 DR. WALLIS: Don't you have lines going
3 through the hatch? You have compressed air or
4 something going through there?

5 MR. WACHOWIAK: That's the problem that we
6 have.

7 DR. WALLIS: Push it out of the way to
8 close the hatch.

9 MR. WACHOWIAK: That's what we are trying
10 to do.

11 DR. WALLIS: Now did you say before there
12 is no recovery from this and that the water is
13 draining out, and it's gone into the reactor building.
14 There is no way to recovery cooling, is there? I
15 mean, you are going to eventually drain the core.

16 MR. WACHOWIAK: Eventually, you are going
17 to drain the core.

18 DR. WALLIS: There is no recovery.

19 MR. WACHOWIAK: We don't like those kind
20 of events.

21 DR. WALLIS: No, I don't like it either.

22 MR. WACHOWIAK: You can stop it.

23 MR. SIEBER: You can stop the event, but
24 like closing the doors.

25 MR. WACHOWIAK: But that's where the

1 question comes in. At what point does the flooding in
2 the reactor building prevent you from keeping on
3 trying to close that door. How long does it take to
4 close the door? Is there some level of water in the
5 drywell that you can't get the door back on anymore?
6 All those things need to be --

7 DR. WALLIS: Or there is some equipment
8 blocking it in some way.

9 MR. WACHOWIAK: I think the equipment we
10 could probably deal with procedures, but once again it
11 is something that I don't know that we want to have
12 hanging over our maintenance and operators' heads
13 there. I think we would prefer a more elegant
14 solution to this.

15 As I said, the design team is looking into
16 what can happen or what we can do in a reasonable
17 manner that provides not necessarily a pressure
18 boundary for containment there anymore but a water
19 tight boundary that we can use so that we can flood up
20 and provide our thing. So this is a PRA insight to
21 the design in progress.

22 MR. MAYNARD: Well, you could also at
23 least clearly limit it to smaller breaks.

24 MR. WACHOWIAK: It is limited to smaller
25 breaks.

1 MR. MAYNARD: You could also have pumps
2 down there.

3 MR. WACHOWIAK: Those are things that in
4 the consideration mix. One of the problems with the
5 pumps down here is, when we are flooded all the way up
6 to the reactor well, we've got 40 meters of water head
7 on top of that hole, and you get quite a bit of water
8 out through a three-inch line with 40 meters of water
9 up on top of it. But we have in the consideration is
10 maybe we bring in some big portable sump pumps that
11 deal with that.

12 MR. SIEBER: Well, you've got to be able
13 to pump it back up to the top.

14 MR. WACHOWIAK: Right. So there are a
15 whole myriad of things that we are looking at to
16 address this, and we are going to try to come to the
17 best solution for both certifying the design, because
18 we want to do that, and for our customers who have to
19 operate this plant.

20 DR. WALLIS: Well, this is a LOCA. You
21 don't go into that hole when the pressure is high, do
22 you?

23 MR. WACHOWIAK: It's not a high -- It's
24 not a LOCA that's caused by pressure in the system.
25 It is a LOCA that mainly is kind of influenced by

1 people being down there.

2 DR. WALLIS: They cause the break?

3 MR. WACHOWIAK: Depends on where it is.

4 There are some valves in there that the break is far
5 enough away in the line that it can be isolated there.

6 MR. MAYNARD: You could have some type of
7 maintenance activity going on in there that breaks the
8 pipe.

9 MR. WACHOWIAK: There's all sorts of
10 things there. Hopefully, when we start building this,
11 we won't be doing those kind of things.

12 MR. SIEBER: Well, the service penetration
13 is a good idea, but I don't think putting it in the
14 hatch is a good idea.

15 MR. MAYNARD: Does the containment -- the
16 equipment hatch up above, does it have a way to close
17 in a fairly rapid manner? I take it, you have some
18 type of equipment hatch up.

19 MR. WACHOWIAK: We have one up on top and
20 one down below.

21 MR. MAYNARD: If you needed to close off
22 containment like in Mode 5 when people have it open,
23 bringing stuff in and out, if you had a LOCA it is at
24 a point. The idea is to be able to get that hatch
25 closed. Do you put any special mechanisms in for

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1 closing that hatch?

2 MR. WACHOWIAK: For the upper drywell?
3 I'm not aware of any scenarios where we would have to
4 close the upper drywell hatch.

5 DR. ARMIJO: Is this a unique problem with
6 this design? I mean, has this issue been in front of
7 BWRs before?

8 MR. WACHOWIAK: It's possible that it has
9 been, but if we look at, let's say, a Mark I plant,
10 the hatch is down low, but the suppression pool is
11 down lower. When you start doing this draining,
12 you've got a long time to fill up the suppression pool
13 before you get to a point where you would have to
14 close the hatch. Also, the ECCS pumps take a suction
15 off that suppression pool and pump it back into the
16 reactor.

17 So this is -- I think this is something
18 that is unique to moving the suppression pool up
19 higher with respect to the reactor. So it's a
20 challenge, and it is -- The main challenge is trying
21 to figure out what is the best option for the
22 customer, because we know we can do it somehow. We
23 just haven't figured out how yet.

24 CHAIRMAN APOSTOLAKIS: Let's move on.

25 MR. WACHOWIAK: Okay. The next thing I

1 want to bring up is that, based on what we have seen
2 so far in our fire analysis, we are not going to be
3 able to say that fire barriers can be uncontrolled
4 during outages. During the outages, we are going to
5 have to do something with the fire barriers.

6 We are either going to have to specify
7 that you don't break them or, if you do, you apply
8 appropriate compensatory measures so that the fire
9 barriers remain reliable. So that was a good thing
10 that was brought up to take a look at during outages,
11 and I think it is something that is going to bear out.

12 There is a possibility that, when we get
13 the detailed routing and layout and fire modeling
14 done, we might be able to relax that, but I don't see
15 that happening anytime during this certification
16 phase. So we will be adding that into our operation
17 and maintenance requirements.

18 Once again, on shutdown it is an iterative
19 process with the design still going forward. Some of
20 the things that -- details that we are dealing with
21 could affect the dominant sequence. Well, they will.
22 We want them to affect the dominant sequence. We
23 don't think there is much left that is going to affect
24 the other sequences and bring them up, but we are
25 continuing to look at that.

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1 As I said before, fire and flood for
2 shutdown is still under development. Flood, we pretty
3 well have nailed down to where we are going to come
4 out for the DCD. Fire, we still have a little bit of
5 work yet to do to get that to the place where we are
6 comfortable releasing it.

7 Now on my last item -- Is there any
8 shutdown questions yet? I'll just move right along
9 into the last one.

10 We saw this earlier yesterday. ESBWR risk
11 management program: We support the goals that we need
12 for this DCD. I think we've got the right scope for
13 what we are trying to do here. We believe we have
14 enhanced the defense in depth of the plant, and
15 through some of the various examples you can see we
16 are using it as a design tool to address things that
17 we are discovering and things that are, in some cases,
18 unique.

19 We are going to continue to modify this
20 thing all the way up to and past plant operation, and
21 this question of where does it fall into whose hands
22 for approval -- I can't answer that, but I do know
23 that we are -- Our goal is to keep advancing this PRA
24 to be state of the art by the time we are operating as
25 a plant.

1 A couple of observations that I have.
2 ESBWR, once again: Robust design; results in a low
3 CDF based on the things that we know about; but as we
4 have been talking for most of this morning, we are
5 testing the limits of what we can do with the
6 techniques that we have here.

7 DR. WALLIS: By the way, while you were
8 talking about what happens underneath the vessel
9 during shutdown, and if these squib valves -- or you
10 break the deluge system when there are people standing
11 around under there, they get a big surprise, too.

12 MR. WACHOWIAK: There's maintenance block
13 valves. Those would be closed.

14 DR. WALLIS: Those were going to be all
15 blocked off, so that that couldn't happen?

16 MR. WACHOWIAK: That's right.

17 DR. WALLIS: Okay, thank you.

18 MR. WACHOWIAK: We looked at that one.

19 The unknowns may be as important as the
20 knowns in some of these cases. I think we've talked
21 about that. So what we are addressing in this PRA is
22 the things that we know about and the things that we
23 can know about.

24 Some screening methods that -- and we've
25 talked about this with the fire stuff. It doesn't

1 seem to be as effective here. Things that we could --
2 If we could show a 10^{-8} sequence using five and a
3 building in an existing plant, we would say, okay, we
4 are done, that's as good as we can get.

5 Here, that's not quite what we can do, and
6 it looks like the thresholds to screen things end up
7 being so low that the unknowns are affecting what we
8 can get to with these thresholds. So that is a
9 difficult question.

10 The other thing that is coming up in the
11 use in the rest of the approval process for this DCD
12 of the PRA -- and here it is looking at risk
13 significant items for the D-RAP and looking at how we
14 do things in the tech specs. Using a relative risk
15 ranking approach and the thresholds that have been
16 used for existing plants can be a problem, I think,
17 for us with the CDF the way we are and with some of
18 the things that we are doing in this analysis.

19 The risk achievement worth value of 2,
20 which has been used for maintenance rule things in the
21 past, gets just about everything in this plant;
22 because everything has some sort of a contribution to
23 keeping the risk low.

24 We've got the function. It's passive
25 function surrounding by the active function with the

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1 support systems, and those things are duplicated over
2 and over throughout -- and all the event trees look
3 fairly much the same. The same equipment is
4 providing things there, and we tend to have everything
5 contributing here, at least somewhat, to risk.

6 An increase by a factor of 2 on 10^{-8} is
7 not the same thing as an increase by a factor of 2 on
8 a 10^{-5} . So that is one of the things there, and so in
9 moving toward passive plants, I am wondering about the
10 relative risk ranking that has been used in the past
11 and how applicable it is for the future.

12 CHAIRMAN APOSTOLAKIS: Well, if the
13 utility decides to make a risk informed change to the
14 plant after it is built, and they use Regulatory Guide
15 1174 -- I mean, geez, even the 10^{-6} would overwhelm
16 everything else.

17 DR. SHACK: They could build 100 new
18 units.

19 MR. SIEBER: You can't make any changes
20 once you get low enough.

21 CHAIRMAN APOSTOLAKIS: The changes there
22 would be even down to the 10^{-7} or 8 range. So we have
23 to change the figure in the Regulatory Guide.

24 MR. WACHOWIAK: So that is one of these
25 things that it's out there on the horizon or just past

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1 the horizon that we ought to be thinking about when we
2 move into approving those other phases of the DCD.

3 CHAIRMAN APOSTOLAKIS: So the main reason
4 why your CDF is so low is because it's a passive
5 plant.

6 MR. WACHOWIAK: Because it's a passive
7 backed up by active backed up by more active.

8 DR. WALLIS: Just by the passive by itself
9 -- You don't get that by the passive by itself.

10 CHAIRMAN APOSTOLAKIS: You get 10⁻⁵.

11 DR. WALLIS: That's right.

12 CHAIRMAN APOSTOLAKIS: You did it, right?
13 You did the focused PRA.

14 MR. WACHOWIAK: Right.

15 CHAIRMAN APOSTOLAKIS: Okay. Anything
16 else? You done?

17 MR. WACHOWIAK: I just want to make sure
18 I put this page back up again. The words are there.
19 We think that, when we compare to other plants using
20 the same methods and the same techniques, we've
21 provided the best level of safety that we've seen so
22 far.

23 DR. WALLIS: Not just for the old fellows.

24 MR. WACHOWIAK: So the next ones will come
25 in after us and say something else. Now it's my turn.

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1 DR. WALLIS: That's been very useful. I
2 thought it was a good overview of the PRA, and we will
3 examine the details, I guess, at some future date.
4 Very useful.

5 MR. WACHOWIAK: Thank you.

6 DR. WALLIS: Thank you.

7 CHAIRMAN APOSTOLAKIS: So who is next?
8 Amy?

9 MS. CUBBAGE: Yes, and we are a few
10 minutes ahead of schedule, and I will review these
11 quickly.

12 CHAIRMAN APOSTOLAKIS: Yes, but it's
13 better if you stood up.

14 MS. CUBBAGE: Okay. I'm getting the
15 computer ready here. I'd like to ask our review team:
16 Bob Palla, Marie Pohida, and Nick Saltos, to come and
17 join me up here in case you have any specific
18 questions about these RAIs.

19 I know that you have received a copy of
20 the RAI letter itself which goes into all these
21 questions in more detail. So this is just intended to
22 provide a quick overview of what questions the staff
23 asked in their preliminary round of questions when the
24 application was first received.

25 We have received responses to some of

1 these questions, but we are waiting for the final
2 Revision 1 to address all of them.

3 The first 10 questions were Bob Palla's
4 questions. They relate to severe accident design
5 features and primarily Level 2 RPA. The first
6 question was regarding the ROAAM methodology. He
7 requested the peer review results to support
8 assessment of the severe accident analysis.

9 We also requested an equipment
10 survivability assessment. We requested additional
11 information regarding the accident management program
12 for guidance and training on the design features, and
13 we requested a more rigorous evaluation of severe
14 accident mitigation design alternatives. That came up
15 a little bit yesterday with the purpose of GE doing a
16 Level 3 PRA, and the results do feed into this
17 analysis.

18 We requested GE to include the
19 contribution from all accident classes in the
20 containment performance. We requested additional
21 information about the lower drywell flooding. This
22 relates to the asbestos steam explosion probability.
23 We requested information about the timing and when the
24 level of water in the lower drywell -- when that would
25 happen.

1 We requested additional detail on the
2 BiMAC system. I think that is going to be a major
3 topic in the review. Additional details were
4 requested regarding corium splash shield and
5 protection of the lower drywell sumps by the BiMAC.

6 Let's see. We requested expanded
7 assessment of PRA uncertainty and importance analysis
8 addressing -- This relates to key containment related
9 features, assumptions and operator actions, and
10 detailed information regarding containment isolation
11 provisions related to containment failure modes.

12 Those were the questions that we had on
13 Level 2. Then the additional questions are Level 1
14 questions. The first set were primarily for at power,
15 and then some additional questions at the end will be
16 regarding shutdown. That's Marie's area.

17 So the first question on Level 1 was a
18 systematic assessment of the impact of thermal
19 hydraulic uncertainty in the PRA models and results,
20 and the main issue there is assessing the MAAP Code
21 for use against the TRACG Code.

22 CHAIRMAN APOSTOLAKIS: I thought there was
23 -- the main issue was passive systems. That's what it
24 is.

25 MR. SALTOS: Nick Saltos. -- with passive

1 systems because of the nature of the guided forces in
2 the Maxus model compared to the plant systems, and
3 errors and uncertainties in the thermal hydraulic
4 parameters can be compared to the guided forces
5 themselves.

6 CHAIRMAN APOSTOLAKIS: What kind of
7 parameters do you have in mind?

8 MR. SALTOS: Decay heat --

9 CHAIRMAN APOSTOLAKIS: But if you have
10 water flowing down, you know, from a height of several
11 meters at least, don't you have enough force there?
12 Do you really care about these?

13 MR. SALTOS: But it's not just that. It's
14 natural circulation. It's gravity. We want a
15 systematic approach, because everything with
16 hydraulics depends -- with a valve here, what happened
17 before? What succeeded? What failed?

18 CHAIRMAN APOSTOLAKIS: Are you focusing on
19 the uncertainties in the various parameters or are you
20 also raising the question of maybe some of the basic
21 assumptions are bounding the geometry of the system,
22 for example?

23 MR. SALTOS: That, too. Yes, all those
24 can be. Geometry, numerical methods could be. Those
25 are -- MAAP, how good MAAP is.

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1 DR. DENNING: But you are also -- I mean,
2 I think that this question really also addresses the
3 question of the probability of failure of the system
4 that is associated with phenomenological uncertainty
5 as opposed to what's happening now for the passive
6 systems. Their failures are all being determined by
7 the failures of certain components.

8 MR. SALTOS: Yes.

9 DR. DENNING: I think this is really an
10 important issue and one that I think the committee
11 ought to have a presentation on later. I think it's
12 a good question.

13 MR. SALTOS: Yes. GE is preparing a
14 topical report on that.

15 MS. CUBBAGE: All right. There has been
16 significant discussion, and we've already had one
17 meeting just on this one RAI.

18 CHAIRMAN APOSTOLAKIS: I know this is an
19 issue for core designs that are based on gas cooled.
20 When are we going -- I mean, I would like to
21 supplement -- get involved in this. Is October too
22 soon? That's okay.

23 MR. WACHOWIAK: I'm not prepared to answer
24 that.

25 CHAIRMAN APOSTOLAKIS: Okay. The real

1 question here, I think, is whether these uncertainties
2 you mentioned may, in fact, change the success
3 criteria. As you say here, the assumed success
4 criteria will change.

5 MR. SALTOS; We don't know that. It may
6 change, and the change could be important or it might
7 not change. We don't know that.

8 CHAIRMAN APOSTOLAKIS: I suspected as
9 much.

10 MS. CUBBAGE: Okay. We requested more
11 documentation of the process for selecting the RTNSS
12 systems. The initial submittal included only the fuel
13 pool and auxiliary system connection to refill the PCC
14 and IC pools with the firewater system, and they have
15 also recently added the BiMAC system. So we want to
16 look more closely at what other systems could or
17 should be included in RTNSS control.

18 CHAIRMAN APOSTOLAKIS: Isn't the whole
19 idea behind this -- how do you pronounce it, RTNSS? --
20 to do something -- to take some structural defense in
21 depth measures, because the uncertainty is so much.
22 I think that's the whole idea.

23 MS. CUBBAGE: That's part of it, and also
24 from a probability standpoint you look at systems that
25 are risk significant, non-safety systems.

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1. MR. SALTOS: Nick Saltos again. The idea
2 is that the non-safety systems are not regulated.
3 They are no regulations for that, and we want them to
4 meet the safety goals, the associated safety goals
5 pretty much for CDF without these systems. And if
6 they cannot meet those goals without these systems,
7 considering even uncertainties, then they will have to
8 take credits for those systems, and then we get
9 regulation for those systems, some kind of regulation.

10 CHAIRMAN APOSTOLAKIS: Wait a minute.
11 Wait a minute. The focus PRA without the active
12 systems shows 10^{-5} .

13 MR. SALTOS: So 5 times 10^{-5} taking credit
14 for the fire pumps which already came in as a
15 candidate for regulation. So then there are
16 uncertainties on top of that that we haven't
17 considered yet, and this number could increase and go
18 up, and some other systems might come in.

19 MS. CUBBAGE: And I think I really wanted
20 to mention that the shutdown aspects here are
21 important as well.

22 MS. POHIDA: I asked this RAI, because no
23 RTNSS evaluation was done for shutdown, and the
24 shutdown -- The focus PRA was done for two reasons.
25 One is to look at the risk impact of only grading

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1 safety related systems. Second of all is in shutdown
2 the decay heat removal function is provided by a non-
3 safety related system. It is not covered in tech
4 specs. Okay?

5 So if you have multiple challenges or
6 multiple challenges to the loss of the RHR function in
7 this plant, that is going to change the shutdown risk.

8 What I'm saying is the likelihood of
9 losing the RHR function, the decay function, could be
10 increased, but it is being provided by a non-safety
11 related system that is not covered in tech specs.

12 In the AP1000 plant, because the decay
13 heat removal function also is not provided by a safety
14 related system, we had availability controls -- okay?
15 -- that were done to maximize the availability of the
16 RHR function during shutdown conditions and its
17 support systems. That type of assessment was not done
18 yet.

19 CHAIRMAN APOSTOLAKIS: But is it possible
20 that you find yourself in a situation where you say,
21 no, the system is too important, it should be a safety
22 related system?

23 MS. POHIDA: Could be. This analysis
24 hasn't been completed yet. The output of the RTNSS
25 process for AP1000 was that the decay heat removal --

1 I mean the RHR system at shutdown and its support
2 systems were not covered in tech specs, but they had
3 availability controls placed on these systems.

4 CHAIRMAN APOSTOLAKIS: I mean, with a
5 RTNSS system is not to declare something safety
6 related, but do something about it. That's really
7 what it is.

8 MS. POHIDA: Especially, it can influence
9 the likelihood or increased likelihood of initiating
10 events, which are challenges to the decay heat
11 function.

12 MS. CUBBAGE: Okay. We requested a lot of
13 additional supporting information to be submitted by
14 GE, including cut sets and --

15 CHAIRMAN APOSTOLAKIS: Excuse me. Has
16 anybody ever used the PRA in, as you say here, the
17 RTNSS process?

18 MS. CUBBAGE: Yes.

19 MR. SALTOS: This review is for the AP600
20 and AP1000.

21 MS. CUBBAGE: The process was established
22 during the --

23 CHAIRMAN APOSTOLAKIS: I know the process.

24 MS. CUBBAGE: And was used on the -- and
25 it is a passive plant issue, and this is the only

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1 other passive design that we have reviewed in addition
2 to AP600.

3 CHAIRMAN APOSTOLAKIS: AP600 was not as
4 passive as this one. Right? Was it?

5 MS. CUBBAGE: I guess you could consider
6 this plant to be more passive, yes.

7 We are waiting for GE to identify the
8 design requirements in the DCD that came out of the
9 PRA so that we could set ITAAC, if necessary or see
10 all action items to verify the assumptions in the PRA.

11 We have requested references for component
12 reliability data. We have requested evaluations of
13 important human actions and associated human errors
14 probabilities.

15 You heard a lot today about the fire
16 analysis. A lot of what Rick is doing now is in
17 response to this RAI. We asked about the fire
18 analysis.

19 CHAIRMAN APOSTOLAKIS: Good.

20 MS. CUBBAGE: And again, fire and floods
21 at shutdown, which was an issue that Rick covered in
22 detail today. That came out of this RAI.

23 We also requested some information about
24 the large release frequency risk during shutdown. Do
25 you want to elaborate on that one at all, Marie?

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1 CHAIRMAN APOSTOLAKIS: Let me understand
2 something here. You keep referring to the goals, the
3 subsidiary goals. The way I know them is that the CDF
4 should be less than 10^{-4} , and the LRF for existing
5 reactors should be less than 10^{-5} .

6 Now you guys sometimes say LRF should be
7 less than 10^{-6} . Is that a new thing?

8 MR. SALTOS: Yes. Well, this was
9 developed in a SECY paper back then when we were
10 developing the policy for the AP600, and it was set to
11 six.

12 CHAIRMAN APOSTOLAKIS: Is that the new
13 thing now?

14 MR. SALTOS: It was developed in late
15 Eighties, early Nineties.

16 CHAIRMAN APOSTOLAKIS: I know t he
17 original was 10^{-6} . Then somehow it became 10^{-5} , and
18 now we are back to 10^{-6} .

19 MR. SALTOS: Yes. Well, not changed
20 since then. That was in the early Nineties.

21 CHAIRMAN APOSTOLAKIS: Well, it's 10^{-5} ,
22 isn't it? It goes up and down.

23 MS. CUBBAGE: We will look up the SECY
24 paper. We can provide a reference on that.

25 DR. KRESS: The new reactors will now be

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1 10⁻⁶.

2 DR. DENNING: Yes. An order of magnitude
3 on both CDF and LRF.

4 CHAIRMAN APOSTOLAKIS: Yes, but these guys
5 are -- at 10⁻⁴ for core damage frequency.

6 DR. KRESS: Yes, that ought to be 10⁻⁵.

7 DR. DENNING: What did you say they were
8 doing? You mean, because they talked about when they
9 didn't take credit for the passive safety systems they
10 got?

11 CHAIRMAN APOSTOLAKIS: No, several times
12 people have referred to the goals, and it's 10⁻⁴, and
13 10⁻⁶ for LRF, and I don't understand.

14 DR. KRESS: I don't either.

15 CHAIRMAN APOSTOLAKIS: Nick said it.

16 MR. SALTOS: This is more conservative.

17 CHAIRMAN APOSTOLAKIS: Yes. The 10⁻⁴ is
18 not conservative.

19 MR. SALTOS: 10⁻⁴ -- Well, this is without
20 the defense in depth, the active systems. That was
21 the agreement at that time to meet these goals without
22 taking credit of the defense in depth active systems.

23 CHAIRMAN APOSTOLAKIS: So the goal is for
24 evolutionary -- a 10⁻⁴ without the active systems,
25 and 10⁻⁶.

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1 MR. SALTOS: Yes. Those were the criteria
2 for bringing in for regulation non-safety active
3 systems.

4 MS. CUBBAGE: You said evolutionary.
5 That's a term that gets thrown around a lot. ABWR
6 would be evolutionary, and these are advanced.

7 CHAIRMAN APOSTOLAKIS: Yes, but they are
8 not Gen. 4. They are not the Gen. 4 stuff.

9 MS. CUBBAGE: Right.

10 CHAIRMAN APOSTOLAKIS: It's just way into
11 the future.

12 MS. POHIDA: Was there anymore questions
13 on RAI-02, the large release frequency? The reason
14 why I asked that question was--

15 DR. KRESS: That's not LE RAI. That's RTL
16 RAI. Right?

17 MS. CUBBAGE: Yes. The large release
18 frequency at this plant is drawn in by events at
19 shutdown. So that's a little bit of a different risk
20 profile than what we've been accustomed to in a plant,
21 and we want to understand this risk profile. So I
22 want to understand about this containment closure, if
23 other events could influence that frequency, and what-
24 not. So --

25 DR. KRESS: But it doesn't have to be

1 early?

2 DR. DENNING: There is no such thing as
3 early.

4 MS. CUBBAGE: I think GE just want it all
5 as LRF rather than trying to differentiate the timing.

6 MR. WACHOWIAK: That's correct.
7 Everything tends to be longer. We weren't trying to
8 try to split hairs to say something is early versus
9 late. We said, if it's a release, it's a release.

10 We actually didn't do much on the LARC.

11 MS. CUBBAGE: Just a release.

12 These additional issues that are listed
13 here were identified in meetings subsequent to
14 issuance of that RAI letter, and they have addressed
15 those in the PRA Rev. We were asking questions about
16 the RCS strain valve path and free seals. Again, the
17 LRF contribution with the containment open; the impact
18 of whether the BiMAC is available or not on the --

19 CHAIRMAN APOSTOLAKIS: Why would that be
20 an issue?

21 MS. CUBBAGE: Which one?

22 CHAIRMAN APOSTOLAKIS: The BiMAC.

23 MR. PALLA: This is Bob Palla with staff.
24 What we were trying to look at is the relationship
25 between the Level 2 and the ability of this design to

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1 meet the safety goals, if one didn't credit the BiMAC
2 system.

3 Now it's basically a system that at this
4 point is conceptual. There is a lot of technical
5 details that would still need to be worked through,
6 and the way that GE has proposed to do this would
7 basically transfer the responsibility for a lot of
8 that to the COL applicant, like the testing program.

9 So -- and another element of this was the
10 ROAAM process in -- The traditional reliance of that
11 process on peer review is quite heavy. In fact, from
12 what we can tell from what GE has submitted regarding
13 the peer review process, it really was not very
14 robust.

15 So we have called into question the degree
16 to which we should be crediting this BiMAC system.
17 Obviously, a number of you have expressed some
18 reservations about a 99 percent reliability of a
19 system that is still conceptual. So we are kind of
20 considering how we are going to approach that in this
21 design certification, and we are going to consider the
22 amount -- you know, perhaps backing off, what if you
23 only assume this thing worked 50 percent of the time.
24 How would that impact the results?

25 Now the way that GE has modeled it, it is

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1 kind of a simplified approach, and I think that
2 basically all of -- If you did that "what if" and
3 didn't credit for BiMAC, basically those releases
4 would go to preventive release. Now if you credited
5 an overlying water pool as having some effectiveness,
6 then you could slice it and dice it, and a fraction of
7 that would still be coolable even without BiMAC. But
8 the reason for asking this question is just to try to
9 parse out how much of the -- how significant would the
10 results change if you didn't credit it at all.

11 We are going to consider looking at some
12 other -- What if you considered less credit for it?

13 CHAIRMAN APOSTOLAKIS: Well, you said, you
14 know, what if it is 50 percent.

15 MR. PALLA: What if it is not there?

16 CHAIRMAN APOSTOLAKIS: Why don't we put
17 just the distribution? Well, I understand that.

18 MR. PALLA: Well, if it's not there, it
19 would be nothing different than ABWR was and we
20 certified a design without the system.

21 CHAIRMAN APOSTOLAKIS: No, I know it is
22 not there, but instead of being sensitivities,
23 assuming different -- I mean, just for the
24 distribution. But the rest of it doesn't include any
25 uncertainty analysis. Right?

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1 MR. PALLA: I mean, to me, you have to
2 know a lot more to do an uncertainty analysis than you
3 do to do a sensitivity.

4 CHAIRMAN APOSTOLAKIS: Yes.

5 MR. PALLA: I wouldn't know how to put a
6 distribution on it. We could try, but I think a
7 sensitivity study is easier to understand and easier
8 for them.

9 CHAIRMAN APOSTOLAKIS: What I mean is --

10 MR. PALLA: Maybe we could have Theo put
11 a distribution on it.

12 CHAIRMAN APOSTOLAKIS: No, but I think you
13 do that, wouldn't you have to consider the
14 uncertainties in the rest of the analysis, though?
15 Why single out -- You would take the whole sequences
16 where that appears.

17 MR. PALLA: Well, we are not looking at --

18 CHAIRMAN APOSTOLAKIS: I'm not
19 criticizing.

20 MR. PALLA: I think a lot of the way that
21 this has been handled in the Level 2 analysis is
22 through more of a bounding approach. I'm not going to
23 say that 99 percent is bounding, but --

24 CHAIRMAN APOSTOLAKIS: You said there was
25 no peer review of the ROAM process. What do you

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1 mean? The actual application of the methodology to
2 this problem? Is that what you mean?

3 MR. PALLA: Yes.

4 CHAIRMAN APOSTOLAKIS: Because ROAAM, I
5 believe, has been reviewed, has it not?

6 MR. PALLA: The ROAAM as a methodology has
7 been reviewed.

8 MR. THEOFANOUS: This is Theo Theofanous.

9 I do want to say that the ROAAM not only
10 has been reviewed, but it has been used very
11 extensively in the past to resolve the issues for the
12 CH Mark 1 liner attack, and in those reviews, as some
13 of you may recall, they were very contested issues.

14 So when we finished the study, we had
15 something like 20 people internationally to review the
16 process, review the results, write reports, and the
17 reports are documented in the same documents in which
18 they had the study.

19 Now on this one here, as far as the stuff
20 that was put in yesterday, it looked to us that they
21 were so -- I don't want to use the word trivial, but
22 it was so simple, and the treatment was so
23 straightforward that we didn't think -- We didn't want
24 to try to review this again, but we picked two people
25 that are independent experts outside of GE, outside of

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1 us, and then GE, to follow their procedures they
2 picked, I think, four people from inside GE, just to
3 follow their own procedures.

4 So we had something like six reviewers,
5 and those are documented in the back of that document
6 that you are supposed to have gotten in December and
7 didn't get it. But I understand it actually came to
8 you inadvertently.

9 In the back there the reports and our
10 responses are in there also, and as you will see from
11 there, our judgment there were no contested issues was
12 actually correct, because there is nothing that was
13 contested by any of those reviews, not even remotely.

14 So maybe what he meant, I think, is that
15 we didn't have the same extent of peer review as in
16 the past, like getting 20 people, and that is correct.
17 So in that respect, it is correct. However, we did
18 have two people independent and four people inside GE,
19 and those reviews indicate there is nothing really to
20 fuss about.

21 CHAIRMAN APOSTOLAKIS: Well, anyway you
22 guys would respond to the RAI.

23 MS. CUBBAGE: Okay. It looks like we only
24 have a couple of issues left here. One would be
25 vulnerability --

1 CHAIRMAN APOSTOLAKIS: Ah, wait a minute
2 now. Modeling of the digital I&C system in the PRA.
3 Is that a fair question, guys? I mean, let's be
4 reasonable.

5 MS. CUBBAGE: Nick, you added that one.

6 CHAIRMAN APOSTOLAKIS: The state of the
7 art does not allow you to do this, and you are asking
8 an applicant to do this, and are they going to
9 establish a research program to do it? What exactly
10 are you asking them to do?

11 MR. SALTOS: Well, the modeling is in a
12 high bounded level. We did that for -- we did that
13 for APR Falmouth. It is modeled in the same way. The
14 actuation failures that we were using -- they are
15 using this passive systems using digital I&C -- are
16 much -- is lower compared to the actuation failure --
17 systems. Therefore, we wanted to see why are those
18 smaller.

19 So they got four trees down to the basic
20 events to where the knowledge we have support the
21 data, and whatever the knowledge does not support make
22 conservative assumptions based on knowledge in modern
23 industry that we can use to support the data, for
24 example, on the software.

25 CHAIRMAN APOSTOLAKIS: Well, I mean maybe

1 what you investigate failures of the digital I&C in
2 the PRA.

3 MR. SALTOS: It was a lot of sensitivity
4 and bounding.

5 CHAIRMAN APOSTOLAKIS: You probably know
6 that lots of research is ongoing right now, one
7 element of which is -- I mean, you guys know how to do
8 it.

9 MR. SALTOS: Well, we don't do it at that
10 point of the day. We need to certify this design, and
11 we certified the AP600 APR a long time ago before the
12 research program is going to be finalized. So we
13 needed to do something about that.

14 CHAIRMAN APOSTOLAKIS: Yes. You are not
15 asking them to model. You are asking them to see
16 whether the -- what is the input.

17 MR. SALTOS: Exactly, and we tried to
18 identify those high level assumptions that would
19 become requirements.

20 CHAIRMAN APOSTOLAKIS: You really like
21 that word, don't you? Every time you stand up, you
22 use it 10 times, requirements. You are with NRR,
23 aren't you?

24 MR. SALTOS: Yes.

25 MS. CUBBAGE: All right. Well, that is

1 all I had. Unless you have any other questions, we
2 are going to turn it over to --

3 CHAIRMAN APOSTOLAKIS: No, there are no
4 other questions.

5 MS. CUBBAGE: Okay.

6 CHAIRMAN APOSTOLAKIS: I'm sorry.
7 Members? I'm sorry.

8 MS. CUBBAGE: Again, this is our
9 preliminary set of questions. We will have additional
10 questions once the staff has an opportunity to review
11 Revision 1 in detail.

12 CHAIRMAN APOSTOLAKIS: I would like to
13 also be brief on this. All these issues are very
14 interesting. So, you know, since we decided to have
15 36 more meetings, we want to get to every single one
16 of them. Okay.

17 MS. CUBBAGE: All right. Office of
18 Research, and actually the contractor, ERI, will be
19 making the next presentation.

20 MR. KHATIB-RAHBAR: For those of you who
21 don't know me, my name is Mohsen Khatib-Rahbar. I'm
22 the principal for Energy Research, which is a company.
23 We are supporting NRC in the severe accident area for
24 ESBWRs.

25 This presentation is very similar to what

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1 we gave actually a few weeks ago. So there is very
2 little new information on it other than keeping --
3 Wow, look at this. Okay.

4 I will give you an overview of what we are
5 doing for the NRC, specifically what is the objective
6 of this work. Today, primarily we are focusing on the
7 work which has been going on for the past few months
8 in the MELCOR development activity. So we have not
9 really started very much in the other issues of the
10 accidents, and the current work that we will be
11 speaking of is the MELCOR work and the confirmatory
12 calculations to verify the applicant's calculations.

13 I will share with you some preliminary
14 results and then discuss some planned analysis and the
15 review of activities.

16 The objective of this work is to support
17 the design certification, review of the severe
18 accident risk by the NRC. We are intending to do an
19 independent assessment of severe accident response.
20 Because it is a new reactor, NRC is trying to learn
21 something about the new specific features that makes
22 it unique.

23 We will also intend to look at some
24 accident source terms as a way to verify the GE based
25 -- MAAP based analysis General Electric has proposed

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1 for the Level 2 analysis.

2 The resolution of severe accident issues
3 that was presented yesterday, of course, is primarily
4 General Electric's responsibility, and one of the
5 things that NRC would want to do here is to try to
6 develop the uncertainties and initial bounding
7 conditions. From what we have learned in the past,
8 this is the essence of really resolving the severe
9 accident issues.

10 It is not so much as whether we can
11 calculate event clearing or not. It is an important
12 issue. What are the uncertainties in specific
13 conditions? How big is the hole size? How much
14 debris you get out? What is the condition in
15 containment, etcetera, etcetera?

16 So the idea here is to try to resolve or
17 try to subjectively develop the solutions and perhaps
18 even subject it to peer review, as it was done for
19 AP600 and AP1000. Then finally, to look at some of
20 the severe accident issues -- as an example, steam
21 explosions -- and to see if NRC considers that to be
22 something significant DCH, etcetera.

23 Let me also give a little bit of the
24 MELCOR activity. The MELCOR model was developed based
25 on the information which was submitted by General

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1 Electric back in late 2005, and the Sandia National
2 Laboratories, which is the developer of the code,
3 issued the latest version of MELCOR, and we got
4 marching orders from the NRC to use that for the
5 analysis.

6 So we developed the initial MELCOR deck
7 for 1.86. This was subjected to independent peer
8 review by Purdue and Sandia and one of their
9 subcontractors. The review comments was provided to
10 us. We addressed the comments. We documented how we
11 addressed the comments, and recognizing that we have
12 problems with MELCOR 1.86, -- these are primarily
13 numerical problems, performance problems -- the
14 decision was made that we will stop that and shift
15 back to 1.85 until these problems are resolved. Then
16 we could come back to that.

17 So what we will discuss today is some
18 preliminary results based on the older version of the
19 code, and we have just received some revisions to
20 1.86, and we are trying to update this input.

21 You may want to know what's the major
22 difference between 1.85 and 1.86 as far as the ESBWR
23 is concerned. One of the things they have done in
24 1.86 is they have developed a molten pool model for
25 within the reactor core, and there is also molten pool

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1 model for the lower half of the reactor pressure
2 vessel.

3 How significant are these in terms of
4 overall picture for the ESBWR, I cannot tell, but
5 those are the recent modeling issues. Otherwise,
6 thermal hydraulics in the codes are basically the
7 same.

8 Other features of this model they have
9 developed: It has the built into containment spray
10 system, the venting system, all the nine yards. Of
11 course, the BiMAC system has not been explicitly
12 modeled, because I am not so sure that it could be
13 modeled within MELCOR, just thinking of the
14 sensitivity.

15 Also in order demonstrate that we are
16 basically taking the correct design conditions from
17 the reactor, we have done three accident steady state
18 calculations with the code and compared that with the
19 DCD results.

20 For some reason this does not show up.
21 The table doesn't show up. Anyway, in your handouts
22 you have some calculation result that shows MELCOR
23 against the DCD results. What you will see there is
24 the biggest difference comes in from the pressure
25 drops across the core plate, and we requested some

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1 additional information from General Electric.
2 Hopefully, we can resolve that, but that is really not
3 a major concern for severe accidents, because pressure
4 drops are really not a concern, just as far as that is
5 concerned.

6 The scenario that we have just picked up
7 to analyze as a preliminary case is a dominant
8 scenario risk contributor in ESBWR. We have zero, and
9 in the short term -- It's a lot of feedwater. Short
10 term and long term fuel and injection -- is not
11 available. The ADS is activated on level. The heat
12 removal by isolation condenser is not corrected, and
13 the PCC and IC pool makeup is available, and is in
14 our analysis. We assumed different makeup of these,
15 and also GDCS deluge system is available and credited
16 in the analysis.

17 We considered two cases, you know, one
18 case where MCCI was suppressed, basically affecting,
19 I think, a perfect BiMAC system; and the second case,
20 which is an obvious case that MCCI is credited. This
21 behaved very much like other small volume
22 containments.

23 Again, for some reason the picture doesn't
24 show up in here, but what does show up --

25 CHAIRMAN APOSTOLAKIS: It doesn't.

1 MR. KHATIB-RAHBAR: Maybe the font is
2 different than the --

3 CHAIRMAN APOSTOLAKIS: Oh, okay.

4 MR. KHATIB-RAHBAR: Maybe I can go
5 through.

6 CHAIRMAN APOSTOLAKIS: No, that's okay.
7 That's all right. You can see it here now.

8 MR. KHATIB-RAHBAR: Can you all see this?
9 Really, the differences in results primarily coming
10 from some of the uncertainty in the assumptions that -
11 - As documented in the DCD, we don't really have
12 enough information, and modular electric and other
13 calculations were run, and most showed actual
14 differences in the code.

15 These are not really significant, but
16 basically, the position of the team, the comparisons
17 are remarkably good, given the fact that they were
18 done with two different codes and so forth. For
19 example, fission product releases -- this is intact
20 containment -- are as close as one can expect to get.
21 They are fairly reasonable.

22 DR. DENNING: Why would the deluge system
23 be -- Why do you have the delay in the activation of
24 the deluge system?

25 MR. KHATIB-RAHBAR: Yes. There are couple

1 of other things. One is in the MAAP calculations, it
2 had stayed intact for a long time after relocation of
3 core debris to the lower half. We don't know the
4 reasons for that. So that substantially changes the
5 time of reactor pressure vessel failure.

6 MR. DENNING: Right.

7 MR. KHATIB-RAHBAR: The other thing is
8 that the deluge system has a temperature sensor on the
9 containment floor. When the temperature is --
10 specific temperature is reached, then the system is
11 activated. That is currently modeled in the MELCOR
12 that we have modeled here. We are not so sure whether
13 that is included in the MAAP or not or whether that
14 is, you know, manually injected or not.

15 DR. DENNING: Presumably, at the time of
16 lower head penetration, you have molten debris. Why
17 didn't it immediately activate when --

18 MR. KHATIB-RAHBAR: Because the
19 thermocouple is supposed to be buried under the
20 concrete. It's not on the surface of the concrete.
21 Is that correct?

22 MR. YUAN: Zhe, you could perhaps comment
23 on that. We assumed it to be the way the thermocouple
24 location, at least you have assumed for your
25 calculations.

1 DR. DENNING: Assume it's four hours.

2 CHAIRMAN APOSTOLAKIS: Speak to the
3 microphone, please. Say who you are.

4 MR. KHATIB-RAHBAR: Why did it take so
5 long for the temperature to be reached for the deluge
6 to become activated?

7 MR. YUAN: I'm Zhe Yuan from ERI. I think
8 we checked that results, because at the rate of mass
9 and the time of mass to come down through the cavity
10 is not sufficient enough to bring up the temperature
11 of the floor.

12 MR. KHATIB-RAHBAR: Initially, you get a
13 small quantity of debris coming out, but the debris
14 has to accumulate to reach enough mass so it can
15 affect the temperature. That is at least what the
16 code calculates.

17 DR. DENNING: Thank you.

18 MR. KHATIB-RAHBAR: This just shows a
19 comparison between --basically the containment
20 pressurization between MELCOR and MAAP, and the
21 results are generally okay.

22 If you were to assume that the BiMAX
23 system is not there, this is a no-brainer. You will
24 clear this containment in 24 hours.

25 What we plan to do is NRC has asked us to

1 look at the risk --

2 CHAIRMAN APOSTOLAKIS: I'm sorry, Mohsen.
3 Go back.

4 MR. KHATIB-RAHBAR: Which one?

5 CHAIRMAN APOSTOLAKIS: The next. Is that
6 what Bob Palla wanted to see? Assuming that there is
7 no BiMAC there, what happens? So you guys come down.
8 I'm trying to understand what's going on, by the way.

9 MR. PALLA: Yes. This is Bob Palla.
10 We've known that this would happen. I think there is
11 a sensitivity study in the ESBWR PRA that would show
12 us a similar result.

13 I was asking for the impact on the PRA
14 results. This is just one sequence. I wanted to look
15 at the sensitivity of the overall results.

16 CHAIRMAN APOSTOLAKIS: Very good. Thank
17 you.

18 DR. DENNING: Mohsen, with MCCI what kind
19 of cesium iodide release did you get in that case?

20 MR. KHATIB-RAHBAR: This is intact
21 containment. This is an intact containment case. So
22 the releases, again, are driven by the designed
23 leakage rates. But of course, what gets released to
24 the containment is -- you know, for BWR what controls
25 the release is -- Since you get the dominant amount of

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1 cesium iodide coming in during the in-vessel phase,
2 that's mostly going to the pool. So it's going to be
3 contained by the pool. So very little amount of
4 cesium iodide comes out. It's not any different than
5 what you see in other plants.

6 In addition, you have a lot of water on
7 top of the core debris heat on the containment floor.
8 So the rest of it is stopped by that anyway.

9 MR. DENNING: Okay.

10 MR. KHATIB-RAHBAR: The rationale for
11 selection of the scenarios that will be analyzed is to
12 provide bounding conditions for the NRC's analysis --
13 for example, the FCI analysis; to enable limited
14 comparisons to the MELCOR calculations; and also MAAP
15 calculations also to assess the sensitivity design
16 operational aspects, like sprays -- NRC is interested
17 in this issue; and also to support any other
18 objectives that NRC may have.

19 So this is like a moving thing, and we do
20 calculations NRC asks us to do.

21 In terms of the rationale for selection of
22 the scenarios, we have looked at the -- There's
23 dominant scenarios, frequency dominant scenarios, and
24 in some cases consequence dominant scenarios. So the
25 idea is to cover the whole spectrum.

1 CHAIRMAN APOSTOLAKIS: We're getting
2 insights, right?

3 MR. KHATIB-RAHBAR: The word that you
4 hate.

5 The MELCOR deck has been completed. There
6 is also -- Some typical calculations have been done,
7 are available. We have identified the scenarios to be
8 analyzed based on the draft Zero and, of course, they
9 may change; and based on MELCOR calculations, for the
10 most part, have been completed, but we are awaiting
11 additional responses from General Electric on specific
12 issues before these are finalized.

13 In terms of the ex-vessel analysis, we
14 have just started looking at this issue. Initial
15 conditions are aimed at confirming the GE calculations
16 under identical conditions. In fact, we are going to
17 be using a code which was developed many years ago.

18 We will formulate initial conditions for
19 ex-vessel analysis, lower head failure location,
20 typical things that one does in ex-vessel analysis,
21 and we will perform an analysis on a wide range of
22 conditions and parameters similar to those which were
23 done for AP600 when we did the reviews for AP600.

24 That basically concludes my presentation.
25 If there any questions, I will be happy to respond to

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1 them.

2 CHAIRMAN APOSTOLAKIS: With lightning
3 speed, Mohsen.

4 MR. KHATIB-RAHBAR: Because I know you
5 guys want to get to the airport. So I don't want to
6 hold you here.

7 CHAIRMAN APOSTOLAKIS: Oh, you've been in
8 this situation yourself. Any questions from the
9 members? Okay. Thank you very much. Yes? Go
10 ahead.

11 MR. WACHOWIAK: I have one point on that.
12 I usually talk loud enough, but I don't have to do
13 that.

14 CHAIRMAN APOSTOLAKIS: You always talk
15 loud enough.

16 MR. WACHOWIAK: Okay. The one question
17 about did that curve answer Bob Palla's question. The
18 answer is no.

19 CHAIRMAN APOSTOLAKIS: Yes. He said it.

20 MR. WACHOWIAK: Okay. That curve and the
21 other ones are just like what we had. It ignores that
22 question. So I just want to be clear on that. That
23 was not to represent what would happen. It's a
24 sensitivity.

25 CHAIRMAN APOSTOLAKIS: We understand that,

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1 Rick. Thank you.

2 Any comments from the members? Okay. So
3 then we will arrange, and Eric here will take care of
4 it.

5 MS. CUBBAGE: He knows where to find me.

6 CHAIRMAN APOSTOLAKIS: We have a meeting.

7 Usually the first week of October, we have the full
8 Committee meeting. So it would have to be after.
9 Yes, sir?

10 DR. DENNING: I did have a question, and
11 that is: You are assuming no letter until after that
12 next meeting?

13 CHAIRMAN APOSTOLAKIS: I hadn't thought
14 about it. It's up to the committee, of course. We
15 can write an interim letter, if we have anything
16 important to say.

17 DR. DENNING: Everything I am seeing so
18 far is quite constructive. So I'm not sure it changes
19 the course of the direction. So I wouldn't see any
20 reason to write it.

21 CHAIRMAN APOSTOLAKIS: Yes. Right now I
22 am not inclined to write an interim letter, but if the
23 members feel otherwise, we can always change our
24 minds.

25 DR. BONACA: I wouldn't. I don't see

1 anything.

2 CHAIRMAN APOSTOLAKIS: There is nothing.

3 MS. CUBBAGE: Too preliminary. We were
4 not expecting a letter at this time but, of course, if
5 you do have any significant issues, the earlier we
6 hear about them, the better.

7 CHAIRMAN APOSTOLAKIS: So we will probably
8 write a letter after we receive the SER, as usual.

9 MS. CUBBAGE: Right.

10 CHAIRMAN APOSTOLAKIS: Typically, there is
11 a separate letter on the PRA. As I recall, for AP600
12 we did write a separate letter, did we not? I'm not
13 really sure.

14 So, no, it is not an issue of letter.
15 It's really an issue of participatory peer review.
16 Right? Educating the committee, raising concerns,
17 getting the feedback from the applicant -- that's the
18 normal way of doing business.

19 MS. CUBBAGE: Right. If we waited until
20 the end of the process to get you involved, it's too
21 late.

22 CHAIRMAN APOSTOLAKIS: The ACRS has
23 changed its modus operandi for a long time now. This
24 is participatory review.

25 Okay, there is nothing else then? I would

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1 like to thank the speakers. This was a very
2 informative meeting, and I learned a lot. I gained a
3 lot of insights.

4 Thank you very much.

5 (Whereupon, the foregoing matter went off
6 the record at 11:30 a.m.)

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CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on
Reactor Safeguards
Reliability and Risk
Assessment Subcommittee

Docket Number: n/a

Location: Rockville, MD

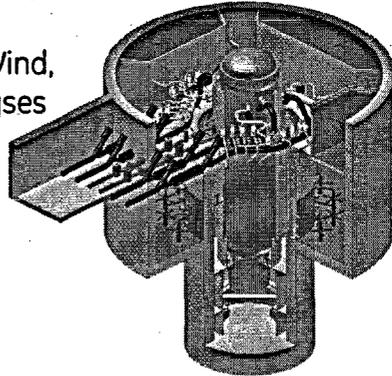
were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.



Eric Mollen
Official Reporter
Neal R. Gross & Co., Inc.

ESBWR External Events Risk Management

Fire, Flood, High Wind,
and Seismic Analyses



Presented By:
Rick Wachowiak
General Electric
April 21, 2006

imagination at work 

Probabilistic Fire Analysis

FIVE Methodology Provides the Bases for:

- > Identifying fire compartments
- > Defining fire ignition frequencies
- > Performing quantitative screening analyses of fire risk

Risk of Core Damage due to Fire in Each of the Area Groups Should be Lower than the Risk of Core Damage due to Internal Events

 imagination at work

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April 20, 2006

Scope of Analysis

Fire scenarios in:

- > Reactor Building
- > Control Building
- > Fuel Building
- > Turbine Building
- > Electrical Building
- > Service Water Building

Full Power and Shutdown Modes of plant operation

 imagination at work

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Bounding Assumptions

Fires Grow Within A Building to Non-Mechanistically Affect All Equipment In A Division

- > Any Fire in a Division I Room In the Reactor Building is Assumed to Damage All Division I Equipment in the Reactor Building

Fire Protection is Not Credited

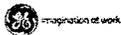
Worst Case Spurious Actuation is Postulated

 imagination at work

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Fire Results

All Fire Scenarios But One Have CDF $< 3 \times 10^{-10}$
Turbine Building Considered One Fire Area
Turbine Building Fire Treated as Loss of Feedwater
This Sequence Has a CDF of 1×10^{-8}
Similar to Loss Of Feedwater in Internal Events



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Shutdown Fire Results

Still Under Development



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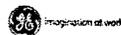
Probabilistic Flooding Analysis

Initiation frequency based upon BWR experience

Flood scenarios in:

- > Reactor Building
- > Control Building
- > Fuel Building
- > Turbine Building
- > Electrical Building
- > Service Water Building

Full Power and Shutdown Modes of plant operation



GE Energy / ESBWR External Events Risk Management
April 20, 2006

Flooding Frequencies

At-Power Flooding Frequencies

Based on the general information contained in NUREG/CR-5750 and NUREG/CR-2300

Shutdown Flooding Frequencies

Shutdown frequencies are calculated based on the data for BWR plants for the years 1980-1996. Provided in NUREG/CR-5496.

The ESBWR flooding frequency values also accounts for a 24 month refueling outage cycle.

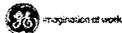


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Reactor Building

Major water sources:

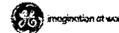
- (1) Fuel Auxiliary Pool Cooling System (FAPCS)
- (2) Reactor water Cleanup / Shutdown Cooling (RWCU/SDC)
- (3) Reactor Component Cooling Water System: (RCCWS)
- (4) Fire Protection System: (FPS)
- (5) Feedwater System: FW pipe breaks are LOCA initiators. FW lines outside containment are located in the steam tunnel. A FW line break in the steam tunnel flood progression into the Turbine Building.



Control Building

Major water sources:

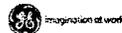
- (1) Chilled Water System: Limited volume of water is not sufficient to cause an initiating event.
- (2) Potable Water and Sanitary Waste System (PWSWS): Small water volume released.
- (3) Fire Protection System (FPS): Pipes are of short length and small diameters (2-1/2 inches). The frequency and the impact of the water released is small.



Fuel Building

Potential flooding sources:

- (1) Fuel and Auxiliary Pools Cooling System (FAPCS): Check valves and vacuum breaker valves eliminate potential siphon effect discharge from the fuel pool. Flooding requires a system pipe break and failure of at least one vacuum breaker valve.
- (2) Reactor Component Cooling Water (RCCW):
- (3) Fire Protection System (FPS): Larger FPS pipes. Water released to the FB lower floor can progress through an open doorway. Large volume of released water could cause the loss of the RWCU/SDC.



Turbine Building

Flooding sources considered are:

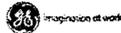
- (1) Circulating Water System (CWS)
Flooding from a break in the circulating water system is the bounding scenario in the TB
- (2) Condensate and Feedwater System (C&FS)
- (3) Reactor Component Cooling Water (RCCWS)
- (4) Plant Service Water System (PSWS)
- (5) Fire Protection System (FPS)



Electrical Building

Flooding sources considered are:

- (1) FPS system: FPS flow rate is low.
- (2) RCCW: Flooding due to diesel generator cooling water system leak in a single diesel generator room is considered to be a negligible risk. Flooding in one diesel generator room would not affect the other diesel generator, and flooding in a DG room would not affect external power supplies, or cause an initiating event.



Service Water Building

The Plant Service Water System (PSWS) is the primary flood source in the Service Water Building.

The loss of service water scenario is included and analyzed in the ESBWR PRA internal events analysis by use of the Complete Loss of PSWS initiator.

The frequency of service water floods in the Service Water Building is inherently included in the Complete Loss of PSWS initiator frequency.



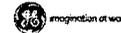
At Power Flooding Scenarios

- AP-1: Reactor Building Outside Containment - CRDS pipe breaks outside containment.
- AP-2: Reactor Building Outside Containment - FPS pipe breaks.
- AP-3: Reactor Building Outside Containment - RWCU/SDCS line break outside of containment.
- AP-4: Reactor Building Outside Containment - FPS line break and general transient
- AP-5: Turbine Building - Complete loss of feedwater
- AP-6: Turbine Building - Loss of Plant Service Water
- AP-7: Electrical Building - Loss of Power Conversion System
- AP-8: Diesel Generator Room - General Transient with Loss of One Diesel Generator



Shutdown Flooding Scenarios

- SD-1 and SD-3: Reactor Building - CRDS pipe breaks outside containment
- SD-2 and SD-4: Reactor Building Outside Containment Shutdown Flooding Scenario
- SD-5 and SD-6: Reactor Coolant System Inventory Control
- SD-7 and SD-8: Fuel Building Shutdown Flooding Scenarios

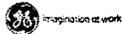


CDF for internal flooding

CDF for internal flooding is a not a dominant contributor to the overall plant CDF.

The contribution due to flood to the CDF is one order of magnitude less than the CDF due to internal events:

Contribution Description	CDF (per calendar year)
Internal Events	2.9E-08
Flood At-Power	3.7E-09
Flood Shutdown	1.6E-09



Key Features Important to Flood Results

- Layout and safety design features
- Safety system redundancy and physical separation provide protection from flooding by large water sources
- Alternate safe shutdown features in buildings separated from flooding of safety systems
- Watertight doors on the Control and Reactor Buildings
- Floor drains in the Reactor and Control Buildings
- Automatic CWS pump trip and valve closure on high water level in the condenser pit



High Wind Risk - Tornado

Treated as Loss of Preferred Power with No Recovery within 24 Hours

Condensate Storage Tank is Assumed Failed

Initiating Event Frequency is Much Lower than LOPP without Recovery

Risk Due to this Scenario is Very Small $\sim 10^{-12}$



Seismic Margins

Addresses the Capability of Safety Systems for Seismic Response

Determined Fragility for All Safety Systems

Assigned That Fragility To Each Branch of The Event Tree

> Non-Safety assigned $0.0 \times SSE$ fragility value

Fragility for the Sequence is the Maximum of Each Branch

Total Fragility is the Minimum of All the Sequences

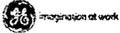


Seismic Margins Results

All Sequences Show At Least 2 * SSE Capability

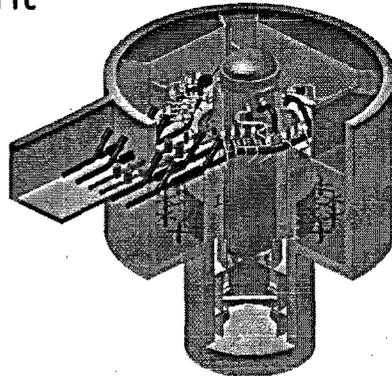
Full Power and Shutdown

Unlikely the Seismic Will Be a Vulnerability



21
GE Energy / ESWR External Events Risk Management
April 26, 2006

ESBWR Shutdown Risk Management



Presented By:
Rick Wachowiak
General Electric
April 21, 2006



Scope of Shutdown Analysis

- Internal Events & External Events
- Seismic Margins
- Mode 5 (Cold Shutdown)
- Mode 6 (Refuel)
- Same Level of Detail as Power Operation PRAs



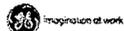
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Initiating Events During Shutdown

- Manual Shutdown
- LOCA – Mode 6 Only
- Loss of Power
- Loss of Shutdown Cooling
- Fires
- Floods

Not Applicable for
Mode 6 With Reactor
Cavity Flooded

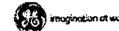
There is More than
72 Hours to Recover
DHR



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Maintenance Activities During Shutdown

- Multiple Pumps / Trains of Feedwater And
Condensate May be Unavailable
- Some Fire and Flood Barriers May Be Open
- ICS Out of Service in Mode 6
- 1 GDSCS Pool Allowed Unavailable in Mode 6
- PCCS Unavailable in Mode 6
- SRVs and DPVs Unavailable in Mode 6



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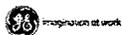
Recovery Actions During Shutdown

Shutdown Events Tend to Move Slower
 More Time to Recover Initiating Event
 Recovery Events Added to Shutdown Model

- > Recovery of Shutdown Cooling
- > Recovery of Offsite Power
- > Recovery of Service Water.

Approximately 5 Hours to Recover

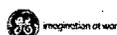
Non-Recovery Value Based on Industry Events that Have Occurred During Shutdown



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Shutdown CDF Results

Manual Shutdown	2×10^{-12}
Loss of DHR	$< 10^{-12}$
Loss of Service Water	3×10^{-12}
Loss of Preferred Power	4×10^{-10}
LOCA	4×10^{-9}

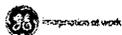
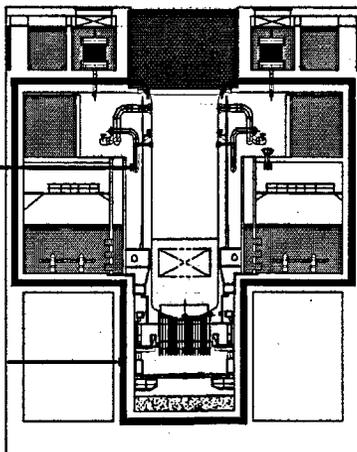


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Containment Water
 Capacity During
 Shutdown LOCA

Approximate Water
 Level With Hatch
 Closed

Elevation of Hatch



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Shutdown PRA As A Design Tool Example

LOCA Dominated by Pipes Connected Below the Core
 PRA Assumes Hatches are Open During Mode 5
 PRA Assumes Containment is Open During Mode 5

GE is Considering Options to Address This Scenario

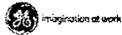


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Shutdown PRA Input to Operational Programs Example

Fire Barriers Should Be Controlled During Shutdown
Remaining Intact is Best Option
Compensatory Measures (e.g. Fire Watch) are Adequate

Detailed Layout / Routing and Fire Modeling Needed to Relax This Requirement



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Final Remarks on Shutdown

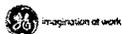
Iterative Process with Design Still in Progress for Shutdown

Fire and Flood Models For Shutdown Still Under Development



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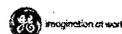
ESBWR Risk Management Insights



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ESBWR Risk Management Program

Supports Desired Goals
Scope is Appropriate
Enhanced Defense-in-Depth
PRA is a Valuable Design Tool
PRA Will Continue to Grow Through Plant Operation



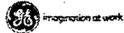
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Overall Results and Observations

ESBWR Robust Design Results in Low CDF and LRF
We Are Testing The Limits of Current PRA Techniques

- > Unknowns may be as important as the known
- Some Screening Methods Not as Effective
 - > Thresholds too low to screen anything
- Relative Risk Ranking Could Be A Significant Issue
 - > Also a threshold problem

When Compared to Other Plants, Using the Same Methods,
ESBWR Provides the Best Level of Safety Available



ESBWR DESIGN CERTIFICATION PRA AND SEVERE ACCIDENTS OVERVIEW

ACRS - Reliability and Probabilistic Risk Assessment
Subcommittee

April 20 & 21, 2006

PRA and Severe Accident RAIs

RAI 19.0.0-1: Requested peer review results for ROAAM methodology used to support the assessment of direct containment heating, steam explosions, and core concrete interactions for ESBWR.

RAI 19.2.3-1: Requested equipment survivability assessment.

RAI 19.2.4-1: Requested information regarding the accident management program under which guidance and training would be provided on the use of such features as containment venting, drywell sprays, and fire pumps for isolation condenser make-up.

RAI 19.4.0-1: Requested more rigorous evaluation of Severe Accident Mitigation Design Alternatives (SAMDA's).

PRA and Severe Accident RAIs (cont.)

RAI 19.0.0-2: GE was requested to include the contribution from all accident classes when characterizing the overall containment performance and risk for severe accidents.

RAI 19.0.0-3: Additional information was requested regarding lower drywell flooding to assess probability of containment failure due to ex-vessel steam explosion.

RAI 19.0.0-4: Additional design details were requested regarding Basemat Internal Melt Arrest and Coolability (BiMAC) system.

RAI 19.0.0-5: Additional details were requested regarding the the corium splash shield and protection of the lower drywell sumps by the BiMAC cooling jacket.

3

PRA and Severe Accident RAIs (cont.)

RAI 19.0.0-6: Requested expanded assessment of PRA uncertainty and importance analysis addressing the uncertainty and sensitivity of results to key containment-related features, assumptions, and operator actions.

RAI 19.0.0-7: Requested detailed information regarding containment isolation provisions/failures related to review of containment failure modes.

RAI 19.1.0-1: Requested a systematic assessment of the impact of thermal-hydraulic uncertainty on the PRA models and results.

RAI 19.1.0-2: Requested more documentation/analyses of the process for selecting RTNSS systems (regulatory treatment of non-safety systems) including systems used during shutdown conditions.

4

PRA and Severe Accident RAIs (cont.)

RAI 19.1.0-3: Requested submittal of additional cutsets and a discussion on the use of uncertainty, sensitivity and importance analyses.

RAI 19.1.0-4: Requested that GE Identify design requirements based on PRA insights and assumptions.

RAI 19.1.0-5: Requested references for component reliability data base.

RAI 19.1.0-6: Requested detailed evaluations of important human actions and their associated human error probabilities.

RAI 19.1.0-7: Requested additional details regarding GE's fire risk analysis.

5

PRA and Severe Accident RAIs (cont.)

RAI 19.3.0-1: Requested risk assessment for fires and floods during shutdown.

RAI 19.3.0-2: Requested discussion of large release frequency (LRF) risk during shutdown.

Additional issues identified during meetings:

- Assessment of potential RCS draindown paths through the RWCU/SDC system and risk of using freeze seals
- LRF contribution from cold shutdown operations when the containment can be open
- Impact on level 2 PRA results if BiMAC is not credited
- Effect of impingement of molten core debris on the lower drywell equipment/personnel hatch
- Drywell water level at time of vessel breach
- Modeling of the digital I&C system in the PRA

6



CONFIRMATORY ANALYSIS OF SEVERE ACCIDENTS FOR ESBWR

Advisory Committee on Reactor Safeguards

U. S. Nuclear Regulatory Commission

April 21, 2006

by:

M. Khatib-Rahbar, Z. Yuan, M. Zavisca, A. Krall and H. Esmaili

Energy Research, Inc.

6167 Executive Blvd.

Rockville, Maryland 20852



OUTLINE

- Objectives
- MELCOR Modeling of ESBWR
- Preliminary Results
- Planned Analyses





OBJECTIVES

- To support the design certification review of severe accident risk by NRC in
 - Independent assessment of severe accident response
 - Confirmatory assessment of representative radiological release estimates
 - Development of uncertainties in the initial and boundary conditions for analysis of selected severe accident issues
 - Confirmatory analysis of selected severe accident issues (e.g., ex-vessel steam explosion, MCCI, etc.)

MELCOR Model Development

- Developed initial input decks for MELCOR 1.8.6 using GE design data
- MELCOR 1.8.6 deck subjected to an independent QA and review (Purdue & SNL/JTA)
- Review comments factored in the modification to the MELCOR 1.8.6 deck
- Due to code performance issues, the deck was finalized for MELCOR 1.8.5
- The initial baseline calculations were performed with MELCOR 1.8.5 & work is underway to finalize MELCOR 1.8.6 deck as performance issues are being resolved by SNL

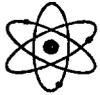


OTHER FEATURES

- Containment spray system and the venting system included
- Refill of PCC/IC pool included.
- BiMAC system not explicitly modeled
- Pre-accident steady state calculation performed prior to simulation of accidents

MELCOR Steady-State Results vs. GE DCD Values

<u>Parameters</u>	<u>Design value</u>	<u>Simulated value</u>
Steam flow rate (kg/s)	2433	2436
Feedwater flow rate (kg/s)	2451	2452
Core coolant flow rate (kg/s)	9034-10584	9452
Control Rod Drive flow rate (kg/s)	5.9	5.9
Cleanup demineralizer system flow rate (kg/s)	24.3	24.3
System pressure, nominal in steam dome (kPa)	7171	7177
System pressure, nominal core design (kPa)	7240	7243
Core inlet temperature (°C)	543-545	543
Total core pressure drop (from bottom of the core support plate to top of the core) (kPa)	70.0	47.0
Core plate pressure drop (kPa)	41.3	31.5
Core maximum exit void fraction	0.916	0.90
Downcomer liquid level (m)	17.27	17.6



MELCOR-Simulated Accident Scenario

- Transient event initiated by a loss of feedwater (i.e., scenario T_DP_nIN of the ESBWR PRA):
 - Short or long-term coolant injection to RPV not available (i.e., GDCS injection to RPV & wetwell injection through equalization lines not available).
 - ADS is assumed to be actuated if downcomer water level drops below 11 m.
 - Heat removal by ICs not credited.
 - PCC & PCC/IC pool makeup available (thereby allowing long-term containment heat removal).
 - GDCS deluge system is also available for injection onto the lower drywell floor.

MELCOR-Simulated Accident Scenario (Cont.)

- Two cases considered:
 - ❖ Case 1: MCCI suppressed (Perfect BiMAC)
 - ❖ Case 2: MCCI allowed to occur (assuming MELCOR standard basaltic concrete composition).

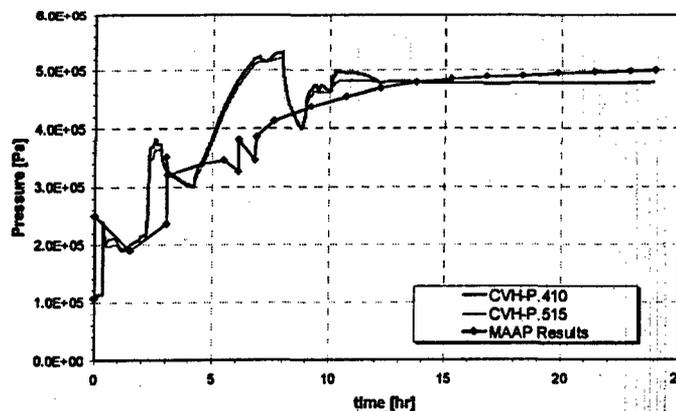


Comparison With MAAP Results (Case 1: Without MCCI)

Event	MAAP ^a	MELCOR
RPV depressurization starts (DPVs open), hour	8.6×10^{-3}	0.33
Start of core uncover, hour	0.36	0.86
Onset of core damage (i.e., fuel temperature exceeds 2500 K), hour	0.97	1.69
RPV lower head penetration failure, hour	6.3	3.91
Deluge system actuated, hour	6.3	7.9
Containment (upper drywell) pressure at 24 hours, bar-abs	5.0	4.8
Containment (lower drywell) temperature at 24 hours, K	425	427
Containment fail/vent, hour	N/A	N/A
PCCS heat removal at 24 hours, MW	18.5	22.7
Water level in drywell at 24 hours (relative to bottom of the RPV), m	13.1	12.5
Axial concrete erosion in 24 hours, m	0.07	0.0
Mass fraction of noble gases released to environment	9.0×10^{-4}	8.7×10^{-4}
Mass fraction of CsI released to environment	7.4×10^{-5}	1.8×10^{-5}

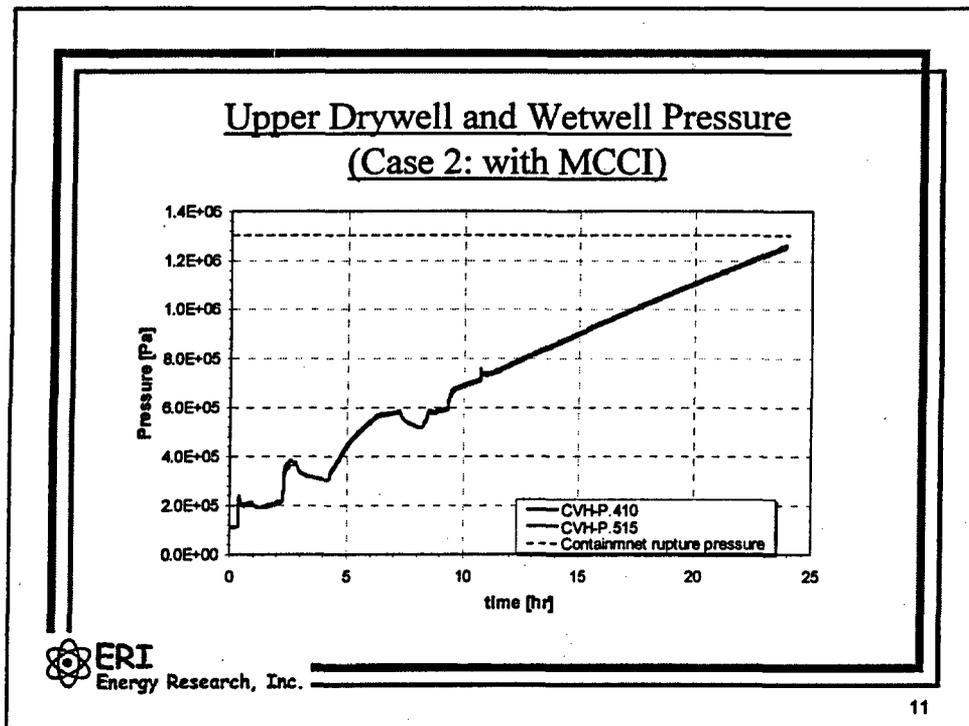
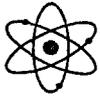
ERI Energy Research, Inc. ^aMAAP results taken from NEDC-33201P (Rev 0)

Upper Drywell and Wetwell Pressure (Case 1: Without MCCI)



ERI Energy Research, Inc.

MAAP results taken from NEDC-33201P (Rev 0)



Planned Calculations

- Rationale for selection of scenarios:
 - To provide initial & boundary conditions for NRC confirmatory analyses (e.g., FCI)
 - To enable limited comparison to MAAP predictions
 - To assess sensitivity to design/operational aspects (e.g., sprays)
 - To support other NRC objectives
- “Risk-dominant”, “frequency-dominant”, and “consequence-dominant” scenarios will be examined, together with influence of various assumptions and sensitivity cases

ERI
Energy Research, Inc.

12



STATUS

- MELCOR model completed and initial confirmatory calculations are underway.
 - Results of a representative accident scenario with limited comparisons to the GE submittal completed
 - Identified representative scenarios to be analyzed
 - Baseline MELCOR calculations for the most part, have been completed with the available data; however, final calculations await the receipt of requested data from GE.

STATUS (Cont.)

- Ex-Vessel FCI analyses have been started:
 - Initial calculations aimed at confirming the GE calculations under identical conditions
 - Will formulate initial conditions for ex-vessel analyses:
 - Lower head failure size and location
 - Debris mass, composition and temperature
 - Etc.
 - Perform analyses to span a wide range of conditions and parameters (similar to those of AP1000)