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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

ESBWR SUBCOMMITTEE

June 3, 2008

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, taken on June 3, 2008, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

MEETING

+ + + + +

ESBWR SUBCOMMITTEE

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TUESDAY,

JUNE 3, 2008

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 9:00 a.m., Michael Corradini, Chairman, presiding.

MEMBERS PRESENT:

MICHAEL CORRADINI	Chairman
SAID ABDEL-KHALIK	Member
GEORGE E. APOSTOLAKIS	Member
J. SAM ARMIJO	Member
DENNIS C. BLEY	Member
MARIO V. BONACA	Member
OTTO L. MAYNARD	Member

MEMBERS PRESENT: (cont'd)

DANA A. POWERS	Member
WILLIAM J. SHACK	Member
JOHN D. SIEBER	Member
JOHN W. STETKAR	Member

CONSULTANTS TO THE SUBCOMMITTEE:

THOMAS S. KRESS

ACRS STAFF PRESENT:

HAROLD J. VANDER MOLEN

HOSSEIN HAMZEHEE

MARK CARUSO

ROCKY FOSTER

AMY CUBBAGE

GEORGE THOMAS

ED FULLER

HOSSEIN ISMAILI

JIM XU

MIKE SNODDERLY

ALSO PRESENT:

RICK WACKOWIAK

GARY MILLER

CLEMENT RAJENDRA

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

(9:00 a.m.)

CHAIRMAN CORRADINI: This meeting will come to order.

This is a meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on the Economic -- on the ESBWR.

My name is Mike Corradini, Chair of the Subcommittee.

The Subcommittee members in attendance are: Said Abdel-Khalik, Sam Armijo, Otto Maynard, Bill Shack, John Sieber, and John Stetkar. Other members present are: George Apostolakis, Dennis Bley, Mario Bonaca, Dana Powers, and our consultant to the Committee, Tom Kress.

The purpose of this meeting is to discuss Chapters 19 and 22 of the chapters of the Safety Evaluation Report, with open items associated with the ESBWR design certification application. The Subcommittee will hear presentations by, and hold discussions with, representatives of the NRC staff and the ESBWR applicant, General Electric Hitachi Nuclear Energy, regarding these matters.

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

Harold Vander Molen 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 May 20, 2008.

A transcript is being kept and will be made available, as stated in the Federal Register notice. It is requested that speakers first identify themselves, and speak with sufficient clarity and volume so that they can be readily heard.

We have not received any requests from members of the public to make oral statements or written comments. So we will proceed now with the meeting, and I will call upon Rick Wackowiak of General Electric Hitachi Nuclear Energy to begin.

Rick?

MR. WACKOWIAK: Good morning. My name is Rick Wackowiak from General Electric Hitachi, and I am the technical lead for the ESBWR PRA. With me today I've got Gary Miller, Principal Engineer from the ESBWR PRA, and then we have our cast off to the side for help. If we get into any specific questions, then we'll get to them as necessary.

This morning, and throughout the day, we want to go through the SER with open items for the ESBWR Chapters 19 and 22 -- is the staff's designation for regulatory treatment of non-safety systems. In our DCD, it's Chapter 19(a), Appendix A to Chapter 19. So those mean the same thing.

The way we're going to go through this is we're going to make our presentation this morning on the PRA, and I believe that will get us through lunch. And right after lunch staff will make their presentation, and then we'll discuss any questions or anything else that comes up from the Chapter 19 review.

This afternoon, then after that, we will make a presentation -- our presentation on the RTNSS, and that chapter of the SER -- 22 -- with open items, and, once again, after that the staff will make their presentation on the same chapter. We'll be here to answer questions about that.

We have a lot of stuff to cover this morning. Many of the -- many of you have seen a lot of the things in the ESBWR PRA report itself. Back in --

CHAIRMAN CORRADINI: 2006.

MR. WACKOWIAK: -- 2006 I think is the last time we talked about this, and we covered some portions of the PRA, up through I believe the Level 1 quantification. And since then, we have submitted two full revisions to the PRA. What we discussed before was the last revision of Chapters 1 through 7, finished that up later on with Chapters 8 through 21 in our report, and then Monday morning you received the next revision of the PRA that is a full -- all now 22 chapters, and we'll talk about -- right toward the end we'll talk about that.

MEMBER APOSTOLAKIS: Why were these revisions taking place? You decided to change it, or is it the result of interactions with the staff?

MR. WACKOWIAK: The DCD has been updated, and so what -- the latest revision to the PRA covers all of the changes that were made to the ESBWR from the time we submitted the last -- or from the time we submitted the last revision through being current with what's in DCD Rev 5.

CHAIRMAN CORRADINI: So we're going to get -- we have not got, but we're going to get --

MR. WACKOWIAK: Haven't gotten it yet.

CHAIRMAN CORRADINI: -- DCD 5 and the associated change to the PRA.

MR. WACKOWIAK: Right. So let me jump to the bottom line on that -- on the Rev to the PRA.

MR. HAMZEHEE: Rick, I think -- I just want to mention that one of the other reasons that you came out with revisions are to also address some of the staff's concerns and questions and those things.

MR. WACKOWIAK: Right. So it's two reasons for having the revision.

We weren't going to spend a lot of time talking about what was in that revision here today, because mainly you haven't seen it. But I just would like to go right to the bottom line for it. The results and insights from the PRA, even though we did some changes to the plant and resolved some issues, they are essentially unchanged from the version of the PRA that you see -- or that you have seen.

MEMBER APOSTOLAKIS: There is one more kind of broad question. Since we don't have a plant -- I mean, there were a lot of assumptions and marketing analysis of the PRA, and so on. I don't remember now -- if somebody actually buys a plant and builds it, will there be a detailed PRA submitted to the NRC, or is that out now? Yes, sir.

MR. HAMZEHEE: Rick, would you like to respond, or do you want me --

MR. WACKOWIAK: I'll respond the way that I understand the current regulation. When somebody buys and builds the ESBWR, they are required to perform a site-specific detailed PRA that conforms to all of the endorsed standards that are in effect one year prior to fuel load.

But that -- there is no requirement that that is to be submitted. It would be -- my understanding is that it would be there for audit purposes. You can come in and look at it. But I don't believe that that's a submitted PRA according to --

CHAIRMAN CORRADINI: Well, but if that day comes, when that day comes --

MR. WACKOWIAK: When that day comes, yes.

CHAIRMAN CORRADINI: -- the results will be available as part of the submittal. The PRA will be onsite.

MR. WACKOWIAK: The results will be available, that's correct.

MEMBER APOSTOLAKIS: But my question is really: will there be another you?

MR. WACKOWIAK: Yes.

MEMBER APOSTOLAKIS: Or are we going to have the situation where you are reviewing something and they would say, "Oh, no. But the design has been certified. You are not supposed to talk about it."

MR. HAMZEHEE: Well, under Part 52 for the COL applicants and COL holders, there are some requirements for the PRA, one of which, as Rick said, is that one year prior to the initial fuel load they have to complete full-scope all-initiating event, plant-specific PRAs, and submit the results and the methodology to the staff for review. So that's a requirement.

And what we have received so far, for instance, as part of the COL application is that they review the existing PRAs and then they evaluate it to see how much additional work they have to perform to make a plant-specific PRA.

MEMBER BLEY: Let me follow that with a question, because we had heard some discussion of how other issues with respect to COL would be handled, and it sounded in other areas like there would just be an exception report. It's the PRA for the design cert with these 10 pages of changes. Is that the way it works?

MR. HAMZEHEE: I'm sorry, Dennis. What is the question? I was interrupted.

MEMBER BLEY: With other design issues,

they told us that when there's a COL they will refer to the design certification and just identify areas where there might be -- where there would be differences. Is that the way this would work?

MR. HAMZEHEE: That's the way they have done it in the last few submittal. But it comes to the staff for review and evaluation. But they looked at the existing PRA, the design certification PRA, and then they determined whether or not that is sufficient for their plant-specific application.

Now, two things they have to consider as a minimum is the following. One, plant-specific features and vulnerabilities; and number two is any departure from design, from certified design, because when COL application comes in they may or may not follow all of the design certification features.

So if there are a number of departures or changes, they have to evaluate them and tell us how they have incorporated those into the risk assessments.

MR. WACKOWIAK: I think we are talking about two different things here, and we've kind of mixed them up a little bit. We have the design certification PRA, and that's based on the assumptions that we made during this review, this design of the planning.

The COLAs will also submit something that addresses the PRA, and it's likely that they will just submit the 10 pages and list exceptions, like you're saying for a COLA, for an application. But, remember, at the application stage, there still is no plant, and there is -- it's still largely based on what we say we're going to do in the design documents.

I think what Dr. Apostolakis was talking about is after the plant is built, then what happens? And at that point, that's when the new statutory requirement for a site-specific PRA comes into play that's based on the as-built and as-to-be-operated plant, and it -- the scope of that is all endorsed PRA standards that are in effect at the time.

And every four years each plant would have to go through and say, "Is there a new standard?" So is now -- is there a seismic PRA standard? Or is there some new standard that's in effect? And every four years the PRA would need to be updated to include any new standards that are out there.

MEMBER APOSTOLAKIS: Now, let me give you an example, so that I will understand better what the plans are. Suppose after this PRA is completed for the built plant, can we raise a question, for example, regarding the frequency of an initiating event that is now in your PRA, or somebody will say, "Wait a minute. This was in the design certification phase. You guys reviewed it. You are not allowed to raise any question now." Is that a fact or not?

MEMBER STETKAR: And when you think about -- let me just add a little bit to help his. Not just the frequency of an initiating event, but suppose there is a piece of equipment in the current plant design -- in the current plant design -- that is not modeled in the current PRA. Are we at some later date able to ask questions about why is that piece of equipment not modeled? Or is this venue the only chance that we have to ask that question?

MR. HAMZEHEE: The answer is yes, the staff can ask that question, how come that piece of equipment is not modeled in the PRA.

MEMBER STETKAR: But when, though? Now?

MR. HAMZEHEE: When they submit their COL application, and then the Part 52 applies to COL holder, so then there is some regulatory requirement that says prior to initial fuel load you have to have a plant-specific PRA which is reflective of your current plant design.

MEMBER STETKAR: But the --

MEMBER SIEBER: We are not going to have access to that PRA.

MEMBER STETKAR: And that's not a change to the design. That's not a site-specific change to the plant design. This is a piece of equipment -- let's call it an X -- that is in the current design. It is not in the current PRA.

It will be in the current design when Joe buys the plant. Joe will not make any changes to X. Joe will not modify the design of X. He will not remove X. He will not get another X. And, therefore, Joe has no site-specific reason to change the PRA for X, because the PRA -- the design-certified PRA theoretically accounted for X. However, it does not.

MR. HAMZEHEE: Yes, you --

MEMBER STETKAR: So how does the review process, and when does the review process, identify that deficiency?

CHAIRMAN CORRADINI: When should it identify --

MEMBER STETKAR: When should it -- well, when should it, or when will it?

MR. HAMZEHEE: Remember, also, there are some requirements under Part 52 that the COL holder, once it starts operating the plant, has to update and upgrade the PRA every four years consistent with the endorsed standards and PRA code. So that's --

MEMBER STETKAR: This is consistent with today's endorsed standards.

MR. HAMZEHEE: Correct.

MEMBER STETKAR: Not with the future endorsed standards. Today's endorsed standards.

MEMBER SIEBER: There is actually a more fundamental question. The PRA that we're going to talk about today represents a PRA for a fictitious plant and examines the boundaries, for example, the site-specific boundaries, seismic conditions, and so forth.

I could picture an applicant saying, "My plant fits inside these boundaries, so the generic PRA is good."

MEMBER STETKAR: Right. Exactly.

MEMBER SIEBER: And the only way we will know whether that is true or not is to examine whatever the staff does to audit the PRA, because you won't have access to the PRA.

MEMBER APOSTOLAKIS: But we can go and audit it ourselves, can't we?

MEMBER SIEBER: Well, I'm not sure exactly what our bylaw says.

MEMBER APOSTOLAKIS: Yes, see, that's the thing. Nobody seems to be sure.

Let me rephrase it slightly. If one raises the question at that time, can either the staff or the applicant say, "No, you cannot raise this question because this issue was settled at the design certification phase." Can they tell me that? Or I can raise any question I want.

MEMBER SIEBER: Well, you can always raise any question you want.

MEMBER APOSTOLAKIS: Yes, I'm worried about --

(Laughter.)

Is it possible for them to say there has been no plant-specific change from the generic PRA you guys receive; therefore, you are not allowed to raise this question?

CHAIRMAN CORRADINI: I guess my -- the pragmatic part of me senses, George, that you can ask the question. The applicant may choose not to answer you, but we have the staff where we want them. So we can keep on asking the staff until we're satisfied, I would think. I would assume.

MR. HAMZEHEE: That's correct, and I --

CHAIRMAN CORRADINI: Is that the wrong

assumption? I think George's concern is that we will be told legalistically we are essentially out of the loop.

MEMBER APOSTOLAKIS: Yes. We don't have the authority to ask this question. Is it clear to you, Rick, what it's going to be?

MR. WACKOWIAK: Yes. I think I understand what you're asking for, or what you are asking about.

MEMBER APOSTOLAKIS: Yes.

MR. WACKOWIAK: And there are other things -- there are other things that I think help provide that linkage. The PRA that -- the site-specific, as-built, as-to-be-operated PRA will be required to meet Reg. Guide 1.200 for use in applications, risk-informed applications at the plant. And now I understand that everything is a risk-informed application, so it's to use for almost any licensing action.

We have the maintenance rule, where the PRA is used in the maintenance rule, and the DRAP -- one of the design reliability assurance program -- one of the activities that is committed to by a COL applicant is to go back with their as-built, as-to-be-operated PRA and reconfirm the important components that are in the DRAP.

So I think there are enough other programs that when you get down to using the PRA you have to make sure that the PRA you have at the time is appropriate for that use. The PRA that we're doing here is appropriate for certifying a design of a plant, and not necessarily appropriate for doing those different applications.

MEMBER APOSTOLAKIS: The problem is that the ACRS doesn't get involved with those applications. We don't. We don't get involved in the actual decisionmaking. We are approving the process. So can someone, then, tell me at that future time, is it possible someone will tell me, "This issue was settled in 2008; you are not supposed to ask questions."

MR. CARUSO: Can I take a crack at that? Mark Caruso from the staff. I think the -- what Rick just said, the fact that the requirements -- the regulations require that they meet the standards, and we have the ASME standard and 1.200, which requires I believe that they have a PRA that represents the as-built, as-operated plant.

If there is a basis for, you know, some -- you know, we look at their design or their procedures, or whatever. We go and audit or, you know, we look at their peer-review results and we say, "Wait a minute.

You know, you guys do things this way. How can that parameter or that frequency that you -- that they have assumed in the design PRA apply? That's a valid question, and we can ask that question. They can't say, "No, you can't ask that question," because you already approved that number five years ago. I believe that's the case.

MEMBER APOSTOLAKIS: But you are saying that I must justify my question.

MR. CARUSO: Yes.

MEMBER APOSTOLAKIS: And I'm saying, so then the answer to my question is, no, you are not allowed to raise an issue that was settled.

MR. CARUSO: No. I think we don't -- you know, I mean, we're not -- we don't review --

MEMBER BONACA: I think there is a basic difference between a defect or something missing in the design and something missing in the PRA that reflects the design. If there is a component that was supposed to be there that is not modeled in the PRA, it's a flaw in the PRA and I don't see why you should not be asked a question. I mean, clearly you have a flaws PRA, because --

MEMBER APOSTOLAKIS: But that flaw is present today, and we will write a letter perhaps saying that the PRA is okay now. So if you approved it today, why are you raising the issue two years down the line? That is my question.

MEMBER SHACK: But it depends on what you're using the PRA for. I mean, the kind of questions we're answering now are, you know, are they going to meet the Commission's safety goals, in all likelihood? You know, have they addressed severe accidents in some way? Whatever application they're making of the PRA at that further time may require more detail and more specificity about a particular system than to answer those kinds of questions.

MR. KRESS: Once you certify a plant, I don't think you can uncertify it. So --

MEMBER APOSTOLAKIS: I'm not talking about uncertifying it. But a PRA is not -- anyway, I mean --

MR. WACKOWIAK: So let me make sure, since we have a lot of material to cover, I think you can see by the size of the package there -- and hopefully it will go -- some of this will go fast, but this is a fundamental question that we need to look at. And I think the first part of my presentation will somewhat get into that.

And I think by having the PRA as part of

Chapter 19 of the DCD somewhat blurs the issue that we're looking at here. What this PRA is is the risk assessment that is being used to say that the design can be certified. It's not a risk assessment for the plant forever.

The application here is: are we going to get a design certification? And the choices and modeling and detail in the PRA is chosen so that we can demonstrate that we meet the Commission's numeric goals, and that we can identify the set of components that we would think are in -- should be monitored under the DRAP program, and a few other things that we'll talk about on upcoming slides.

But the PRA is here to support the design certification application. The PRA is not the PRA that the plant will use forever.

MEMBER SIEBER: But I think it's fair to say that an applicant desiring to build a plant will take this PRA --

MR. WACKOWIAK: Sure.

MEMBER SIEBER: -- and say, "This PRA bounds this design. So all I have to do is go and look where my design differs from the certified design, modify the PRA to take that into account." That's the PRA of record.

And then, later on you can say a couple of things. One of them is, "I'd like to make a change under 1.174, but I'm going to redo my whole PRA and take into account specific plant conditions as opposed to the generic ones." And squeeze in the boundary, the risk goes down, the changes you make may be riskier, but it fits 1.174.

MR. HAMZEHEE: That's correct.

MEMBER SIEBER: And I think that --

MR. HAMZEHEE: That's a fair -- that's right.

MEMBER SIEBER: -- the way I understand the regulations, that's allowed.

MR. HAMZEHEE: That is a fair summary.

MEMBER SIEBER: And the other question is: you can go the other way and say, you know, we have a cutoff in risk below which you don't consider. Well, there's a pretty low cutoff point from individual risk.

On the other hand, there may be thousands or millions of ways, points of entry to get there. And, therefore, it adds -- even though each individual piece doesn't add much to the risk, in the aggregate it adds a fair amount. So I think that's another thing that needs to be examined carefully at this point in time.

CHAIRMAN CORRADINI: John?

MEMBER STETKAR: I think, listening to this discussion, it's kind of interesting because what I'm hearing is everyone is discussing about how the PRA, as it exists today, may be changed in the future to reflect the as-built, as-operated plant design.

Those changes that I have been hearing are all discussions with regard to changes in things that are in the PRA. Is the testing frequency the same in the PRA as in the actual plant? Is the real valve X in the plant the same as was assumed in the PRA? Those are changes to things that are in the PRA.

No one -- and this is after 30 years of doing risk assessment and seeing people use risk assessment -- no one ever looks at changes to things that are not in the PRA. No one ever does that, unless they add a new valve, or a new pump, and say, "Well, this is a new pump. I must put it in my PRA, because it was obviously never in there."

If something is not in the PRA today, no one will ever look at a change to the thing that is not in the PRA, unless somebody actually changes that physical piece of equipment. I guarantee, the staff will not review it, the licensee will not look at it

and ask the question of, "Why is this not in the PRA?" Well, it was not in the PRA because the people who developed the PRA for the certified design decided that it did not need to be in the PRA. That's good enough for me; I'm the licensee.

I've seen this for 30 years of people using PRA. Things will not change in the future. That's why I'm personally very concerned about completeness in this PRA as it's developed today, regardless of how it will be used in the future.

If it is not -- if it does not contain all of the equipment in the plant, if it does not contain all of the initiating events that can affect the plant, if it does not contain all of the types of testing and maintenance that can affect the plant, no one will ever go back and add those in, because none of the discussion that I've heard here for the last 20 minute has discussed people going back and adding things into the PRA that is not there, except for plant-specific hardware changes.

MR. WACKOWIAK: And I would disagree with that, not that we didn't say it, but I would disagree that that's -- that's not part of the process.

On the bottom of the slide here, the updated as-built PRA prior to fuel load, that PRA needs to -- needs to meet all of the requirements in Reg. Guide 1.200, and any other -- which will then, I assume, subsume all of the rest of the endorsed standards.

So, for example, right now there is no standard -- endorsed standard for fire PRA. It's in the works, but it's not there. In this particular application, we tried to use as much information as possible from that developing standard in generating our fire PRA. But we couldn't do all of it. Some of it the information just isn't there, and we'll talk about that a little bit later. And some of it just isn't settled in the industry yet.

However, when that standard is endorsed, and we go back to do the as-built PRA, then everything that -- in that standard, whether we model it or not in the DCD PRA, would have to be included in the as-built as to be operated in the PRA.

So that's how I think the -- "controls" is the wrong word for it, but that's how we ensure that going forward with the new plants is not going to be like the last 30 years with the PRA, that once you have something, that's it, and nobody wants to change it. The Commission has tied the as-built plant PRAs to the standards, and then the standards, as they are updated, the PRAs are required to update to meet those standards every four years.

So I think that's how we get into that. And if we tried today to build a PRA based on a lot of things that some of it is knowable and some of it is not knowable, and convince ourselves that we have covered everything, I think we'll be making a mistake. We can only cover the things that we know about.

Now, there are some examples here that we'll have to get into. We've made some decisions in this PRA about how to deal with certain failure modes -- failure modes for equipment that hasn't been specified, hasn't been purchased, no one has looked at it, we don't have an owner's manual for the equipment, and we do recognize that we have to do a failure modes and effects analysis on that equipment.

And then, for the PRA you would adjust based on the types of information you would find in the FMEA for that equipment. And we see that happening as a continuous process as we fill in the detailed design of the plant, as we set up purchase specifications, as we choose vendors to pick these components, and try to do this little by little along the way.

But it's the as-built PRA that -- at the end that conforms to the standards that says, "You've got to have your failure modes and effects analysis for all of the components, and you have to have -- address those in your PRA." So I think we get there, and I think -- and I think it's different than what we've seen in the past. I think that there are new regulations on this that help.

MEMBER POWERS: Let me ask you a question about that. What you said is all true, I assume, and it seems reasonable to me, but what perplexes me about the presentation is that, given all of those assumptions, given that there is no failure modes and effects, the only thing I see in the PRA presentations and bottom line numbers, you never go through and say, "Okay. Here I have gone through and looked at my performance metrics, and this particular piece of equipment for which I have not specified, has not been purchased, I do not have a user's manual, and I have no failure modes and effects," turns out to be very critical. And yet it never gets an answer.

Why is that? I mean, I see it nowhere. Maybe I don't recognize it, but I never see things like risk achievement worse or risk reduction worse for these hypothetical pieces of equipment that are so critical to these minuscule numbers that show up here on the bottom line.

And it seems to me that that's the piece of information that I want to see now, not in the future, not when the plant gets built. I want to know about it now.

MR. WACKOWIAK: Some of those things are in Chapter 11 of the PRA. There is a section on sensitivities and uncertainties. We addressed the failure rates of the squib valves, which are the main set of critical components that we're relying on. And there is discussions throughout the different system chapters, and in Chapter 11, that do give the risk achievement worse and Fussell-Vesely's of the components that we have modeled in the PRA.

And then, in the discussions -- and that's both for the Level 1, and then I believe we also have similar tables for components with respect to the large release. But I'll have to -- some of those were done in response to questions and not necessarily in the final document.

But that type of thing is addressed, it is discussed, and I think what you'll find in the set -- in the PRA of the assumptions and insights in each of the chapters that we have -- we have a set of insights and key assumptions from that chapter with respect to that particular topic -- that those types of things are discussed.

And then, the final piece of all of that is in Chapter 17 of the DCD. You know, I thought out these chapters and things a lot, so you've got to kind of follow me. There is -- the DRAP is in there, and the DRAP points to an evaluation, an expert panel evaluation, using PRA as an input of the list of the risk-significant components for the -- the risk significance with respect to maintaining reliability that we've assumed in the middle.

And that set of components, which will be then verified by the as-built plant PRA, is carried forward and monitored in the maintenance rule. But I think we've got discussions of those sorts of things in the document, and Chapter 11 would be the place to start.

MR. HAMZEHEE: Rick has a lot of stuff to cover. So if you don't mind, if we can get started, and hopefully at some point we'll know more about what he has done and we can ask more questions.

MEMBER STETKAR: Rick, before you start, let me just ask you point blank -- I just want a yes or no here. You mentioned the standards before. Would you characterize the ESBWR PRA as its exists now

-- Level 1, internal event only -- Level 1, internal event only -- as consistent with the standards in Reg Guide 1.200?

MR. WACKOWIAK: Yes.

MEMBER STETKAR: Thank you. That helps.

MR. WACKOWIAK: Okay. So I think most of the things on here we've already covered in one way or another, but I want to make one last point on the middle bullet there. The design PRA provides a bounding assessment, provides the safety case for the plant license.

If we consider this as a risk-informed application, this PRA is helping us decide, does the plant meet the safety goals? And there is other details and things that are in there. We talk about small numbers. Okay. Maybe the numbers are small, but there are other things that we don't cover in the PRA. You know, where it talks about the dinosaur-killing meteor, those kinds of things, we don't have those kinds of things in the PRA.

The things that historically have been excluded, because they were low-level risk, we didn't remodel those big common events to show that they are still low risk. They're assumed to be the same as existing plants for the most part.

What we did do is we tried to take our events that are -- that do have high risk or measurable risk in existing plants, and address, through design, the features of the plant that we would need to make those risks at about the same level as the things that have always been historically excluded as being acceptable risk.

So that's what we're trying to do. We're trying to -- we're not trying to say this is the number. We're trying to say that the things that have historically been -- contributed to risk at nuclear powerplants for this design should be on par with things that are considered acceptable risk for having a nuclear powerplant.

MEMBER STETKAR: Are you saying that you believe that the actual core damage frequency, then -- the real core damage frequency -- is lower than the estimate in the current PRA? Or could it be substantially higher?

MR. WACKOWIAK: What I was trying to say is that if the risk due to a -- well, let's come up with one of these hypothetical scenarios. Currently, nobody models a moderate meteor hitting the Atlantic Ocean and causing a tsunami and wiping out the eastern seaboard. Okay? That ESBWR probably would not survive that.

MEMBER STETKAR: Currently, people do model seismic events, though, and you don't.

MR. WACKOWIAK: And there's a reason for that. We can get into that later. But for that particular piece, we don't model that. That's considered an acceptable risk or else we wouldn't have nuclear powerplants on the coast, and we don't change that.

Now, for the things that you're talking about here when we do have a seismic PRA standard and it's implementable -- right now, the plant is on paper. We can't go and walk it down. We can't -- we can't tell how the thing was installed. We would be guessing at anything for seismic risk at this point in time.

MEMBER STETKAR: But you do have HCLPF capacities, though, for all of the safety-related equipment, and actual fragility curves for several of the safety-related structures that seem to be derived from fairly detailed analyses.

MR. WACKOWIAK: Yes. We --

MEMBER STETKAR: And we have experience from doing seismic fragility analysis for a large number of components and structures, and have general ratios of median capacities to HCLPF capacities, and we have generic seismic hazard curves. So it's pretty easy to actually try to quantify some -- perhaps an upper bound, but some upper bound to the seismic risk. It takes about, oh, 20 minutes.

Could be about a factor of 30 times higher than the total core damage frequency from everything else, if I did my 20-minute calculation correctly. And yet it's not -- and I probably didn't do it correctly, and it's probably a bit conservative. But it could be several times higher than everything else combined, and that might change a lot of your insights about relative importance of various systems, various design features, in the plant, because in fact a lot of those decisions are based on those numbers, aren't they?

MR. WACKOWIAK: They're based on some of those numbers.

MEMBER STETKAR: Okay.

CHAIRMAN CORRADINI: Why don't you continue.

MR. WACKOWIAK: Okay. I'll try to go through the up-front stuff a little quicker now, so we can get to the open items. One of the things that I was trying to say here is that, like we've been talking about through this -- we were talking about the design of the plant, some of the choices that we made in the PRA were to not rely too much on human actions.

That's the procedures column. And not -- and to use generic data based on historical equipment performance, similar type equipment performance, because now we're focusing on what choices are made in the design, and we think we can make changes to the plant that influence risk more by changing design.

And then, later, as the design is frozen and actually built, and it's more than frozen at that time -- cast in concrete -- we can look at things, improving practices through procedures, and other things in the man-machine interface, and improve things with maintenance programs and things like that.

Our purpose here was to eliminate the severe accident vulnerabilities that we had recognized in the -- from the existing plants. We use a systematic process for finding these things through our PRA. We integrate the PRA into the entire design process. We are -- as we go through the design process, we make corrections to the design.

One of the things I mentioned in the beginning was that the PRA results really didn't change very much, even though when you look at the list of things that changed from DCD Rev 4 to Rev 5 there are some fairly large things there that were in there to address containment branch issues and other things.

And in the end, the things that were in there didn't affect the PRA as much, because we were using the PRA to help guide how those different changes were implemented. And it fit within the envelope that we already had. It did not introduce any new failure modes, and that sort of thing.

Once again, we used both quantitative and qualitative PRA tools. A lot of -- we talk a lot about the numbers, but the qualitative is also important when you are working with a design and something that isn't built yet.

And as I think we have said before, with most of the people that are on this Committee, we have a philosophy for our qualitative design that, where we have a function, it's served by passive systems, and then we apply active systems, one or more active systems as a backup to that, and then we use diverse support systems for all.

And what we find is, when we're coming up with a conceptual design, as long as we follow this sort of concept, we end up getting the numerical results that we want in the end. So before we even start designing something, if we look at it this way, we are pretty sure that we're going to get to where we want to be.

MEMBER APOSTOLAKIS: Can you give me an example of a support system or a passive system?

MR. WACKOWIAK: Yes. You have to remember that, through the evolution of these passive designs, passive is -- passive things still move, and so our squib valves are considered passive -- legislatively passive, if you will -- because they are powered by stored energy in the chemical charge in the squib and then in the batteries that ignite that.

So the support system there would be the DC power to ignite the squib charge. And so for support and diverse support, we have our safety-related DC power system that performs that function, and then we also have a non-safety related system on a different platform that also backs that up.

MEMBER SIEBER: Let me ask this question. During ordinary operation, the operator in the control room, if he is presented with the symptoms of an accident in a plant, would first rely on active systems -- diesel generators, pumps, valves, and so forth. To what extent do you take that into account in your PRA analysis? And since these are categorized as non-safety systems -- and, therefore, don't have the controls that 1(a) systems have, nor the tech specs -- how do you ensure that -- how do you calculate the failure rate?

MR. WACKOWIAK: The way that the -- that we're set up in the PRA is that some of these systems are -- some of the active systems are automatic, and some are not. Okay? We have reviewed -- for the ones that are automatic, we have reviewed the importance of the systems that are used to actuate those, and for the important ones they make it into things like either the tech specs -- once again, we'll talk about some of our non-safety equipment. I think this afternoon in RTNSS we'll talk about some of the non-safety equipment that made it into tech specs.

We also have an availability controls manual that addresses things that are important for RTNSS, important to meeting the PRA's goals, but not necessarily meet the threshold for tech specs. And then, as I mentioned before, the DRAP, which folds into the maintenance rule, covers most of the other things.

I think as somebody mentioned here

earlier, that it's real easy to get a lot of things to be able to effect a number that is fairly small. And so there are a lot of equipment that are going to be monitored for availability and reliability in the maintenance rule that address some of those things.

The other thing in the man-machine interface that we are working with the human factors engineers now is we find it important that when the operators start to do something with the active systems, that running those active systems doesn't actually do something to disable the passive systems.

We've gone through and for the systems that we have now, we have looked at -- and there's an updated section in the new PRA of a systematic search for adverse system interactions. If you turn this system on, will it do anything to the passive systems? Will it cause them to not function? And that information is either being addressed through design or it's being addressed through passing that information back to the people who are developing the emergency operating procedures and severe accident procedures.

And we have had some examples I think that we've talked about for those in the past, following some sort of a -- now this is after a LOCA-type accident, if you will, the decision whether or not to reduce pressure in the containment through using a containment spray. That's something that they have to really think about doing when you get into that scenario, because the passive system relies on the steam in the drywell to replenish the GDCS pools to keep injection going into the core.

And if you use spray to knock down the steam, you may lose injection. So you have -- the procedures have to be crafted carefully that says, "Before you spray, make sure you have an active injection source." So those are the kinds of things we look at, and we either address them through design with interlocks and other things or we feed it back into the human factors evaluation to make sure that the procedures adequately reflect those.

So now, how do we get to that in the PRA numbers? Some of those things we -- we didn't try to model the operators going and actuating all of the active systems possible to prevent the passive systems from coming on. If there is a specific action that is like the automatic high-pressure CRD pump is supposed to come on, we might model an operator action to back up that automatic action.

Or, in the case where we have a low

pressure injection system, we would say, yes, the operators will use -- will line up and use the low pressure injection system from the suppression pool into the reactor vessel. But there is only a handful of those actions in the -- and any sort of other things would be addressed in the adverse system interaction.

MEMBER BLEY: Rick, where in the -- I thought you said it was in the PRA. Where in the PRA document do you describe this examination where you look through all of those things and identify the potential problems?

MR. WACKOWIAK: It wasn't -- that was one of the open items that we had is it wasn't there before. It was only in our internal documentation, and now that's in 19(a) of --

MEMBER BLEY: 19(a).

MR. WACKOWIAK: That's right.

MEMBER BLEY: That's the one that has just been released --

MR. WACKOWIAK: The one that has just been released.

MEMBER BLEY: -- that we haven't seen that.

MR. WACKOWIAK: Yes, that was -- in the

past, that was one of our open issues.

MEMBER BLEY: Related question, and you'll get to initiating events somewhere here, but in your initiating event discussion, you talk about lifting them from essentially previous PRAs, and also by doing something like a failure modes and effects analysis to uphold the systems.

I didn't see any detailed look at how you did that analysis through all of the systems. Where is that in the PRA?

MR. WACKOWIAK: The screen of the systems for initiating events.

MR. MILLER: That is in 19(a) as well, yes.

MEMBER BLEY: So that wasn't in the one we have looked at. But it is in the new one.

MR. MILLER: That has not changed in 19 --

MEMBER BLEY: It's in 19(a)?

MR. MILLER: It was in the text.

MEMBER BLEY: It's a text.

MEMBER STETKAR: There's kind of a paragraph per system, and I don't remember the --

MEMBER BLEY: Oh, I saw that.

MEMBER STETKAR: -- the section.

MEMBER BLEY: But that --

MEMBER STETKAR: That's not a systematic --

MEMBER BLEY: What I'm looking for is something -- that the impression I got from the introduction was a systematic look, system by system. We looked at each part of this system, and, you know, here's what it could affect and here's how it could lead to an initiator. So that is not in the PRA.

MR. WACKOWIAK: What you are looking for I think requires more information about the actual components in the system, and how the control systems would respond to different upset conditions. What we've assumed for right now, for those things, is that a feedwater control system, feedwater heating system for example, will probably behave like existing feedwater heating systems, maybe better, maybe not, but it would be subsumed into the historical loss of feedwater.

MEMBER BLEY: All I saw was like a paragraph that said, "Here is the things that might be troublesome, but nothing that indicated how you had gone through in a systematic way.

MR. WACKOWIAK: Okay.

MR. MILLER: Well, we did assess -- we did ask a question of, you know, its relative significance. The initiator itself -- was it significant to the overall CDF, for example? Was this failure mode a significant contributor? So we did systematically go through and ask those questions.

MEMBER STETKAR: How do you know how significant it is, if you haven't actually quantified it in the PRA, a priori, given the very small numbers? I've been doing this for 30 years, and I've always been wrong when I tried to guess like that. I'm still wrong.

MR. WACKOWIAK: The ones that we looked at through that process were the ones that were modeled in the PRA.

MEMBER STETKAR: Okay.

MR. WACKOWIAK: So your question from before -- if it's not modeled --

MEMBER STETKAR: You don't know.

MR. WACKOWIAK: -- we would have had to use some sort of a judgment to decide. And when we used that judgment, that was when we were creating the list of initiating events.

Okay. Is there any interest in going through the features? I think everybody --

MEMBER STETKAR: Yes.

MR. WACKOWIAK: -- here has -- Yes. Okay.

MEMBER STETKAR: I have a question. On the outlet of the GDCS pool, there is a normally open manual valve. This drawing does not show that valve. The PRA does not contain that valve. If that valve is closed, it will disable the respective GDCS pool for both short-term vessel injection and for containment deluge. That could be quite interesting for the combined pools B and C, because it will disable six deluge valves and four injection paths.

The valve is not modeled in the PRA. If you model it with a 10-year test interval, as it is according to the tech specs, it will increase the unavailability of each GDCS pool by a factor of 136 times higher than what is currently modeled in the PRA. Why is that valve not modeled in the PRA?

MR. WACKOWIAK: That valve was initially put into our screening model. And when we identified it as an important valve, we provided to the HFE group a requirement that that valve be instrumented, and that there be procedural checklists in place with a double signoff coming out of the outage for it.

And I'm trying to think -- there's one other -- oh, yes. It's not only instrumented by alarmed in the control room if it's in the wrong position.

MEMBER STETKAR: That's if the valve stem is in the wrong position.

MR. WACKOWIAK: That's correct.

MEMBER STETKAR: It doesn't tell you a thing about the internals of the valve, does it?

MR. WACKOWIAK: That's correct. And our thinking -- so that was -- when we got through those three, that's how that manual valve screened. And in looking at that, we also recognized that our check valve data for those lines, which performs the same function, we increase --

MEMBER STETKAR: No, it doesn't. If that valve is closed, no water goes out of the tank. The check valve prevents water from the vessel going back to the tank. This prevents water going out of the tank, if it's closed.

MEMBER APOSTOLAKIS: Can you show us where the valve is? You can use a cursor maybe. I don't know. It's over there.

MR. WACKOWIAK: Right here.

MEMBER APOSTOLAKIS: Okay.

MR. WACKOWIAK: Right under the word "GDCS injection line."

MEMBER APOSTOLAKIS: Okay. Yes.

CHAIRMAN CORRADINI: Are you finished with your explanation? I guess I want to hear this one completely through before we --

MR. WACKOWIAK: Yes.

CHAIRMAN CORRADINI: -- come after you.

MR. WACKOWIAK: So in our model, we model the check valve. We model the check valve as needing to open, as well as needing to prevent backflow.

MEMBER STETKAR: Be careful. You did not model the check valve as needing to open. You modeled the check valve failure to stay open.

MR. WACKOWIAK: Okay.

MEMBER STETKAR: You assumed it's normally open. You did not model a check valve needing to open.

MR. WACKOWIAK: Okay.

MEMBER STETKAR: Keep going. By the way, this 136 is used in your own data for the failure rates.

CHAIRMAN CORRADINI: Are you finished explaining? Because I don't know if you are.

MR. WACKOWIAK: Well, where I was trying to get to with that is we thought that the similar components that had a similar function, in terms of getting the water from the GDCS pool into the reactor, including the check valve -- we'll look at the failure mode that was there, failed to remain open -- and the squib valve, that those together provide a reasonable probability for getting the -- for addressing that particular failure mode.

Now, I understand that this manual valve also addresses -- affects the BiMAC, and so we'll have to go and look at that.

CHAIRMAN CORRADINI: Can I just rephrase your answer? Because I want to make sure -- since I'm not a PRA guy, and you guys -- the right hand of this table is hot this whole day, urge -- charged up. So are you saying that you didn't model it because the failure probabilities of the two downstream valves were large enough that they washed out even --

MR. WACKOWIAK: No.

CHAIRMAN CORRADINI: So what are you saying?

MR. WACKOWIAK: What we said was initially we modeled it. We identified it as important. So we moved -- we added controls onto the valve -- the indication, the alarms, and the procedures. And once we got to all three of those things -- the indication, the alarm, and the procedures -- the process that we used says that that failure mode is a low enough probability --

CHAIRMAN CORRADINI: Okay.

MR. WACKOWIAK: -- because all we're not covering is the stem separating from the disk. We are not covering that particular failure mode.

MEMBER BLEY: That one does happen in the real world, though.

MR. WACKOWIAK: Yes.

MEMBER BLEY: Often enough to be troublesome.

MEMBER STETKAR: And the failure rate that you use -- three times 10^{-8} -- is indeed derived from data or observed events, exactly those types of observed events. That failure rate is in the PRA database for spurious closure of manual valves.

MEMBER ABDEL-KHALIK: Are there any cases in which check valves are installed backwards?

MEMBER STETKAR: Now you would know this.

(Laughter.)

MR. WACKOWIAK: I am sure it can happen. Now, one of --

MEMBER ABDEL-KHALIK: So let me just continue, then. What happens if the check valve, between the GDCS and the squib valve, is actually installed backwards?

MR. WACKOWIAK: GDCS won't work.

MEMBER ABDEL-KHALIK: Not just that.

MR. WACKOWIAK: Not just that?

MEMBER ABDEL-KHALIK: Right. Because it would allow water from the vessel, then, to move in the opposite direction. And if it's moving at a high enough pressure, it would actually eject the water out of the GDCS pool.

MR. WACKOWIAK: The ITAAC for GDCS is a flow test into an open vessel from the GDCS pool into the reactor. So that test will verify that the check valve is installed properly before fuel load. There's an ITAAC for performing -- for draining the vessel through the GDCS -- or draining the GDCS pools through lines into vessel, with an open vessel low pressure test, and then from -- the data from that test you'd back calculate the line losses for those GDCS lines and demonstrate that they're within the values used in the TRACG analysis.

MEMBER ABDEL-KHALIK: And that would be done without the squib valves in place, or what?

MR. WACKOWIAK: Oh, let's see. The startup test guys told me how they thought they were going to do that. I think they -- I think they're going to put in the line a different -- I think they're going to put in something in the location where the squib valve is that's equivalent to the open squib valve for when they perform that test, because I don't think they're going to actually actuate squib valves here in the plant during that test.

MEMBER ABDEL-KHALIK: I mean, normally, the isolation is done by the squib valves. Those --

MR. WACKOWIAK: Right.

MEMBER ABDEL-KHALIK: -- check valves don't perform any function during normal operation.

MR. WACKOWIAK: Right. But they still -- we still have to test that the line is open before we put fuel in the reactor vessel, and that -- we also check that the check valve --

MEMBER ABDEL-KHALIK: But in order for that to happen --

MR. WACKOWIAK: -- is installed properly.

MEMBER ABDEL-KHALIK: -- you can't do that with the squib valve in place.

MR. WACKOWIAK: The squib valve would have to be opened in order to perform that test. Removed or some other surrogate valve would be put into place, so that valve would be open, so that it would drain to the vessel. So we would check the check valve during that test.

Now, the squib valve itself -- can the

squib valve be installed backward and not perform when they reinstall -- when they put that one back in? I don't see how the design concepts that we have been using will be susceptible to that sort of failure mode. But the check valve will be checked with flow through the check valve.

MEMBER ABDEL-KHALIK: Thank you.

MEMBER MAYNARD: Current plants typically have requirements for surveillance on leak check of check valves for lines coming off the RCS. Would this plant most likely have a similar surveillance requirement on the leak tightness of the check valve? I know that current plants do.

MR. WACKOWIAK: I don't know the answer to that question.

MEMBER BLEY: The problem is, this check valve is normally open.

MEMBER STETKAR: Right. It isn't -- it's normally biased open.

MEMBER MAYNARD: I understand that. And some other check valves are, too. But typically check valves coming off the RCS are required periodically to have a surveillance to make sure that they are --

MEMBER STETKAR: I thought I read something in there that said that there was some type of test line to verify operability of that check valve.

MR. WACKOWIAK: There may be. I just don't know the answer to that.

MEMBER STETKAR: The reverse flow direction.

MR. WACKOWIAK: So noted that we -- that one particular failure mode of that valve is probably not covered in the PRA.

Okay. I think we've talked about most of these things here already. But the PRA, we did do Level 1, 2, and 3, covered internal and major external events, covered full power and shutdown. We do do a seismic margins analysis rather than a seismic PRA. I've covered just about everything there.

What's new since we talked last time is the systematic search for modeling uncertainties. We underwent a process where all of our engineers got into an expert panel mode and went through the models gate by gate, and wrote down everything they needed to know to make that logic work the way it was. And we've got documentation for that.

And then, from that -- did the flow chart make it into the documentation?

MR. MILLER: In the NEDO.

MR. WACKOWIAK: In the NEDO? So then we took all of those -- all of those evaluations and took all of the assumptions and went through a process to determine if it was a key assumption with respect to meeting the safety goals. And so that process is in there.

MEMBER APOSTOLAKIS: Can we talk about it later? Or is this it?

PARTICIPANT: This is it.

MR. WACKOWIAK: Yes. This is it for right now, because it's in the new material.

MEMBER BLEY: Let me understand a little better. You went through your models, your fault tree models, to identify --

MR. WACKOWIAK: And event tree models, yes.

MEMBER BLEY: And event tree models. Did you ever do something similar but up at the higher level of the actual -- I guess it works through here. I'm okay. This is in the new stuff, so we'll see that. And you were looking for anything that could affect the performance.

MR. WACKOWIAK: Right. What we are -- what we recognized here, since we talked last -- how many years ago that was now --

MEMBER APOSTOLAKIS: Almost two.

MR. WACKOWIAK: -- that when -- in PRAs when we talk about assumptions, people list their -- we say, "List your assumptions," and they'll list 10 things, or, you know, there is some list of assumptions. And it's just like Dr. Apostolakis was saying earlier today. This is not a plant that is built. It is on paper. And everything is an assumption.

So if we are going to be comprehensive at looking at all of our assumptions, we really needed to go back through and look at everything that we put down. Everything in the model right now is an assumption, and it would need to be verified.

MEMBER BLEY: When you did this process, which is a process I was disappointed I didn't see before, and I'm happy to hear that you've done it, did you also ask, what are all of the things that could defeat this system, including things operators could do? You know, in your HRA analysis, there is a statement that, gee, in any plant with good -- essentially good procedures, errors of commission are negligible.

Well, in a plant that is highly passive, there might be some things people could do for reasons you didn't quite think of that would be important. Did you ask that question as you went through all of these functional issues?

MR. MILLER: I think we asked that a little bit in the adverse systems interaction that Rick talked about earlier.

MEMBER BLEY: Is that documented in the new PRA?

MR. MILLER: The discussion of a consideration of operator actions is documented in 19(a).

MEMBER BLEY: Okay. I'm looking forward to seeing it.

MR. WACKOWIAK: And the kind of things that we went through in this was you'd have a gate in the model, and it's okay to say, "What do I need to know? You know, why are the different things in here?" Work those things out.

We also asked everyone to go through and say, "Describe the things that you've excluded from that gate," so we have both -- we're including and excluding --

MEMBER BLEY: And you've documented that?

MR. WACKOWIAK: That's documented.

MEMBER BLEY: Okay. Good.

MR. WACKOWIAK: So this -- it would be interesting to go back and see that particular question about the valve --

MEMBER BLEY: That valve, yes.

MR. WACKOWIAK: -- the stem separation. I'm pretty sure that they use the criteria that I mentioned, though, to say why --

MEMBER STETKAR: But if it's documented, it would help an awful lot.

MR. WACKOWIAK: Yes.

MEMBER APOSTOLAKIS: So we are going to see these when, Hossein? With the NUREG?

MS. CUBBAGE: The extra CD should arrive today by FedEx, so I'll try to get those --

MEMBER APOSTOLAKIS: Oh, to you.

MS. CUBBAGE: To me, yes.

MEMBER APOSTOLAKIS: Okay.

MS. CUBBAGE: And I'll get --

CHAIRMAN CORRADINI: It first has to go to her.

MS. CUBBAGE: I physically have it, but I just got it yesterday.

MEMBER APOSTOLAKIS: Will the Committee have an opportunity to express a view?

CHAIRMAN CORRADINI: Sure.

MEMBER APOSTOLAKIS: When?

CHAIRMAN CORRADINI: Well, first we have to get it. But --

(Laughter.)

-- I would say it's going to be a while.

MEMBER BLEY: I think that's the stuff of the whole meeting. I mean, that's crucial information.

CHAIRMAN CORRADINI: I would say -- I would -- can I reverse it? I don't think -- I don't sense that the right-hand side of the table is going to be feeling ready to write a letter until we review it.

MEMBER APOSTOLAKIS: That was my next question.

CHAIRMAN CORRADINI: Yes. That's what --

MEMBER APOSTOLAKIS: Are we --

CHAIRMAN CORRADINI: I'm just trying to jump a couple steps.

MEMBER APOSTOLAKIS: Okay.

MR. WACKOWIAK: And then, just to go on with this, there was a question that had come up about the PRA quality. I think it's listed as one of the open items that Hossein is going to present as being resolved at this point. But we did an internal self-assessment against the ASME-2005, and provided information to the staff on the results of our review.

We are also providing some feedback to the ASME Committee for when they write their update to the standards, so that it can be used for new plants or plant designs rather than existing plants. There are some things that they need to consider, so we'll be folding that back in.

MEMBER BLEY: As you did that, did you identify things that were not in the current standard that ought to be for highly passive systems?

MR. MILLER: I think the problem we had was there are a lot of things in the standard that are for operating plants versus a design plant. Obviously, things like walkdowns we can't do. As far as passive versus active, since these were looked at on a functional level, I can't recall any differences that we had.

MR. WACKOWIAK: I do have one thing that I'm not really sure how to present it to the Committee, to the ASME Committee. When you're doing a review of a passive equipment, the best estimate valves or best estimate calculations may not always be the right way to evaluate those things.

In many cases, bounding assessments are --

give you more information than trying to come up with a best estimate for something passive. I think the uncertainties there are just probably too large. So something that would fall into a capability Category 1, or maybe barely make 2, because of -- we didn't -- we used a bounding value rather than a best estimate, I think that needs to be rethought for passive plants. I think there are some cases, like in the Level 2 area -- I believe the way that we address Level 2 using the ROLL methodology, and doing bounding assessments, is the right way to address the passive containment rather than the multi-million node containment event tree that would tend to dilute the contribution of certain phenomena.

So that's my opinion. I'm not sure how to write that up and send it yet, because it's a change in philosophy from what they have. But that's something that we also learned.

We've -- and I'm sorry you walked out, because it was the first time I actually put the mean on the slide instead of just a point estimate.

(Laughter.)

But the idea here to show -- and we've talked about this before -- what we tried to do is to make -- a low number was not necessarily the objective. We tried to address balanced risk profile, and it just so happens that when you try to address outliers on many things, the overall number continues to go down for these particular events.

So what we were really trying to get at was coverage for most types of upsets in the plant, and I think we've achieved that. There is isn't any one thing that really causes problems, and that's basically going back to that same philosophy that if you have a combination of passive and diverse active systems, we can get pretty good coverage.

Now, the question comes back: can we use this in a seismic assessment later? We've got a lot of things covered here, and what we need to do is see how we would use some of the protections built into the different scenarios. By that I mean things -- in a seismic PRA assessment, we wouldn't just use the safety-related equipment. We would want to look at the capabilities of some of the non-safety equipment.

So your assessment is right. If you just do the numbers for the seismic -- for the safety-related equipment for seismic, you are likely to get a very big number. But I think some of these other pieces of equipment that are non-safety related do have some seismic capability, and we should be able to mitigate that.

MEMBER STETKAR: For the record, I'm not saying a very big number, in terms of the safety goal or anything like that --

MR. WACKOWIAK: Right.

MEMBER STETKAR: -- it's a much larger number than the numbers that we see on the screen there.

MR. WACKOWIAK: Right.

MEMBER STETKAR: But not -- just for the record, I'm not implying that the seismic risk is large compared to the safety goal. But it could be substantially larger than what we see there.

MR. WACKOWIAK: Larger than this. But, once again, it's only considering the safety-related equipment.

MEMBER STETKAR: That's true, although most of the non-safety related equipment usually is designed to equal to or less than lower seismic capacities than safety-related equipment. So --

MR. WACKOWIAK: Some of it is. When we talk about RTNSS, we'll talk about which set of equipment is designed to the same --

MEMBER STETKAR: Regarding this slide, Rick, just out of curiosity, an unusual situation is that the mean, since you said you finally put it on a slide, is slightly lower than the point estimate. That almost never happens. Do you know why it happened here?

MR. WACKOWIAK: I think that it's another artifact of the number being small, and that the mean and the point estimate are just right near each other and small variations --

MEMBER STETKAR: Usually the things like correlated uncertainties and -- the state of knowledge uncertainty in your data will tend to, if nothing else, push the mean value from the uncertainty distribution higher than that point estimate value, if nothing else.

MR. WACKOWIAK: And I would say that one of our issues from the review against the standard is that on common cause failures our state of knowledge is somewhat limited by the code that we used. So it probably -- when we're working on addressing that, that may change somewhat, and the mean may come up slightly over the point estimate when we address that in the way that our uncertainty software addresses the correlation of common cause failures. We understood that.

MEMBER BLEY: Rick, a related question.

If these results include that look you guys did through all of the uncertainties and success criteria and phenomena, I would have expected that to yield some broader uncertainties that would have pushed the mean higher than your point estimate. Did anything come out in that direction? Are those uncertainties factored into this result?

MR. WACKOWIAK: They are not factored into this result. In Chapter 11, we have an extensive set of uncertainty and -- of sensitivity analyses that we looked at with respect to those specific items.

MEMBER BLEY: And that's where we'll see it.

MR. WACKOWIAK: And that's where you'd see that. There are --

MEMBER BLEY: So this is just the basic --

MR. WACKOWIAK: This is just the basic model.

We have a chart in there that just gives you a sense of what all of the different things are. You know, once again, the pie chart is -- historically represents just the Level 1 internal events. You can get an idea of where we are with the different types of events. All are around the same order of magnitude. Once again, though, all of them include different -- varying levels of uncertainties.

For example, in the fire, even though in the full-power CDF the fire looks like it's about the same as the internal events, in the shutdown it is higher than the internal events. We have to remember that we didn't do any fire modeling to address the spread of fires, and we didn't do any fire suppression. So those numbers really are -- they're not on the same level of modeling detail.

CHAIRMAN CORRADINI: So the shutdown numbers are upper bounds, then.

MR. WACKOWIAK: The fire numbers we believe are upper bounds.

CHAIRMAN CORRADINI: I'm sorry. Yes.

MR. WACKOWIAK: The internal events shutdown, we think that with the exception of one open item that's still in play, we think that that's probably a pretty close number for the internal events shutdown.

MEMBER POWERS: Do you think the fire is an upper bound because you didn't model suppression, but on the other hand you didn't model spread either?

MR. WACKOWIAK: We assume that every fire spreads to its maximum capability.

MEMBER POWERS: In just the fire area?

MR. WACKOWIAK: We considered failure of fire barriers to -- for it to propagate into the adjacent area, and then spread to completely fill the adjacent area.

MEMBER POWERS: So the adjacent areas were spread into?

MR. WACKOWIAK: Yes, following the failure of a fire barrier. And one of our insights from the shutdown PRA is that fire barriers need to be controlled during outages.

MEMBER POWERS: That's a good insight.

MR. WACKOWIAK: Well, there's talk about whether or not you -- you know, would that be a requirement in --

MEMBER POWERS: Most of them are open.

MEMBER APOSTOLAKIS: Let me ask you, Rick, some -- a sort of philosophical question.

MR. WACKOWIAK: Oh, good. I like those.

MEMBER APOSTOLAKIS: If you go back to the '70s, and you look at various studies that were done in the first PRA topical meeting in Newport Beach, the numbers one sees for -- under vulnerability of safety systems were typically 10^{-6}. And then, as we learned more, collected experience, and so on, the numbers have shifted up by about two orders of magnitude roughly. Now, it depends on the event tree, but roughly it's about 10^{-4}.

So we were very optimistic, and then the numbers became more -- now, this 10^{-11} and 10^{-10}, do you think that these numbers will shift up a little bit, still meeting the goals of the Commission? I think they will. I don't know how, but they will.

MR. WACKOWIAK: Some of these numbers may shift some. Now, we are doing some things differently than were done back then, because we are using the PRA throughout the design process. So when we start selecting components, and, you know, part of the -- not only part of the DRAP, but as part of the GE design process, as we go and select components and determine ways to install those components, we're going to be looking at it with respect to this.

So it's not -- it's not just the numbers are done here, they're good, and when you build this plant everything is going to come out okay. We have to take, you know, some looks at that along the way. There have been examples through the last year, year and a half, where something that looked like a perfectly good configuration change from the designer's point of view, when it got to the PRA signoff we had to go back and say, "This is not the right way to look at this. We have to come up with a different way of implementing what it is you are looking for, because we may affect some of these values."

Now, do we have to have a 10^{-8} CDF?

MEMBER APOSTOLAKIS: No.

MR. WACKOWIAK: That's not a requirement. And -- but it -- the way that the modeling and the numerics turn out, is that when we apply the good defense-in-depth techniques, and when we apply diversity techniques, the -- using today's modeling practices it comes out this way. If we discover something that changes that, it's okay.

MEMBER APOSTOLAKIS: No, I fully agree with that. I mean, I'm not saying that --

MR. WACKOWIAK: I've seen some of those old results. I think I even saw some control rod drop analysis that somebody had that was a 10^{-20} frequency for the --

MEMBER APOSTOLAKIS: The lowest I have seen is 10^{-31}.

MR. WACKOWIAK: Right.

MEMBER APOSTOLAKIS: But that was not for a system. That was --

MR. WACKOWIAK: Right. It was --

MEMBER APOSTOLAKIS: I think to put things in perspective, I believe the age of the earth's crust is three 10^9 years. So we are talking about a reactor here that was built when the crust started forming.

(Laughter.)

And there has been no failure since. Basically, that's what we're saying.

Now, I will be the first one to admit that I don't know how to raise the number. I don't know, maybe John here has some ideas. But even with those, they are not -- even 10^{-9} --

MR. WACKOWIAK: He had the unavailability of a system go up by a factor of --

MEMBER APOSTOLAKIS: No, no.

MEMBER STETKAR: No, no, no. Just a tank, not a system. One tank, not a system.

MEMBER APOSTOLAKIS: In other words, with the details you can raise it to an order of a magnitude. Okay. Big deal. I mean, it's still low. It's still low.

MR. WACKOWIAK: And, once again, what we were trying to do with this was not to come up with an absolute low number. The intent was to try to take events that result in risk from operating a commercial nuclear powerplant, things that have risk associated with them, and lower that so that it's on the same par of things that we have determined to be acceptable risks.

The things that were excluded from the design, like the 10^{-7} aircraft impact into the buildings, and other design areas where if the frequency is below some value you don't have to design for it. We want to make normal events -- the risk from normal events to be similar to things that we have already decided are acceptable risks.

MR. KRESS: Let me ask you a question about your LRF. When we used to use LERF, it was defined in terms of timing with respect to ability to evacuate.

MR. WACKOWIAK: Right.

MR. KRESS: Now, you know, with this plan, you no longer have LERFs, so you have to redefine LRF some way. Does it involve a magnitude of release or what? How did you define that?

MR. WACKOWIAK: Not in these numbers. For the baseline PRA, it was a bounding approach. If the containment was open for any reason whatsoever, anything other than leakage through the shell, we considered it a large release.

MR. KRESS: Okay. So it didn't matter

that you really might not have had a large release.

MR. WACKOWIAK: Right. And in some of the sensitivity analyses, we did look at the magnitude of specific -- of specific things. And it -- I think we can show that any release of the iodines -- I think there's a couple of groups there. Iodines come to mind, but some of the groups, if the release is less than three and a half percent, or -- yes, less than three and a half percent of the inventory, then it would not be large. But the only place that we applied that was in sensitivity analyses, not in this base model.

CHAIRMAN CORRADINI: So just to make sure I understand -- again, I'm interpreting -- it's what I read. So in all of the shutdown estimates the LRF is the CDF, which means that the containment is open, or is assumed open.

MR. WACKOWIAK: Right.

CHAIRMAN CORRADINI: So that is point one. Point two is the -- for the at-power internal events, you are showing something like eight percent -- eight percent? Less than 10 percent containment failure probability.

MR. WACKOWIAK: Right.

CHAIRMAN CORRADINI: For internal events.

I'm sorry, yes.

MEMBER APOSTOLAKIS: Now, the fire probably will go up, because this is kind of a bounding code analysis. A more detailed analysis could go up. We don't know. It could go down.

MR. WACKOWIAK: Actually, I think the fire analysis is probably going to go down, because there is not much source of fire ignition in this plant. The electrical systems are pretty much low voltage systems.

MEMBER APOSTOLAKIS: But, you see, with numbers like these now, it seems to me that other things would start dominating, like transient fuels, organizational screw-ups. In other words, the design did its job and now we have all of this other stuff --

MR. WACKOWIAK: Right.

MEMBER APOSTOLAKIS: -- that you can't predict. I mean, some of the --

MR. WACKOWIAK: Right. You would run into things like that that are not fixed in place, initiators maybe, maybe something else.

But remember with the fire, though, we did a lot of things to the design to make the fire low. We were worried about inadvertent actuation of the squib valves during a fire, because if the BPS valves open, then we lose our isolation condenser system. That would not be a good thing. Or the isolation condenser is the best thing to have in these fire scenarios.

So we arrange the plant so that the cable that had to get to the squib valve to provide the power had to go through two load drivers in two different fire areas. And that most of the connections between the cabinets are with fiber, so they are not subject to hot shorts. And we also looked at where logic cabinets were located and made sure that certain logic cabinets were not collocated in a room with other ones, so that we maintain diversity during fire.

MEMBER APOSTOLAKIS: That sounds very good, but you also used FIRE, right?

MR. WACKOWIAK: Not this time.

MEMBER APOSTOLAKIS: Oh, not this time. Oh.

MR. WACKOWIAK: Yes. Starting in the last --

MEMBER BLEY: You changed the -- when you get the new report, we'll have a new FIRE analysis.

MR. WACKOWIAK: Rev 2 that you already have was our first attempt at applying NUREG-6850 where we -- so that's in there.

MEMBER BLEY: Speaking of hot shorts, have you been following the CAROLFIRE work at Sandia?

MR. WACKOWIAK: As much as we can. It's -- now that the last DCD rev is in, I'll be able to follow it more.

MEMBER BLEY: I think it's worth taking a look at.

MR. WACKOWIAK: Yes.

Okay. So go through some of these. I don't know when you guys are required to have a break or anything, so you just tell me.

CHAIRMAN CORRADINI: We're not required.

MR. WACKOWIAK: Okay.

CHAIRMAN CORRADINI: Go for a few more minutes, and then we'll --

MR. WACKOWIAK: So --

CHAIRMAN CORRADINI: Is this a logical point to break for you, or do you have somewhere else a few slides later?

MR. WACKOWIAK: We can break almost anywhere in these, because now the way the rest of the -- the rest of my slides are implemented is I'm going to go through chapter by chapter, say what we have, and if there's any open items, and, if we do, how we have addressed them.

CHAIRMAN CORRADINI: After this, then. Go ahead.

MR. WACKOWIAK: Okay. So we talk a lot about initiating events being based on historical data. For transients, we use NUREG-5750, categorize our equipment into those categories, and look for similar types of failure modes and how they would match up.

Loss of offsite power -- once again, based on the historical data. We have asked the customers to provide their loss of offsite power data for us, and we have looked at that in our PRA as well.

LOCAs -- we scaled the numbers that are in 5750 to match up with the ESBWR arrangement. Since we don't have recirc pipes and things like that, we tried to -- we kept the frequencies about the same, but we distributed amongst different pipes and different -- we include inadvertent ADS and then spurious DPVs and multiple spurious SRV openings in our LOCA data. So some of the steam line LOCA frequencies may look very large, but it's mainly because these other system-based things are included in those LOCAs.

We did include vessel rupture with an evaluation method in NUREG-1806 based on the forged vessel construction and the forged nozzles.

Break outside containment -- once again, 5750, we looked at the lines that are connected to the reactor vessel. Interfacing system LOCA -- we did have two candidates for those, but it turns out that those particular failure modes were covered in other LOCA events, so we just added the frequency into those other ones. And they were much lower because of the isolation capability.

We looked at loss of service water and loss of instrument air as special initiators. So the list that we have here is a fairly standard list of Level 1 initiating events. No open items in this area.

The accident sequences -- we used a linked fault tree methodology, and I think you've seen our event trees in the report. The event trees that you've seen already are pretty much -- other than some tweaks in the new one, they are essentially the same event trees. We include all of our front line systems, both passive and active, in our event tree headings, and the support system are then built in under the fault tree.

Success criteria is based on thermal hydraulic calculations, combination of MAAP and TRACG.

What we did, though, was we found a bounding criteria that we would apply to all of the event trees, and that's most of the cases. There was some things on -- I'm trying to remember which one it is now.

I think there's one area where we used different success criteria on one branch between two different event trees, but we tried to determine -- and I'll get to that on the next page -- what the limiting number of GDCS valves would be for our worst-case LOCA, and then we applied that to all LOCAs rather -- you know, whether it was worst case or not.

MEMBER ABDEL-KHALIK: But if we look at the opposite problem, what would be the success criterion for non-condensable gas accumulation in the GDCS line? How much gas can you actually tolerate and the system would still perform?

MR. WACKOWIAK: I know that question has come up several times, and I believe the last resolution of that -- of that was that the line is required to be oriented such that non-condensable gases won't accumulate in the line. The slope of the line -- the low point is the squib valve, and it goes up from both ends from there.

MEMBER ABDEL-KHALIK: So the problem is essentially designed out?

MR. WACKOWIAK: Right.

MEMBER ABDEL-KHALIK: But --

MR. WACKOWIAK: Well, for that -- for non-condensable gas. There were other questions about non-condensable gases in the ICS heat exchangers, and the way we dealt with that is we -- we require venting of the ICS heat exchanger to consider it for success. So the system to purge the gas out of the ICS heat exchanger is required for the success, so we don't ask the question, how much non-condensable gas is going to be in there.

MEMBER ABDEL-KHALIK: So in going through this whole process, you are assuming that whoever is going to put these lines together will actually do it right.

MR. WACKOWIAK: Their ITAAC for those slopes on those lines.

CHAIRMAN CORRADINI: I'm trying to remember back two years ago when we last had you -- I think it was August -- and we discussed this. I seem to remember that there was a decision -- or maybe I'm -- "decision" is the wrong word, but at least a suggestion that more TRACG calculations be done to benchmark --

MR. WACKOWIAK: I'll get to that.

CHAIRMAN CORRADINI: You're going to get there?

MR. WACKOWIAK: I'll get to the point where we acknowledge that we have to do.

CHAIRMAN CORRADINI: Okay. Fine.

MR. WACKOWIAK: Okay?

CHAIRMAN CORRADINI: Thank you.

MEMBER ABDEL-KHALIK: Let me just follow up. When we talk about squib valve failure, and, you know, probability of failure, what is included in that?

MR. WACKOWIAK: It's the probability -- the squib valve itself is -- it includes the pyrotechnic material not igniting, the shear pin not shearing, and the scored cap not coming off of the pipe. So those are the failure modes that are subsumed within the data that we have for the squib valve.

MEMBER ABDEL-KHALIK: So when you look at an event like the Cooper event in 1976, when the standby liquid control system was deemed to have failed, because of a fuse failure, that is not included in any probabilities of squib valve failure that you may have included.

MR. WACKOWIAK: That particular failure

would be included in the detailed model for the I&C system, because the I&C system is what actually provides the power out to the squib valve. And what we've shown is is that those types of detailed failures -- unless it's a common cause failure -- doesn't show up in the answer. So --

CHAIRMAN CORRADINI: You mean they are too low to show up. Is that what your point --

MR. WACKOWIAK: Yes, they don't make the truncation level, unless it's a common cause failure. So in the particular case that you are talking about, we may have a fuse failure that, because of the information that is known about the I&C system right now, we don't necessarily know if it's going -- if there is going to be a fuse there. We can talk about the details of that.

The I&C system itself makes the power for sending it out to the squib valve. There is some sort of protective device there, but I don't know if it's a fuse or if it's something -- if it's something else. But that sort of thing would affect one valve, and if you remember the way that our squib valves are set up, every squib valve has four electrical wires connected into it. So we would have to fail four different fuses in different divisions, and then one in a non-safety system, in order for a fuse failure to prevent a squib valve from opening.

MEMBER ABDEL-KHALIK: But we don't know the details yet.

MR. WACKOWIAK: But we do know it would take four fuse failures in order for that phenomena to happen to one squib valve. So I'm confident that, unless it's a common mode failure, then it's not going to affect the final result.

MEMBER BONACA: But where did you get the frequencies for those three failure modes that you subsumed in the squib valve?

MR. WACKOWIAK: That's from -- I'll have to look back again, but I think -- I think that the squib valve data was in the ALWR database. And those were the types of failure modes that were considered for those.

MEMBER STETKAR: Rick, I have to apologize. I was looking at something else here, and you were talking about something and I had a question. The squib valve designs here do have four separate igniter power supplies?

MR. WACKOWIAK: Yes.

MEMBER STETKAR: Yes. Okay, thanks. I've seen other ones where they have four separate logics, but there is only a single -- there is only a single-firing power supply circuit, so there's four separate --

MR. WACKOWIAK: Four separate --

MEMBER STETKAR: -- igniter power supplies.

MR. WACKOWIAK: -- igniter power supplies.

MEMBER STETKAR: Okay.

MR. WACKOWIAK: And on the three that are the safety-related, the current configuration actually has two power supplies in each of those. So it's actually I think seven power supplies that can give power to that valve and ignite it.

MEMBER STETKAR: Okay.

MEMBER ABDEL-KHALIK: So what is the common mode failure probability of these fuses that would affect all of the squib valves?

MR. WACKOWIAK: What we have in our model right now is a common mode -- we have three common mode failure designators in the I&C system. One would be the loss of communication amongst all of the remote computer boxes. And I don't remember what that number is. There is another one that is associated with the logic in the computers. I don't remember what that one is right now.

But then, there is also the one that we address the software failure that would say don't ignite any of the squib valves across the platform, and that value is set at 10^{-4}. We think that particular value would cover anything like a common mode failure of hundreds of fuses out in the plant, things like that. So there is a 10^{-4} chance that any of our platforms will fail to ignite all of the safety system.

MR. MILLER: We don't have the detail, but there's a lot of self-diagnostics in the digital control system. So the latent failure is like a fuse that is broken or open, would be detected prior to actuation.

PARTICIPANT: That is a common mode failure.

MR. WACKOWIAK: Yes, the fuse is a tough one to detect, because it looks like it can handle the trickle current, but it won't be able to handle the surge for blowing the valve. So it's a funny failure mode, or a strange failure mode, to have there. But I'm confident that through the sensitivities that we've done on the details of the I&C system, every time we've tried to model the details of the I&C system we end up with a 2,000-page fault tree, because the thing is very complex, and we end up getting three basic events out as the answer every time.

MEMBER ABDEL-KHALIK: So you have actually looked at this --

MR. WACKOWIAK: We haven't looked at --

MEMBER ABDEL-KHALIK: -- plant event and designed your system so that this particular event is excluded?

MR. WACKOWIAK: A single fuse failing a system is excluded in our plant design. There are no single-point fuse failures that will disable a system in this plant design.

MEMBER ABDEL-KHALIK: But still, we don't know what the common mode failure probability of the fuse is.

MR. WACKOWIAK: And we don't know if it's even going to be fuses yet is the hard part. It may -- the protective device may not actually be a fuse, because it's the system -- we're not coming from a 250-volt DC battery out to a field squib. The computer cabinet itself has a power supply in it -- two power supplies actually -- but it's making a 12-volt signal from that power supply to send out to the device.

MEMBER ABDEL-KHALIK: So what do these

numbers mean anyway, if we don't know how the system will actually be designed?

MR. WACKOWIAK: Once again, in all -- when we've looked at the details of the design of the I&C system, because of the way that it is -- the redundancy and the -- basically it's the redundancy in the way it's connected, that we can put in almost any numbers for these values, and the only things that come out are the common cause failure of the software to operate, common cause failure of the communications protocol to be -- basically to be specified properly, and the common cause failure that the logic processors would fail. And that one comes from the manufacturer's data.

But the specifics of it -- to understand how these work, we have talked about 12 different ways to get power to that squib valve. Or not 12 -- seven different ways to get power to that squib valve, and that's for one of the squib valves. And we see on here for the GDCS valves, one of those others, the PRA says that only two of the eight have to actuate.

We have shown by calculation that it's -- probably one would be okay, but, you know, right now we're not taking credit for that. So if we have -- so to get to a failure of seven of those valves, it would be a common cause of 49 isolation devices that would have to fail, and these are isolation devices that are tested in the plant, and our configuration includes a test switch for these squib valves, where during the outage they can put the full firing current into a resistor and show that the rest of the circuit is still functioning.

So I -- you know, I'm -- we could put something in for these types of isolation devices, but I'm sure that no matter what number we use it's not going to be bigger than the 10^{-4} that we just said the I&C system just won't work. And that's an assumed number right now, because there is controversy on how you would calculate such a number. But I'm certain it's less than 10^{-4}.

MEMBER ABDEL-KHALIK: Thank you.

MR. WACKOWIAK: That's how we dealt with those things. We do have a detailed model, and it's just -- it's huge. And with all of the sensitivities we've done, you still just come out with those three basic events, three massive common cause failures, out of the system.

MEMBER STETKAR: I'm assuming, by the way, that that -- the model is fully linked together, right? When you solve the model, that your model for the I&C systems is actually linked to the front-line systems, isn't it?

MR. WACKOWIAK: We have --

MEMBER STETKAR: Because in the individual systems you show that with like a 10^{-3} or 10^{-4} or 10^{-5} input, but I'm assuming that that's just for display purposes. Is that correct?

MR. WACKOWIAK: That's for display purposes in the system. Those are linked. But, once again, when we do quantify the whole model, we don't use -- we do a sensitivity with the 2,000-page I&C model, but when we run most of our other cases we have a simplified model that has those failure modes that come out, those individual failure modes, and it has the links to all of the support systems, the 125-volt AC power, and the DC power system.

So all of the details of all of the different failures that could happen are not linked in the model when we solve the model, but we do do sensitivities to show all of it.

MEMBER STETKAR: Where is that simplified logic shown? That must be some simplified logic.

MR. WACKOWIAK: The previous version of the PRA showed the detailed logic.

MEMBER STETKAR: Right.

MR. WACKOWIAK: And then, back at the back page was the simplified logic. And I think we've -- we changed that this time, so that the chapter shows the logic that was actually linked into the tree, and then the detailed logic is contained in an appendix.

MEMBER STETKAR: When --

MR. WACKOWIAK: So it was in --

MEMBER STETKAR: We'll get to that in the system.

MR. WACKOWIAK: We'll get to that. So, once again, on the success criteria, we did look at various things. What we -- where we went through is we calculated for large LOCAs, we looked at all of our large LOCAs, have a big matrix that says, "What is the -- you know, in different sensitivities, what is the minimum number of components that you can use?" We have come up with like one, one, zero, and two, and so we selected the next thing up higher, two, two, one, and four. Once again, medium LOCA, we had to add DPVs in there, and we did the same sort of process.

Now, so let me just get to this next part here, and then I'll talk about the open item that we have on that. On our mission times, one of the things that we have -- that was pointed out here is that the mission on these plants is very long. If we were to cut off our sequences all at 24 hours, you know, we don't have very much left, because some of these failures actually occur out in the second day, third day, and I think one of our sequences even has the core damage occurring at 108 hours following the initiating event.

So our event tree branches look for the safe stable state. Safe and stable in this plant is not necessarily cold shutdown. A hot state is okay, and that's defined. So these sequences consider the entire mission time. But when we put in data, the data values for something that has to operate for the mission time, we put in a 24-hour mission time.

MEMBER APOSTOLAKIS: In terms of timing, if there is a problem, you have the active systems going first, right?

MR. WACKOWIAK: Yes.

MEMBER APOSTOLAKIS: And when and why would you switch to the passive system?

PARTICIPANT: Because they don't work.

MR. WACKOWIAK: The active systems no longer work.

MEMBER APOSTOLAKIS: What does that mean?

MR. WACKOWIAK: Let's say we have a pump injecting water into the vessel, and sometimes three or four hours into the mission the pump would fail. Then, since we are considering recovery in our models, that pump failing to continue to inject would result in water level going down, and then the active system -- or the passive systems could come in and still recover in --

MEMBER APOSTOLAKIS: They would come in automatically?

MR. WACKOWIAK: Yes.

CHAIRMAN CORRADINI: So can I just interject one thing here? Because you said something that I guess I hadn't thought of. But let's use that example and push it a bit. So let's say one particular part of the active system failed, but another part of the active system was working. You have procedures in place that say, "Ah ha, because of sister interaction this passive system will be defeated. Shut down this other active system to allow the passive system to operate." You were using sprays and pumping into the vessel. But I guess I want to make sure I'm clear on this, because that sort of interaction can get you in some sort of a pickle.

MR. WACKOWIAK: Yes.

CHAIRMAN CORRADINI: So have I got it right that if I were to have this active system failure, there are going to have to be emergency operating procedures in place that says that I'm going to shut down other active systems to allow the full complement of the passive systems to work?

MR. WACKOWIAK: There are some limited cases where that would be in place. The spry is one of them that --

CHAIRMAN CORRADINI: Well, that's -- brought that one up, and I hadn't thought of it.

MR. WACKOWIAK: Right.

CHAIRMAN CORRADINI: But I guess this is something I was thinking of coming in.

MR. WACKOWIAK: Yes. The way that we would want to deal with that is, like I said, before you spray, you verify one of two things -- one, that you do have active cooling going into the core, okay, or the core is outside the vessel and you don't care about that. But anyway, you do have active cooling.

When you've established that you do have active cooling, that usually means that you have AC power available, you have cooling water available, you have the full complement of just about everything onsite when you get to the point in the procedure where it says to do that.

So then we'd be in a situation where we

had the LOCA, we've been injecting and things for a while, and then subsequently we started losing all of our power and all of our diesel generators and things after they worked successfully for some period of time.

Those types of complex time-space sequences are not included in this model, and that might be one place where some of the CDF might go up. We would have to know a lot more about the specific equipment and about our procedures and operating training and things in order to do that. It's not something that can be done at the design phase.

CHAIRMAN CORRADINI: I'm not so much worried about the CDF numbers. I want to understand the logic about something actively failing and then getting appropriate emergency procedures such that they'd have to look for certain attributes or characteristics to keep the rest of the active systems going. Otherwise, you essentially get into this situation where the passive systems can't function as designed.

MR. WACKOWIAK: So in this particular case, if you lost your cooling or lost your injection, then the procedures would have to say don't spray anymore to reestablish the steam path through. But, remember, the water tanks are still there, so it's not like if the -- if the GDCS has not injected yet, there is still 2,000 cubic meters roughly of water that's there for the initial injection. Decay heat is lower, because you've been removing heat from the vessel for quite a long time. I think the accident scenario progresses much differently at that point. So --

CHAIRMAN CORRADINI: Okay.

MR. WACKOWIAK: -- those are concerns, and there are also concerns -- the things that concern me more than those sorts of things that -- when the operators have control of the plant, and then something fails and they have to respond to that, I think their -- those types of things can be handled to through the procedures and training. Operators usually are pretty good these days at dealing with that.

What I'm more worried about in the design phase is that the -- that the designers or the reviewers get overzealous in trying to protect some of these systems. So if you -- one step might be, if you have the active systems going, maybe you would turn them off before you put too much water inside the containment to displace nitrogen.

Well, the designers would say, "Oh, yes, I've got to protect that, so my containment pressure doesn't go up too high." Where we would say, "No, you want to be very careful of that," because the containment doesn't actually fail at the design pressure. The containment fails much higher than the design pressure, and you need to be deliberate on how you would give those kinds of instructions.

So where we are right now in the design phase of this is we are interacting with the designers to make sure that we have a proper balance of functions to turn off active systems, if you will, versus the operators having control of the plant so that things will operate.

MEMBER APOSTOLAKIS: Is it possible to have the passive systems actuated while the active systems are working?

MR. WACKOWIAK: Yes.

MEMBER APOSTOLAKIS: And then, what will happen?

MEMBER MAYNARD: They are going to actuate.

MR. WACKOWIAK: It's a completely -- it's a different set of signals that -- if water level gets into Level 1, the passive systems --

MEMBER APOSTOLAKIS: And then what

happens? I mean, is there a sequence that you have analyzed or --

MR. WACKOWIAK: Yes.

MEMBER APOSTOLAKIS: Oh, it is analyzed?

MR. WACKOWIAK: So the question is, if something like low pressure injection is working, but just not keeping up, then what happens if the passive systems come on?

CHAIRMAN CORRADINI: That's a good one.

MR. WACKOWIAK: In that particular case, the SRVs would already have been open, because the low pressure systems need the SRVs to perform their function. So the first 150 seconds of the ADS sequence would be meaningless. The ACS valves are already open.

The DPV squib would blow, but since the reactor vessel is already depressurized at that point, we -- you know, and cooler water is coming in, maybe we would lose a few more pounds of pressure there when those actuate. And then, when the GDCS squibs open, then the water would drain into the reactor and fill up. And then, the low pressure system, since it is always in a recirculation mode from the suppression pool back into the vessel, would probably preclude the need for using the PCCS at that point.

Yes?

MEMBER SIEBER: Would it be fair to say that if we don't address Dr. Corradini's question that the PRA result that we now see is not fully reliable, that the risk would be higher than what this analysis says?

MR. WACKOWIAK: Well, I don't like the term that a number isn't reliable, or the results aren't reliable, because the purpose of the results is to show that we meet the goals.

MEMBER SIEBER: Right.

MR. WACKOWIAK: Now, you might say that the results might be low, but they are still adequate for performing the application that -- the risk-informed application that we are doing, which is a design certification for the plant.

MEMBER SIEBER: That is specifically the question now. It seems to me that Dr. Corradini's question identifies an area that hasn't been fully explored. The question is: to what extent can we rely on the answer when there's a piece of the puzzle that's still missing?

MR. WACKOWIAK: That's what needs to be decided. Is there enough there that shows that we meet all of the goals with margin such that the plant should be certified?

If there's no other questions about that --

MEMBER ABDEL-KHALIK: You can't address this issue until you have a complete set of procedures.

MR. WACKOWIAK: It's even more than that. I think you have to have the equipment in order to develop those procedures. So it's a chicken and egg sort of thing. You really can't -- you can't know exactly what you have until you actually have it. They are far enough along the line that, you know, procurement specifications and things like that, much farther than anywhere in the licensing process here.

MEMBER SIEBER: In the old days, the process was that the vendor would provide procedural guidelines to the applicant, the licensee, to write the plant-specific procedures. Do you plan, as part of the package of supplemental plans to customers to provide procedural guidelines like that?

MR. WACKOWIAK: I think there's a -- in the area of the emergency operating procedures and the severe accident guidelines, there is a COL item now that those procedures need to be developed. The lead for that at this point is with GE, working with the

DCWG, and it's kind of outside of the scope of the certification. But that whole process is going on. There will be a common set of guidelines and probably procedures and training for all of the ESBWRs.

MEMBER SIEBER: It seems to me, though, that for you to develop a reliable PRA, and also to design a few parts of the plant, you have to know what the operator is going to do or you have to decide what he is going to do and write it down in terms of guidelines, that all of the plant-specific features or company-specific things that they would ordinarily put in there would get into it when the detailed procedures are written. I mean, you didn't say yet that you are going to write the guidelines.

MR. WACKOWIAK: Well, absolutely, we would -- we have some guidance in there. In Chapter 19, there is a list of insights from the PRA, and some of those insights have to be implemented in the procedure development plan, and those are identified in the latest one -- which ones are -- they were just called operational programs before.

But as you look at those, most of those are things that are implemented through procedures and training. So we have already got some guidelines from the PRA.

But, remember, the PRA itself -- and people talk about a reliable PRA and things that -- the PRA is built to answer the specific questions that it was built for. And what we're trying to show with this one is that we meet the goals and the other few things there. You'll notice in our application we did not try to do risk-informed tech specs.

Our PRA needs to include all of those things that you are talking about in order to do risk-informed tech specs, so we did not do that in this application.

MEMBER SIEBER: Yes. But there's other risk applications, and the development of other software and hardware for the plant PRA has value.

MR. WACKOWIAK: Oh, it does. But we want to make sure that we have the right PRA for the right applications. And we think -- it is our contention that this PRA is sufficient to ask the questions that have been answered for design certification. It may or may not be sufficient for doing other things. And when we've got --

MEMBER MAYNARD: The question that's on the table is: is that going to be a COL issue? That once the procedures are developed and the equipment is picked, then the COL applicant would have to show that with that equipment and those procedures that it stays within the bounds of the PRA established for the design certification.

MEMBER SIEBER: But the COL applicant is going to write the procedure. So I'm wondering what the check on that is.

MEMBER BLEY: Well, let me ask it a slightly different way. I don't fully understand the ITAAC business, but it's inspection, test, analysis, and acceptance. Could these criteria end up being acceptance criteria in the form of an ITAAC, once your work is all done, that would flag it for the COL, then, that those have to be included? That's probably more for staff than you guys. I don't know. Would anyone address that?

MR. WACKOWIAK: I think that these things that we're talking about here are all intertwined through that. And the question is: is there a specific point that you could point to me that does that? Because you have to remember that the procedures development is tied in with this I&C development, and that's something that they called DAAC.

And, you know, around here DAAC is a four-letter word. But there's part of the design that is just based on -- right now on acceptance criteria, and the I&C systems and much of the human factors things, like the development of the EPGs, things like that, are in this design acceptance criteria where we have rule -- we have a process for how we're going to develop those, but they have not been developed yet.

And when they are developed, then those things are submitted as DAAC closures through one of the -- probably the first COL applicant, most likely North Anna, but probably the first -- the first COL applicant for review. Does this particular aspect of the human factors -- does it close out the design acceptance criteria? If that is okay, then everyone else references that closure of it. So there's other --

MEMBER BLEY: Where I was headed is, is there an accepted place for these assumptions that are important to the PRA and that ought to end up in procedures? Do they end up as DAACs then? How do we make sure that when we get to the next step these things don't just fall through the cracks and they aren't there in the procedures?

MR. WACKOWIAK: They currently exist in a table in Chapter 19 of the DCD, so that's where they reside today.

CHAIRMAN CORRADINI: That's where they're captured.

MR. WACKOWIAK: That's where they're captured today.

MR. HAMZEHEE: I think -- Dennis, I think one thing we're trying to ensure at this time is that there is a clear documentation of all of these assumptions -- and we call them operational programs -- so that they may become COL action items. And through the application, then they have to ensure that these assumptions/procedures are somehow incorporated into their operating procedures and checked and balanced.

MEMBER BLEY: And I guess the point we're raising is that "somehow" part is leaving us a little queasy.

MR. HAMZEHEE: Yes.

MEMBER BLEY: "Somehow" needs to be defined.

MR. HAMZEHEE: Yes. And I think --

MEMBER BLEY: And it ought to be defined pretty soon.

MR. HAMZEHEE: I think we -- there may not be ITAAC. We will get back to you on that. But these are all COL action items that become --

MS. CUBBAGE: Right. This is Amy Cubbage. You know, by nature of these assumptions and insights being in Chapter 19 of the DCD, they become requirements for all future licensees for ESBWR forever. And so if they -- if they don't meet those requirements, they have to come in through a departure through the Part 52 change process. They become design requirements.

MEMBER APOSTOLAKIS: But something confuses me a little bit. You said earlier, Rick, that we have not included in this PRA -- the way I understand it anyway -- this transition from active to passive system cooling, and the operator actions because the procedures and equipment are not known. But for design certification purposes, a PRA is good enough. How does that follow from missing something that appears to be very important? Why is it good enough for the design certification when an important transition is not modeled?

MR. WACKOWIAK: We did do a look -- this was the adverse system interactions look that we have been talking about here. What can happen if an active system is working, either during or prior to a passive system active, and then we have a qualitative assessment of -- is that a failure mode that has to be addressed? Okay?

And so, for example, on one of these things associated with adding water into the containment, prior to the passive systems actuating, one of the concerns would be that you have displaced or possibly displaced more nitrogen in the containment, so the containment pressure could be higher.

But in the PRA assessment what we say is that the containment failure occurs at three times -- at or above three times the design pressure, and you can't get to those kinds of pressures just by adding this extra bit of water into the containment. So we've gone and qualitatively looked to see if there are anything like that that affects the system in the PRA.

But the specific modeling of that sequence has not been done. We think it will come out okay.

MEMBER APOSTOLAKIS: So what you're saying is that, yes, we did look into how things can become complicated, but we assume -- we looked at the consequences of if they become complicated.

MR. WACKOWIAK: Right.

MEMBER APOSTOLAKIS: Okay. That makes sense.

MR. WACKOWIAK: And then, in our PRA model, then, we assume that if there's a failure, a run-time failure of an active system, then that -- we decided that that happens early at time zero, so that would go on, and we didn't model the details of that time phasing. But we think it's note -- that the consequence is not going to be significantly different from what we have in the PRA now.

MEMBER APOSTOLAKIS: Thank you.

MR. WACKOWIAK: Okay. On the accident --

MEMBER APOSTOLAKIS: There is no break, I guess, huh?

MR. WACKOWIAK: Let me just get this one here, the accident sequence analysis --

CHAIRMAN CORRADINI: Let's just get to this, George, and then we'll have a break.

MEMBER APOSTOLAKIS: When?

CHAIRMAN CORRADINI: In a minute or two.

(Laughter.)

MR. WACKOWIAK: The accident -- we have a couple of significant open items. The one we talked about was the thermal hydraulic analysis. Specifically, the cases that we showed for the MAAP versus TRAC comparison didn't cover PRA scenarios. They were design basis scenarios.

And then, there was another question about TRACG models, and are they -- what is the justification for calculating the clad temperatures in these regimes, since it was qualified for other regimes. Those specific responses are, unfortunately, still being developed, and we don't have that right now. The latest DCD took precedent over this RAI, so those will now be picked back up.

MEMBER APOSTOLAKIS: Okay.

MR. WACKOWIAK: There was a question about the rationale for selection of the limiting accident scenarios. We provided the road map to where that selection can be found throughout our document. And the other one is the treatment of parameters affecting the thermal hydraulic uncertainty was not provided before, and we provided in an RAI response the information needed to understand how we made those selections. And I think that table is now included in the PRA.

MEMBER APOSTOLAKIS: Rick, are you familiar with the work that has been done primarily in Europe on these things, the RMPS method for passive systems? I mean, have you addressed where they develop a number of steps. First, you look at this and that and that, you know, that kind of stuff. I mean, are you familiar with that?

MR. WACKOWIAK: By name, no. But it's possible that I -- I'm not familiar with the name.

MEMBER APOSTOLAKIS: Also, EPRI issued a report just a few months ago. You are familiar with that? A review of activities of passive system reliability. The EPRI report is probably the best, because it -- do you have it?

MR. WACKOWIAK: If we don't, I'll get it. I have to say.

MEMBER APOSTOLAKIS: Okay.

MR. WACKOWIAK: Yes. The thing that we --

MEMBER APOSTOLAKIS: He is not asking me to give it to him, so --

CHAIRMAN CORRADINI: He has it. Can you -- he's waiting for you to ask him.

(Laughter.)

MEMBER APOSTOLAKIS: I'll give it to you.

MR. WACKOWIAK: Well, the way that those --

MEMBER APOSTOLAKIS: No, because that report is not -- that report, not only does it review what has been done in the literature, but also it goes to past ACRS subcommittee meetings, what was done with AP-1000, what issues did you raise. So in that sense, it is kind of the latest.

MR. WACKOWIAK: Okay. Sounds like a good source.

CHAIRMAN CORRADINI: So before -- I think we're done with this slide. Before we go to your next one, is this a good time for a break?

MR. WACKOWIAK: This is a good time for a break.

CHAIRMAN CORRADINI: Okay. So we will reconvene at 11:20.

(Whereupon, the proceedings in the foregoing matter went off the record at 11:06 a.m. and went back on the record at 11:25 a.m.)

MR. WACKOWIAK: Okay. I am going to start going through the rest of the chapters again and trying to cover the open items. Once again, it is all great discussion, and we want to have it, and hopefully we can get through the program. But I don't want to leave you with unanswered questions.

MEMBER BLEY: We might have a question before the day is over.

MR. WACKOWIAK: Okay. The next chapter in the PRA is a systems analysis. Just basically some statistics -- we have 29 systems in the plant that we model. That's roughly a third of the named systems, 39 functions that are there, that we have in the model from these systems.

The kinds of things that we -- that aren't in there tend to be things that don't affect getting water to the core or provide support systems to the systems that do get water to the core.

We based our model on the descriptions that are in Tier 2. And, once again, since that is a fairly high-level description, it may not be sufficient in all cases. Augment that with topical reports, which you should also have access to on some of the issues. But then, we also use some internal design specifications, which are -- I think the only information available to you there is the summary that we put in the PRA, and the rest would be auditable material rather than submitted material.

We assume a typical maintenance schedule. We didn't try to come up with anything complex. We did a sensitivity, I believe, on the maintenance terms that we put in the model.

MEMBER STETKAR: Rick, let me ask you about that. If I understand -- let me make sure I understand the tech specs correctly. The tech specs, as I understand them, seem to allow one complete division of safety-related -- let me call it DCIS, because it's one division of the safety-related actuation systems -- both batteries, power supply, everything -- to be out of service indefinitely, is that correct? There is no time limit if I have one --

MR. WACKOWIAK: Yes. The specs only include three.

MEMBER STETKAR: They only require three. So I can have one out indefinitely, and then -- I've lost my notes here, but there are time limits that kick in if I have two out -- three -- and I can have up to three out of service simultaneously. I don't know how you do that, but it will allow three to be out of service for I think two hours, something like that.

MR. WACKOWIAK: Oh, okay.

MEMBER STETKAR: Let's go back to the first condition, however. Since I can -- and I understand that this is in the technical specifications, I'm assuming it, to allow the licensees to perform online preventive maintenance and the types of things that people like to do, because the design supports that type of activity, why is there nothing in the PRA that accounts for the fact that one complete division of the actuation systems can be out of service? And, in fact, two divisions can be out of service. In fact, maybe even three divisions could be out of service, although that might be a rare event.

It's allowed by the tech specs, and, if it's allowed, people are not breaking the law by doing it. It's not clear to me how somebody could actually remove three divisions from service and be operating at power, but I think they can do it with two.

And PRA does not have any contribution from those -- let me call them maintenance alignments rather than -- and it's not repair-type maintenance. It's just normal preventive maintenance, inspection, could be modification work even, anything that you could do at power that removes it from service.

MR. WACKOWIAK: That's right. The maintenance that we expect on this DCIS system is really only associated with calibration of instruments, the instruments themselves not the DCIS, and for doing battery discharge tests. Everything else that is going on in this system is self-diagnosed, and so they would be going into the cabinets based on repair work.

MEMBER STETKAR: That is repair of failures.

MR. WACKOWIAK: Yes.

MEMBER STETKAR: However, in Europe, there are many plants operating that have similar four-train safety systems, and they have regular preventive at-power preventive maintenance, inspection programs, where indeed they do take the entire train out of service, not for repair of failures but because they don't want people inside those cabinets checking things on an active system. They actually de-energize the entire train.

The duration may be a couple of days to even a week or 10 days depending on the plant's maintenance programs, and so forth, and --

MR. WACKOWIAK: It is my understanding from talking to our designers of the DCIS system that that will not be going on in this plant.

MEMBER STETKAR: It's allowed by the technical specifications.

MR. WACKOWIAK: I know that it's allowed by the tech specs, but the tech specs were written that way to allow things like battery testing.

MEMBER STETKAR: No, it has separate tech specs for the batteries.

MR. WACKOWIAK: I understand that.

MEMBER STETKAR: Compared to the

divisions. It's very clear.

MR. WACKOWIAK: I understand that that's that way. The way that they have explained this to me for the -- the way that the plant will be operated, so I know we're in-bounding here, but, you know, I'm making the leap for the as-to-be-operated, that they don't want anybody in those cabinets.

MEMBER STETKAR: Well, then, why aren't the technical specifications written that way to prevent people from doing that?

MR. WACKOWIAK: Okay.

MEMBER BLEY: Well, let me ask you an easier question. Given what you said, I should be able to go to Appendix 19(a) and find that this is an assumption, that they won't be in those cabinets as often as allowed by tech specs. Will I find it there?

MR. WACKOWIAK: No.

MEMBER BLEY: Okay.

MR. WACKOWIAK: No.

MEMBER BLEY: Should I find it there?

MR. WACKOWIAK: I wouldn't expect it to be found there. The place where I would expect it to be found, but I don't know that it's there, would be in Section 4 of the DCD in the -- not 4 in the DCD, 4 in the PRA, in the description of the assumptions of the

DCIS system. But I don't think that that assumption is there.

So that's an interesting question, and I understand that the tech specs are written that way. Did we ever -- do you remember if we ever effected the fourth division in the availability controls manual?

MR. MILLER: The fourth division of?

MR. WACKOWIAK: Q-DCIS. We talked about that at one point. I don't know that it made it into this. But, once again, the PRA does assume that there isn't any maintenance other than corrective maintenance needed on these systems.

And as a matter of fact, the way that they explained the system to me is that each of the tri-conic -- I think the tri-conics cabinets have the ability to have two redundant cards in every slot. And so if the first one fails, the other one hots, it's not really -- they are always hot-swapping, but the other one is there and the system doesn't even need to go offline for corrective maintenance.

So we could probably do -- look into our set of sensitivity studies and look at what would happen if we only had three of the four divisions, and see if that made any difference to the results. Once again, I'm guessing -- and it's right now a gut feel

-- that the common cause failures would still be dominant. Because, remember, the way that our system is set up, the individual valves themselves, the mechanical devices, aren't division-based. Each mechanical valve still gets its feeder from multiple divisions, so it's -- the tech spec is what it is, and I believe that the PRA is correct in assuming the things that we have assumed.

Now, we can do the sensitivity to see how important that would be. Where I'm a little bit worried about the sensitivity, though, is that we made some assumptions about which divisions -- you know, since there is three safety-related divisions connected to each valve, and we actually have four safety-related divisions, which ones go to which, because I think that was going to be decided at the time that they were doing the final electrical layout. Probably won't make much difference, that --

MEMBER STETKAR: We ought to go -- keep on schedule here, because that's fine structure, but it's --

MR. WACKOWIAK: It's an interesting question, and it's probably worth a look.

CHAIRMAN CORRADINI: Keep on going.

MR. WACKOWIAK: Then, the last thing is,

you'll see in the fault trees that there is multiple plant configurations allowed -- this pump in standby, this one running -- but we really only picked one when we did the quantification.

MEMBER STETKAR: Oh, is that right? You said some --

MR. WACKOWIAK: We have a set. We tried to do it based on split fractions at one point, and it wasn't solving. And then, when we quickly did a hand calc to see what it was doing, we ended up -- we were solving the PRA model more than four million times in that case, and it turns out there is -- no wonder it doesn't run.

MEMBER STETKAR: You need some pretty interesting complementary logic to get it to work.

MR. WACKOWIAK: But we don't think it makes that much difference to the --

MEMBER STETKAR: Which division did you set -- is it obvious in the new version which division is running?

CHAIRMAN CORRADINI: Careful. What was passed out was the new DCD, not the new PRA.

MEMBER STETKAR: But it includes the new Chapter 19.

MR. WACKOWIAK: It includes the

Chapter 19, but the rest --

PARTICIPANT: But it does not include the new PRA.

MR. WACKOWIAK: We are going to get that.

MS. CUBBAGE: I have it on a stick.

MR. WACKOWIAK: We are going to get that.

(Laughter.)

MR. WACKOWIAK: I'll have to look to see if, in the quantification file, they actually -- that we actually did or did not list what the flag files were. I don't remember if that is listed in the table.

MEMBER STETKAR: That's important for documentation, for people to understand how the plant is lined up normally.

MR. WACKOWIAK: Yes, and it really would -- most of the systems are pretty symmetrical in this plant. We don't have a lot of asymmetry. We did some looks at which ones would be the best to be the ones operating, but I really don't remember if the flag settings were listed in the PRA document.

MEMBER STETKAR: Well, I couldn't find them anywhere, but in the Rev 2 PRA, I was led to believe the rotating thing kind of worked, because all I saw was the fault tree --

MR. WACKOWIAK: No, it didn't work.

MEMBER STETKAR: Okay.

MR. WACKOWIAK: Not with the computers we have today.

System analysis -- there were no significant open items in the systems analysis. In the data analysis -- we have talked about this before -- we think we picked bounding data, and there could be -- you know, there is always controversy on what's bounding and what's not. But we made an attempt to do that. We tried to use the data from the ALWR URD.

We do have a generic database that we use for other GE projects that -- like the Lung Min project, and things like that, that we rely on if something is not in the ALWR URD, and then some things are based on engineering judgment. I think the data analysis says where we got all of the -- which of those things gave us the data. I think it even goes down to the sources in the GE database.

For the passive components, we did adjust failure rates for long maintenance intervals, and we have previously talked about that process, and that is described in the PRA. We have uncertainty distributions for all of the data, and, once again, like we said earlier, the way that our software is set up we may be missing some state of knowledge correlation in the uncertainty on the common cause failure.

MEMBER STETKAR: What software are you using?

MR. WACKOWIAK: It's CAFTA 5.1(a), and then whatever -- I don't remember the exact number, but whatever version of uncert came with 5.1(a). It's not the current --

MEMBER STETKAR: Okay. But it's CAFTA.

MR. WACKOWIAK: -- version. There are some things that have been changed there that might help this, and we are looking into that.

The squib valve failure rates we -- we did increase the failure rates on the squib valves from what the database had, mainly because of uncertainty and the types are somewhat different than what has been used in the past.

The sizes are pretty comparable to things that have been used in the past. We don't have any 18-inch squib valves or anything like that in this plant, but they are somewhat different in design. So --

MEMBER ABDEL-KHALIK: What is the original source of the data, and how large is that database?

MR. WACKOWIAK: The original source, the URD?

MEMBER ABDEL-KHALIK: For the squib valve failure rates.

MR. WACKOWIAK: I'll have to get back to you on that. I don't know that answer.

MEMBER ABDEL-KHALIK: Yes. I would be very interested in knowing where that -- those numbers come from.

MEMBER SIEBER: Aren't the squib valves for this plant unique to this plant?

MR. WACKOWIAK: Some aspects of the squib valves are unique.

MEMBER SIEBER: Like the size and the display and --

MR. WACKOWIAK: Yes. Some of them, the disk is not that much different from what others have used. The GDCS and equalizing line valves are not that -- are not that different in size than what has been used in standby liquid control systems before. The DPVs are a larger special design, and -- but that has been prototype tested. We've got data from the test.

So that's a good question, because the data -- is the data just from nuclear powerplants? Or is it -- does it come from other industries as well? We can look into that.

MEMBER SIEBER: Well, your explosive charge database is lot of industries.

MR. WACKOWIAK: A lot of industries.

MEMBER SIEBER: I think NASA has --

MR. WACKOWIAK: NASA has got a lot of that.

What I say here, high end digital system failures, where some of these things are still being hashed out, as many of you well know, in the -- what we use in -- what we should use for the digital failure rates. We do have a point estimate for some of these things that we're discussing now, or that the industry is discussing, and we chose to use the high end of the industry numbers in our PRA. The -- I guess that's all I want to say there.

We have screening values for our limited number of operator actions. I think we've talked about this before. Many of them tend to be on the order of .1 or higher, and the ones that are lower are the things where the operators have days to perform the action. You probably found one that is higher than that, too, or --

MEMBER STETKAR: Lower with about 30

minutes, yes.

MR. WACKOWIAK: Lower? I don't know if --

MEMBER STETKAR: They are actually taking -- the cognitive responses are taken pretty much from ACEP curves.

MR. WACKOWIAK: Yes.

MEMBER STETKAR: And they tend to be in the middle to the upper end of the ACEP curves, but not necessarily at the upper valve.

MR. WACKOWIAK: Right.

MEMBER STETKAR: So some type of performance shaping factor analysis must have been done for some of those actions.

MR. WACKOWIAK: And some of those --

MEMBER STETKAR: And some time windows were assigned. I mean, there are 30-minute, one-hour time windows.

MR. WACKOWIAK: And some of those time windows there -- and we'd have to look at the specific ones -- some of those values always occur in orgates with other values, and so sometimes we put all of the -- all of the particular action in under one of the terms, and then the other one is just the thing that wasn't covered in that common value. So some of those lower ones for the 30-minute might be where it's split out.

MEMBER STETKAR: It's manual GDCS actuations.

MEMBER APOSTOLAKIS: Now, the digital system failures, I mean, reduce probabilities, right? Can't you just get out of it, you don't use probabilities and give an argument why you think these things are reliable? I mean, the probabilities are really, when it comes to these systems, they do not have any basis.

MEMBER SHACK: Expert judgment.

MEMBER APOSTOLAKIS: No, even if --

PARTICIPANT: There's no experts is the problem, to say expert judgment.

MEMBER APOSTOLAKIS: Maybe if you can argue in terms of diversity, redundancy, that kind of stuff, it's acceptable. And leave it out of the PRA. Because -- yes, leave it out. Don't put probability -- don't put probabilities. Do whatever it is you want to propose.

MR. WACKOWIAK: Well, and the one thing where we looked at this in terms of using this particular probability of 10^{-4}, which is the common failure that the system just doesn't work, or there is a complementary -- the common cause failure that the system does things that you didn't want it to do. That is also included as one of the failure modes.

We've looked at that somewhat, and because of where the goals are, if we use 10^{-4} or 10^{-3} or 10^{-5}, you still end up making the same decisions on what needs to be in the tech specs, what needs to be in the ACM, what needs to be in RTNSS.

MEMBER APOSTOLAKIS: But the program --

MR. WACKOWIAK: That whole range, it -- so for the purpose of this exercise, I'm not sure that --

MEMBER APOSTOLAKIS: No. The problem, Rick, is that if we let this go, other people later will say, "Well, gee, at look this. 10^{-4}, they used it, you approved it. What are you complaining about?" Let me ask you this --

MR. WACKOWIAK: That doesn't always work, though, because we started with 10^{-5}, because that's what Westinghouse did, and that's --

MEMBER APOSTOLAKIS: See, that's the problem.

MR. WACKOWIAK: But we didn't use 10^{-5}; we used 10^{-4}.

MEMBER APOSTOLAKIS: You can't put numbers that make no sense in it. You don't analyze organizational failures, do you?

MR. WACKOWIAK: No.

MEMBER APOSTOLAKIS: So why should you analyze these. You have to give -- you can give qualitative arguments.

MR. WACKOWIAK: That's right. And, actually, it's a similar thing. Analysis of the digital failures turned out to be -- specification or organizational failure. So it's the same problem.

MEMBER APOSTOLAKIS: We have a -- I mean, this Committee or Subcommittee has been trying now for at least a year to convince everybody not to put probabilities where they don't belong. And the stuff is beginning to go along with us. Maybe we made a mistake with Westinghouse, I don't know, but this 10^{-4}, 10^{-5}, there is no basis for it, absolutely no basis.

MEMBER BLEY: You need something in there, but maybe you don't need a number. You need to make sure --

MEMBER STETKAR: You need a placeholder. You need a placeholder of some sort.

MEMBER APOSTOLAKIS: That's fine, as long as you don't use a number.

(Laughter.)

MR. WACKOWIAK: And what we tried to do

with it was we looked at whether changing the number would lead us to different decisions.

MEMBER APOSTOLAKIS: At some point, it will.

MR. WACKOWIAK: So, at some point it will. If we got to 10^{-2}, it would give us a different decision. If it got down to 10^{-6} -- if it got down to 10^{-6}, we could eliminate the diverse protection system. So --

MEMBER APOSTOLAKIS: I don't know about that, but it's really a problem that we have right now. But we can't go on that -- this way. You know, the research is not done, we don't understand something, ah, we'll use a number anyway, because then these things acquire a life of their own. Now, that may not be your problem, but it's an agency problem. Okay? And I really don't want to see a number there, huh?

MR. WACKOWIAK: Can we move on?

CHAIRMAN CORRADINI: Yes, let's keep on going. Can we?

MEMBER APOSTOLAKIS: I don't want to see a number there. Can you take that out?

(Laughter.)

MEMBER BLEY: Rick, one thing I want to

ask you about -- I really want to ask the staff about this when they're on, but I just wanted to get an anchor point from you. We've had a long discussion a couple of times about these vacuum breakers, the new big valves.

MR. WACKOWIAK: Okay.

MEMBER BLEY: And you refer to the testing program and to a Bayesian approach. Do you use a Bayesian approach in a lot of areas, or was it peculiar for this one?

MR. WACKOWIAK: That one was different, because there were actually tests that were run. In the rest of the DCD, we have generic data, and we have nothing to update that generic data with. In this particular case, they were doing the Bayesian update for a specific purpose. They had a --

MEMBER BLEY: Okay.

MR. WACKOWIAK: -- vacuum breaker, they tested -- did various tests on that vacuum breaker, and then they updated the generic vacuum breaker data with their test information.

MEMBER BLEY: Have you done a lot of other Bayesian analysis, or is this kind of unique to the PRA work you guys have done?

MR. WACKOWIAK: That's the -- in answering that RAI, it's the only place that we --

MEMBER BLEY: Okay. Fair enough.

MR. WACKOWIAK: -- use that.

MEMBER BLEY: One more question on this, and then I'm going to talk to the staff about it. Are you comfortable, or do you understand the effect of the prior on the posterior results?

MR. WACKOWIAK: What?

MEMBER BLEY: Have you really played with that analysis enough to understand that?

MR. WACKOWIAK: Yes.

MEMBER BLEY: Was there an RAI on this issue?

MR. WACKOWIAK: There was an RAI on the reliability used of the vacuum breaker, yes.

MEMBER BLEY: Okay. I guess I missed that one. I was looking for it and couldn't find it. But, very simply, let me say that --

MR. WACKOWIAK: The Bayesian update that was used for that was actually to answer a different question in the SBWR program.

MEMBER BLEY: Okay. The prior that is given is anchored to data on valves that are completely different, have nothing to do with this valve. And the range of the prior, including the uncertainty, essentially guarantees the answer that came out.

MR. WACKOWIAK: That's correct.

MEMBER BLEY: And it's not a broad enough prior. I want to ask the other folks about their review of it.

MR. WACKOWIAK: Okay.

MEMBER BLEY: It lets you use a very small sample of data to prove something that's really just saying, "I picked a prior so low that whatever data I put in is going to get me the answer I wanted coming into the process."

MR. WACKOWIAK: The purpose of that evaluation in the SBWR program was to demonstrate that the vacuum breaker design was a passive component and did not require any sort of active backup.

MEMBER BLEY: Okay.

MR. WACKOWIAK: We rejected that. Our design includes an active backup to the vacuum breaker. So --

CHAIRMAN CORRADINI: You mean the valve closure, the isolation valve.

MR. WACKOWIAK: The isolation valve is on there, because in our judgment, my group's judgment, the Bayesian update that was performed for that purpose of deciding that that was a passive valve did not conclude that that was a passive valve.

MEMBER BLEY: Okay. And I would go further to say that your results are really essentially wrong, and they are driven wholly by the prior rather than the results of the test.

MR. WACKOWIAK: Okay. We can talk about other things associated with that report offline.

MEMBER APOSTOLAKIS: This brings up --

MEMBER BLEY: That's fine. I mean, it's --

MEMBER APOSTOLAKIS: This brings up another issue. I don't think today's meeting is detailed enough. And we've had two meetings before, and they were I would say at the same level. Okay? Will we ever have an opportunity to actually go into details and have slides that present, "This is what we did here," and somebody says, "Well, I agree, I disagree."

MR. WACKOWIAK: So let me just --

MEMBER APOSTOLAKIS: In my view, this is too high level.

MR. WACKOWIAK: So let me try --

MEMBER APOSTOLAKIS: We did just the analysis, we did this other analysis, and if we happen to have seen something relevant, then we raise it.

MR. WACKOWIAK: Right.

MEMBER APOSTOLAKIS: I don't know how to handle this. I mean --

MR. WACKOWIAK: In the previous two meetings since, I don't remember --

MEMBER APOSTOLAKIS: It was the same thing.

MR. WACKOWIAK: Was it? Okay.

MEMBER APOSTOLAKIS: Well, not the same presentation, but, I mean, you know, slides and data analysis, we did this, we did that, without really jumping into the details.

MEMBER BONACA: Maybe what they are showing in the afternoon is more --

MEMBER APOSTOLAKIS: The staff? No, the staff will tell us what they did.

MEMBER BONACA: George, I think the purpose of --

MEMBER APOSTOLAKIS: No. I'm talking about what I see here, which hasn't been presented yet, seems to get into more details technically.

MR. WACKOWIAK: In some areas, but there are --

CHAIRMAN CORRADINI: I don't think we are going to answer your question to your satisfaction at this moment. But I think we've got to discuss it, because we're going to have essentially a lapse in time between -- we have a couple more chapters which we have received, that we're going to look at, and then we're going to have a lapse in time where we have about six months that we can call special meetings to get the details.

I think -- Sanjoy is not here, but I know he sent me a number of e-mails, and Said has talked to me about thermal hydraulics. And PRA may be another area we're going to have to have a couple of days just for that.

MR. HAMZEHEE: George, and I was just going to suggest that the purpose of today's meeting is not really to get into the details of some of these technical areas. This is to give you the overall status, the issues, the significant open items. However, if there are specific areas that you'd like to learn more about, then we have to have those meetings that you mentioned and go over the details. Today, we haven't even gotten to half of our presentation, and half of the day is over.

MEMBER APOSTOLAKIS: Right. I understand that, but I don't recall ever having these kinds of meetings that you guys are talking about where we have a special meeting, Subcommittee meeting, to talk about data analysis, frequency, or whatever. We never do that. I don't recall it. I mean, it was always thermal hydraulics, 15 Subcommittee meetings, PRA today, and we're done.

(Laughter.)

PARTICIPANT: Half an hour.

CHAIRMAN CORRADINI: Let's go on. We can talk about that this afternoon.

MS. CUBBAGE: We'll get you here for a day. I mean --

(Laughter.)

PARTICIPANT: She's got you. She's got you.

(Laughter.)

You were set up. You just walked into that one.

(Laughter.)

MS. CUBBAGE: I mean, the bottom line is we would -- we would come back, if there's topics you want us to discuss. We just need to schedule it.

CHAIRMAN CORRADINI: We are going to have to get back to that. Let's let him go on. But you're right, I think we're going to have to.

MR. WACKOWIAK: And to do the kinds of things you're looking for sounds like, based on doing Reg Guide 1.200 reviews at sites, you know, you'd probably need to book two weeks of time to go over everything that you want to go over.

MEMBER APOSTOLAKIS: These are extremes. One extreme is what we are doing today; another extreme is two weeks for data. I mean --

MR. HAMZEHEE: George, if you pick a few areas that you are interested, or other members, then we can have like half day one day, special meeting, just on those areas. But you know how broad the PRA is, and we can't really cover every single area in a day, and that's not feasible.

MR. WACKOWIAK: And then, when we would set it up, we would have to set it up so that we're not going over all of the same upfront material every time, too. So it's a balance. We'll figure that out, or you guys can figure that out with your schedule.

CHAIRMAN CORRADINI: Keep on going.

MR. WACKOWIAK: So in data analysis there were no significant open items remaining. Human reliability analysis, we have talked a bit about this. The pre-initiating event values, we have done that evaluation, and we took the list of the important pre-initiating events and that's now in the hands of the human factors.

MEMBER STETKAR: Back to data, because you skipped it, this is probably a mechanics thing, but I was just curious -- the code -- does CAFTA -- I'm not familiar with CAFTA. Does CAFTA generate the MGL parameter values internally, or do you do that manually and input -- you have those terrible, terrible fault trees with all of that stuff in it.

MR. WACKOWIAK: Yes.

MEMBER STETKAR: And each basic event has a number.

MR. WACKOWIAK: Right.

MEMBER STETKAR: Does CAFTA --

MR. WACKOWIAK: CAFTA generates those numbers. We put in the --

MEMBER STETKAR: You put in the basic -- you put in the failure rate, the beta gamma delta values, and it generates -- I think the numbers are wrong. You may want to go look at that.

MR. WACKOWIAK: Wow. Okay.

MEMBER STETKAR: Because I think if you add up all of the MGL -- all of the failures, they add up to something that is greater than what you started with, which is not correct.

MR. WACKOWIAK: Okay.

MEMBER STETKAR: Check that. We'll get together later. I'll show you the example that we did, because if it's -- if it's something internal, that's just something in the code.

MR. WACKOWIAK: We've got to figure that out.

MR. HAMZEHEE: I think it happens sometimes, John, when they don't do one minus. So just --

MEMBER STETKAR: I don't care. If the code is generating the numbers --

MR. WACKOWIAK: Because I know we've done -- early on when we adopted that method we did some backup calculations to show that we were getting the right answers, but it is automatically generated.

MEMBER STETKAR: Fine. Go on. I was just curious. That's the only thing on --

MR. WACKOWIAK: It's possible that something might be -- the human action-induced initiating events, we talked a little bit about this. It's covered in our discussion of initiating events, but maybe not to the level of detail that you were looking for. We'll have to go into our internal files and maybe get -- if we had a day on that, we could bring more information.

MEMBER BLEY: And I guess what I was getting at is with a passive -- you've used the PRA in a very good way with a design to get rid of the things that were contributors. Now you've got a machine that's a little different.

MR. WACKOWIAK: Right.

MEMBER BLEY: And maybe the traditional techniques don't do everything. Maybe they don't find what is left, one of the things that might be left is people interfering with some of these functions that I hope to see in 19(a) that you've looked at, and trying to identify some of those rather than saying, "Errors of commission have to be small."

I think they might normally be, but it's small compared to a really low number. Now, maybe they're not that small anymore.

MR. WACKOWIAK: Right. And the only -- but, remember, the only way that that would be an issue is if it's the same type of errors of commission that result in the same types of things that would happen to the plant as the existing plants. If it's low enough in the existing plants it would still be low enough here.

It's only when those errors of commission, even though they are low, they have some vastly different result in the plant that could increase the risk. So those are the kinds of things that we qualitatively look for, and --

MEMBER BLEY: I think we've made that assumption in existing plants, and it might not always be true. But then, a plant with a 10^{-8} core damage frequency at the current time, maybe they're not so small compared to that. So I think it's worth a look.

MR. WACKOWIAK: Okay. Also, once again, you know, I think we talked about the HFE. We did a dependency analysis where we went through the quantification and looked for the cut sets that had multiple events and adjusted things accordingly.

No significant items in the HRA. Presented the Level 1 results earlier on in the day, so we won't dwell on this. We look a little bit at how it is going to be passed into Level 2. Our designators are slightly different than -- maybe than what were used in the past. CD-1 is a low pressure core damage event; 2 is the long-term; 3 are high pressure core damage events; 4 are events where reactivity had not been under control before the core was damaged; and 5, the Vs, are containment bypass sequences.

CHAIRMAN CORRADINI: One is low pressure; 3 is high pressure; 4 is?

MR. WACKOWIAK: Four is the ATWS-type events.

CHAIRMAN CORRADINI: Okay.

MR. WACKOWIAK: Where reactivity remains high and the containment is really at a higher energy state when the core damage --

CHAIRMAN CORRADINI: There is some sort of combination of operator action and lack of recognition that gets you into a problem.

MR. WACKOWIAK: Operator actions and also automatic actions.

CHAIRMAN CORRADINI: Well, I guess I want to understand the majority of the source of the yellow. Is that failure of squib valves? You said it in your --

MR. WACKOWIAK: Yes.

CHAIRMAN CORRADINI: So that's the main thing, because I read through it and there was some talk about the PCCS and this and that, and the isolation condenser. Excuse me. But as I understand the way the system operates, when all is said and done that is totally the unavailability -- or the inoperability of enough squib valves to get to -- of enough depressurization valves to get you to low pressure.

MR. WACKOWIAK: Yes. Almost every cut set will involve the squib valves in some manner, because if the squib valve worked you can't have core damage. So --

CHAIRMAN CORRADINI: And according to your --

MR. WACKOWIAK: -- about every -- just about every cut set has something that affects those squib valves.

CHAIRMAN CORRADINI: And according to your previous -- somewhere in here -- matrix, you need two.

MR. WACKOWIAK: Yes, you need two GDCS, and then there is also we say three of the DPVs. Those kind of go together, so you're going to find just about every cut set you will be able to trace it back somehow to affecting squib valves.

MEMBER APOSTOLAKIS: But then you do a sensitivity analysis, right?

MR. WACKOWIAK: That's right.

MEMBER APOSTOLAKIS: And you multiply the failure rate, as I recall, by a factor of 10.

MR. WACKOWIAK: Yes. For the squib valve.

MEMBER APOSTOLAKIS: Yes. What do you do

about the common cause failure?

MR. WACKOWIAK: The common cause failure was also multiplied by 10.

MEMBER APOSTOLAKIS: Because the failure rate was multiplied by 10.

MR. WACKOWIAK: Right.

MEMBER APOSTOLAKIS: Didn't you say earlier this morning, though, that we really don't have any experience with squib valves? What was the original value that was multiplied by 10? What was the basis of the original value?

MR. WACKOWIAK: The basis of the original value is probably nuclear powerplant squib valves that we modified by some factor and it's probably close to a factor of eight to account for long test intervals. So it's an increased failure rate over the existing nuclear database of squib valves.

MEMBER APOSTOLAKIS: How extensive is that database?

MR. WACKOWIAK: It's not. That's the question. It's not --

CHAIRMAN CORRADINI: That's the question where we were --

MR. WACKOWIAK: The question is that: is that an adequate --

MEMBER APOSTOLAKIS: My ultimate question is: how meaningful is multiplying by 10? Because we are used to orders of magnitude and they say, "Oh, 10, well, that's pretty good. It's an order of magnitude."

Well, if the original number was -- had no basis, I don't care that you multiply by 10. That's my problem.

CHAIRMAN CORRADINI: Well, I think that's a question that we have listed that Rick noted and can't remember, and we've got to get more information on.

MEMBER APOSTOLAKIS: Why does this have to be handled as a sensitivity analysis and not part of the uncertainty analysis?

MR. WACKOWIAK: The distribution also covers them on the uncertainty analysis.

MEMBER APOSTOLAKIS: Oh, you are putting it in there. I have to remember that. A lot of this stuff is -- it's pretty narrow.

MR. WACKOWIAK: Okay.

MEMBER APOSTOLAKIS: The broader issue of sensitivity, by the way, I think you have some pretty convincing arguments there. Just that sensitivity analyses always have an element of arbitrariness.

I'll take this number, multiply by five. I'll take this other number, multiply by 10, and see what happens. Why don't you put -- multiply by 100? And why don't you do it to all of them? Why do you do it one by one?

See, that's the value of uncertainty analysis, that it gets rid of all of this stuff. I think you have --

CHAIRMAN CORRADINI: Isn't that just --

MEMBER APOSTOLAKIS: What?

CHAIRMAN CORRADINI: No, no. No, I wasn't going to say anything.

(Laughter.)

MEMBER APOSTOLAKIS: Well, I mean, we have point estimates here that show that the numbers are extremely low. They don't reflect the sensitivity analysis, I don't think.

MEMBER SHACK: When he does the parameter uncertainty analysis, he gets different numbers, and they are still pretty low.

MEMBER APOSTOLAKIS: Right. Because they are limited to the parameters for which you have --

CHAIRMAN CORRADINI: But as I understand Rick's -- if I understood his answer to you, then we are eventually going to get, well, it's in Chapter 11, I don't remember the result off the top of my head. But he would then have propagated this factor of 10 into Chapter 11 uncertainty analysis, and we should see essentially a range of --

MR. WACKOWIAK: No, we didn't do an uncert run based on the increased factor.

MEMBER APOSTOLAKIS: No, it's a sensitivity.

MR. WACKOWIAK: Sensitivity.

CHAIRMAN CORRADINI: Oh. I misunderstood you. I thought you said it was also rolled into the uncertainty analysis. Excuse me.

MEMBER APOSTOLAKIS: What I conclude from everything they have done is that these individual numbers are not that meaningful. But the risk is low. That's my overall conclusion by looking at everything they have done. Would I have done it different? Some parts of it probably I would have.

But all of this stuff that they have in the chapter on sensitivity analysis adds confidence, but I don't know how much. If you ask me, you know, is it 10^{-7}, I don't know. But the stuff they've done is pretty good, but, I mean, why can't we have a complete uncertainty analysis, so that people can say, "Well, gee, you use a 95th percentile for this failure rate for squib valves. Why?" Rather than saying, "I multiply by 10."

CHAIRMAN CORRADINI: But you've answered my question, which is --

MEMBER APOSTOLAKIS: Which is the most important thing of the meeting, right?

CHAIRMAN CORRADINI: Well, because I assume that the depressurization valves with the squibs were causing all of -- most of the yellow, and that is what I wanted to make sure I understood.

MEMBER APOSTOLAKIS: Didn't Rosen raise a question about the squib valves? Do you remember, Bill?

MEMBER BONACA: For the P-1000.

MEMBER SHACK: AP-1000 because they had squib valves that were bigger.

MR. KRESS: Bigger. They're the ones that --

MEMBER APOSTOLAKIS: These are not.

PARTICIPANT: These are 18-inch squib valves.

CHAIRMAN CORRADINI: Their fourth stage squibs are enormous, right, because they had stages in one, two --

MEMBER APOSTOLAKIS: AP-1000.

CHAIRMAN CORRADINI: Yes.

MR. WACKOWIAK: And I think that our -- the DPVs are still about a six-inch valve roughly.

CHAIRMAN CORRADINI: Okay. Sorry.

MR. WACKOWIAK: Okay. One of the things you'll notice when you read the new results, the CD-3 is smaller and it moved into the CD-1. The thing there is it's just a Level 1/Level 2 interface. Most of the -- or a lot of the scenarios in CD-3 are associated with stuck open relief valve cases. And what happens is the core starts to melt while the reactor is still at high pressure, but by the time the reactor vessel fails it is already at low pressure from the stuck open valve.

So they are probably -- in our current -- in the Level 2 results, as you have seen, we have already made that adjustment on the Level 2 side. In the upcoming PRA, we made that adjustment on the upfront side. We used the vessel pressure --

MEMBER APOSTOLAKIS: As I recall --

MR. WACKOWIAK: -- at the time of containment failure instead of at the time of core damage to decide which --

MEMBER APOSTOLAKIS: You run a case where all of the human reliability or human unreliability numbers were set equal to unity, right? And you still found that the core damage frequency was 10^{-6} or something.

MR. WACKOWIAK: Yes.

MEMBER APOSTOLAKIS: Maybe it's a question for the staff. What if the next design does this and they get a core damage frequency of 10^{-3}? Then, what do you guys do? I mean, as long as these sensitivity analyses work, then everything is fine. But at some point then we say, you know, don't set them equal to one set and you go to .63. See, that's a problem with this kind of approach, because if you do the same thing to the --

CHAIRMAN CORRADINI: But the uncertainty analysis --

MEMBER APOSTOLAKIS: -- digital I&C, it doesn't work.

CHAIRMAN CORRADINI: But the uncertainty analysis --

MEMBER APOSTOLAKIS: You built it.

CHAIRMAN CORRADINI: But the uncertainty analysis would still have to have a justification of the range that you propagate through the analysis.

MEMBER BLEY: You would have to do sensitivity --

(Laughter.)

CHAIRMAN CORRADINI: I mean, that was going to be my nasty little comment before you said it. All an uncertainty analysis is is a more organized sensitivity analysis, in the sense that you have to justify the range.

MEMBER APOSTOLAKIS: It's much better organized.

MR. WACKOWIAK: There's a table in the initiating events analysis I think that says what the size of all of the different penetrations are. And you can get an idea from that.

MEMBER APOSTOLAKIS: The biggest difference is that you don't do it individually.

MR. WACKOWIAK: Yes.

MEMBER APOSTOLAKIS: It's not just that you have distributions and you argue. You don't do it individually. You do the whole thing, and you propagate.

CHAIRMAN CORRADINI: That I got, kind of. Sorry.

MR. WACKOWIAK: And as long as it's associated with the reliabilities of components and things, and that works just fine.

MEMBER APOSTOLAKIS: Yes.

MR. WACKOWIAK: I have some slides here that talk about the top five or describe the top five sequences. I don't know, do you want to cover these here? But you get the idea that there are things that are associated -- inadvertent open relief valve is the top cut set -- or top sequence, I'm sorry. Successful scram, feedwater injection failed, high pressure injection also fails. Our CRD pumps are our active high pressure injection system.

Low pressure systems fail because of manual depressurization failure, but the ADS is successful. Vacuum breakers are successful to keep the containment in an operable state. And low -- once again, low pressure injection, asked after ADS, is unsuccessful. Vessel fails is low pressure.

And then the last piece there, the lower drywell water level is low. Our calculations show that it's less than .7 meters in the lower drywell. So that affects what's going on in the Level 2.

The next one is an ATWS sequence. That starts from a general transient. Once again, in this scenario, we didn't specifically ask what happens to the depressurization. But when we looked at this sequence in this past, we find that most of the -- we did a split fraction for depressurization. Most of the sequence would end up in the low pressure end of it, and, once again, in the containment analysis it turns out that it didn't matter which bin we put it in. So we just assumed low.

Loss of feedwater event --

MEMBER SHACK: Just on these low drywell water levels, there is some cryptic remark in there that you rerouted the GDS spillover to keep the water levels in the lower drywell below the magic 1.5 meters.

MR. WACKOWIAK: Yes.

MEMBER SHACK: But I can't find any description of what in the hell was done.

MR. WACKOWIAK: Because it's magic.

(Laughter.)

CHAIRMAN CORRADINI: So it's not my imagination that I couldn't figure that out either. I sent him an e-mail saying I couldn't understand your water management.

MR. WACKOWIAK: No. It's probably a manifestation of the several iterations of the DCD and the PRA. But what we did is we set the spillover line high enough that the suppression pool won't spill back into the lower drywell.

CHAIRMAN CORRADINI: And why is that --

why is that an important thing?

MR. WACKOWIAK: If we have a steam --

CHAIRMAN CORRADINI: Where does it spill, then?

MR. WACKOWIAK: -- leak into -- if we have a steam leak into the drywell, and GDCS doesn't work, so we're not injecting into the vessel with GDCS, what happens is the steam that goes into the drywell is condensed in the PCC heat exchanger and puts into the -- goes into the GDCS pools. Since they are not draining, they overflow.

We have a design in the plant so that if it just overflowed onto the floor it would go to the lower drywell, and all sequences would have a high lower drywell water level, right, because that's where it ends up. So, instead, we put -- for lack of a better term -- gutters on the GDCS pools, so the water that spills over the GDCS pools goes into the suppression pool area and is stored there.

We raised that spillover line high enough such that you could boil all of the water out of the vessel in these scenarios and you still don't end up with a suppression pool level high enough to spill water into the lower drywell.

In the latest version, in your new

Chapter 19, those gutters on the GDCS pools actually list it as a design requirement coming out of the PRA.

CHAIRMAN CORRADINI: So can you just -- can I just say it back to you so I get it right? So if there is some sort of overflow or GDCS, it has essentially a rain gutter which sends it to a suppression pool, and the suppression pool -- even with all the water inventory in the RPV, it will not overflow in the lower drywell.

MR. WACKOWIAK: Right.

CHAIRMAN CORRADINI: As I finally got -- we can hold this off until later. But as I finally got to explain it -- as I finally got to some picture in your PRA, you showed a combination of insulation in the pedestal and flow areas, and I was trying to figure out where the water accumulated. If it didn't accumulate in the suppression pool, and it couldn't go in the lower drywell, it seems to pile up along the shield.

Am I misunderstanding, or can we just -- and if we can wait until later when we talk about the Level 2, because this kind of has an interest to me with Level 2. But I guess I still don't get it on how you are keeping it out. Except for condensation --

MR. WACKOWIAK: Right.

CHAIRMAN CORRADINI: -- how you keep it out of lower drywell. I mean, I understand this one part, but there is other things in getting --

MR. WACKOWIAK: For things that are LOCAs that discharge the water into that area around the vessel, we assume that that all does go to the lower drywell.

CHAIRMAN CORRADINI: Oh.

MEMBER SHACK: But break -- is that a break inside the shield wall? It goes to the lower -- and then, well, how about a break outside the shield wall? Is there something that caps that part? No, because the skirt is not --

MR. WACKOWIAK: No. But if the water can get to the lower drywell, we're not counting on any kind of insulation or anything holding it out of the -- holding it out of the lower drywell.

CHAIRMAN CORRADINI: So it's just the accident sequence that determines the --

MR. WACKOWIAK: How much water comes in.

CHAIRMAN CORRADINI: -- water level. I thought it was -- there was a -- I misunderstood. In reading a certain part of the PRA, I got the impression there was a design effort to -- except for condensation, to keep water out of the lower drywell.

MR. WACKOWIAK: No. It's this overfill -- overflow from the GDCS pools is what our effort was.

CHAIRMAN CORRADINI: Okay. Thank you.

MR. WACKOWIAK: And the instructions to the operators not to spray until after the core is out of the vessel.

The top five are all -- they are in your slide packages there, and they are in the case. So the --

CHAIRMAN CORRADINI: Before you go to this, I'm going to look at the Committee. Is this the time for a break for lunch? Because you are now going to go through containment performance analysis, the off-power events, and then to Level 2, is that correct?

MR. WACKOWIAK: I'm going to go through -- I'm going to do the Level 2 right now, and then we're going to go to the external events, and then we'll go to shutdown events.

MEMBER APOSTOLAKIS: How much time do you need, Rick?

MR. WACKOWIAK: Three more days probably.

(Laughter.)

I'm trying to wrap it up as fast as I can, because we still have RTNSS to do this afternoon.

RTNSS is a much shorter package, though.

MEMBER SIEBER: Well, you're almost halfway done with --

MR. HAMZEHEE: And the staff presentation, Rick. We haven't even talked yet.

MR. WACKOWIAK: I know you haven't talked yet.

MEMBER APOSTOLAKIS: The staff may not get a chance to present.

MR. WACKOWIAK: No. We need to --

CHAIRMAN CORRADINI: Move on.

MR. WACKOWIAK: The current schedule has us, oh, going for another 12 minutes before I'm supposed to be done.

CHAIRMAN CORRADINI: So why don't you try to do the containment performance analysis, and then we'll break for lunch.

MR. WACKOWIAK: Okay. And we've talked now it has been probably two years, or more than two years since we talked about this. We based our severe accident evaluation on the ROAAM methodology to determine which sorts of things in the containment area now should be treated probabilistically, the systems in which things -- which things should not be treated in that way and treated in a bounding way, and that will be the different phenomenon.

Our containment system models -- it's -- we now have -- or this -- we have fault trees. Now we have -- it has been that way since Rev 2. We have fault trees for things like the vacuum breakers, and the other systems that are in the containment model. They are linked into the containment event tree. And when I say a fully-linked model, we take it all the way from the initiating event now through the Level 2, all the way to the Level 2 end states, and without a -- you know, calculating point estimates and transferring them to a different model.

As a matter of fact, these days, when we calculate the Level 1, we just run the whole Level 2 model and extract the Level 1 results from the Level 2 model.

MEMBER STETKAR: Does that mean all of the systems, the support systems are fully linked in Level 1 and Level 2?

MR. WACKOWIAK: Yes.

MEMBER STETKAR: I thought you were binning --

MR. WACKOWIAK: We used to. Starting in Rev 2, we made it fully linked.

MEMBER STETKAR: Well, it said fully

linked, but I don't understand the mechanics of -- you actually link the event trees together.

MR. WACKOWIAK: Yes. It's --

MEMBER STETKAR: Okay.

MR. WACKOWIAK: Yes. It's one big model, and the way it's set up we can take the results, we put it into a spreadsheet and tell the spreadsheet, okay, give me the Level 1 results, or give me the Level 2 results. It's all the same thing.

And then, as we mentioned earlier, any release larger than the allowed leakage, which is leakage through the containment liner, is considered large in our model.

We've talked about -- years ago -- but our containment event trees. This particular one is the low pressure Class 1 with lower drywell water level. This would be attached into our event trees as one of the end states. We asked the deluge line, which is a model of the squib valves and the power supplies now, and the next question, is debris successfully cooled? That comes from ROAAM. Whether or not the BiMAC performs like it's supposed to.

Containment isolation system is asked. That's a system model again. Vapor suppression function is the vacuum breaker function. Containment heat removal short term is PCCS. Containment heat removal long term is refill of the pools, and residual heat removal systems.

And then, there is operation of the vent, and, once again, that is for our purposes. But for generating the radiological releases, but filtered release and overpressurization both still end up in LRF. So the LRF model both -- anything other than sequence 1 is considered LRF.

MEMBER APOSTOLAKIS: LERF with an E?

MR. WACKOWIAK: L-R-F.

MEMBER APOSTOLAKIS: Oh.

MR. WACKOWIAK: Yes. I don't know that there's any earlies in this plant.

Just to get an idea of what kind of results we get from our Level 2, almost everything falls into our category that we call TSL, which is the allowed leakage. TSL just happened to creep in as our -- one of our acronyms, but it's the intact containment. Tech spec leakage is what it stands for, but it's -- we don't really leak that much, but it's what is allowed.

Filtered release is small. Containment bypass is the next one. This is containment bypass where the release is into the containment, and then the containment is open and it goes out, as opposed to the one down at the bottom, which is a break outside containment, where it's just -- there is no containment involved at all in that in those scenarios.

CHAIRMAN CORRADINI: And that would be what? A break outside containment?

MR. WACKOWIAK: Reactor water cleanup line break, main steam line break, where the isolation valves fail.

CHAIRMAN CORRADINI: Oh, okay.

MR. WACKOWIAK: Those types of things.

CHAIRMAN CORRADINI: Okay. Thank you.

MR. WACKOWIAK: We have overpressurization due to vacuum breaker failures, overpressurization due to the other two containment heat removal sources, the RHR systems, and then the PCCS long term.

CCIW, which is the -- we have core-concrete interaction, but there is a water -- overline water pool on top of the melt. And what this is -- this case is the one where the BiMAC doesn't function for some reason, and in this particular case it would be because some type of -- well, no, that would be a different -- the BiMAC doesn't -- itself doesn't function. These results are from the previous, before we had the test done, so I think we assumed that it had a 10^{-2} failure for the BiMAC. We'll talk a little bit more later. I hope to get to that about --

CHAIRMAN CORRADINI: So do I.

MR. WACKOWIAK: -- what we have come up with.

CCI dry, which means the water didn't get down there to the BiMAC, and then the areas where there is an ex-vessel explosion. That's where we have a deep subcooled water in, and the material comes out of the vessel, and we have a steam explosion that fails either the BiMAC pipes or the drywell hatch, leading to a release.

Direct containment heating turns out to be a -- physically, the containment failure due to direct containment heating we have determined to be physically unreasonable. Everything is within the loads of our design. We --

CHAIRMAN CORRADINI: So you can have --

MR. WACKOWIAK: -- for completeness, but we have -- in the Chapter 21 we have determined that it is not possible to get to the right set of parameters needed, amount of melt, ablation rates, discharge rates, to get to a point where the containment would be failed by the DCH event.

CHAIRMAN CORRADINI: Are we going to talk about this again in the severe accident -- or severe accident --

MR. WACKOWIAK: I've got some slides on it, and I hope --

CHAIRMAN CORRADINI: Well, I guess I -- I tried to read through this, and I understood -- I understood what was being said. I didn't understand why you excruciatingly went to do an EVE, but said this one can't happen, because if I --

MR. WACKOWIAK: We excruciatingly went and did both of them, and this one turned out that we couldn't fail containment, and EVE turned out to be --

CHAIRMAN CORRADINI: Because the loads were just not hitting the --

MR. WACKOWIAK: Right.

CHAIRMAN CORRADINI: Okay.

MR. WACKOWIAK: And it turned out that we could set up an EVE case where the loads would fail the containment. So we went to excruciating detail in both of them.

MEMBER APOSTOLAKIS: So physically, unreasonable means that it's -- it's what, it's impossible or it's --

MR. WACKOWIAK: You can't set up the

conditions for it to happen. We would either need a core that was three times the size of the one that's in the vessel, or we would need physical properties of the vessel, so that it would ablate, so fast that the -- much faster than seen in any previous experiments. Just -- we just can't set up a case that would drive the pressure up high enough to fail the containment.

MEMBER POWERS: So what experience do you know of for ablating the vessel?

MR. WACKOWIAK: I would have to go back and look at the report. I don't have -- I haven't looked at that in a while. Don't remember.

CHAIRMAN CORRADINI: But I think where I'm going with it -- I'm not sure if Dana is going the same way -- but in the analysis that I remember -- and I can find it somewhere in here -- there were calculations done that showed large pressures that went beyond the capability of the -- and they were deemed unphysical why?

MR. WACKOWIAK: Well, what we --

CHAIRMAN CORRADINI: Because the release rate was deemed unphysical? Because I --

MR. WACKOWIAK: What we did -- what we did in that, we calculated our best estimate, and that's not shown in these slides. I don't know. Sometimes we -- we don't show the thing that we expect, but we show the thing we don't. But anyway, we had the best estimate, which didn't challenge the containment. Then, we did an evaluation with the parameters set to the upper bound from the various experiments that we looked at, and we didn't fail the containment.

And then we said, okay, what is it going to take to fail the containment? What kind of parameters do we have to put in there to make it fail the containment? And when we look at what those parameters are, it turns out to be things that just -- that can't happen.

CHAIRMAN CORRADINI: But it was due -- I guess I'm back to Dana's question, because I had the same thing. It looked like release rate was the dominant --

MR. WACKOWIAK: Right.

CHAIRMAN CORRADINI: Okay. Reason that you weren't making it.

MR. WACKOWIAK: Right.

CHAIRMAN CORRADINI: Not inventory but release rate.

MR. WACKOWIAK: The release rate was one of the more dominant -- or was probably the dominant one. But, once again, the upper bound case, the case 2 where we used the bounding parameters observed in -- and, once again, I'll have to look it up, which -- in the experiments that gave us that case, the case where the pressures went up high, we adjusted things beyond that.

We do have a significant open item in the Level 2. Further information was requested on the vacuum breaker design, that we have the -- some of the information about the vacuum breakers in ITAAC, and also what happens with the emergency procedures related to a failed vacuum breaker.

We have responded to these in RAI responses, and so far the preliminary information we have is that that response was satisfactory. There is -- just to build on that, there is further vacuum breaker design discussed in Chapter 6, and I know you guys talked about that in detail here a couple of months ago. And we do have a COL item that is established to develop the emergency procedures as part of the COL process.

MEMBER STETKAR: Is the new version of the PRA updated to include the changed isolation valve design?

MR. WACKOWIAK: Yes. Yes, the current version of the PRA that we sent this week covers all of the design included in DCD Rev 5. There is no delta anymore between the PRA and the DCD.

Now, we'll cover how we've covered that in a minute, but -- okay. In the source terms, you know, it -- you'll probably say I didn't do justice to these topics here in this meeting, but, you know, we evaluated 15 different release categories and decided which ones were representative sequences. Pretty standard stuff here.

Calculated the magnitude and timings of the releases and presented that information. In Chapter 9 of the PRA, there is an extensive set of plots and other things that -- I know the staff has done confirmatory analysis on those. No significant open items came out of that, and if you want to get into detail, it would probably be a different meeting.

Offsite consequences -- we used a -- what we consider a bounding site, but, you know, once again it came from the ALWR URD. It appears to remain bounding, but 60 years from now who knows if it will still be bounding. We do have quite a bit of margin in the results.

What we find is that, from our dose results, most of the dose risk is associated with the containment intact sequences. The individual risk, which is an early fatality within one mile of the site boundary, that's dominated by ex-vessel explosion, which was -- you know, it's clear that that just breaks the containment and there's an unscrubbed release from those scenarios, so that's reasonable.

The societal risk, which is latent deaths, out to a 10-mile boundary, half of that comes from EVE, about a quarter or a fifth from the bypass events, and another 10 percent from the break outside containment events. All scenarios that we would have expected unscrubbed releases to the environment.

MEMBER ARMIJO: Now, in this analysis, no one evacuates, no one --

MR. WACKOWIAK: No one evacuates.

MEMBER ARMIJO: -- takes any special precautions, and you have this population just doing what it was doing.

MR. WACKOWIAK: Just doing what they were doing, and we did some sensitivities and looked at different energy and plume and weather conditions, and found that if certain weather conditions, especially when it's more asymmetric like along the Southern coast, they tend to give you a little different result.

But we've included sensitivities from

other types of weather patterns, population distributions, and I think what we found is the population distribution has to go up by orders of magnitude before we start bumping up against the -- up against the stated limits for these.

So, yes, while we recognize that the population might not be exactly right, so many years from now it might not be bounding anymore, it would have to change by a real lot before it would be an issue.

MR. KRESS: The ex-vessel explosions require water being in the bottom head floor.

MR. WACKOWIAK: In the lower --

MR. KRESS: Yes, so that frequency is driven by the flood system --

MR. WACKOWIAK: No.

MR. KRESS: -- not getting water?

MR. WACKOWIAK: No. This is -- those are driven by scenarios where the -- they are basically LOCAs, where the LOCA is discharged into the lower drywell.

CHAIRMAN CORRADINI: That gives you the 1.5 meters?

MR. WACKOWIAK: It depends on the size of the break, but if the break is big enough then that gives us the 1.5 meters in the lower drywell. And it's -- we've shown that it's possible to have those steam explosions.

Now, will it happen every time? Probably not. But it is possible, and it is possible to get enough force out of one of those explosions to fail the containment. So for this -- for the purpose of this analysis, we've assumed that it does every time if there is water down there.

CHAIRMAN CORRADINI: So just one last -- I'm sorry, Tom.

MR. KRESS: Go ahead. That answered my question.

CHAIRMAN CORRADINI: So when you say "fail," what is -- I guess I'm back to the 29 percent, 72 percent, and 50 percent. What does "fail" mean here, above surface release? Are you assuming something relatively severe? Because this strikes me as surprising I guess. I'm trying to understand what the failure is. What are you taking as the failure? Just an open containment at a high vent?

MR. WACKOWIAK: Everything is assumed to be vented from the reactor building. So it's a kind of sort of high vent. It's, you know, a few meters. It's not --

CHAIRMAN CORRADINI: Okay.

MEMBER SHACK: It's not an elevated release by any --

CHAIRMAN CORRADINI: All right. That answers my question. Thank you.

MEMBER SHACK: What does that bullet -- the containment intact sequence is 29 percent EVE? But the containment is not intact if you get --

MR. WACKOWIAK: I said mostly from containment. TSL is containment intact.

MEMBER SHACK: Okay. So this --

MR. WACKOWIAK: I was referring to the --

MEMBER SHACK: It's referring only to the .58 percent.

MR. WACKOWIAK: Yes. I could have done that better.

MEMBER POWERS: The containment intact sequences are dominated by iodine?

MR. WACKOWIAK: I think so, but I'm going to have to go back and look. I'm trying to remember what the graphs look like, and I'm just not getting there right now.

MR. KRESS: Are those the results that come out of the MAAP code?

MR. WACKOWIAK: We generate the source

term from MAAP, and then we take the table of source terms from MAAP with the magnitude and the timing and input to MAACS-2. Now, MAACS has some limitations. You know, there is only -- you can only consider 24 hours of time, and things like that, so we take -- so some cases will take a 72-hour release and compress it into 24 hours, just so the code will work.

MR. KRESS: Well, with MAAP, iodine would be considered an aerosol data.

MEMBER POWERS: Why would that be correct?

MR. KRESS: Pardon?

MEMBER POWERS: Why would that be correct?

MR. KRESS: That's a question. But it -- the release rate treats it like an aerosol. Not the release rate, the behavior in containment has a -- treats it as an aerosol.

MEMBER POWERS: The control rods are boron-carbine blades?

MR. WACKOWIAK: Yes.

MEMBER POWERS: Went from stainless steel to boron-carbide -- similar to what you have in existing --

MR. WACKOWIAK: I'm guessing it is. I don't know why it would be different.

MEMBER POWERS: What do you use for

oxidation of the boron, steam oxidation of boron?

MR. WACKOWIAK: I am not prepared to answer that. The question hadn't come up.

MEMBER POWERS: The problem is that, the steam oxidation of boron produces boric acid. Boric acid reacts with everything, so there is nothing to form particular with iodine, so you get a strong gaseous component. That gaseous component comes into your containment. I assume you try to scrub it with the PCCS, but, at the same time, you are radiolytically attacking air, cabling, and what-not, that's acidophil in the water. That comes back out of the water.

So I would think that, especially for containment intact, it would be gaseous iodine that would dominate.

MR. KRESS: Well, we had this question earlier, and we are awaiting an answer. It seems like you are continually pumping iodine into the containment, because of --

CHAIRMAN CORRADINI: But I think at the time when you -- when we had this, the acidification was due to the fact that -- was due to the fact of the -- what you were saying was the process of the radiolysis.

That's the last time I remember we were bringing this up, because they were MELCOR calculations that the staff showed at some point. I'm trying to think. It was maybe Chapter 6 discussion.

MEMBER POWERS: There are three ways to facilely acidify water. There is a lot of ways to acidify water that people speculate about, but three ways that have been demonstrated to acidify water.

Air radiolysis forms nitric acid. It tends to be slow. Radiolytic or pyrolytic decomposition of cabling insulation. Tends to be kind of intermediate. And radiolytic and dissolution attack on paint, and solvents in paint especially. There are keytones, and they are relatively readily oxidized to carboxylic acids. And that tends to be a short-time acidification.

MR. WACKOWIAK: And for those particular failure -- or for those particular modes, I know there are ITAAC to address some of those things. There is a maximum mass of cable insulation that is in ITAAC, and then there is also an ITAAC on coatings that could potentially generate or acidify the pool. So I think that's how that was addressed, but I don't -- this was addressed outside of the PRA area.

MEMBER POWERS: Are you thinking of

solvent-free coatings in this containment?

MR. WACKOWIAK: I'm not sure what the -- what they are considering there. I know that there is an ITAAC that addresses coatings. Don't know the details behind that. I just know that they have addressed it.

MEMBER POWERS: You've done a lot of work recently on solvent-free coatings. Not because of severe accidents or anything like that. It's because people just don't want to put up with the solvents and all of the hassles of EPA and everything like that. And they're very good. They're very interesting coatings.

MS. CUBBAGE: I think in the context of Chapters 6 and 15, we owe you -- GE and the staff owe you another presentation on that. There are a number of open issues in that area still. I think that will get to those issues.

MR. WACKOWIAK: All you'd get from me is what I remember rather than anything that might be right.

MEMBER POWERS: Which is probably more than I remember. The older I get, the less I remember. What was your name again?

(Laughter.)

MR. WACKOWIAK: Offsite consequences, we had no open items, or no significant open items.

CHAIRMAN CORRADINI: So at this point, I would like to take a break for lunch, if it's all right with folks. And I'd like to ask that we're back by 1:15, 35 minutes. I'm sorry.

(Whereupon, at 12:38 p.m., the Subcommittee recessed for lunch.)

A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

(1:31 p.m.)

MR. WACKOWIAK: Let's try to get back on schedule. Where we left off was in the uncertainty and sensitivity analyses. We've talked about various things throughout the morning, so I think we -- I understand what your issues are in the uncertainty area and propagating more data.

MEMBER APOSTOLAKIS: So, Rick, for example, you mentioned that your --

(Laughter.)

I interrupted you?

MR. WACKOWIAK: No. No, no. Go ahead.

MEMBER APOSTOLAKIS: We are grown men.

MR. WACKOWIAK: We are?

MEMBER APOSTOLAKIS: For design certification purposes, even though I wouldn't do it that way, I think you are succeeding. But if you want later to use this for risk-informed applications, regulatory applications, I don't think that a sensitivity analysis will do it.

MR. WACKOWIAK: Okay.

MEMBER APOSTOLAKIS: Because I don't know. Should I be using the results with a factor of 10 higher rates for the squib valves or not? I mean, this is the problem you are running into. But if you want to say the design is robust, and this and that, I think the totality of these calculations gives me that confidence.

CHAIRMAN CORRADINI: But if I can just make sure I understand, George. If you were to encapsulate all of the variations within an uncertainty analysis, you still have to justify the ranges, and that is not going to be by just changing how you do the analysis. That's going to have to be by essentially discussing how the data was developed and --

MEMBER APOSTOLAKIS: But I would submit that it's easier to justify a distribution than a single number. And other people think it is the other way around, but it isn't. It's easier to justify a range of numbers with probabilities and say, "I will multiply by a factor of 10."

MR. KRESS: And your comment about the -- when you used the distributions, you fold in all of the uncertainties, whereas you're doing one at a time with the --

MEMBER APOSTOLAKIS: You schedule one at a time. Now, would it make a big difference? Frankly, I don't think so. I don't think so. But it would be nice to --

CHAIRMAN CORRADINI: But the way you would fold in all of the -- all of the -- fold in the distribution was simply because you would have a discussion about coming to some consensus of what it ought to be bounded by.

MEMBER APOSTOLAKIS: No. I would like at the end when we say, "Yes, the risk is, you know, eight 10^{-8}," or whatever, to have a feeling that that really comes close.

CHAIRMAN CORRADINI: I just want us to take the squib valve as an example, because Said asked about data -- the database or the data source. And to the extent that you've got the data source, and you looked at it and kind of went, oh, there's only 30 experiments, and they are kind of scattered, eventually you've got to get a few people together and say, "Okay. Given what you know, this is the approximate shape."

That -- your point is that -- that exercise, in and of itself, is valuable.

MEMBER APOSTOLAKIS: Of course, yes. And that it will be easier to defend this curve rather than a single number, you know, multiplied by 10.

CHAIRMAN CORRADINI: Okay.

MR. WACKOWIAK: And I think I agree that that would be the case, that would be easier to defend. But sometimes when you just have the number, the -- you can't do as many things with just the number when we look at, you know, putting things into DRAP and maintenance rule, you have to do other things. So important to do, and I think eventually we'll get there.

MEMBER APOSTOLAKIS: I'm not saying it's easy or straightforward, but look what we are doing over here. We say, okay, here is the pie, the distribution, the contributions. This is the dominant sequence. All that is based on the point values, isn't it?

MR. WACKOWIAK: Right.

MEMBER APOSTOLAKIS: And then, on the side we say, well, we also did a sensitivity and jumped up a little bit. But the fundamental approach is those point values. The results are all -- again, I am not -- for present purposes, I suspect this is --

MEMBER SHACK: Of course, while you were out of the room, he did show a mean value, George.

(Laughter.)

MEMBER APOSTOLAKIS: Lower than the point estimate. Last time it was higher. It was higher.

Two years ago it was higher.

PARTICIPANT: That was then; this is now.

MEMBER APOSTOLAKIS: Sorry?

PARTICIPANT: That was then; this is now.

MEMBER APOSTOLAKIS: That was then; this is now. Yes. We have very powerful arguments today.

Anyway, why are we --

MEMBER SIEBER: So it really would be very important for us to look at the sources of data and the nature of the data of -- that was used to come up with the failure rates for the squib valves, because --

MEMBER APOSTOLAKIS: Now that they gave us permission to have many Subcommittee meetings, we will try to complete with the Thermal Hydraulics Subcommittee.

MR. WACKOWIAK: Okay. Speaking of thermal hydraulic, one of the significant open items in the uncertainty and sensitivity was the thermal hydraulic uncertainty. We talked about that in the accident sequence slides from the thermal hydraulic side. We covered this in two ways. I think there was a presentation on this before where we also looked at it from the probabilistic side.

Basically, what we did was we -- we

adjusted the success criteria in our event -- in our fault trees to find information about what type of -- how bad would our estimates need to be before it had a large impact on the risk results. And so we looked at the GDCS valves, DPVs, and the PCCS heat exchanger.

In the design basis, there is just -- it's just evaluated as a single failure. It does no good for us to look at those design basis calculations in the PRA. But basically what we did was we started from there, and then we added redundancy, so it's success criteria. So one failure was a failure of the system; then, two, a failure of the system; three, failure of the system; to see where the numbers would break.

MEMBER SIEBER: This is just sort of a sensitivity essentially on the boundary conditions.

MR. WACKOWIAK: Right. We wanted to look at the --

MEMBER SIEBER: Not on the physics for what you're modeling.

MR. WACKOWIAK: It's not on the physics. That's right. We looked at it two different ways. With TRACG, we're trying to look at the sensitivity on the physics. And here we are trying to get an idea of what would it do to the PRA if we came up with a different number after looking at the physics.

And I think we have gone -- we went through this in a previous meeting more in detail, but in the end, as long as we have any redundancy left -- so we have six -- if the success criteria comes out to be six of eight GDCS valves, that's about where it changes. Whether it's two, three, or four, would really make not much difference to the results, save for --

MR. KRESS: Success was if the core stayed covered?

MR. WACKOWIAK: Success in these cases was that the -- that we did not get significant heatup in the -- I'm sorry. Success was the core stayed covered in our -- in this set of sensitivities. In the thermal hydraulic sensitivity, or area where we were looking with TRACG, we were looking at the rapid rise in the core heatup.

MR. KRESS: So the reactor looked at the temperature that --

MR. WACKOWIAK: Yes. We looked at that. In the other analysis that isn't -- hasn't been submitted yet, and we haven't brought that here.

CHAIRMAN CORRADINI: So just so I understand this, the curve you showed previously, the purple, as we're going to the right, we're just having more and more of the GDCS pipes failing to operate.

MR. WACKOWIAK: Yes. There's different cases on there -- GDCS, DPVs, and PCCS. It's -- what it's saying is: do we need two, or do -- do we need two, do we need three, four, five, six, seven, eight --

PARTICIPANT: Failures.

MR. WACKOWIAK: -- failures. No, for success. So in this case, one failure of anything would be core damage. In this case, you need two failures, this case you need three failures, four failures, five, six, on down the line. And there's a couple of things that aren't exactly one through six in there, because there were different combinations.

The purple bar was something that we looked at with the PCCS heat exchangers. Our base model does assume some unavailability for maintenance of those heat exchangers, but we are not convinced that those heat exchangers are going to be maintained later on down the line.

So basically the PCCS has -- without the maintenance concern, it breaks much later with the number of PCCS heat exchangers.

So what we concluded from this is that

while, yes, we still want to understand the success criteria based on the thermal hydraulics codes and what the codes are telling us, we are confident, after looking at this, that even if we are off by a little bit in those -- in the codes, one way or the other, and the success criteria that we used is robust, and the results won't change if we -- if some time later in a different analysis we have to adjust success criteria by one component or one heat exchanger. And I said that -- that part of this has been given to the staff already.

The fire risk assessment now, starting with Rev 2, we are using NUREG-6850 methods. It is -- we talked about it a little bit today already. It's -- we couldn't do everything that you would do -- no fire modeling. So the assumption is all fires grow to be fully developed and affect the whole area.

As it was asked before, what about propagation in the other areas? Yes, we have a probability of a failure of fire barriers, allowing it to go into the next area. We also did a look there of propagation of smoke between different areas with the -- in the ventilation system, and that's described in the report.

No credit for the suppression. And we did make an assumption. Our I&C design is supposed to be set up such that if -- if the cabinet that contains the logic cards does start to fail, that it is not possible for it to be spuriously issuing commands out into the field. And there is -- we can get into more detail about how that is structured.

We don't think it can happen. However, for the cases where we have multiple fires, or fires spreading between multiple rooms where these processors are, we add a non-mechanistic SRV actuation to the case. Basically, what that does is it causes a failure of the ICS. So it's -- when the fires spread between -- to multiple rooms, we reduce our capability to respond with ICS, those scenarios.

MEMBER STETKAR: Spurious SRV actuation on this plant is a good thing.

MR. WACKOWIAK: No. SRVs are small enough that -- and require and have some back pressure, such that an SRV is sufficient to depressurize the plant enough where ICS won't work, but it can't depressurize it enough so that GDCS can work. So it's that intermediate stage there, and an ICS spurious SRV is not really a good thing.

MEMBER STETKAR: Are you saying that the only spurious signals that you modeled in the fires were spurious SRV actuations?

MR. WACKOWIAK: The design of the I&C system is that it can't -- you really can't get a fire to cause it to spuriously issue commands. It is not like an analog system where you change the voltage or the current on some line, and a random noise can go down and actuate the valve.

What you have -- what we have here is a complex string of checked valves and using sequence numbers -- command sequence numbers and all sorts of things, such that if one of the processors starts to fail it is, as far as we could tell, impossible for it to be interpreted by the device at the other end as a close to contact to -- close the contact in two different rooms now, and actuate those valves.

MEMBER STETKAR: The device at the other end has some actuator?

MR. WACKOWIAK: Yes. Yes. And it's not set up -- and the way that the cables are routed, we don't have hot cables in with these. These are all dead, de-energized cables, and the only power source is coming from the I&C system to tell it to open.

So we don't really see how we can do it, but we included it in here just in case. And we picked -- the system that gives us the most benefit in a fire is ICS, and we picked the system that gives us the most benefit as the one we are going to fail by our spurious actuation.

And I think I just covered all of this. But, once again, one of the things that we found in our fire risk is that we really do need to adhere to the -- to our separation criteria that we have in the design. There is extensive separation criteria covered by the design, and by the ITAAC, and we have even found areas where for non-safety systems that are in the RTNSS category that we have applied requirements for fire separation of that equipment.

As I mentioned earlier, I think the fire risk is probably going to be reduced when we get the as-built information, and look at fire modeling. But, once again, the point came up, what about other transient combustibles and things like that that are left out? You know, we will probably hit some floor on the initiators that you just couldn't justify going below.

Once again, once we get fire mitigation procedures, too, we think that fire risk should go down somewhat. Somewhat, not expected to be a lot.

And at this point, there is no open items in the fire area.

In flood, we have made some bounding assessments in the flood model. Kind of like the fire, where the fire takes out the whole room, we have assumed that if we have -- if we start a flood, then we drain whatever reservoir that is going to be. So if it's a break in the suction line for the CRD pump, the entire CST gets transferred into the reactor building. Or if it's a fire water line, the entire million gallons of fire water gets pumped into the building. So it -- that's the kind of things that we looked at there.

Some past PRAs tried to look at capability of doors that were not flood doors to provide some kind of mitigation. We didn't do that. Unless it was a designated door, you know, submarine-type door to prevent flood propagation, we didn't take any credit for that. No credit for operator actions. And even after all of that, the flood still didn't come out -- internal flood now -- didn't come out to be a significant contributor to risk.

One of the main things, though, that we did have to do with that is make sure that the control building doesn't have the fire water standpipes within the building. They are outside the building, so that that flood doesn't become a dominant contributor. So it's low because we made it low.

And right now there is no open items here.

Now, let's get to some open items. In the high winds assessment, we assumed that seismic Cat 1 buildings can withstand hurricane and tornado events. Seismic Cat 2 buildings are designed to withstand hurricane events. And the main difference there isn't the wind loading, but it's the missile protection.

The seismic Cat 1 buildings, we add additional material to preclude penetration from tornado-generated missiles. In the seismic Cat 2 buildings, the missiles that we protect against are hurricane Category 5 type missiles rather than tornado missiles.

Non-seismic buildings that house our RTNSS C equipment, which we'll talk about later -- it's more the defense-in-depth, non-safety-related equipment -- we can -- it can withstand the hurricane events there, and the seismic events are treated a little bit differently. But the plan is for them to withstand the hurricane events.

Now, our frequencies are based on the historical data for the different -- for the tornadoes and for the hurricanes. We tried to set up a process of setting up a bounding wind frequency. The way we did that for tornadoes was that we -- we calculate or we got the tornado frequency from -- and I had this in my head a few hours ago, but I can't remember it now, from National Weather Service sort of data source. I don't remember which one we got it from now.

But anyway, and we increased that to cover any local variations. I believe it was by an order of magnitude, and said that that was what our tornado frequencies were. And we look at different tornadoes, the lower scale tornadoes and the higher scale tornadoes, and failed different buildings, and the equipment located in those buildings based on those scales.

The hurricanes we did a similar thing, but our data comes from the NOAA data on hurricanes over the last hundred years or so, and --

MEMBER POWERS: What made you think that the data over the last hundred years are applicable for the next hundred years? You have not noticed that in -- episodically things appear in the paper speaking to global warming and increased hurricane frequencies?

MR. WACKOWIAK: So we looked at those. We also looked at it for the past -- the information that we used to generate the frequencies was actually based on the years when nuclear powerplants have been operating. So we looked at the hundred years to get the relative frequencies between Cat 1, 2, 3, 4, and 5 hurricanes. But the frequencies of the hurricanes themselves were based on -- or the frequencies of, yes, the hurricanes that we used in the model were based on hurricane-initiated events at nuclear powerplants. So that really only covers the last four years worth of data.

MEMBER POWERS: But if we are -- the weather prognosticators are correct, that was a period of relatively low hurricane frequencies.

MR. WACKOWIAK: That's possible.

Now, when we go through and we looked at what it is that we do with the hurricane events, and one of the things that we recognized in our insights is that we do -- that high wind events are important to risk, and designing for them are as well. In ESBWR, we have a reactor building that is meters-thick of concrete above the -- the above-ground area. What is that?

MR. RAJENDRA: It's 54 meters.

MR. WACKOWIAK: And the -- we have capability inside the building for --

MS. CUBBAGE: Excuse me. You need to identify yourself.

MR. RAJENDRA: This is Clement Rajendra. The height of the reactor building is about 54 meters above grade.

MR. WACKOWIAK: Right. And most of that -- all of that is concrete wall.

We have enough water inside the building to allow decay heat removal for three days without anything coming from the outside. If the building fails at the upper floors, which is the thinnest part of the walls and the ceiling and the roof, that doesn't affect this heat removal capability.

We have added a seismic Category 1 building, and a seismic Category 1 fire tank that has a million gallons of what that we can use a self-contained diesel-powered pump to pump it up into those pools up on top. And now in this last rev of the DCD, we have added a seismic Category 2 low building to the ground that has two ancillary diesel generators in them that can be used to power other electric pumps that are in the seismic Category 1 building.

So I think, in the end, where we may not have the high -- the frequency on the high wind perfectly established for the future, what might happen in the future, but for the purposes of design certification I think we have added everything that is prudent to add to the design of this plant to respond to high wind events, especially that can knock out power and access to the site for longs periods of time.

We can withstand a massive direct hit hurricane on this site for seven days without even having to worry about getting things from offsite. So --

MEMBER STETKAR: How do you do that if your batteries only have 72 hours' capacity?

MR. WACKOWIAK: The batteries have 72 hours of capacity. But, once again, I said we have added this new seismic Cat 2 building, a low building down nestled in amongst other things. And we have two one-megawatt ancillary diesel generators there that can be used to power the Q-DCIS system after the batteries run out.

And the fuel storage that we have for that is also in a protected -- hurricane wind-protected building that can provide fuel for those to operate for the seven days. So I would agree that we have not gone to the extent to try to figure out what global warming would do to the increased hurricane frequency, but I do believe we have added equipment to the design sufficient -- as much as can be reasonably asked to address these sorts of events.

MEMBER STETKAR: In your tornado analysis, why did you use only the footprint of the plant site for the tornado strike frequency? Large tornadoes, especially F3 to F5, typically have a fairly large damage path length. In some cases, miles. I mean, the damage area of like an F5 tornado can be up to 10 square miles.

MR. WACKOWIAK: Yes.

MEMBER STETKAR: So a tornado -- an F5 tornado could actually hit five or six miles away from the plant and still affect the plant. It's not just the tornado that happens to touch down inside the plant boundary. They can come from outside and get you.

So, therefore, the effective exposure area, if you will, is considerably larger than the plant footprint.

MR. WACKOWIAK: So which kinds of failures would we be looking at for the -- let's say the tornado that is a half a mile or a mile away from the site?

MEMBER STETKAR: No, no, no. It touches down a half a mile, but it makes it to the site. It actually is an F5 tornado as it roars through the plant site and goes five miles down the road. It didn't touch down within your .14 square miles. It touched down at a point --

MR. WACKOWIAK: Okay.

MEMBER STETKAR: -- five miles away.

MR. WACKOWIAK: And then got --

MEMBER STETKAR: Came five miles, went through the site, and kept going. It was still Cat 5. So, therefore, the effective exposure area, if you want to think about it that way, especially for the larger hurricanes -- not hurricanes, tornadoes -- can be substantially larger than the site.

MR. WACKOWIAK: I'm going to need to go back and look at how we did that. I thought we took that into account. But the way you're explaining it now, you're making me --

MEMBER STETKAR: I was just reading it. I wanted to make sure that I understood something, and it just says that the site -- I can't read things and talk at the same time, but the site is approximately .14 square miles.

MR. WACKOWIAK: Right. And we did use that. And my understanding of the way this was done -- granted, you know, you have to get into the details like you're doing, is that, yes, if it touches down here, that's one thing. You've got it. But if it touches down here, it's got to go that path to get it. And if it goes any of the other 360 degrees, it --

MEMBER STETKAR: That's true.

MR. WACKOWIAK: And I thought we took that into account, but I don't know that we did. So I'll have to go back and look at that.

MEMBER STETKAR: If you do the integrals, it's --

MR. WACKOWIAK: Right. It's --

MEMBER STETKAR: -- details, but --

MR. WACKOWIAK: You have to do the integrals to find out the right way to do that. So, once again, if you asked me cold, I would have said we did that. But you're reading what's in there, so I'll have to go back and look.

The significant open items for these areas -- we -- the way our analysis is is that for certain buildings, if it's designed for hurricane winds, we said that it would not -- that the building would not fail. And the open item on that is that while there might be an increased failure probability of that building, that's designed for the hurricane.

In the hurricane areas, what we have looked at is that the loads on the seismic Cat 1 and

2 structures are really bounded by the seismic events -- the loads on the building -- by about an order of magnitude. So designing for the seismic events we think gives us more margin than would just be present if we only designed it for the hurricane category winds, and we're responding to that RAI hasn't -- hasn't been sent out yet. That's a new one.

So we'll be responding by relating it to the loads that we actually designed the building for rather than specifically saying this is a hurricane thing or a tornado thing.

The other -- the next open item is whether credit was taken for equipment in seismic Cat 2 structures hit by tornado missiles. I think there is a table that we have in the analysis that says for Cat 2 structures it is designed for hurricane missiles, and probably to be clear it should say and it will be failed by tornado missiles. But the implication in the analysis assumed that for tornadoes those Cat 2 structures, tornado missiles, those would be damaged, but for hurricanes they wouldn't.

Also, questioning our declarations, whether the tornado and hurricane assessments are bounding, that kind of probably gets back to some of this issue about possibly increased frequency in the future of hurricanes and the tornadoes. Once again, our analysis shows that within a reasonable change in tornado frequency, the analysis really isn't sensitive to that.

But we did for the hurricanes indicate that it is important, and we think that we provided all reasonable protection from hurricanes. Now we're talking about numbers after that point.

And then, once again, these responses -- these are RAIs that came out in the last month or so, and we are working on our responses to those.

Now, in the seismic margins assessment, what we have done is that we only took credit -- I've got a one instead of an I here, but we only took credit for equipment that is located in seismic Cat 1 structures in our seismic margins analysis. So we have kind of discounted everything that is in the non-safety-related category. We failed it. We failed everything else, so that the margins analysis is only based on a limited set of equipment. So we know that that's -- that doesn't cover everything that we have available to us.

Our structural capability -- we can infer what that capability is based on the buildings being designed to Cat 1 requirements. And since those are

-- those rules are fairly proscriptive, we know, based on experience, what the margins are going to be for those types of buildings.

The capability that we use for the systems housed in those buildings, on the other hand, is an assumed value. We looked at similar types of systems in similar applications at other plants, and said, okay, they all look like they will meet those kinds of margins. But instead of just doing the analysis based on that, we added a COL item to confirm in the as-built plant that the systems actually do meet that -- meet the margins capability. And, once again, that is confirmed in 1.67 times the SSE capability for the buildings and equipment.

That brings us to our significant open issue in this. The spectrum shape that we used for the certified design response spectrum is not what we used in the margins analysis. We used a performance-based spectrum in the margins analysis. We describe that it bounds -- it bounds most potential, or all of the potential, ESBWR sites, so it could be the CSCRS for most sites, but it's not in the design.

We think that the ground motion response spectrum is the right one to use when we're looking at margins. When we're designing these buildings, yes, we'll use the combined response spectrum that we have. But then, when we're looking at, what is the capability beyond the design, we believe that using the site-specific GMRS is the right spectrum for confirming that COL item. And there is a disagreement on that right now. That is basically where we are.

Seismic margins SSE has not been defined as the CSDRS. That's the same issue as the above.

And then, finally, the fault tree for fire protection water system doesn't model all of the components in the system that must survive the earthquake. Yes, that was an omission in our previous -- we took credit for everything that is needed to run the fire protection water system, the seismic Cat 1 system that we have. We took credit for that, but just didn't write it down in the assessment. Now we explicitly show all of the support systems needed to make that work as being required to be confirmed in the HCLPF confirmation.

So we will still be working with the staff on which is the right spectrum to use for confirming margins. Our main issue with this is that in -- we know that we want -- in the design of the plant, we are using the more conservative CSDRS. It's a combined spectrum that includes both high frequency and low frequency events. And it's not real for any site. It's a composite spectrum.

So we're designing to that. But we feel that when we're looking for margins beyond the design, we should really look at what the margins are beyond the design at the specific site. You should -- we can design for one thing, but confirm margin above what we would actually see rather than margin above a theoretical curve. So that's going to be -- that's our position right now, and we are -- we are still talking about it.

In the shutdown area --

MEMBER APOSTOLAKIS: Are you done with seismic?

MR. WACKOWIAK: Yes.

MEMBER APOSTOLAKIS: Just a question or clarification. You conclude that the HCLPF is .6g, as I recall.

MR. WACKOWIAK: I think it was .6 in Rev 1.

MEMBER APOSTOLAKIS: I'm sorry. And the SSE is .3?

MR. WACKOWIAK: .5.

MEMBER APOSTOLAKIS: Okay.

MR. WACKOWIAK: That's why it went up to

.84.

MEMBER APOSTOLAKIS: I was looking at the wrong graph. .5g -- is that sufficient for east of the Rockies?

MR. WACKOWIAK: Go ahead.

MR. RAJENDRA: Yes. The .5g at 100 Hertz is for North Anna, and that is the highest that we get -- see on the eastern seaboard.

MEMBER APOSTOLAKIS: Really?

MR. RAJENDRA: Yes. Yes, sir.

MR. HAMZEHEE: You need to introduce yourself again for --

MR. RAJENDRA: My name is Clement Rajendra.

MEMBER APOSTOLAKIS: Okay. The .3g sounded too low to me. But if you say the .5 --

MR. RAJENDRA: .5g.

MEMBER APOSTOLAKIS: Okay.

MR. WACKOWIAK: Okay?

MEMBER APOSTOLAKIS: The high confidence is 99 percent?

MEMBER STETKAR: It's 95 percent confidence of less than -- of five percent or less failures. So it's roughly one percent or less mean failures if you do the math.

MEMBER APOSTOLAKIS: Okay. We'll come back to this at some point.

MR. WACKOWIAK: Now, the next thing, we had looked at the shutdown risk analysis. Everything else that we presented in the Level 1 was for Mode 1, full power operation. We took a look at 2, 3, and 4, and looked at the tech specs that we have, the differences between Modes 1, 2, 3, and 4, and qualitatively determined that 2, 3, and 4 should be bounded by the full power analysis.

At this point, we didn't look at any transition risk between modes. We don't think that that is really needed in the design cert. That is more of an operational issue that will be addressed in the later PRA that we talked so much about.

Five and 6, we needed to split that. Let me be clear on this, because it's -- may be different than what you are used to. Mode 5 in this plant is cold shutdown, and Mode 6 is refuel. Four is hot shutdown, or 4 is -- 3 is hot shutdown, 4 is safe shutdown, stable shutdown, 5 is cold shutdown, 6 is refuel. And 4 -- so anyway, in Mode 5 we had to split that into two areas, one with the head on and one with -- and the other with the head off.

The main difference with the head on

versus head off is that if we do lose decay heat removal with the head still on, then the plant can repressurize and we can use the isolation condensers. Also, if we had to use GDCS, we would be required to use DPVs and depressurize with the heads on. With the head off, GDCS will work without any further help.

Then, there is Mode 6 where it -- in refuel now we look at unflooded where the water level is down near the dryer and separators, and then flooded where it is still up all the way to the reactor cavity. Significant timing differences between the scenarios and those -- in those different modes. So those are the four different things that -- states that we looked at for shutdown.

We didn't take any credit for containment in shutdown. So this really is based on a refueling outage rather than going to cold shutdown for some tech spec issue. We would have credit for the containment possibly in those, but we didn't take credit for it here.

The LOCA during shutdown turns out to be more than 90 percent of the CDF for these scenarios. And the main issue with that is that if we have a LOCA in the lower drywell that begins to be filled up with water, if the hatch is closed, the containment acts like a cup and can be filled and keep the core covered just by pouring water into the containment.

If the hatch is open, then we can't do that. The water comes out the hatch, and, as a matter of fact, we can't even fill the reactor building if we -- if so much water was available, mainly because grade level is at the bottom of the core, and so it would come out through the drains there rather than the top of the core, to use that for a cup.

So our insight from this is that the lower drywell hatch does need to be controlled during outages, and we have gone back and forth on what the specific procedural guidance would be for that. But we do indicate that someone has to be available to close that hatch if we were -- if we got to a point where there was a LOCA in the lower drywell.

CHAIRMAN CORRADINI: Just to make sure I understand, so it would be a mode --

MR. WACKOWIAK: Five or 6.

CHAIRMAN CORRADINI: Okay. We said --

MR. WACKOWIAK: Send people in to work in the lower --

CHAIRMAN CORRADINI: No, that I understand. I was just trying to understand that you were strictly speaking about Mode 5. But it's Mode 5 or 6.

MR. WACKOWIAK: Yes, 6 is the same problem. Even though there's more water and we have more time to respond to it in Mode 6, the end state still comes out to be the same. You have to get water in. But we didn't look at -- also, we didn't look at other bizarre once-through modes where we would maybe throw a hose in the top and pump in water faster than it's pouring out the hole in the bottom, and then out through the walls in the reactor building. Didn't take credit for that at this point.

I think we need some procedures before we can do -- get ready for that.

MEMBER MAYNARD: On the hatch, not only can somebody close it, you also have to be able to -- you also control lines and stuff like that that might be running through that?

MR. WACKOWIAK: Sorry, I left that part out. We don't allow any service lines or power cables or anything to go through the drywell hatch. We had service penetrations in the lower drywell to handle equipment during outages.

MEMBER STETKAR: Can you actually close the hatch against the hydraulic head if water is pouring out of the drywell through the opening?

MR. WACKOWIAK: The calculations that we did to determine the time to close the drywell hatch were based on how long it took for the water to get to the bottom of the door. So once the water got to the bottom of the door, we assumed no recovery.

CHAIRMAN CORRADINI: The hatch opens, by design, in or out?

MR. WACKOWIAK: Out.

CHAIRMAN CORRADINI: Is it --

MR. WACKOWIAK: And, once again, it doesn't have to -- it doesn't have to be a pressure boundary at that point. It just needs to be a water seal boundary.

CHAIRMAN CORRADINI: I understand.

MR. WACKOWIAK: So it doesn't have to be fully tensioned in to stop the water, and we are designing the hatch so that it can be easily closed and sealed for this water seal, so it wouldn't take quite as much time as installing it -- the hatch in some of the current plants.

MEMBER STETKAR: Is it a -- I didn't look at any of this. Is it a hinged hatch, or is it a removed hatch with a little local crane and a --

CHAIRMAN CORRADINI: Has it been designed at all?

MR. WACKOWIAK: Well, I think the sketches that are -- you know the sketches from the general arrangement. I think they show a hinge.

PARTICIPANT: I don't recall.

MR. WACKOWIAK: And we're still looking at what the detailed design is. You know, some of us have come up with really cool things where it's hinged, kind of like a bathroom store -- stall door with a magnet, and you just take the magnet off and it closes. Then, the life safety people don't like that, because somebody might get stuck in there. All sorts of things that we have to --

MEMBER STETKAR: How did you handle human-induced LOCAs during shutdown?

MR. WACKOWIAK: We have a discussion of the human-induced LOCAs in the PRA. You know, changing out CRD mechanisms, there's interlocks built into the machine that takes those apart, so that, you know, you have to have the seal. We have removed -- we have added maintenanced valves into all of the lines, so that any of the power-operated valves that need to be maintained can be isolated before they are maintained, so we don't have -- we don't have to use any free seals in this plant.

And then, drain and sample lines we moved outside of the containment isolation valve boundary, so that opening up the wrong drain would not drain everything because the containment isolation would still isolate that path.

MEMBER STETKAR: Since I didn't have a chance to read that section, from what I'm hearing, it sounds like there are no human-induced LOCAs. Is that correct?

MR. WACKOWIAK: In the model we did not explicitly put in any human-induced LOCAs, and we have had several RAIs back and forth on all of those issues, and the discussion centered around the interlocks on the machines, getting rid of free seals, moving drain and sample valves outside of the -- so we think we've got it bounded there, and now -- then what we're left with is a -- you know, a frequency of a pipe break.

And the kind of things that -- you know, it's a low pressure, not a real lot of flow. The kinds of things that are probably in the pipe break frequency at that point are, you know, the -- somebody runs a machine into the pipe and breaks it off, and things like that.

MEMBER STETKAR: I'm just curious. Since it's 90 percent of the total core damage frequency, and it's only quantified by pipe breaks --

MR. WACKOWIAK: Right.

MEMBER STETKAR: -- assuring that the human contribution to that is precisely zero could be important, especially because creative people have managed to drain reactor vessels, despite multiple redundancies of normally closed valves.

MEMBER APOSTOLAKIS: That would change the frequency, right, of occurrence -- to include the human --

MEMBER STETKAR: That's correct.

MEMBER APOSTOLAKIS: I mean, it's not that we have something entirely new. Unless it --

MEMBER STETKAR: Once some --

MEMBER APOSTOLAKIS: -- some intervention.

MR. WACKOWIAK: It changes the frequencies. And for those specific types of things, we tried to address the things where something is put in place that we think the pipe is intact, and then the human action occurs remotely and then nobody knows about the floor. So these sorts of things associated with, you know, the --

MEMBER STETKAR: That's recognized in the --

MR. WACKOWIAK: -- break the pipe, they

are getting wet, and recognizing the pipe is broken, and that should make it easier to close the door.

MEMBER STETKAR: No. These tend to be things where people are doing maintenance and repairs on systems. And Joe thinks that the isolation valve is closed, but it really isn't. And they cut into the pipe, and said system is now not available as a mitigation system if it's one of them, or whatever.

MR. WACKOWIAK: Right.

MR. HAMZEHEE: Another point that, Rick, you maybe forgot to make is that some of the human-induced LOCA during shutdown is a little easier to quantify when you do the plant-specific shutdown risk, because you have more procedures, more configurations. For you guys to get some more accurate estimation of that would be difficult.

MEMBER STETKAR: That's correct. But in that sense, this is an area where you might expect the risk contribution to increase as you went to the COL stage where you might know more about how you --

MR. WACKOWIAK: That's right.

MEMBER STETKAR: -- are going to manage the outage.

MR. WACKOWIAK: And, once again, we think we did the kinds of things that we need to do. We moved the penetration, so we can get the -- or moved things into penetration so we can get the door closed. Requirement to have somebody to monitor and close the door, moving -- putting in maintenance valves so we don't need to do free seals, interlocks on the machines for changing the CRDs.

MEMBER APOSTOLAKIS: But is it the frequency only that changes, or the actual sequence of events?

MR. WACKOWIAK: No, it's just the frequency.

MEMBER APOSTOLAKIS: If you have a random one, then are the operators going to do anything to mitigate it? Or is it all of --

MEMBER STETKAR: The only thing that you can do to mitigate it at that point is -- well, that we had to take credit for is getting the door closed. Once the door is closed, the automatic systems take care of it.

MEMBER APOSTOLAKIS: And they will do that even if it's human-induced?

MEMBER STETKAR: Yes.

MR. WACKOWIAK: The only thing would be is if it's human-induced, for example -- I don't want to think of scenarios. If it's a human-induced scenario that affects a mitigation system -- for example, if the human inadvertently opens the GDCS deluge valve --

MEMBER STETKAR: I'd have to think about that.

MR. WACKOWIAK: -- in that particular case, if the human opens up one of the deluge valves, we still have the other two tanks. And if they open the deluge valve, there is no reason for that to be in the vessel. The vessel is still filled with water, so that really wouldn't even be an initiating event.

We've tried to go through some of those scenarios and --

MEMBER APOSTOLAKIS: So there might be others.

MR. WACKOWIAK: The significant open items that we have left in the shutdown risk analysis is to define the tech spec for DPVs during Mode 5 and 6 with the head on. Previously, we were ambiguous on how many DPVs needed to be operable during those modes of shutdown. Rev 5 of the DCD specifies that six DPVs are going to be required during shutdown. And that's consistent with what we have in our model.

Staff requested that building the isolation condenser to function effectively for some operational conditions in Mode 5 -- this is one thing that was identified late in the process, and we haven't fully digested what we need to do here with this one.

But the scenario is is that if the water level during shutdown -- during the Mode 5 head-on conditions, usually they flood up to the flange on the vessel head before they take the head off. But if you flood up that high, then the isolation condenser inlet lines are flooded. And it's -- the conjecture here is that they would not function as isolation condensers if we repressurized there because we have a water seal or something on that.

We agree that that's an issue that we need to look into, and we are looking into it, and we'll get back.

(Laughter.)

All right. The next one is to determine the range of conditions, temperature, and level for which reactor water cleanup shutdown cooling can adequately remove decay heat in the various modes. Once again, this is a question that came in fairly recently. Or, I'm sorry, we have responded to this one, and the staff is looking at our response to this issue.

Our point is that we can maintain the

reactor in a subcooled condition as long as the reactor water cleanup shutdown cooling suction, mid-vessel suction nozzle, is covered. It might not be 120 degrees in the vessel like we want it to be in cold shutdown if we have a reduced set of equipment. But we can maintain it in a cold shutdown condition with multiple different configurations of that system.

There is also concern about injection may bypass the core. The shutdown cooling flow rate comes back in through the feedwater nozzles, and the feedwater nozzles are up on the top of the -- outside the shroud area. And then, the suction for shutdown cooling is at the mid-plane.

The question -- I guess the question came out in -- to GE that -- how much water just -- cold water just goes back and bypasses versus being fully mixed in the -- outside the shroud area. We have sent in a response to the staff. They are looking at it.

The one thing is this configuration, similar to what was in the ABWR -- and the ABWRs have successfully dealt with cold shutdown -- so we think we got it, but it's still under review. Slight different configuration, but it's similar.

CHAIRMAN CORRADINI: I have a question here.

MR. WACKOWIAK: Okay.

CHAIRMAN CORRADINI: So a number of us would have a number of questions here. Do you have the expertise in the room to answer detailed questions about this? Otherwise, I have a suggestion to move us along.

MR. WACKOWIAK: About this?

CHAIRMAN CORRADINI: Yes.

MR. WACKOWIAK: I can probably answer --

CHAIRMAN CORRADINI: So here is my proposal.

MR. WACKOWIAK: -- 80 percent of your questions.

CHAIRMAN CORRADINI: Okay. But I have a proposal. We are falling behind and --

MR. WACKOWIAK: Way behind.

CHAIRMAN CORRADINI: Yes. And so what I was going to suggest is for severe accident management that a number of us submit questions through the staff to you about this to clarify things or questions we have and skip this for now, because this is a whole 300 pages that I went through. But I'm not sure if we're going to have a chance to go through in any detail here.

I'd rather hear the staff about the rest of the Chapter 19, and then allow us time for RTNSS.

MR. WACKOWIAK: Let's do that and --

CHAIRMAN CORRADINI: I'll look at the Committee. I checked with a few of us to see if it's okay with ones that I expected a lot of questions. Is that okay?

(No response.)

Hearing silence, I think that's approval. So --

MR. WACKOWIAK: And I think that the only thing I want to say here is there are open items on this that they will talk about. BiMAC testing was one of the open items. Testing has been completed. We have submitted the report to the staff.

CHAIRMAN CORRADINI: Do we have that, though?

MR. WACKOWIAK: I -- yes. Somebody --

CHAIRMAN CORRADINI: We have the BiMAC test?

MR. WACKOWIAK: The test report, do they have it yet?

MS. CUBBAGE: We have it. I'll have to verify if you --

CHAIRMAN CORRADINI: Okay. So, then, I definitely positively want to hold off until I look at that.

MR. WACKOWIAK: And it's a proprietary report. So just be aware that that is. When we want to discuss that, we should probably have a closed session.

CHAIRMAN CORRADINI: No, we don't have it. No, I think that would be fine, then, because I think we would rather -- at least I would rather see that and look at that -- those results before we ask you a few of the questions we've got.

MR. WACKOWIAK: And then, these other additional open items are things I think I covered in passing in the other topics, but they are also underway.

I want to do one statement about what you'll see in Rev 3. What we did to do Rev 3 of the PRA is not updating the entire PRA. It's easy in a PRA to change a couple of numbers and end up having every page look like it was a change, just because of the results and things are -- propagate on through. So we didn't want to do that to facilitate the review.

So what we did was like a typical PRA maintenance and update process. We reviewed all of the differences between the plant from what we had in the model before, and where we are now, and we added a Section 22, which goes 22.1, 2, 3, all the way through 21, and we describe what the differences are and what the results of those differences are, and any sensitivity analyses that we needed to do to demonstrate that we understood what those results were and what the final numbers would be.

In Section 7, we did do a full Level 1 internal events requantification of the PRA, and demonstrated that with the exception of two sequences that swapped places the results remained essentially unchanged. And when you look at 22, you will see it's set up like a guide to how to review the PRA update from what we did before, and the plan with the staff is that now, after this -- they've had a chance to review that, then we will update that into the main report, they will come out and audit that we implemented it properly, and by then we'll have another Section 22 that has the newer things, added detail, whatever, from the detailed design process. So now we're in a PRA maintenance process, even though we are still in the DCD right now. So we're --

MEMBER BLEY: If I understood you right, except for Chapter 7, Chapters 1 through 21 are identical, then, to Rev 2?

MR. WACKOWIAK: But we have clarifications and corrections from RAI responses in those sections.

MEMBER BLEY: That are in those sections.

MR. WACKOWIAK: Yes. So it is --

MEMBER BLEY: Some update.

MR. WACKOWIAK: If they said -- if we did something that was adjusting the document but didn't affect the quantification, we put it in that section to clarify it. But anything associated with a new model or a new quantification would go in 22.

In the end, we found the same results, the same insights, and the same -- essentially everything was the same as before. It was just using different equipment. You had asked, "How is that possible?" Well, the reason it's possible is because our -- the way our design process is set up right now with the PRA plugged in at every step of the design process, and we make sure that when things are changing in the plant they are being changed consistently with the things that are modeled in the PRA, and we only change things in the PRA or in the plant to change that if there is a good reason for it.

And so far we have been able to take all of the different design changes to address the rest of the branch's questions about the design of the ESBWR and make it fit right within the framework of the PRA that you saw back last year in September when it was submitted as Rev 2.

MEMBER STETKAR: Rick, let me just make sure I understand, because we don't have it, but it will help once we get it. As a specific example, between DCD Rev 3 and Rev 4, the instrument air system design changed completely.

MR. WACKOWIAK: Yes.

MEMBER STETKAR: Would I find the new model for the instrument air system in Chapter 4 of the Rev 3 PRA or in Chapter 22?

MR. WACKOWIAK: 22.4.

MEMBER STETKAR: 22.4.

MR. WACKOWIAK: And in that section, we give the new model and we discuss the -- if there's any difference in contributors at the system level, and then we talk about how that affected the results of the integrated models.

MEMBER STETKAR: But you did integrate the new model into the full PRA.

MR. WACKOWIAK: Yes.

MEMBER STETKAR: Okay. Thanks.

MR. WACKOWIAK: I think the only things where we didn't integrate everything is something in the high winds area we still use the Rev 2 model. We didn't use the underlying for the -- for that. And maybe in the fire again, too, because there is a lot of little connections that you have to make in fire with all of the flag files, so --

MEMBER STETKAR: It just helped. There are so many thousands of pages of fault trees that a little bit of direction, which thousands of pages to look at, helps. Thanks.

MR. HAMZEHEE: Rick, do you plan to provide any additional guidance as to what is in Rev 5 for the PRA Subcommittee later on?

MR. WACKOWIAK: If they would like it, we're going to be discussing it with you for half a day tomorrow.

MR. HAMZEHEE: That's correct. I just -- all right.

CHAIRMAN CORRADINI: Thank you.

MR. WACKOWIAK: Okay.

CHAIRMAN CORRADINI: So we'll turn to the staff now on the Chapter 19.

MR. HAMZEHEE: I will just start talking while they're getting ready. There are just a couple of --

CHAIRMAN CORRADINI: We want to catch up, so --

(Laughter.)

MR. HAMZEHEE: Since we don't have a lot of time, I wanted to make a verifying remark first with the response I gave early this morning, and that was with regard to the COL application and PRA and COL holder application. And I think based on the changes to the Reg Guide and Part 52 that were made last year, right now we asked the design certification applicant to submit their PRAs, mainly the results, and description of the methodology.

And then, the results is very significant. There are a lot of things they have to submit. Similar things, we have requested the COL applicants to submit. But for COL holder, there is a Rule Part 52 that says they have to perform full scope, all initiating events, all modes, for those that -- the NRC-endorsed standards exist one year prior to the fuel load. But they don't have to submit the results to the NRC, and they have to have them available so that if the NRC staff feels like they need to review or audit something, they can go and audit the results. I just wanted to clarify this.

And then, another point I want to make before we go ahead and talk, if you don't mind, Rocky, is the fact that I just wanted to let you know that in the last several years we have had many interactions with the GEH staff. And through the RAI process, we have raised a lot of technical questions and a lot of issues, most of which have already been addressed.

And as a result of those interactions and RAI process, GE has made a lot of improvements to their PRA studies. And as a result, you see that they have Rev 0, Rev 1, Rev 2, and they just issued a Rev 3 PRA. And as Rick mentioned this morning, they have also made a lot of design improvements as a result of their PRA studies that have been updated and upgraded in the last few years.

So I just wanted to make that comment for the record. With that, Rocky can --

MR. FOSTER: I'm going to go ahead and start, then. We are here to brief the Subcommittee on results of the staff's review of the ESBWR DCD application, Chapter 19. My name is Rocky Foster. I'm the lead project manager on Chapter 19. Mark Caruso, to my right, is the lead technical reviewer. And then, we have numerous technical reviewers that have worked on this project, and the vast majority of them are in the audience right now.

Our presentation we are going to provide you today will be the RAI status summary of the applicable regulations. SER technical topics, significant open items, and COL action items are related for each section of Chapter 19.

RAI status -- we had 289 RAIs that we issued; 272 of them have been resolved, and we have 17 open items as we speak.

MEMBER STETKAR: Those are impressive numbers, but they are numbers.

(Laughter.)

MR. FOSTER: Yes, sir.

MEMBER STETKAR: If I were to ask you to characterize your technical review of the PRA, would you -- on a scale from a high level review through a moderately detailed review to a detailed review, how would you characterize the level of scrutiny in terms of completeness, level of detail? That's not necessarily reflected by numbers of questions, although that might be a measure.

I'm trying to get a sense from a technical level of detail and --

MR. HAMZEHEE: Mark is going to cover it later. But if you want --

MEMBER STETKAR: Oh, okay. Fine.

MR. HAMZEHEE: -- it now --

MEMBER STETKAR: Keep going. Keep going

then.

MR. FOSTER: Okay.

MEMBER STETKAR: Keep going. Keep going.

MR. FOSTER: And now I will turn it over to Mark for the --

(Laughter.)

MR. CARUSO: And my first comment -- my first comment was going to be on the 289 RAIs, and sort of give you some perspective on that, which I think is exactly what you just asked.

I'd say, you know, we got PRA -- Rev 1 of the PRA some time ago. I'm not sure -- 205 or 206. And there was, I would say, a fairly detailed -- quite detailed review of that done by the staff. Nick Saltos was the reviewer at that point, and he generated most of these -- a good share of these questions.

MEMBER APOSTOLAKIS: Who did those?

MR. CARUSO: Nick Saltos.

MR. HAMZEHEE: He was the original reviewer, and then there were some changes in the staff.

MR. CARUSO: Detailed questions on the modeling and all of the -- in Chapter 4, all of the different system models, there were a number of detailed questions on the modeling, all of the models, questions on the data, a number of questions on particular data values, and my -- were they appropriate, a number of questions on common cause failure, questions on providing additional information on insights, addressing the thermal hydraulic uncertainty.

So over the past year, I took over for Nick about a year ago when Nick moved to the PWR group. And over this past year, we have received a lot of responses to those questions and looked at those responses over I guess last summer. Most of the responses to those questions are included in Rev 2 of the PRA which we got some time around -- started getting it some time around August. In some cases, questions went away -- questions went away because the design was changed, modeling methods were changed.

So I think there was -- I would say there was a significant update between Rev 1 and PRA Rev 2. Now, I would say the level of review of the responses to those questions was probably not as detailed. It was: are these reasonable responses? Do they address the question? In some cases, we weren't satisfied with the responses, and in most cases we were satisfied with the responses.

MEMBER BLEY: Mark, just to really understand what you've told us so far, going back to the Rev 1 review, your folks actually looked at the event trees and fault trees to see that they modeled the system as it is described?

MR. CARUSO: Yes.

MEMBER BLEY: And looked at the data analysis or how the data was handled down at that level.

MR. CARUSO: And we looked at that in Rev 2, too.

MEMBER BLEY: Spot-checking or actually trying to look at most of it?

MR. CARUSO: Well, I mean, if you look at Rev 2, you look at the fault trees and the basic event, they go on and on and on. So I -- from my own perspective, I would say it was a sample check review. In some cases it depended, if there was a question we had asked that related to a certain part of modeling, and they responded to it, we would go in and look at that.

MEMBER BLEY: Just an aside -- if I took one of those systems that is maybe 200 pages long and took out the common cause cut sets, it's a much smaller --

(Laughter.)

MR. CARUSO: That's true. Reviewable, yes.

So we're left with basically 17 open items, and they -- I also wanted to say I focused my efforts on the Level 1 topics, and then sort of a coordination for the group. We had a number of people work on different parts of the PRA review -- fire, high winds, work on the shutdown. Those people are all here, and if there are questions in those areas we will have them address those questions.

And I think from the -- at least from the perspective of the Level 1 PRA, I think overall we feel like we have some of the same concerns that you have expressed about the sensitivity studies and about some of the data, and do we know these numbers, the squib valve failure rates and software common cause failure.

But I think, overall, looking at, you know, what they've done and the modeling, the data they have used, the sources they have used, and then the results they got, and a comparison of the results they got with the design of a plant, that we feel pretty good about their Level 1 core damage -- well, their Level 1 results, in the sense of from the point of view of meeting tradition's goals.

So I think I would say overall we have some open items to resolve, but we're -- I think we see the light at the end of the tunnel.

MEMBER APOSTOLAKIS: Can we really claim that we demonstrate that the Commission's goals are met? I mean, that's a pretty strong statement, it seems to me, given that we don't have a lot of detail and we don't have a plant. We have to find better words I think.

MR. CARUSO: Yes, I would agree. I would say we need to make a judgment as to whether or not, you know, we think --

MEMBER APOSTOLAKIS: As to whether the design should be certified.

MR. CARUSO: Yes.

MEMBER APOSTOLAKIS: This is the decision. We are not meeting the Commission's goals. In fact, some of my colleagues here will claim that we have never demonstrated that we met the Commission's goals, right?

MEMBER POWERS: Never.

MEMBER APOSTOLAKIS: Never. See? He spoke up. Even for LWRs. So let's not stretch it.

MR. CARUSO: Well, we can certainly

make --

MEMBER APOSTOLAKIS: Sorry. What?

MR. CARUSO: I mean, I think we can also turn it around to say, "Do we think they don't meet the goals?"

MEMBER APOSTOLAKIS: No, that's very different. That's a very different conclusion.

MR. CARUSO: It's a very different question.

MEMBER APOSTOLAKIS: Very different conclusion. But given that a lot of things are missing, if there are assumptions that have been -- have had to be made, and all of that, I can see how one can conclude that the design should be certified, but to claim that we meet the Commission's goals is a little bit, well, too much.

MR. CARUSO: I have another slide here later on that shows that there are a number of other objectives that the Commission had. That was one objection.

MEMBER APOSTOLAKIS: That's different, and I think it was Commissioner Jaczko who made the statement recently that we can't really demonstrate that we meet the Commission's goals, even with LWRs.

MR. CARUSO: I agree. I find that the

stickiest one to deal with as the staff making the conclusion about it. The other objectives I think are much easier to deal with.

MEMBER APOSTOLAKIS: Well, if you focus on the decision in front of us, namely should we certify it or not, I think that is -- it's clear what you're doing or what they are doing and what you are doing.

MR. CARUSO: But I agree with you. Here we have an objective that is based on numbers. They've got numbers there -- I mean, goals -- CDF and LRF numbers. We have a PRA that doesn't match a real plant, doesn't match real procedures, and creates a great deal of uncertainty in terms of a numerical analysis. So, you know, that's hard to deal with.

MR. HAMZEHEE: And I think you may, George, in general be right, but what Mark is eluding to is the fact that if you look at some of the Commission goals, there are a set of them that Mark is going to glance through. And, for instance, one of them is to make sure they use PRAs during the design phase to improve this design of the plant, and they have demonstrated -- they have definitely demonstrated that.

MEMBER APOSTOLAKIS: I have no objection to that.

MR. HAMZEHEE: So that's one objective.

MEMBER APOSTOLAKIS: I just think that in this area, the precision in language is really important.

MR. FOSTER: Sure. We do have an upcoming slide that goes to the objective.

MEMBER APOSTOLAKIS: Don't be defensive. Don't be defensive.

MR. FOSTER: They help to outline things for the --

MEMBER APOSTOLAKIS: You see to agree with me.

MR. HAMZEHEE: I do.

MEMBER APOSTOLAKIS: Okay. No?

MR. HAMZEHEE: All right. Keep going.

MR. CARUSO: I would say from my perspective that when I look at their design and their modeling in the design, and the things that they have addressed in terms of trying to reduce the vulnerabilities that the other plants have, I would say I feel confident that this -- if someone buys this and builds it and, you know, puts in responsible procedures and the other stuff that they put in, it could very much, you know, exceed -- you know, meet the goals and exceed the goals. But I agree we are not there yet in terms of saying that's the case.

MR. KRESS: If you looked at the next slide, I think you pretty much can agree that those things have been --

MR. HAMZEHEE: And that's what I was trying to say. There are a number of them that have been demonstrated to be --

PARTICIPANT: That's the Commission objectives.

MR. KRESS: It may include some --

PARTICIPANT: Oh, we'll bypass it.

MR. HAMZEHEE: These are the ones that have been published, discussed, shared with the industry, with the ACRS, with the NRC staff members, and there is nothing that we are not aware of.

MR. CARUSO: This is our guidance. This is our focus. These are our criteria in doing this review. Not so much a PRA review as a review of their use of the PRA and -- but you can't get around the -- is the PRA at a quality level that is good enough I guess I think is one of the key issues that we have had.

MEMBER APOSTOLAKIS: But see how carefully they have phrased this. Determine how the risk associated with the design compares against --

compares against the Commission's goals. That's how you interpret --

MR. KRESS: But for my information, where will I find this well-known LRF? It's relatively new.

MR. HAMZEHEE: These are not new. These are among different policy papers and documents. And if you want, we can find you the reference documents that have this information available. There isn't one single place that you can find it, in other words. Am I right, Mark?

MR. KRESS: I just wasn't familiar with the LRF.

MEMBER APOSTOLAKIS: Yes, the LRF of 10^{-6}, I think that was a question we raised in the past, too.

MR. KRESS: Yes, we've raised it.

MEMBER APOSTOLAKIS: Where did this come from? You say the Commission --

MR. KRESS: I didn't realize it had actually become a Commissioner's goal.

MEMBER SHACK: Yes. The trick is, though, they never defined what an LRF is.

MR. KRESS: And that was one of the questions that --

MEMBER SHACK: You have a frequency but

not a definition.

MR. HAMZEHEE: Well, we will get back on that.

(Laughter.)

MEMBER SHACK: They never defined it. That's -- we're getting distracted. Let's let them go on with their show.

MR. HAMZEHEE: Let's get back to the -- I'll get you the document.

MR. KRESS: Appreciate it.

MR. HAMZEHEE: Sure.

MEMBER APOSTOLAKIS: So where are you now? Slide what?

MR. CARUSO: We're Slide 8.

MR. HAMZEHEE: Do you have any more questions about Commission's objections?

MR. KRESS: But, George, couldn't you agree that since they all have been -- because you can say a positive statement about all of these being met?

MEMBER APOSTOLAKIS: I'm sorry. What?

MR. KRESS: On this slide, I would have thought that you could be positive that all of these have been met.

MEMBER APOSTOLAKIS: Yes, it could be positive. Yes.

Now, I have a minor question, though. What if their CDF were six times 10^{-5}? Would you conclude that they compare favorably with the Commission's goal of 10^{-4}?

MR. HAMZEHEE: Probably not.

MEMBER APOSTOLAKIS: Ah, okay. Good. It's close enough that, then, you need to include all of the other things -- other risk contributors, make sure the comments you made this morning are adequately addressed. Is the common cause values correct, what about this, what about that. But since there are four -- three, four orders of magnitude, even if you add some of those things, there is still a high confidence that they are below the Commission's safety goal.

MEMBER APOSTOLAKIS: Good.

MR. CARUSO: I think for me -- in wrestling with that question -- you know, it is 10^{-8}. And, you know, whatever it is -- two orders of magnitude smaller. Why am I -- what should I really expect? Should I expect that to be, you know, a number that is in the right range? Or should I expect them to be substantially above the goals?

And I looked at -- the thing that I looked at was: what have they done compared to plants that we know -- we sort of have a benchmark in the operating plants -- 10^{-5}, 10^{-6}. These guys are, what, two, three orders of magnitude higher.

How are they different? So we looked at, you know, the things that they've done, and they're substantial in terms of, you know, station blackout and improving ATWS protection.

All right. Let's move to Slide 8. Basically, we are basically walking through the sections of the SER. Section 19.1.2, quality of PRA, the major topics in this area were -- that we looked at were the success criteria for common cause failures, the PRA technical adequacy, and the maintenance program. We felt these were important issues.

Since common cause failures, because the PRA was showing that because the diversity and redundancy, common cause was the major contributor. So we looked at how they treated common cause failures, and we felt that they had done an appropriate job in terms of methodology and data.

PRA technical adequacy -- we felt that, you know, we had given it --

MEMBER APOSTOLAKIS: Let's talk about common cause failures. By common cause failures do you mean the standard approach for redundant systems, and so on? Are you satisfied they have done a good job in the digital I&C?

MR. CARUSO: Is it a software issue?

MEMBER APOSTOLAKIS: Yes. I mean, are you saying --

MR. CARUSO: Here I agree with you again. 10^{-4} -- I don't know what this number is. I don't think anybody knows what this number is. And I'm not sure when anybody will know what this number is.

MEMBER APOSTOLAKIS: Do you raise that issue anywhere?

MR. CARUSO: What I thought was they put a relatively -- the core number in there that made the common cause software failure show up as a significant contributor. So, you know, essentially if you are to go lower in that -- higher in that number, you know --

MEMBER APOSTOLAKIS: It would still be dominant.

MR. CARUSO: Right. It would still -- so, I mean, they -- well, I think it tells us that as long as we feel uncertain about what the common cause failure rates are for software and for digital I&C systems, that, you know, they should be treated as significant contributors.

I don't think you can -- I think -- well, the other thing is if you look at the modeling they did, I mean, there is a whole lot of stuff in there that's equipment and sensors and, you know, software common mode failure in one little box down there. And --

MEMBER APOSTOLAKIS: But we do have regulations, at least guidance --

MR. CARUSO: Yes.

MEMBER APOSTOLAKIS: -- so for the deterministic guidance that deals with the issue of common cause failures for digital I&C. I mean, they don't have to quantify everything, in other words. The decision, as we have been told many times, is the result of the whole process. And the process includes deterministic evaluations, probabilistic evaluations, and so on.

MR. HAMZEHEE: Let me just also expand on what Mark is saying. We don't intend to resolve, under ESBWR, all of the existing issues related to digital I&C. It's outside the scope. But if we claim that we resolved it, we are telling -- we are not telling you the truth. There are issues that industry is dealing with, and they are still working on them. And it's not or has not been resolved as part of ESBWR design certification PRA.

Now, we have two options under these conditions. Either don't put any numbers next to digital I&C and just don't model it. That means you are assuming the success of the digital I&C 1.0 or the failure probability is zero, or go and use your best of knowledge with what you have available and what you know about your digital and do some quantification.

GE decided to go ahead and use what -- the numbers that they could find or could to some degree justify, and haven't included those numbers and modeling into their PRAs. That's what they have chosen, and Mark is right -- we are not able to resolve some of the issues, and we don't know enough about system yet to either agree or disagree.

MR. CARUSO: But we did sit down with Rick and have him go through this design, and, you know, I think it's safe to say that the types of redundancy and diversity that they put in their design are, you know, very strong. They end up using different designers, different --

MEMBER APOSTOLAKIS: I don't doubt that. It seems to me that you should flag that issue, say, "Is anybody reviewing the digital I&C arrangement they have from the deterministic perspective?"

MS. CUBBAGE: Absolutely.

PARTICIPANT: Oh, yes.

MEMBER APOSTOLAKIS: Okay. All right. So why, then, don't you say that this is happening there, and in the PRA use it -- find the right words to say that you are not really that sure about the numbers. I would expect to be flagged down.

MR. HAMZEHEE: All right. That's a good comment. I think we will write it down and go back and --

MEMBER APOSTOLAKIS: Don't feel responsible --

MR. HAMZEHEE: No, no, no.

MEMBER APOSTOLAKIS: -- that everything has to be quantified.

MR. WACKOWIAK: I have a comment on that. Rick Wackowiak from GEH again.

MEMBER APOSTOLAKIS: Yes.

MR. WACKOWIAK: The difficulty with leaving it up to the deterministic side is I think they may come up with different insights than what we would, than by looking at it this way. If you look at it directly, the digital I&C issued only from the deterministic side, assuming that the system can fail and you need to do something about that, you end up with a situation where you want to add more diverse control systems and add and add and add, whereas when we do it this way in the PRA, at least as dubious as the number may be, when you add new control systems you also bring with it the baggage of a control system can spuriously operate or do something that you don't want it to do. And we can catch those in the way we did our PRA modeling.

And so it kind of puts a balance on the deterministic side, which is good to do, because we can say that maybe just adding new control systems as a backup is not always the right answer, because it can cause more problems sometimes than what it is solving.

And we can do -- we can look now at our digital I&C system. And with the failure rate of 10^{-4}, for the software, if you will, adding diversity with another digital system is prudent in some applications, but it's not prudent in others. And backing up an isolation function at 10 -- if the failure rate of that system really is 10^{-4}, then you don't want to have another digital system that can isolate systems that you want to have work in the plant.

So I think there has to be a balance. We have to do something. I don't know what the right thing ultimately will be, because that is still up in the air. But I think we -- if we leave it to the deterministic side only, we're going to get more digital systems in places where we don't want them.

MEMBER APOSTOLAKIS: Well, it's not entirely clear without that, because you can always raise this issue of spurious actuation without resorting to probability. Plus, there seems to be a consensus that we don't really understand how I&C systems fail. So if we start putting numbers there just to make a point, it doesn't make much sense to me. But as long as the staff identifies this as some let's call it weakness of the analysis, then maybe that's good enough.

See, we've had this problem over the years that the lack of information never stopped the regulatory guys.

(Laughter.)

They will make a decision no matter what, which is fine. But it has to be based on knowledge, on what we know. And if we don't know enough, maybe be conservative and all of that. But the truth of the matter is we don't understand how these digital I&Cs fail. So to say, you know, I put in 10^{-4} and see what happens.

And the other problem that perhaps is not your problem, but is our problem here, is that the moment these things go on paper then they create a precedent. Then, you know, the next guy says, you know, why did you approve it then? Why don't you do it to me, too? You know, it creates a problem. The agency is spending a lot of resources right now trying to understand how the I&C may fail. And when it comes to real decisions, we say we don't care. That doesn't make much sense.

MR. HAMZEHEE: We wrote it down. We'll go back and see what's the best way to address this in our SER. But I think the key thing, as Mark said, is that we ensure that they have enough defense-in-depth diversity into the design, so that if some of these numbers are not correct or inadequate that defense-in-depth would take care of it.

MEMBER APOSTOLAKIS: Right.

MR. HAMZEHEE: So at least that's what we could do during the design certification review. I'm sorry.

MEMBER BLEY: I guess I just want to get something on the record, George. In the I&C Subcommittee, I agree, we ought to be focusing on failure modes and understanding them. I think having worked on, as was done here, including the fault tree analysis that includes some of the interactions with people.

Some of the things that we do know how to model, and some of the structure that they've done, gets us moving in the way of getting there. But I think the statement, as you suggested from the staff, as you said, that we don't have a lot of confidence is an appropriate one now. But if we don't have people trying to move these models forward, it is going to be a long time before we get there.

And I haven't looked in great detail at what is here, but at a little and some of what is there online -- what Rick said -- is showing things that can affect the system, and I think that's how we'll move ahead.

MR. CARUSO: Okay. Let's continue on. Slide 8. PRA technical adequacy -- in the DCD Rev 4, GEH had indicated that, to the extent possible, they had met category -- capability category 2 attributes of the PRA standard. And so we felt like, gee, we need more than that, so we queried them on extent of basically, you know, you need to tell us and explain to us in more detail why you think this PRA is of good enough quality for the design certification application.

And they responded to that. They explained to us their review of the PRA against the attributes, the capability category 2 attributes in the standard, and identified those that they didn't treat and identified why they didn't or what the impact of not treating them was. And we felt that their response was adequate.

MEMBER BLEY: Can I say something here? Mr. Chairman, maybe this is something we ought to hold for more detailed meetings. But I think the fidelity of the fault trees to the systems descriptions is something we want to get into in some detail with you. And at least some of us in looking have had some concerns in that area, and I don't -- it seems that's an area where you folks have accepted what's been done as being appropriate. I think we want to get into that in some detail.

In the other one, it's just a single thing, but it's the one I raised earlier this morning. These vacuum breaker valves are very unique, and the analysis that was done to come up with a number cites a report, and you go to that report and they lay out an approach through a Bayesian analysis. And they define a prior that is kind of pinched on the ends, and what they conclude is that you can run 3,000 tests to ensure that your failure rate is less than one in 30,000. And I think you guys ought to go back and look at that again.

MR. HAMZEHEE: Yes. We already took a note this morning.

MEMBER BLEY: Okay.

MR. CARUSO: I think in regard to your comment about fault trees and review of the fault trees, when we were thinking about how are we going to deal with these pages and pages and pages of fault trees and it's a review -- I think what we thought was this is too much. And we said, "Well, what about the other PRAs that are done in the industry?"

And so we raised with GEH, you know, "Are you going to peer review this PRA?" Because that's how we -- that's what we rely on in other PRA reviews, to make sure that that level of detail has been looked at to an adequate level, and that's within our standard.

Well, and then they said, "Well, we don't have independent reviewers to do it," and so they did something -- a compromise in a sense of organize their own peer review team and sort of follow the peer review thing of bouncing it off the standard. So I think when you discuss these issues with the Committee about how to, you know, broaden the standard for design certification PRAs, these are the kinds of issues that are important.

MEMBER BLEY: Let me make a suggestion. Before we have a detailed meeting to look at them, take a few systems -- I&C, GDCS -- and look at the top levels of the fault tree. Go down one or two levels, or three, and see how you see it matching up.

MR. HAMZEHEE: All right. Okay.

CHAIRMAN CORRADINI: We are moving on?

MR. CARUSO: Yes.

CHAIRMAN CORRADINI: Good.

MR. CARUSO: Slide 9 discusses the significant open items here. We just talked about the PRA quality. I think Rick went through the thermal hydraulic analysis for the passive system, what they're doing there. Unless there is any additional questions, I don't think we need to go -- repeat that.

MEMBER ARMIJO: The TRACG model, that has been around for a long time, what is the problem with using the TRACG for calculating the clad temperature. What is the issue there?

MR. CARUSO: The issue there is that the staff never reviewed it for that application, because in the ESBWR, in the design basis analysis, they never uncovered the core. So the staff didn't review the ability of the code to deal with core uncovery and approaching 2,200 degrees.

We're asking GE to address this. We're not saying, "You need to do a design basis" -- you know, we're going to do a design basis review of this part of the code. But you need to give us confidence because the code has been around and it has been tested. Give us some good confidence that it can handle that. I think they -- we haven't seen their -- they have submitted their response. We haven't looked at it, but I think there is probably a success path there.

MEMBER ARMIJO: Has the staff used its own codes for calculating that -- those situations for comparison with what GE has done?

MR. CARUSO: George Thomas, are you here anywhere? Can you --

MS. CUBBAGE: If you're referring to design basis, the design basis space, we use the TRACE code, and, you know, we don't look at uncovery in that situation either.

MR. THOMAS: This is George Thomas, Reactor Systems. TRACG, we are using for a LOCA and where we are calculating the cladding temperature. But for the PRA, and the Appendix K, they will not be the same. But being able to review the TRACG for the PRA application --

MR. CARUSO: His question was: have we used our own codes to look at this stuff?

CHAIRMAN CORRADINI: And when you do an audit calculation, what do you use? The core design is essentially a current BWR core design. So what do you use for your audit calculations?

MR. THOMAS: TRACE. You are using --

MEMBER SHACK: They are comparing a design basis calculation where it's flooding, not 2,200. So the -- have you done it with -- you know, have you done any check calc -- for your PRA checks, have you done it with another code, if not TRAC? I mean, if not TRACE.

MEMBER APOSTOLAKIS: But you are using the codes of the applicant, or you are not --

MR. THOMAS: We are using TRACE. We are using the calculation to verify TRACG. This is being done by our different --

MEMBER SHACK: But you are not using it for success criteria of this type.

MEMBER APOSTOLAKIS: Right, right. You

have used it in the past to certify the code.

MR. HAMZEHEE: But I think you may have heard earlier that the issue we had here was we wanted to address some of the uncertainties associated with passive systems, success criteria, and GE used MAAP-4, which is the acceptable code for industry. And we told them that because MAAP-4 we have now reviewed it and approved the code, and may not know enough about it, why use -- why don't you use TRACG to make some comparison and benchmarking. That was the overall concern with this RAI.

MEMBER ARMIJO: Then, they did it.

MR. HAMZEHEE: Then, they did it. Now we have concern for some cases using TRACG make sure you can justify that TRACG can model it properly.

MEMBER ARMIJO: Okay. And they have responded to your --

MR. HAMZEHEE: They are working on it. They haven't done anything yet. He is going to tell you about the status. We don't know the results yet. So let's wait until we get something, and then we'll get back to you.

MEMBER ABDEL-KHALIK: I'm sorry. Let me just rephrase --

MR. HAMZEHEE: Sure.

MEMBER ABDEL-KHALIK: -- what you said. You asked him to do the comparison with TRACG, and after they did that you came back and said, "Do you have questions about TRACG?"

MR. CARUSO: No. All the questions were at the same time. The one question was we -- they were separate issues. The first issue was we wanted to make sure they had -- they had done their -- basically, their benchmark of MAAP for cases where there was no core uncovery, no steam, no approaching 2,200 degrees, although 2,200 degrees was what they said -- that's our criteria for success.

But they had compared the code that they used to do all the studies with cases that were, you know, design basis cases. They weren't cases where you only had, you know, two valves or two out of six or whatever. They weren't the cases in the PRA.

We said, "Hey, we want to see -- we want to see that MAAP can do the job when, you know, you guys -- you are approaching a severe accident, you're uncovering the core." You know, that's where the benchmarks -- we want to make sure, because we -- we are aware of issues with some of the thermal hydraulic capabilities of MAAP. And we felt for those reasons that they could at least do the benchmarking at those points and show us that the codes were good there, and then we would have confidence that MAAP was okay.

The second issue was that they had said that their success criteria in doing this was going to be core uncovery of 2,200 degrees clad temperature, and they were going to use TRACG. And our folks were concerned that we had never reviewed TRACG for that -- for that type of heatup. And we wanted to have some confidence there.

CHAIRMAN CORRADINI: So let me just ask that question again, because I'm still not clear I got the answer I was expecting. So in current BWRs, the geometry is pretty much the same. So what other calculations does the staff do for current BWRs under the situation you have core uncovery? It's not trace, is it?

MEMBER SHACK: It's Appendix K LOCA.

CHAIRMAN CORRADINI: It's Appendix K LOCA with RELAP 5 I would assume, is what I was expecting to hear, but I could be wrong.

MR. HAMZEHEE: I think for the design basis calculations, George, if you can expand on it, what do you use for design basis calculation during the confirmatory or independent analysis by NRC staff?

MR. THOMAS: We are using RELAP.

MR. HAMZEHEE: RELAP?

MR. THOMAS: RELAP, yes.

MR. HAMZEHEE: Okay. Fine.

CHAIRMAN CORRADINI: Okay. Thank you.

MEMBER APOSTOLAKIS: Now, when it comes to this treatment of parameters affecting thermal hydraulic uncertainty, can you elaborate on that? What do you mean by that? Do you mean things that may affect the performance of the passive system like --

MR. CARUSO: Heat transfer coefficients in the isolation condensers.

MEMBER APOSTOLAKIS: Yes. And how about things that may affect the geometry?

MR. CARUSO: Tank size, valve area.

MEMBER APOSTOLAKIS: You don't get into those things?

MR. CARUSO: Yes. The issue was they didn't tell us what parameters they treated. And they didn't tell us how they treated it. You said --

MEMBER APOSTOLAKIS: Oh, so it's a broader question.

MR. CARUSO: Please tell us, you know, which ones did you use? How did you treat them? Were they bounding? Were they nominal? So it was -- we just didn't have the information. We felt it was important to understand that.

MEMBER APOSTOLAKIS: And this is not in Rev 3 of the PRA, right?

MR. WACKOWIAK: A partial response is in Rev 3.

MEMBER APOSTOLAKIS: Rev 3.

MS. CUBBAGE: That was Rick Wackowiak.

MR. HAMZEHEE: Rick, will you speak up in the microphone and introduce yourself, please?

MR. WACKOWIAK: This is Rick Wackowiak. It's partially addressed. The pieces that we have already answered in our responses are in Rev 3. The pieces that have not been sent in as an answer are not in Rev 3 at this point.

MEMBER ARMIJO: You are still working on it.

MR. WACKOWIAK: Yes.

MEMBER APOSTOLAKIS: Okay.

MR. CARUSO: Okay. Slide 10 is design features. I think we talked about that. Rick talked about the various design features they have. I think I -- in my opening remarks I mentioned I felt that they had incorporated a wide diversity of design features that addressed previous vulnerabilities and that they included a table. There's a table in the

SER that compares the design features in ESBWR with those in previous BWRs, and tries to focus on places where vulnerabilities have been addressed.

We don't have any open items in this area. We felt like a number of the Commission's objectives could be addressed with the discussion of design features.

Slide 12 -- 19.1.4 deals with internal events at power insights for Level 1 and Level 2 PRA. I think Rick pretty much discussed those insights. We didn't have any open items in that area.

MR. KRESS: Did you consider using MELCOR to audit some of their Level 2 results?

MR. CARUSO: I believe that was done. Ed?

MR. FULLER: This is Ed Fuller from the NRC staff. MELCOR was used to do some confirmatory assessments for the -- to evaluating severe accident behavior and ability of the severe accident mitigation features to respond.

And a number of scenarios were evaluated, and quite a bit of detail was gone into to evaluate these scenarios, at least six or eight scenarios. Some of those scenarios were actually compared with equivalent sequences that GE analyzed in their PRA, and the results of the comparison appear in the document that was prepared and submitted to the NRC, the latest revision of which was at the beginning of 2007.

MEMBER SHACK: But those reports from EPRI don't seem to be in ADAMS. They're referenced in the SER, but when I --

MR. FULLER: Can you get to the -- can you get to the proprietary part of that?

MEMBER SHACK: Yes. When I come in through CITRIX.

MS. CUBBAGE: We'll check on that.

MR. FULLER: Well, I think they're there.

MEMBER SHACK: I searched six ways from sundown and couldn't come up with it. But --

MR. FULLER: Is Hossein Ismaili here?

MR. HAMZEHEE: We will get back to you, and we will provide it to you if you can't get it.

MR. FULLER: Because Hossein and I went through this a little while ago.

MR. ISMAILI: Yes. This is Hossein Ismaili, staff. I just recently put the ESBWR severe accident report into ADAMS. I can get you the ADAMS number and give it to Ed.

MEMBER SHACK: Okay. Within the last week?

MR. ISMAILI: No. Maybe a few months back. I don't remember.

MEMBER SHACK: Okay. I can't find it. You'll have to tell me how to do it.

MR. CARUSO: Go to Slide 14, external events at power PRA. Covered the seismic margins analysis, the high winds analysis, fires, and floods. We had open items in two areas -- a seismic margins analysis and a high winds analysis.

Rick went through those and we concur with his assessment of where things are and what the issues are. And I can go through it again if you want, or --

CHAIRMAN CORRADINI: I have a question.

MEMBER APOSTOLAKIS: Go ahead.

CHAIRMAN CORRADINI: I guess at the end you said you had 17 open items. So maybe you weren't here last time we were together, and so the general feeling of the Committee was -- and I'll just say it now, maybe you can end with this in your conclusion. I'm curious from the staff's standpoint -- of the 17, what is the ones that were you? Are they all of equal concern? Are some just rudimentary clarifications? That sort of classification would help me.

But you can wait until the end to kind of summarize that. That's I guess what I'm looking for in all of this, because I -- a lot of these Rick has gone over, but I'm curious, from the staff's standpoint, which ones keep you up at night, if anything keeps you up at night?

(Laughter.)

MR. CARUSO: Well, I know some of these keep some people up at night.

(Laughter.)

You know, I think this one on the spectrum shape is we're at a -- on that one, and I don't think there's a success path in sight yet. So I would say that --

MEMBER SHACK: Let me understand that. I thought -- I was confused on that one. So the certified design one is like the -- what is it, the old Reg Guide 1.60, the standard spectrum, is that what they use?

MS. CUBBAGE: Plus. Plus, it envelopes the North Anna site.

MEMBER SHACK: Oh, it has that extra bump. It's got -- so that's the certified seismic design. Now, which one are they using for the -- to calculate the HCLPF? Just the old one?

MS. CUBBAGE: From a design perspective --

MR. XU: Jim Xu from the staff. The

design -- the certified design response factor is the combination of the reg guide and the specific wind spectrum from North Anna, okay, is envelope spectrum. It kind of -- it looks like two humps. One hump for low frequency; the other hump for high frequency. Right, okay.

But there is two issues that concerns staff with regard to seismic margin assessment GEH had to perform. One is the shape. Okay. And that has to do with the definition of seismic margin earthquake. Okay.

We believe, as a standard design, you should use the CSDRS as the seismic margin earthquake in your seismic margin assessment. GEH chose to use a performance-based spectrum, which is somewhat different from the CSDRS in the low frequency range.

And that's one disagreement we have, and we are going to continue to discuss on how to resolve that issue.

CHAIRMAN CORRADINI: Okay. Okay. I understand now.

MR. HAMZEHEE: Is it clear?

MEMBER SHACK: To me at any rate, yes.

MR. HAMZEHEE: All right.

MR. XU: The second issue has to do with

the COL holder's item. Okay. Since the majority of SSCs in the cost sites has assumed a HCLPF value, okay, they only assessed five structural components for the HCLPF capacities. The rest of the structural system component in the cost site has assumed a HCLPF value of 1.67 times the design basis.

Therefore, they have a COL holder's item to confirm by the holder prior to fuel loading that --

MEMBER SHACK: That seemed fair enough. Until you have a structure, you can't go off and compute the --

MR. XU: That's a very fair statement, and we agree with that. But we believe if we -- if we have to draw a conclusion that a certified design has a seismic margin, had that margin 1.67 times the CSDRS, okay, then the holder's item, should we use that as a reference for HCLPF calculation? Okay.

The GEH had a different position on that. They believe that the specific GMRS should be used for that confirmation, and that is another issue we have the difference with GEH. So those are the two major issues that we have.

MR. HAMZEHEE: That is the safety margin that we have built into this calculation.

MR. WACKOWIAK: This is Rick Wackowiak

again from GEH. The situation there is is that the CSDRS has a different shape than the GMRS in all cases. You know, it's the one hump versus two hump. And why would we want to have a plant confirm margin above an event that can't happen at that site? That's what our position is with this, that when we go to do the confirmatory HCLPF, it should be based on what is at the site, the best estimate for the site.

If it was simply a case that it was the same shape but a different level, we could probably talk about that, because then it's margin. But here it's margin against an event that can't happen, and that's what our main point is about using the GMRS versus the CSDRS.

MR. HAMZEHEE: And for the sake of time, we are not going to resolve it now.

(Laughter.)

Can we wait for a response?

MEMBER APOSTOLAKIS: Let me ask another question, though. Since the seismic analysis is based on margins, and the fire is really the same thing -- bounding -- we really don't know what the contribution to core damage frequency from earthquakes is, right?

MR. HAMZEHEE: That's correct.

MEMBER APOSTOLAKIS: And, in fact, they

could be dominating the other, the transients, for example, that have been identified as dominant contributors. And we don't know by how much. All we know is that there is a high confidence -- 95 percent probability that -- you know, the probability of failure is less than .05.

How, then, can I compare with a safety mode if I don't know?

MR. CARUSO: Well, that you can't compare. All you can do is get a good feeling that if they -- you know, based on their analysis, that if they satisfy the COL requirement to meet those HCLPFs, that they will, you know, design --

MEMBER APOSTOLAKIS: But let me put it a different way. We have said earlier -- I think Hossein said it -- that they are giving us at 10^{-8}, maybe close to 10^{-7}, and there are three orders of magnitude until I hit the Commission's goals. And there is an assumption there that other things will not really raise the CDF by three orders of magnitude.

So is it reasonable to say that these other things include earthquakes and fires, that I will not come close to 10^{-4}?

MR. HAMZEHEE: Well, let me express my opinion now. At the design state, that's the best you can do. However, again, once you get plant-specific PRAs during the actual COL holder and actual construction of the plant, then they are asked by Part 52 to perform seismic PRA if the standard exists. At that time, they will perform a risk assessment of seismic.

And if there are some vulnerabilities, or things that may have high risk contributions, they may have to make some seismic improvements. They may have to have some additional protection to ensure that the risk profile is acceptable.

MEMBER APOSTOLAKIS: But when it comes to the objectives of the Commission that you had earlier on a slide --

MR. HAMZEHEE: Yes.

MEMBER APOSTOLAKIS: -- it seems to me you have to use very careful language when you write your SER.

MR. HAMZEHEE: Yes. That's right. But again, remember, there is no site right now, so the best they can do --

MEMBER APOSTOLAKIS: Oh, I know the reasons. I'm just addressing the conclusions that, you know, we meet the goals, we meet this, we meet that. With a margins analysis, especially if I'm already down to 10^{-8}, I don't know. Okay? I would be surprised if this thing was 10^{-4}, but the fairer statement is that we really don't know and that at this stage maybe this is good enough.

MR. KRESS: I recall, George -- I recall an ACRS fellow at one time was chartered to make a study to see if you could convert HCLPF -- how he would pronounce it -- into an estimate of the CDF value. I don't know what became of this study.

MEMBER APOSTOLAKIS: I don't know. That was before my time. You can imagine how far it goes.

MR. KRESS: It wasn't before Bill Shack's time.

MEMBER APOSTOLAKIS: Bill Shack is there from the creation.

(Laughter.)

MEMBER SHACK: I have a different question, though, for Rick, and that is, the performance-based criterion sort of implies a CDF of around 10^{-5}. Do you think that's an appropriate goal for this plant?

MR. WACKOWIAK: My understanding -- this is Rick Wackowiak. My understanding is that the initiator is implied at around 10^{-5} performance base, and then we show margin of one and two -- or twothirds beyond that. So it's less than 10^{-5}.

MEMBER SHACK: That's -- I think that's the staff's approach. They take the 10^{-5} initiator, and then add the 1.67. I think the performance-based one backs off on that 10^{-5} initiator, because you've got margin built into the plant and you're going to really get 10^{-5} CDF, which is where everybody sort of is at. And, therefore, it is good enough for current plants. Is it good enough for this plant? Worth looking into.

MR. CARUSO: Okay. We're going to move on to Slide 17. But before I do, I wanted to mention a couple of things in regards to Dr. Corradini's comment. One is that the 17 open items all aren't covered in the slides. There is a number of open items that are very low, didn't even meet the threshold for talking to you about, and those are no problem.

And the other thing I'll say is the ones that we have talked to up to the point of the seismic design one are -- we see success paths. We're not concerned about those.

MR. HAMZEHEE: In other words, there are no show-stoppers.

MR. CARUSO: Right. On the high winds

analysis, we had several open items, and Rick went through those. And we're awaiting your responses, and I think there are probably success paths there, too.

CHAIRMAN CORRADINI: Thank you.

MR. CARUSO: Slide 17, PRA for other operational modes. I think these are the most interesting of the open items, because they address whether or not systems we credited in the PRA, you know, are going to function as they were assumed. So I think -- of all of the open items, I think these are probably the ones of most interest to us, and we are working with GE, and there are some -- we are walking down paths.

MEMBER APOSTOLAKIS: Parallel paths.

MR. HAMZEHEE: I think you heard Rick this morning.

MEMBER SHACK: Riemannian or Euclidean?

(Laughter.)

MR. HAMZEHEE: And then, you also heard Rick this morning that mentioned when he was going through the risk profile that the shutdown risk is over 90 percent. And because of that, we spend more time and pay more attention to these issues related to shutdown mode risk assessment. So we didn't just spend time on everything -- areas that were more risk-significant.

MEMBER APOSTOLAKIS: So shutdown, earthquake, and fire, all at the same time.

MR. HAMZEHEE: What's the probability of that happening, George?

MEMBER APOSTOLAKIS: 10^{-3}. It's of the same basis as a software.

MR. CARUSO: If there are no further questions on the open items in the area of the PRA for other operational modes, we'll move on.

Now, Slide 21 is severe accidents. Do you want to go through that or hold off on that, since you --

CHAIRMAN CORRADINI: Well, you can tell us what you're thinking.

MR. CARUSO: All right.

CHAIRMAN CORRADINI: I'm curious.

MEMBER SHACK: I think if you are beating them up, we won't have to now.

MR. CARUSO: In severe accident mitigation, the only open item there was the BiMAC test report. We have the report now, and we are reviewing it. I don't anticipate that -- there being issues there, but I don't want to put words in anybody's mouth.

MEMBER APOSTOLAKIS: Has the staff reviewed ROAAM?

MEMBER SHACK: Oh, don't go there.

(Laughter.)

MEMBER APOSTOLAKIS: Is there a safety evaluation report of ROAAM?

MEMBER SHACK: Not that I'm aware of.

MR. KRESS: They accepted it for DCH issues, as best I remember.

MEMBER SHACK: It was first developed for steam explosions in '85.

MR. KRESS: Steam explosions.

MR. FULLER: This is Ed Fuller from the staff. The ROAAM report is essentially Chapter 21 of the PRA, and we reviewed it as part of reviewing the PRA. And with the exception of what you see up there right now, the BiMAC test report, which was an RAI or two RAI open item, we pretty much have written what we feel about it in our SER of open items.

We are reviewing the test -- you know, just to answer the question you are all thinking about, we are currently reviewing this topical report. Last summer we actually went out and saw the rig and got a make-believe or a repeat of a test that was already done to see how it worked.

And, of course, we wanted to see the test results, and those RAIs are asking essentially for the test program and test results. We now have them. We find that these -- this is a very significant report. We are having a contractor help us, and we expect to see a draft report in the middle of July, and RAIs produced --

MEMBER APOSTOLAKIS: Which report are you referring to, Ed?

MR. FULLER: We are reviewing the test report that was produced by GE, providing the test results for the BiMAC.

CHAIRMAN CORRADINI: But I think, Ed, what George was asking is, the process by which you do the calculation -- let's say you had all of the experiments you wanted. The ROAAM process, I think George is asking, has it been reviewed? And I'm not aware of it.

MR. FULLER: It has been reviewed as part of reviewing the PRA, Chapter 21 of the PRA. And our SER with open items discusses the recoverability, the ex-vessel steam explosions, and the DCH components of that report.

MEMBER APOSTOLAKIS: Okay. Thank you very much.

MR. HAMZEHEE: Thanks, Ed.

MR. CARUSO: Slide 23, we had an open issue on.

CHAIRMAN CORRADINI: Let's just go back one slide. So I'll give you a hint to some of the things that some of us might be thinking about. So I am not sure, but if I remember correctly, two years ago we were told this was upcoming. And I'm guessing this is a heat transfer test. What worries me most about all of this is the transient deposition of the melt.

I think Dr. Powers actually has mentioned this a couple of times somewhere in the ESBWR, the times we have gone through this. But the transient deposition of the melt onto this device, and would it survive that deposition, that's just one thing that I worry about.

MR. HAMZEHEE: And I think it's a good time, because we are currently starting to review it. So if we hear your concerns, we can pay more attention to and when we do review the report.

CHAIRMAN CORRADINI: So we owe you something. We promised to get it to you also.

MR. HAMZEHEE: Great. All right.

MR. FULLER: This is Ed Fuller from the

staff again. What we are reviewing are heat transfer tests, not any configurations of particular molten material onto the pipes. However, the heat fluxes that the experiments are simulating presumably are somewhat characteristic of what one might expect.

So in our review, we are looking at not only the adequacy of the test facility scale for applicability to the ESBWR configuration, we are looking at the range of test data as compared with what we would expect in severe accident loading conditions, and determining the adequacy of the predictions as compared to data. Okay? And we have some well-known experts in this, one of whom is in this room.

MEMBER POWERS: I guess I don't understand. If you are looking to see what is prototypic about the wrong heat transfer regime, you are going to be frustrated. The problem is that with core debris interacting with any material, it is not just a step change in heat flux. It's a step change in the temperature and the heat flux.

We have known that for 25 years, that the two are not the same. I mean, looking for something that says, "Well, it's a prototypic step change in the heat flux," without looking at a prototypic step change in the temperature, you're looking in the wrong regime. We will not see the phenomena that will affect the stability of the structure.

CHAIRMAN CORRADINI: Yes. Just to make sure everybody sees what I think Dana is saying, he said this I thought it was a couple of years ago when we were in the August PRA meeting. The concern is is that if you get the initial deposition, you are going to create a spallation effect, and you will just rip away what you built before it even starts cooling.

I mean, you just essentially short-circuit the device, because as it deposits you are going to get this very large temperature, and a thermal cracking spallation effect.

MEMBER SIEBER: A refractory.

CHAIRMAN CORRADINI: I seem to remember that's what was said way back then.

MEMBER SIEBER: I mean, it's the same problem you have in a steel mill. You don't pour those things in cold. You preheat it, because it can't tolerate the step change in the temperature. It tolerates the heat flux. The heat flux is fine. But the step change in temperature doesn't let -- the material will not stand up to it, so they preheat it. They preheat them with blow torches. I mean, they get the sucker high, so it can stand -- when you just pour a steel melt in it.

Steel melts typically never run over about 1,500 degrees Centigrade when they cast them, usually a good deal less than that. And now you're talking about something that if you come in -- it depends on the phase and what not -- at substantially higher temperatures.

MEMBER SIEBER: Well, the test reg they have doesn't model that part of the operation.

MEMBER POWERS: Then, you are looking at the wrong stuff.

MR. HAMZEHEE: Thanks for the inputs. We will take them into account when we review the topical report.

MR. CARUSO: Slide 23, the vacuum breaker performance issue. That is not an open item anymore, so -- we got the information we needed, and we're happy with it.

Section 19.2.4 was containment capability, containment performance capability. We identified some problems in the finite element analysis. GEH has given us a response in that area, and I think it's safe to say we are on a success path there.

And Slide 25, accident management, we had asked them for a description of the process for developing the severe accident guidelines, and they have provided a response, and that is currently under review.

So if there are other questions, I'll take them now. No, I guess in --

CHAIRMAN CORRADINI: Are there other questions by the Committee?

(No response.)

Okay. I think this might be a good time for a break.

(Laughter.)

So we'll get back here at about 4:00 with Chapter 22.

(Whereupon, the proceedings in the foregoing matter went off the record at 3:39 p.m. and went back on the record at 4:02 p.m.)

MR. MILLER: Good afternoon. I am Gary Miller. I was introduced before. Rick and I will be talking about regulatory treatment of non-safety systems and how we have addressed that for the ESBWR.

The SECY document has specified that there are five criteria that should be addressed when treating a regulatory treatment for non-safety-related systems, and these are the five criteria. They go through deterministic items such as items needed for the ATWS rule and the station blackout rule, items that are needed to resolve long-term safety issues beyond 72 hours, and this is important because for advanced passive reactors safety-related is defined for 72 hours -- functions that are needed to maintain 72 hours. Beyond that, we are allowed to maintain those safety functions with active or non-safety-related systems, and this is what we will be addressing in Criterion B.

Criterion C is the probabilistic criterion, and it looks at whether or not we meet the Commission's safety goal guidelines of CDF of less than 10^{-4} per year, and a large release frequency of less than 10^{-6} per year. And that is if we take credit only for safety-related systems.

Criterion D has to do with containment performance goals, and Criterion E is something we have already talked about a little bit, and that is the adverse system interactions.

Okay. The first criterion, what we want to do is identify non-safety-related systems that are required in order to meet the ATWS rule. And that would be -- the ATWS rule requires that you have an alternate rod insertion, standby liquid control, and recirc pump trip or basically some method of reducing reactor power rapidly. Since we don't have a recirc pump trip, we have feedwater runback for the ESBWR.

The non-safety-related portions for the ESBWR that meet these are alternate rod insertion and feedwater runback supplied by the diverse protection system.

The SLC actuation is safety-related. And as far as station blackout goes, all of the components that are necessary to cope with the station blackout are safety-related. So the bottom line for Criterion A is that the DPS, or diverse protection system, has these functions that would be in RTNSS, in the scope of RTNSS.

Okay. Long-term safety and seismic, that is the criterion that we are looking at in Criterion B. To define safety, we looked at the key safety functions of the plant, and that would be core cooling, containment integrity, control room habitability, and post-accident monitoring. So I'll step through each one of those.

Core cooling -- after 72 hours, there is a need to make -- to provide makeup water to the IC/PCCS pools, so the isolation condenser and the PCCS heat exchanges have sufficient capacity to perform their function for 72 hours. But after that point, at some point the water in the pools will boil off, and that needs to be replenished.

That function of providing the makeup is provided by fire protection water, and it is pumped up by the diesel fire pump. And as a backup, there is an electric fire pump, motor-driven fire pump that is powered by ancillary diesel generators. These are permanently installed diesel generators capable of powering the electric fire pump and other loads that are required for long-term issues.

MEMBER ABDEL-KHALIK: I'm sorry. Could you go back one slide? At one time we were sort of -- information was presented to us on feedwater temperature control as a means for power control. How does the feedwater runback interact with the feedwater temperature control?

MR. MILLER: Okay. With regard to RTNSS, the requirement is solely: how do we meet the ATWS rule? And the requirement is that --

MEMBER ABDEL-KHALIK: We look at it in terms of effectiveness.

MR. WACKOWIAK: Right. What is going on here is the feedwater signal essentially runs back to zero demand. So it rapidly reduces the water level outside the shroud area. And when the water level is reduced in a natural circulation system, it is the head of water in the shroud that causes the natural circulation flow to go. As we reduce water level down farther and farther, there is less head to drive natural circulation. So that's what the intent is there.

We run water level back down to around five feet above the top of fuel, and then at that point the operators take manual control of the injection systems and maintain the water level around five feet above the core.

MEMBER ABDEL-KHALIK: But how does the feedwater temperature controller respond during a feedwater runback?

MR. WACKOWIAK: The feedwater temperature control is not part of this scenario.

CHAIRMAN CORRADINI: I think he's asking if you did this, does the controller do it --

MEMBER ABDEL-KHALIK: What happens to inlet feedwater temperature?

MR. WACKOWIAK: It really depends on what is going on with the BOP. If the transient that initiated this involves closing the MSIVs, then there is no more feedwater heating anyway. There is no more steam to provide feedwater heating.

If the initiating event is something else, I don't think -- the part of the logic that addresses this is not doing anything to release -- there is nothing in the current scheme for the feedwater control system that says to do anything different with the feedwater heating during this event. You wouldn't heat it up. You wouldn't cool it down. I think it would just still try to control independently.

But, you know, as soon as the water level starts coming down and we get past a Level 2, we'll isolate the MSIVs anyway, and there won't be any more feedwater heating.

MEMBER SIEBER: The assumption is the turbine trips as the root cause of the accident. On the other hand, if the turbine trips, then everything is bottled up. And so you -- if you topped off the feedwater, it would stay the same as it is, except you would generate more bulk boiling in the reactor, it seems to me.

MR. WACKOWIAK: Okay. Yes, that's the initial response -- not putting cold water.

MEMBER MAYNARD: Okay. So this temperature control is not part of this design certification.

MR. WACKOWIAK: No, it's not part of RTNSS. That's part of the feedwater control system, which is in a different digital control system all together.

MS. CUBBAGE: But it is part of the design certification. Right. It was added several years into the certification, so you haven't seen it yet in detail.

MEMBER SIEBER: All right. But the system is isolated once you get the ATWS event, because you are really regulating amount of extraction steam flow.

MR. WACKOWIAK: Right. When we have the ATWS event, feedwater demand will be run back to zero. So very quickly after that we will have a Level 2 in the reactor, which will close the MSIVs and stop any extraction steam to the feedwater heating system. So it's -- they are really two separate subjects.

MEMBER SHACK: Do the IC and PCCS pools communicate? Are they really one big pool?

MR. WACKOWIAK: I can show you. There are separate compartments for the heat exchangers, but it is one big connected pool. We can show you a schematic of that.

MEMBER BLEY: It's like there are gates on it that they can pull out or something?

MR. WACKOWIAK: No, it's pipes.

CHAIRMAN CORRADINI: Well, I think they are interconnected. The external pool communicates. So as you lose from one, you lose from the other.

MEMBER SHACK: Yes. When you feed one, you feed the other.

MR. WACKOWIAK: For the first 24 hours or so, the two halves of the building are separated. But after 24 hours or so, the connection between the two halves of the building open. And so it's all one big interconnected mass.

MR. MILLER: Okay. We talked about core cooling. The next one would be containment integrity -- to maintain stable conditions in the containment. That is provided by PCCS. And, again, after 72 hours we need to provide makeup to the IC/PCCS pools and, just as I described before, by the fire protection water and the two pumps that I described.

MR. KRESS: Is there a limiting amount of that water?

MR. MILLER: The fire water storage tank is -- has been sized to account for that, and it's -- I'm not sure what the capacity is.

MR. WACKOWIAK: It's around a million

gallons, but the size is based on removing decay heat for seven days. So the water that is in the pools in the reactor building initially, plus the fire tank, is enough to remove decay heat for seven days.

MR. MILLER: Okay. Another long-term phenomena called -- within the containment is the accumulation of non-condensable gases. So you look at the containment profile. Beyond 72 hours, it is not stable. There is a slight increase due to hydrogen and oxygen radiolytic decomposition.

In order to get rid of that and provide a means to reduce containment pressure, we have -- for the ESBWR we have PCCS vent fans. And their function is to redistribute the non-condensable gases to provide -- well, provide more efficient heat transfer and to reduce pressure. Another item we have is passive autocatalytic recombiners to recombine the hydrogen to the non-condensable gases. Of course, those are working at time zero, but, you know, they would take credit for this long-term buildup of hydrogen and oxygen.

MEMBER POWERS: These are palladium-based?

MR. MILLER: I can't say for sure. I have heard that it's something. Do you know if it's palladium?

MR. WACKOWIAK: The specific units have not been specified. And I think you guys had some presentations on the -- on what the containment designers are thinking along those areas in Chapter 6. Beyond saying that there is a requirement in RTNSS for this, that is the extent of what we do.

We found in the PRA itself because of the ultimate failure pressure of the containment is so much higher than the design pressure, even without the combiners, the -- we don't challenge the ultimate pressure in the containment due to radiolytic decomposition of the water.

MEMBER ARMIJO: Are these PCCS vent fans operating during the initial 72 hours, or just after?

MEMBER SHACK: In the PRA, not in the design basis accident.

MEMBER ARMIJO: I'm just wondering how --

MEMBER BLEY: In the real world.

(Laughter.)

MEMBER ARMIJO: When do you operate them, and how long are they operated with battery power versus some other auxiliary power?

MR. MILLER: Okay. The PCCS vent fans are powered from the ancillary diesel generators. So they can be put on at any time. The idea would be it would be for long-term. The PRA doesn't even credit them.

MR. WACKOWIAK: And because we are looking at margin to design pressure with these fans, we need to turn them on at 72 hours. If we were looking at margin to containment ultimate pressure, it would be, well, five months before we would need to turn them on. Something like that. I don't know. I'm just --

MEMBER BLEY: But they are manually started.

MEMBER SIEBER: If it's not -- if a component is not required for mitigation of a severe accident, that is what makes it a non-safety system? And assuming that's the case, things like the diesel generators, and so forth, must have quality requirements. And I see a slide is where that is a bullet, and it must have some tech specs about it. But are you going to address exactly what the quality requirements are and the tech spec requirements for things like outage times and --

MR. MILLER: Yes.

MEMBER SIEBER: -- preventive maintenance and all of that stuff, so that one can actually say, "Yes, I think they are going to be there," as opposed to it's non-safety and it's -- you know, if it sits and rots away, that's okay, too.

MR. MILLER: We will address in the next few slides how we -- the treatment we provide.

MEMBER SIEBER: I would like to hear enough detail to have some comfort that the non-safety systems would be available to help mitigate a severe accident.

MR. MILLER: Okay.

MEMBER SIEBER: If they can do it.

MR. MILLER: Control room habitability is -- the function there is to keep the dose down to an acceptable limit, and to maintain the temperature to an acceptable limit, so that the control room can be habitable for the duration of the accident.

The long-term dose protection is provided by emergency filtration units, and those are powered by our safety-related DCIS or Q-DCIS. And that is powered by batteries for 72 hours, and beyond that also by the ancillary diesel generators.

MEMBER BLEY: Quick question. At some sites, when you actually have a real plant, you might need protection for the control room for hazardous gases of one sort of another. Does that go in the design to start with, or is that an add-on plant by plant?

MR. MILLER: That would have to be plant

by plant. There is no -- it's certainly not within the scope of RTNSS, but I'm am not familiar with any other hazardous gases that we would have onsite at that --

MR. WACKOWIAK: I think there is a COLA item about that.

MEMBER SIEBER: A lot of utilities use gaseous chlorine to treat their circulating --

PARTICIPANT: Or it can be going past on a barge.

MEMBER SIEBER: It could be, or some factory down the street. But the common one is chlorine.

MEMBER POWERS: One of the issues that has come up with control rooms in existing plants is the allowable unfiltered in-leakage. I don't know what the -- what you have as your allowable unfiltered in-leakage to be, but I was wondering if you have taken steps to ensure that whatever it is it's preserved over the lifetime of the plant. Because certainly what we have observed in the existing plants is that they have a relatively low unfiltered in-leakage on day one.

On day two, the first modification that the control room has made, and that tends to lead to higher -- ever higher uncontrolled, unfiltered in-leakage, and that it is not maintained.

MR. WACKOWIAK: The control room habitability area, as they call it in this plant, is serviced by these emergency filter units. And that area and these units are all safety-related, and that in-leakage is covered by the tech specs for the control room habitability area.

MEMBER POWERS: All of which is true for the existing plants. All of -- most of whom no longer meet their tech specs. Have you taken steps to see that that doesn't occur in new plants?

MR. WACKOWIAK: We have had many a discussion with the potential customers over just that issue.

MEMBER POWERS: I'm glad you've had the discussions.

MS. CUBBAGE: I just wanted to confirm that it is a COL item in Chapter 6 for the site-specific analysis of toxic gas.

MEMBER BONACA: The question I had was: this classification by function, and the corresponding design requirements, where do they come from? Are they part of some requirements from Part 50, or 52, or is it simply --

MEMBER POWERS: I mean, this whole slide comes from a reg guide.

MR. WACKOWIAK: It's in the reg guide now, but it wasn't in the reg guide when we started. When we started all of this was in a combination of SECY and SRM papers, and then a letter that the staff wrote that took the various SECY papers and combined it into something that was a readable unit.

Subsequent -- and that's what Westinghouse had when they did the AP-1000, and, when you read the reg guide, the reg guide actually tells you to go and take a look at what AP-1000 did.

MS. CUBBAGE: Right. Well, I'll just point out that this is strictly a passive plant issue RTNSS, so the staff at this time had not, you know, made a decision to write an SRP, to have guidance, because we don't intend to be applying this in the near term to any other designs.

MEMBER BONACA: When I go back to the -- later to the design, there is a lot of requirements there. Makes you almost want to go back to the -- you know, nuclear design and say, "On this end, the requirements are" --

MR. WACKOWIAK: In the SRP for quality assurance, SRP Section 17, there is a discussion of the quality requirements for equipment that is in this category, the RTNSS category. And while all of the elements of quality assurance are in that section, we allow the use of different standards.

So, for example, instead of Appendix B for certain things, for a quality assurance program at a vendor site, we would allow an ISO-9001 quality assurance program. So while all of the elements are there, and they rightly should be there, the acceptance criteria is relaxed for these.

MEMBER BONACA: And now you are proposing this, and the staff has not yet --

MR. HAMZEHEE: No. I think there has been a lot of interactions.

MEMBER BONACA: Okay.

MR. HAMZEHEE: But the latest revision of the RTNSS has not been reviewed yet. But they have made a lot of changes/improvements as a result of the RAIs that have been sent to them. So there is good agreement as to what needs to be done.

MEMBER BONACA: Okay.

MS. CUBBAGE: And starting with DCD Revision 0, there was very, very limited SSCs that were included in RTNSS. And as you can see now, there is quite a list of them now, and that's a result of staff review.

MR. WACKOWIAK: There was one in Rev 0.

MS. CUBBAGE: There was one, yes.

(Laughter.)

Refill of the PCCIC pool.

MR. WACKOWIAK: The fire pump.

MEMBER BONACA: And how many do you have now?

MS. CUBBAGE: Too many to count.

(Laughter.)

MR. MILLER: Okay. We talked about control room --

MEMBER SHACK: Where is 50.69 when you need it?

MR. WACKOWIAK: Well, this I think would be similar to 50.69.

MEMBER SHACK: Do you think you can come up with a similar list?

MR. WACKOWIAK: Well, not really, because Parts A and B are deterministic, and there is -- we have to do these things irrespective of what -- because we are protecting the design basis limits here rather than the risk limits. So it's different.

MR. MILLER: Okay. I'll move on to long-term temperature control, and the air handling units in the control building have heating and cooling units in them that are powered by Q-DCIS. And, of course, as I said before, that has 72-hour batteries, and beyond that the ancillary diesels will supply that. So all of these components that I have talked about are within the scope of RTNSS.

And, finally, post-accident monitoring -- the functions -- the monitoring functions themselves are provided by the Q-DCIS, and in addition to that emergency lighting for the operators to perform these monitoring activities. And that, again, is supplied by the ancillary diesels for the long term.

So these are the long-term safety issues for RTNSS Category P, and we'll talk about the seismic issues coming up.

The design treatment, as we talked about earlier, for all RTNSS Category B components, because they are not safety-related, we want to provide reasonable assurance that they will function when they are needed. So the design treatment that we have for those is -- they are required to have redundancy. They are required to be fire- and flood-protected. And this is all, of course, described in DCD Chapter 19(a).

Hurricane Category 5 missile protection, and they also need to be able to withstand the accident environment that they are -- would be exposed to.

The RTNSS components are required to be within seismic Category 2 structures or better. And in most cases, or if not all cases, I think they are in seismic Category 1 structures, except the ancillary diesels.

MEMBER SIEBER: Are the components themselves, do they meet a seismic qualification?

MR. WACKOWIAK: The components -- that's an interesting question that has come up several times, initially I think by us, and then through others. And we tend to have a -- to talk about seismic qualification of components, whereas the qualification of components, including the seismic aspect of it, is really covered under equipment qualification, which is the bullet above design for the accident environment.

So what we've said with these Category B pieces of equipment, their seismic condition is that following a seismic event they need to be functional following the event. They don't need to be functional during the event, but they need to be functional following the event.

But that's -- you know, saying something is seismic Category 2 I think is a -- for equipment is a shortcut that a lot of us take when we really mean that it's in a seismic qualification/equipment qualification program.

MEMBER SIEBER: And this is a standard qualification program like now applies to Cat 1 equipment, or something less than that? Something less than that, right?

MR. WACKOWIAK: It's less than that. For Cat 1 equipment, typically it has to --

MEMBER SIEBER: You don't have to run it while you're shaking it.

MR. WACKOWIAK: Right. You --

MEMBER SIEBER: Okay.

MR. WACKOWIAK: -- run it after you've shaken it.

MEMBER SIEBER: You're supposed to run it.

MR. WACKOWIAK: Yes.

MEMBER SIEBER: Okay.

MR. MILLER: As Rick mentioned a little while ago, in DCD 17, with quality assurance, it identifies RTNSS quality measures that are required, and for RTNSS B we have quality suppliers. It's not Appendix B, but it's something perhaps a little bit less than that in some cases.

MR. WACKOWIAK: Or just different.

MEMBER SIEBER: ISO-9000.

MR. WACKOWIAK: That's one of the things the SRP calls out, yes.

MEMBER SIEBER: Would that be considered acceptable?

MR. MILLER: Yes. And the Availability Controls Manual was developed in response to RTNSS to identify RTNSS equipment and to impose additional regulatory oversight. It's not quite technical specifications. It's more like a technical requirements manual where there are LCOs, and there are surveillance requirements for these RTNSS components.

But the consequences would not result in a plant shutdown or anything like that. It was -- it is strictly to provide increased attention to it, make sure that these components are surveilled and operated with a higher level of --

MEMBER SIEBER: So if you decide to do an overhaul to one of these ancillary diesels, and it says here you could finish it in a week or two weeks, you get halfway through it and find, you know, that something isn't right or a supplier isn't there or some other job comes up, there is no regulatory impact if you go beyond the two weeks?

MR. MILLER: Well, there is regulatory impact in regard to maintenance rule and Criterion A(4), which would require us to assess the risk when we take equipment out of service.

MEMBER SIEBER: Yes. But when you assess the risk before you take it out of service, you don't presume that it will stay out of service.

MR. MILLER: But when it's out of service --

MEMBER SIEBER: You can take it all apart, and you can say, "Gee, I don't think this is going to work out." We don't need that anyway. It's not in our tech specs.

MR. WACKOWIAK: One of the things that we have to remember with the maintenance rule for this, on A(4), when you take this out of service, we assess the risk of the plant. And let's say we find out it is going to take longer, and now you have some other new maintenance activity that has some synergy with this one that is coming up, and now they overlap.

A(4) would direct you most likely to postpone that second maintenance activity until after you get the first one restored. And, still, we would get the -- if it's too much unavailability on these pieces of equipment, everything in RTNSS is covered as a high safety-significant in the maintenance rule, it can still go into A(1). It still gets into the corrective action program that way.

Because these pieces of equipment, especially in RTNSS B, by their very nature, they are not needed until more than 72 hours after the initiating event. This is the appropriate treatment for this type of equipment.

MR. HAMZEHEE: I think, Rick, also another way is we have to define target reliability and availability for these RTNSS systems, and consistent with the PRA assumptions. So if you assume that diesel is supposed to only be out for the whole 18 months 60 hours, so you have to maintain that 60 hours. You can't just take it out for longer than that. If you do, then you have to do some engineering evaluation and assessment as to why you did it, and then comply with some of your procedures.

MR. WACKOWIAK: It goes into A(1).

MR. HAMZEHEE: Correct.

MR. MILLER: Okay. Criterion C is probabilistic, and the idea is if you take away all of the non-safety systems, what would your CDF be? And would it be lower than the goals of 1E minus 4 per year and LRF of 1E minus 6 per year.

So to do that, we -- you know, we quantified the model with those parameters and determined that the goals were not met. What we found -- we looked at the dominating contributors to the core damage frequency at that point, and it had to do a lot with the common cause failures of Q-DCIS, that type of thing that we were talking about earlier.

And so it felt like the natural thing to do would be to add the diverse protection system into the RTNSS scope to see if that would bring the CDF and LRF above the goals, which it did. So it's the first thing we did is to add the diverse protection system within the scope of RTNSS.

But then, you have to determine within the diverse protection system -- because it covers many different functions, you have to determine which functions are really contributing to the risk. So we determined the significance of those by removing one function at a time, or one train at a time, to determine if the CDF or the LRF goals were exceeded.

And if you took a certain DPS function out of service, and the goals were exceeded, then that was significant. And we did identify the four on the bottom here as being significant. And because they are significant, then they required tech specs. So each one of those has been assigned a tech spec. Those are GDCS actuation, ADS actuation, isolating the RWCU shutdown cooling valves in the event of a break, and opening of the cross-connect valves, the IC/PCCS pools, after the long term so that the pools can refill and re-establish the level.

MR. WACKOWIAK: And just to back up some of this evaluation, we were meeting the CDF goals. In most -- in all of the cases, I believe it was the LRF goal that got these functions into the high category.

MR. HAMZEHEE: You mean LRF?

MR. WACKOWIAK: L-R-F, LRF.

MR. HAMZEHEE: You can say either.

MR. WACKOWIAK: L-R-F, LRF.

MR. HAMZEHEE: LERF is large early release frequency.

MR. WACKOWIAK: That's LERF, not LRF.

(Laughter.)

MR. MILLER: Okay. In addition, Criterion C asks to provide an assessment of uncertainty, and --

MEMBER ABDEL-KHALIK: I'm sorry. Going back to what you were saying before, what was that quantitative delta that -- on the basis of which the function was deemed to be significant?

MR. WACKOWIAK: If the core damage frequency, including -- if the core damage frequency with the system that -- one of the functions we have on the bottom failed, is greater than 10^{-4}, or if the large release frequency is greater than 10^{-6}, then it would be considered significant, and that particular function would be required to be treated in tech specs.

As it turns out, that the top -- I believe it's the top function was slightly above 10^{-6}, and the other three were right at, you know, 9 times 10^{-7}, 7 times 10^{-7}, so we put them in the -- into that category to say that they required tech specs. Did that answer your question?

MEMBER ABDEL-KHALIK: They were put in that category, even though they didn't meet the quantitative criteria that were used in --

MR. WACKOWIAK: They were close enough.

MEMBER ABDEL-KHALIK: And they were put in this category because they were just on top of the list?

MR. MILLER: They were close to the goal.

MEMBER BLEY: They included uncertainty.

MR. WACKOWIAK: Yes. If we included uncertainty, maybe they would be above it. See, what we have is we took the safety-related systems in the plant -- they are in the model now -- and then we added the diverse protection system functions, put that into the model. When we quantify that, everything is below CDF or 10^{-4} CDF, and below 10^{-6} LRF.

Then, we went through each of these DPS functions, and we failed each one one at a time. And we looked at what the CDF was in each of those cases. And for the first one, it was one point something times 10 -- or the LRF was 1.7 or one point something times 10^{-6}, and then the next ones were down just below that. So we said that without those functions then the core damage frequency and LRF goals are not quite met. They are just barely met or not quite met.

So what we did is we added these functions to technical specifications, so now there is a testing and availability requirements through technical specifications for these four functions that we determined are important.

The other DPS functions that we included in the model are now -- are included in the availability controls manual, and they are controlled through this other process and maintenance rule. So everything has some kind of control on it, but the important ones are in tech specs.

MR. MILLER: Okay. Also, in Criterion C is a requirement to assess uncertainties, and thermal hydraulic uncertainties, things that we have talked about earlier today. To do that, we didn't need to add FAPCS, but we did because it's a very flexible, active system.

So if you did have a lot of -- with uncertainties in your passive systems, we have thrown in FAPCS and RTNSS to provide additional regulatory treatment for that and higher assurance that it would be performing its functions as required. And the two functions that we have added are low pressure injection and suppression pool cooling.

And because we added FAPCS, that is fuel and auxiliary pool cooling system, and that is fuel pool cleanup and residual heat removal functions. To support that, we need the standby diesel generators and the plant investment protection, or the PIP buses. So those are in the scope of RTNSS because they support FAPCS.

And we need -- to control that, we need the non-safety-related DCIS. We need HVAC for the buildings, controlling the NDCIS and FAPCS, as well as cooling for the components. So we have reactor component cooling water, nuclear island chilled water, to cool the HVAC, the pumps, the motors, the diesel generators, and, finally, to cool the cooling we have service water.

CHAIRMAN CORRADINI: So can you help me here? So this is post 72 hours?

MR. MILLER: No. This is Criterion C probabilistic. So --

CHAIRMAN CORRADINI: So you have now an active system. I guess I'm -- I didn't read this section ahead of time. I was reading something else. I'll admit to that openly. You have an active system which is backup to the passive systems that now you are going to treat in a RTNSS, which means it must be available or can be available? That's what I'm trying to understand, because you have now added a whole laundry list of subsidiary systems that have to be treated. Is that correct?

MR. MILLER: That's right. We have augmented the -- well, they were non-safety -- they are non-safety-related, right, so there is no tech spec requirement.

CHAIRMAN CORRADINI: But you can add them to the list.

MR. MILLER: We are going to add them to the list, and the Availability Controls Manual augmented design standards that I'll get into the next slide. So we are adding, you know, higher assurance of their reliability.

MR. HAMZEHEE: If I just may add a couple of things, hopefully that will clarify it. I think as he mentioned, because of uncertainty associated with passive system design, we want to make sure some of the active systems that are used to mitigate severe accident consequences are under some regulatory treatment.

How do we define what those systems are? We define five criteria, one of which is PRA-based criteria. So, and what -- the way we do it is we perform a focused PRA to define which those systems are.

CHAIRMAN CORRADINI: No, that part I got.

MR. HAMZEHEE: Once you define those systems, then you have to now decide on the treatment of them. What do you do with these RTNSS systems? They don't have to be safety-related, and you cannot apply the safety-related requirements for RTNSS. Then, we have some treatment that we say you need to follow for these RTNSS, one of which is put them in tech specs because that is the best control you can have.

The ones that are not as important, then we have some targeted liability, availability. Some that are less important, we put them in the availability controls manual, and so forth and so on.

MEMBER BLEY: That's negotiated, I take it.

MR. HAMZEHEE: Correct. Yes. But there are some high-level requirements that are in the Commission paper that say how you treat these RTNSS-related systems.

MEMBER BONACA: The question I have is --

MR. HAMZEHEE: Yes.

MEMBER BONACA: -- and you explained it before you went about the writing of this -- I would expect that for AP-1000 it would have the same criteria.

MR. HAMZEHEE: Correct. They do have -- follow similar criteria and approach.

MEMBER BONACA: So the requirements would be the same. I mean --

MR. HAMZEHEE: Correct.

CHAIRMAN CORRADINI: If it's not

negotiated, I don't think so.

MS. CUBBAGE: Negotiated I think is --

CHAIRMAN CORRADINI: Different.

MS. CUBBAGE: Well, I mean, things like whether they're in tech specs or not, we have regulations 50.36, and if it meets the criteria to be in tech specs it's going to be in tech specs. That's not negotiated.

CHAIRMAN CORRADINI: But I guess I just want to make sure I understand the concept. The concept is you started this whole thing off saying we didn't have to add the system, but we did. And so this is a pool cooling system for spent fuel pools?

MR. WACKOWIAK: What we had in the original --

CHAIRMAN CORRADINI: Well, that I'm going to get to, yes.

MR. WACKOWIAK: Yes. This system provides coolant injection from -- suction from the suppression pool, you put it in the vessel. It also can take suction from the suppression pool, put it through a heat exchanger, and go back to the suppression pool.

It also does -- provides spent fuel pool cooling. So this is one of the reasons why we chose this system to go in, because there are other systems that can provide backup to the passive systems. There are other ones that are there. And since we went through the numerical requirements for what we needed to have in, and we were able to satisfy all of the numerical requirements just using the diverse protection system, that still didn't bring in active systems.

So we said, "If we are going to bring in an active system, let's bring in the system that ends up giving us the most flexibility for its use." So now if we are going to treat something, we will treat a system that can do a lot of things rather than trying to treat a bunch of other systems.

CHAIRMAN CORRADINI: But bring in --

MS. CUBBAGE: Mike, if I may, I mean, the criteria are not negotiated. The functions that the plant has to provide are not negotiated. It's that they can choose to select what systems they want to to satisfy the requirements and the functions. In fact, they have added systems in some cases rather than putting higher treatment on existing systems. That is their financial decision.

CHAIRMAN CORRADINI: No, no. That I think I get. But I just want to make sure I understand, though, that by doing it this way -- I'm sorry, excuse me. That the policy that is being followed is that there is going to be some sort of additional backup system that is active.

MS. CUBBAGE: Well, the specific criteria was to address uncertainty. And so you have to establish what the uncertainty is you are trying to fix.

CHAIRMAN CORRADINI: The uncertainty, though, in this case I assume is -- I'm going back to the definitions here -- meet the containment's performance goal, which is, then, the -- right, this is a -- oh, I'm sorry. Excuse me. I was looking at the wrong one. This is a C. The safety goal guideline.

So there's enough uncertainty in the passive safety function -- I want to say it a different way. There's enough uncertainty in the passive safety systems function that this is a way to give an assurance that you've met it. That's the way I read the C. Do I have it right? I don't have it right?

MR. WACKOWIAK: When we talked earlier, we were talking about not knowing what the right value is for the failure of the Q-DCIS system. There is some uncertainty there in the number that we pick. Did we pick 10^{-4}? Is that too high? Is it too low?

FAPCS -- these functions don't rely on Q-DCIS, so we're able to address the uncertainty in that particular number that we picked for the safety-related system by saying we have a different system that can perform some of the functions that were taken up by that --

CHAIRMAN CORRADINI: So let me just push my point, that I'm --

MR. WACKOWIAK: Squib valves -- we have uncertainty -- and we talked about this -- did we pick the right numbers for the -- data numbers for the squib valves? And this system can provide backup for some of the functions that those squib valves provide.

MEMBER SHACK: "Backup" is the wrong word, because this is the first low pressure system you are going to use, right? I mean, the passive is sort of the last.

MR. WACKOWIAK: I mean, it's manually operated, so it probably would get to be a --

CHAIRMAN CORRADINI: But I see your -- I see how you're explaining it, but I would interpret it separately, which is two meetings ago you weren't here, or some meeting ago you weren't here, and we were torturing another part of GE a lot about gas and the GDCS.

This essentially is a redundant system for the GDCS for low pressure. Once I depressurized, this provides the cooling I need.

MR. WACKOWIAK: Right.

CHAIRMAN CORRADINI: Okay.

MR. WACKOWIAK: So we would address that uncertainty as well. What we tried to do is we tried to pick the system that would give us the most coverage of the various uncertainties that we have.

MR. CARUSO: Can I make a point? Mark Caruso, staff. To your point, I think one of the reasons, at least in our SER what we said, was we said this was an especially appropriately -- appropriately good choice of a system, because the whole genesis of RTNSS was -- is really about uncertainty, it came about because of uncertainty in the passive systems.

And they said, "Hey, you've got these active systems, but we want to make sure that there is some treatment because, you know, there is uncertainty in the passive systems." There is no RTNSS for non-passive plants. So here is a system that really addresses, you know, as a backup for the passive system. So we think it's a very -- it's a very appropriate choice. I think your point is very well taken.

Their official criteria that they used it for was uncertainty in their focused PRA, I believe. But I think --

MR. WACKOWIAK: But we will use your criteria as well. That's how --

MR. CARUSO: Yes. We did in our SER.

CHAIRMAN CORRADINI: Well, so let me ask the staff this question, then, and I'll stop because this is good education for me. So for -- the AP-1000 was an example of what they chose to meet the guideline, that was an active system. Can you give me a reminder?

MS. CUBBAGE: I can tell you in two minutes if you want to keep talking, and I'll come back.

CHAIRMAN CORRADINI: No. I'll stop talking. I'll just let them go on.

MS. CUBBAGE: I think it was --

CHAIRMAN CORRADINI: I'm trying to understand --

MEMBER STETKAR: I'll buy your two minutes for you.

MS. CUBBAGE: Diverse actuation I believe was one of them.

MEMBER STETKAR: Gary, if you go back to the previous slide, I just -- for clarification, because I also will honestly admit that I did not read this section either. I notice under the supporting functions for FAPCS you have a -- what appears to be a rather complete list, except for the fact that I don't notice non-safety DC power in that list. Why?

MR. MILLER: Non-safety DC power.

MR. WACKOWIAK: In the case here, the standby diesel generators have their own DC power source to get them started.

MEMBER STETKAR: Sure.

MR. WACKOWIAK: And once they are started, the way our uninterruptible power supplies are, which is the way all of our DCIS is, including NDCIS, the diesel generators can power directly through that system, and the batteries aren't required to keep it going.

MEMBER STETKAR: How do you close the circuit breakers for the FAPCS points?

MR. WACKOWIAK: The power to close those circuit breakers come through the AC power systems. It is not directly out of the DC power system.

MEMBER STETKAR: That's not what I read in the non-safety DC power system design. It said it supplied control power for operation of circuit breakers on switch gear, which would be those circuit breakers.

MR. WACKOWIAK: Okay. We'll have to go back and take a look at how that exactly is. But my understanding was that once we got the power back to the bus, the bus actually provides the power for the -- for those breakers.

MEMBER STETKAR: One could design electricity to do that, but one doesn't normally do that. And it didn't --

MR. WACKOWIAK: We talked at length about whether or not we needed the DC batteries. The issue with recharging the batteries in these scenarios is that that brings in additional ventilation requirements, because of the hydrogen. And so we spent a lot of time discussing that this set of systems would work without those batteries.

MEMBER STETKAR: Okay.

MR. WACKOWIAK: Now, it may be procedurally controlled that they have to do some manually closing of some of those breakers. I'll find that out.

MEMBER STETKAR: And the fact that these are -- if these are somehow specially treated --

MR. WACKOWIAK: Right.

MEMBER STETKAR: -- they might be different, but it --

MR. WACKOWIAK: There are some breakers that require DC-controlled power. I don't -- we talked about this, the --

MEMBER STETKAR: But the problem with this has got to be that it's not only the FAPCS, but the chillers and the RC -- all of those things that -- all of those things.

MR. WACKOWIAK: That's correct.

MEMBER STETKAR: All of those things.

MEMBER ABDEL-KHALIK: Let me just conceptually understand what I heard in the past 10 minutes. If none of the squib valves were to open, if none of the gravity-driven safety systems were to work, if these systems were to function as you expect them to, you will still meet the safety goals.

MR. WACKOWIAK: We will still not prevent --

MR. MILLER: We will keep the core covered. We will keep the core covered. We didn't quantify taking -- we didn't quantify failing all of the squib valves.

MS. CUBBAGE: I think they said the

opposite. They said if you do the focus, Gary, with only safety systems, you needed to add in some non-safety systems to meet the goal. They didn't say the opposite, which is what you said.

MEMBER ABDEL-KHALIK: Well, that's what I'm trying to get to.

MS. CUBBAGE: Oh, okay.

MR. HAMZEHEE: And I think also remember when -- just let's forget about RTNSS. When they did their PRAs, they took credit for the operations of safety systems as well as non-safety systems. That is how they do their PRAs. They don't have to only take credit for the operations of safety systems.

And they came up with their published CDF of 1E minus 7 or 1E minus 8, whatever that number was. Now, we want to know, since those active systems are not safety-related, how high the CDF would have been if they did not take credit for non-safety active systems?

So there is a category for RTNSS selection that says if you don't take credit for those non-safety active systems, how high does your CDF get? And if it does get really high, is it going to exceed 1E minus four? If so, then you've got to put them under regulatory treatment, even though they are non-safety-related. That's really the essence of what they have done under C, and they call it focused PRA.

MEMBER APOSTOLAKIS: Why didn't you make it safety-related?

MR. HAMZEHEE: That's a different question now.

(Laughter.)

CHAIRMAN CORRADINI: You were giving an example of --

MS. CUBBAGE: Yes. For AP-1000, this was the certified version. They had automatic diverse actuation for ATWS and ESF features, injection with the normal RHR and the associated power supplies, and hydrogen igniters.

CHAIRMAN CORRADINI: So they had -- they had RHR injection.

MS. CUBBAGE: Yes.

MR. WACKOWIAK: We followed a very similar process and got a very similar answer.

CHAIRMAN CORRADINI: Thank you.

MEMBER APOSTOLAKIS: So you really have this high confidence that there is a big difference in reliability between safety-related and non-safety-related.

MR. HAMZEHEE: That's not what we said.

We just want to make sure, just in --

MEMBER APOSTOLAKIS: I mean, why have the agency go through all of this process of RTNSS and od it only with a focused PRA? One would expect that the non-safety-related systems are much worse than the safety-related systems. Is there any evidence that says that? The answer is no.

MR. HAMZEHEE: The answer is no, but because NRC staff wants to have some regulatory oversight for those systems that are important and perform risk-significant functions, but are not safety-related, because if they are not safety-related there may not be enough regulatory oversight. And this is one way of providing that regulatory oversight.

MEMBER APOSTOLAKIS: I mean, gee --

MS. CUBBAGE: Well, also, the RTNSS process actually was developed not with AP-1000 but with AP-600. It's beginning to be a lot of years ago, and did you have maintenance rule, did you have all of the other programs to ensure reliability.

MEMBER APOSTOLAKIS: Safety-related -- declaring something safety-related increases its cost for DOE by a factor of three or four, which is pretty significant. So one would expect the benefits to be commensurate with that? And evidently they are not.

I have been looking for years for evidence that safety-related pumps are much better than non-safety-related.

MR. HAMZEHEE: I am not going to answer the question. I don't know yet to answer that, but that's why we have 50.69 treatment.

MEMBER APOSTOLAKIS: That's a good example. I mean, the South Texas firm that -- the overwhelming majority of safety-related components should be down to Category C, because from the risk perspective they are not really contributing.

So, yes, Mike, what do you want to say?

MR. SNODDERLY: I wanted to just point out for Dr. Bonaca's point about --

MEMBER APOSTOLAKIS: Identify yourself.

MR. SNODDERLY: I'm sorry. Mike Snodderly from the staff. To get at Dr. Bonaca's point, just so you understand, one of the key differences between the AP-1000 certified design and this -- the present ESBWR design is -- and you mentioned the normal RHR would receive what they call the RTNSS B design treatment.

So, for example, it was seismic Category 2 an availability controls for those systems. So for RTNSS C -- so right here we see Availability Controls

Manual and seismic Category 2. So that treatment applied to the RHR and its support system.

So for ESBWR, if we can go now to the RTNSS C slide you're on, it would be availability controls for the front-line systems, and the seismic category treatment would be designed for accident environment. So you asked about differences. That's one difference.

And, of course, the reason for that -- there is a reason, and one showed up as being more significant and this one didn't. So it's important I think to understand that.

MR. HAMZEHEE: So there are -- there may be differences, but the approach is the same, and the requirements are the same.

MR. WACKOWIAK: The approach is similar, and the requirements are the same.

MR. HAMZEHEE: Yes, thanks.

MEMBER BLEY: But back to what you were saying, George --

MEMBER APOSTOLAKIS: Yes.

MEMBER BLEY: -- while you buy two pumps or two valves -- one safety and one not -- they might be the same valve or pump. If one of them, once you've installed it, has no requirements for maintaining it and no need to have it there all the time, it often turns into a spare part. And this is not there at all.

So they are requiring some level of reliability of this equipment day to day.

MEMBER APOSTOLAKIS: Is that really true?

MEMBER BLEY: It has been true.

MEMBER APOSTOLAKIS: If it's not safety-related, they just let it go to hell?

MEMBER BLEY: If they don't need it for anything.

MEMBER MAYNARD: That's the way it used to be before the maintenance rule came out. I think the maintenance rule is one of the best things that came out. And that was really the difference between safety-related and non-safety-related. Not so much the quality of the equipment; it's more your assurance that you've maintained it and it's reliable.

The maintenance rule kind of does away with that line of safety-related/non-safety-related. Talks about the importance of it, and the availability and the maintenance of that to keep it available. But there is not really that much difference between the equipment itself. It's more how you maintain it, how you treat it, how you keep it available.

MEMBER SIEBER: And that depends on the quality of the licensee.

MEMBER BONACA: Essentially, the distinction is when you use equipment that is put out for a safety purpose, but it is never run unless you test it, because it doesn't have an operational role.

MR. WACKOWIAK: And yet the system that we chose here -- and this one happens to be one that is normally operating and running all the time. That went into the decision to pick that system.

MEMBER BONACA: That gives you confidence regarding the operability.

MR. MILLER: Okay. I'd like to continue with the design treatment for RTNSS Criterion C, which we just talked about, is very similar, as you can see, to what we had for the RTNSS B redundancy, fire, flood. And as I mentioned, the diverse protection system functions that were required are actually in tech specs. The Availability Controls Manual captures the other -- the front line systems that I have mentioned.

Criterion D has to do with meeting containment performance goals, and they are -- the BiMAC and the GDCS deluge valves, because they are non-safety-related were included in that category, so they will receive RTNSS treatment as well.

And then, the final criterion was a request to look at adverse systems interactions. We found two instances -- the bottom line, drywell hatches, we've talked about before. So that if those hatches were open during shutdown and we had a LOCA condition, we would want to close those, so we included those in RTNSS so that they could have availability controls and enhanced quality.

The reactor building HVAC purge exhaust charcoal filters -- these filters are not safety-related. However, they play an important role in a very long-term beyond design basis severe accident situation where we might have fuel damage. We may have to cool the coolant through the fuel building, the FAPCS heat exchangers, which are in the fuel building. No, wait a minute, in the -- we would normally --

MR. WACKOWIAK: Yes. With this one, we -- we normally would want to cool the core long term using FAPCS, because FAPCS is a much more flexible system and it's lined up so that we can take a suction from the suppression pool, put it through a heat exchanger, and get back to the vessel, or back into the suppression pool.

The problem is is if there does happen to be a significant source term in the suppression pool, whether it's from a severe accident, or where we first looked at this was in design basis accidents where we have to non-mechanistically impose a source term that is there.

The pathway of the water out of the reactor building, and then back in, led to some interesting dose consequences. So we have another system that -- the reactor water cleanup system. We reconfigured that, so that it can perform the same cooling function using some cross-tie valves with the FAPCS system, all within the reactor building.

If you ask why that's not in RTNSS, when we look at our core damage frequency, core damage situations, the probability of meeting FAPCS is somewhere -- for core cooling is somewhere on the order of 10^{-4}. But the probability of needing this cross-tie is only in core damage events, so that's on the order of 10^{-8}. So in 99.99 percent of our cases, FAPCS is the right system to use for this. So that's the RTNSS system.

But the thing is, when we put this cross-tie into operation and start pumping contaminated water throughout the reactor building, the source that is generated from that using the standard methods of doing design basis source calculations requires us to have some cleanup of the atmosphere in the reactor building during that mode of operation.

So we had a system that would do that -- the purge exhaust charcoal filters. And what we said is if those purge exhaust charcoal filters either fail or are unqualified for performing that function, when we turn on this cross-tie and the failure of these charcoal filters would have an adverse interaction on our dose calculations.

So we moved these purge filters into RTNSS, and we actually require those filters to have the same quality as a standby gas treatment filter to meet the same performance requirements in Reg. Guide 1 point -- it escapes me now. There is a four in there somewhere.

So it's to treat that scenario. So these are one of the things that we're looking at. If you're going to operate the plant under various conditions like a radiological event inside the containment, and you want to get into long-term cooling, then there are systems that if they don't -- active systems, if they don't perform properly, there could be adverse interactions. In this case, it's a dose consequence.

We put it into RTNSS. We put quality requirements on this charcoal filter system. And then, also it falls into the Availability Controls Manual, so now it has to be tested periodically, and we would monitor the availability of the equipment in that system. So it's always available, should be available within the mission that we have defined in the maintenance rule.

MEMBER APOSTOLAKIS: So monitoring the availability is one of the regulatory requirements for RTNSS?

MR. WACKOWIAK: Yes. Everything --

MEMBER APOSTOLAKIS: Do you cover what the requirements are, or is it somewhere -- I'm sorry. I didn't read it. What additional regulatory requirements are imposed on these?

MR. HAMZEHEE: Again, because these are non-safety systems, and we want to have a --

MEMBER APOSTOLAKIS: I understand why. What are the requirements? It says regulatory treatment. What is that regulatory treatment?

MR. HAMZEHEE: That means they have to define some target reliability and availability for these risk-significant systems and their associated components, and then monitor it throughout the life of the plant, through different existing programs such as maintenance rule, such as reliability assurance program, and some others.

MEMBER APOSTOLAKIS: So that's it.

MR. HAMZEHEE: Correct. Yes. Nothing more.

MEMBER APOSTOLAKIS: Reliability.

MR. HAMZEHEE: Correct. Reliability/availability, yes.

MR. WACKOWIAK: And there are some design requirements, like redundancy, we -- I think we added those criteria, but --

MEMBER APOSTOLAKIS: Redundancy?

MR. WACKOWIAK: Redundancy. We want to make sure that the things that we take credit for in the RTNSS are not always -- are not just a single train. We have looked at how we have multiple trains to perform the function, so that now when we do do maintenance on that, we have a backup.

MEMBER APOSTOLAKIS: Yes.

MR. WACKOWIAK: And so we would use good design practices in designing them. They would be separated. We don't run the cables together in the same trays. We try to separate fire areas as much as possible. That sort of thing.

MEMBER APOSTOLAKIS: Then, the question I guess, which you will answer very quickly, why don't we do the same with the safety-related?

MR. HAMZEHEE: Well, safety-related systems, by definition, have enough control in place already, such as tech specs --

MEMBER APOSTOLAKIS: The question is: why don't you relax all of the other requirements you impose on safety-related and just say reliability/availability.

MR. HAMZEHEE: That's a different --

MR. WACKOWIAK: Where do we sign?

(Laughter.)

When can we sign? I'm ready.

MEMBER APOSTOLAKIS: No. I'm just asking, because I hear that the most expensive part is this paper trail that you have to keep. If we are to have a performance-based regulatory system, why isn't monitoring the reliability and availability good enough?

CHAIRMAN CORRADINI: George, they want you on their team. I had a question.

MEMBER APOSTOLAKIS: I'm curious.

MEMBER BLEY: You know, one answer would

be it probably would be for most things. For some others, you would need some explained concurrently, like guaranteed operability under adverse conditions. But that --

MEMBER APOSTOLAKIS: Yes, sure. That --

MEMBER BLEY: The framework is hinting that that's the way you ought to go.

MEMBER APOSTOLAKIS: Because it appears there is a big difference between the treatment of safety-related and the RTNSS.

CHAIRMAN CORRADINI: I had a question about D. Are you satisfied with your answer?

MEMBER APOSTOLAKIS: No.

CHAIRMAN CORRADINI: Okay.

MEMBER APOSTOLAKIS: I think I want to get a better answer, though, because this is something that has come from the mountain. These guys aren't just inventing it.

CHAIRMAN CORRADINI: So I want to understand D. So BiMAC and GDCS, by RTNSS D, are in. So that means you've done a calculation that says, "If they weren't in, something is not going to be met." What is not going to be met?

MR. WACKOWIAK: What is not -- what we can't assure is met -- remember, we -- our containment analysis doesn't look at the best estimate. It looks at what we can prove. So if we don't have the BiMAC under our current analysis, we can't assure that in all cases the basemat melt penetration won't cause the corium to leave the containment in less than -- or in -- keep it in the containment for more than 24 hours.

CHAIRMAN CORRADINI: So that leads me to my other question, which is in Chapter 11, Tables 11.3.19 and 20, which I did read, your sensitivities don't turn on and off the BiMAC's performance. In Level 2, you did a lot of one-offs, but unless I miss it, I don't see it there.

MR. WACKOWIAK: The answer is, if we turn it off, then by our calculation -- by our methodology, not our calculation, by our methodology if we turn off BiMAC, it's containment failure every time.

CHAIRMAN CORRADINI: Eight percent becoming 100 percent?

MR. WACKOWIAK: Yes.

CHAIRMAN CORRADINI: Okay.

MR. WACKOWIAK: So we did have an RAI on that, though, that asked us to look at basemat melt penetration probabilistically like the ABWR did. And we duplicated the evaluation that was done for the ABWR more or less using MAAP-4.

They used MAAP-3 and MELCOR analyses, but we tried -- we tried to set up the same conditions and demonstrated that if we used the same assumptions, same best estimate assumptions that the ABWR used, then we would still need 10 percent or better for the containment failure goal through basemat melt penetration.

So it's a separate calculation. But it doesn't -- it doesn't fit in our -- it doesn't fit into our methodology. That methodology requires making a judgment of the probability of things that you don't know -- how much melt comes out of the vessel, and ABWR, like a lot of other plants did, they did various sensitivity calculations and said, "Okay. It is 90 percent this much, 10 percent this much; or 50 percent this much, 50 percent that much."

And when you go through the containment event tree that way, where you split everything up that you don't know into probabilities that you think they might be, you can get things that show up. It's a 10 percent chance that the core is going to go out, 90 percent chance that it is going to stay in.

CHAIRMAN CORRADINI: Whereas, the approach you guys are taking in Chapter 21 is a bounding approach.

MR. WACKOWIAK: Right. What we said is --

CHAIRMAN CORRADINI: I should say you considered a bounding approach.

MR. WACKOWIAK: It's considered a bounding approach. We can't prove at this point that simply putting water on top of the melt will always arrest the melt. Therefore, we assume that it would continue to erode the concrete.

MEMBER SIEBER: ABWR doesn't do BiMAC.

MR. WACKOWIAK: That's what made us put in the BiMAC. We rely on it for that.

MEMBER SIEBER: ABWR doesn't have BiMAC. They just spread the core out.

MR. WACKOWIAK: No. And that's what was certified.

MEMBER SIEBER: Pardon?

MR. WACKOWIAK: That's what was certified, getting back to the question earlier. If it's certified, then that's it.

MEMBER POWERS: When you put water on top of the core debris, do you substantially attenuate to radionuclide release?

MR. WACKOWIAK: Yes. Yes. As a matter of fact, the end state from a scenario where we have emptied the deluge into the vessel, or into the core that's in the lower drywell, we have somewhere between 12 and -- 12 or more meters of water above the top of the melt. And I don't know that I've seen any curves that show anything more than about, what, five or 10 feet of water above melt in terms of decontamination factor.

MEMBER POWERS: Yes. The deepest calculation that I'm familiar with had 32 feet of water.

MR. WACKOWIAK: Thirty-two feet? Okay.

MEMBER POWERS: It actually attenuated some of the krypton and xenon at that depth.

MR. WACKOWIAK: Well, that's similar to what our end state will be --

MR. MILLER: Okay? Well, I'll continue then. We have some open items. Some of the SSCs needed for post 72-hour safety were housed in structures below seismic Category 2, and that's a legacy of DCD Rev 4 we have -- with the addition of things like the ancillary diesel generator, all of the Criterion B components are in structures that are Category 1 or Category 2. So this should close the item.

Additional information was also required on the design to enable the staff to confirm that we are adequately protected from floods and natural phenomena. And we have provided a response to that.

The availability controls -- there are a few items here on some specifics within the availability controls specifying the number of functions required and the surveillance requirements. A lot of these were received late into the game as we were trying to get the revision out. We have addressed some, and some we will be addressing in a followup.

CHAIRMAN CORRADINI: That's it?

MR. MILLER: That's it.

CHAIRMAN CORRADINI: Thank you. Questions? George?

MEMBER APOSTOLAKIS: Just a general interest. Does anyone from the staff know where I could go to learn more about why the requirements are imposed on safety-related and --

MS. CUBBAGE: Background on?

MEMBER APOSTOLAKIS: Question that has never been resolved. Where should I go to learn about this? Is it 50.69?

MR. HAMZEHEE: No. There should be some other reference documents or Commission papers that may have some background information for you. 50.69

is basically how to have a risk-informed approach to get relaxations from some of those safety-related requirements or classification.

MEMBER APOSTOLAKIS: But Risk C category components are treated, again, somewhere in between. Are the requirements on Risk C similar to these, or different?

MR. HAMZEHEE: They should all be similar. Now, one can choose to have additional requirements, like for instance putting them in tech specs, so that it's more stringent. That's it. But requirement based on the Commission policy paper is that for those systems that perform risk-significant functions, and are identified as RTNSS, the designers and the potential future licensees have to establish targeted reliability and availability, and then monitor it during the life of the plant.

Now, one can do that by putting it in the tech specs, in the maintenance rule, in the RAP, in different -- there are different mechanisms by which you could assign and then monitor the reliability and availability of these components.

MEMBER APOSTOLAKIS: I guess what I want to understand is why there are additional requirements, additional requirements, to be imposed on safety-related systems.

MS. CUBBAGE: On safety-related systems?

MR. HAMZEHEE: On safety. That -- as I said, that's a different question, but we'll go back and see if we can provide you with some reference documents. That may have some basis for why the agency chose to have those safety-related type requirements, and what the bases are. We have to go back and search. I can't remember.

MEMBER APOSTOLAKIS: I mean, what confuses me is that both the active systems that have declared RTNSS, and the passive systems in this case, are expected to perform under accidental --

MR. HAMZEHEE: Well, the only --

MEMBER APOSTOLAKIS: Why are we asking only reliability/availability questions here, and the other one we are asking for much more?

MR. HAMZEHEE: I know that one of the main reasons is because those safety-related systems are being taken credit in the Chapter 15 design basis accidents. But now does it mean that they have to have additional requirement? That's something that we need to go back and look at some of the existing documents and give you some of the bases. I don't know the answer.

MEMBER APOSTOLAKIS: I remember there were a lot of -- there was a lot of resistance on the part of the staff when 50.69 was approved as to what requirements should be relaxed for this Risk C category. And until you -- I mean, is there a document that says this is what the staff believes the reasons are? And the NRC is --

MR. CARUSO: Let me take a crack. I think the answer to the question is it's the regulations . The regulations -- 50.36 and tech specs -- the systems that are -- you know, satisfy the accident analysis and are basically the safety systems, they have to have tech spec controls. Non-safety systems that don't fall in that category don't have to have tech spec controls, except now in this RTNSS process it's possible for them to have it based on these other criteria that we have incorporated.

The other difference I think is -- I mean, as far as the maintenance rule goes, all of the RTNSS systems are in the maintenance rule, all of the safety systems are in the maintenance rule, they are all pretty much considered equal there.

The other difference I think is in QA. The requirements -- the regulations require that safety systems have to have Appendix B quality assurance requirements. These other systems don't. They have something less.

So I think 50.69 is a move toward the risk-informed regulation where you would treat everything. But I think right now we have regulations that require certain things of safety systems. That's -- if you look at those regulations, you will --

MEMBER APOSTOLAKIS: I agree that there are regulations. I know them. My question is, why we are demanding this here and not there.

MEMBER SHACK: Because it is what it is.

MEMBER APOSTOLAKIS: Is it because the system has inertia, and, you know, it takes time to get used to this performance-based risk-informed approach? Because all the stuff you mentioned is from the previous era.

MEMBER SHACK: Right.

MS. CUBBAGE: We are using the same --

MEMBER APOSTOLAKIS: All I remember is we questioned this in the presence of the Commission, and the then-Chairman got really upset.

MR. CARUSO: I mean, there may be some information in the stuff that Mary Drouin is doing on -- you know, Mary Drouin is working on this futuristic approach to regulation, coherence and risk-informed Part 50. There may be some discussion in there that would be helpful.

MEMBER APOSTOLAKIS: If you can get me the documents, that would be good. And if there is any suspicion that they are not doing the right thing, then maybe the Committee will take some action.

MR. CARUSO: Okay.

MEMBER APOSTOLAKIS: What did you say, Rick? You seem to be very happy.

MR. WACKOWIAK: No. I think that if you have a good set of design requirements for the components, and you -- and you buy them from a reputable vendor and you have a reliability program, like the maintenance rule, then you get most of what you need to make the plan safe.

MEMBER APOSTOLAKIS: But that would require a change in the regulations, which means something is --

CHAIRMAN CORRADINI: Can we move on?

MEMBER APOSTOLAKIS: We may, yes.

CHAIRMAN CORRADINI: Thank you.

MEMBER APOSTOLAKIS: Unless it is a thermal hydraulic issue, he is willing to give me the time of day --

MEMBER SIEBER: I think the discussion is worth at least one comment. In the current plants, the Category 1 components are geared toward design basis accidents, and severe accidents beyond that have no requirements. And in this case, there is -- there is a difference in the design basis accident, and the equipment required to mitigate that is also safety-related. But you have assist equipment that is non-safety-related.

So I think that we're consistent between existing plants and these new designs as far as categorizing things. And having a sort of intermediate regulatory treatment of non-safety systems is an improvement.

MR. FULLER: This is the Subcommittee on the staff's review of ESBWR DCD Chapter 19(a), SER Chapter 22.

Once again, I am the lead project manager for Chapter 22. Mark Caruso is our lead technical reviewer, and we have numerous technical reviewers. Many of them are still in the audience.

I'll outline our presentation. RAI status summary, applicable regulation, SER technical topics, and significant open items.

For this chapter we had 24 RAIs, and we

have been able to resolve 16 of them. We have eight open items left to resolve.

MS. CUBBAGE: I will also add that a number of the Chapter 19 RAIs were directly related to RTNSS, so those numbers appear smaller than reality.

MR. CARUSO: Slide 6 --

MS. CUBBAGE: Well, there were a number of Chapter 19 ones that have now been closed.

MR. CARUSO: Slide 6 talks about the regulatory guidance and requirements that apply for the RTNSS evaluations. I think we have talked about this a great deal during the last presentation as to these guidance documents here embody the genesis of why you need to have RTNSS, why it applies to passive systems, what are the issues.

A number of the staff's issues, Commission's issues, became the framework for the process. Then, the Commission told the staff and EPRI to go off and develop this process. This is the process that Rick talked about, the criteria and the process that they used.

As far as regulatory requirements go, we talked a lot about how some things -- some things -- in this process there is a risk piece that looks at risk-significance of these non-safety components and identifies that risk-significance.

That, coupled with the fact that there's a requirement in 10 CFR Part 36 that says -- has criteria for what systems, structures, and components should go in tech specs, and one of those criteria is anything that is determined to be significant from a risk assessment or operating experience.

So that requirement is a basis for -- can be a basis for having systems identified through the RTNSS process go in the tech specs. I should also mention that maintenance rules aren't on there and probably should be on there, because it plays a big role.

MEMBER APOSTOLAKIS: Are there documents the ones that I wanted?

MR. CARUSO: Well, they would be helpful. I'm not sure that they -- they don't really talk about the safety systems. They talk about the non-safety --

MEMBER APOSTOLAKIS: Oh, just the regular, not safety. Oh. But they seem to be --

MR. HAMZEHEE: These are RTNSS-related safety that may help your thought process to some degree.

MEMBER APOSTOLAKIS: Okay.

MR. HAMZEHEE: But are not exactly what

you were asking for.

MR. CARUSO: Slide 7. I think these are the criteria for selecting RTNSS systems, and I think Gary went through these. I don't think we need to go through these again.

This slide, Slide 8, is a summary of the important topics in RTNSS. I think Gary went through these, too. I don't think I need to say any more about these.

I guess, yes, we want to get to the open items. And I guess what I would say is our open items are primarily based on the information that was provided in DCD Rev 4. And what Gary talked about was sort of their revised approach to RTNSS, a number of modifications, and how they are treating RTNSS, and DCD 5, which very much go to these issues.

And so I think we have heard about this stuff in phone calls, in slides, and I think the general feeling is that it's definitely going in the right direction to address the concern to fundamental, open items that we had. But it's complicated what they have done, and where they have moved things around in the categories and stuff.

And so, you know, we need to look at it, make sure we understand it. There's a lot of confusion about exactly what they did and how it addresses the different criteria. So I think, you know, this particular item here in the system interaction area -- this one in fact they have given us a response on, but they have added some stuff in the system interaction area, so we need to look at that.

Again, these open items apply to the Category B, the long-term safety criterion. And this is something that has been substantially revised in Rev 5 -- the concerns we had that some of the B items previously were being housed in instructions that were not even seismic Category 2. And that was our fundamental concern, and I believe they are addressing that concern directly in Rev 5.

The same thing goes for the issue about protecting these systems against floods and hurricanes. So I think there is a success path there; we just need to look at what they've done.

And the last set -- as Gary said, there are a number -- we have identified a number of concerns. You know, we have their Availabilities Control Manual. It is attached to Chapter 19(a). And it has been reviewed by a number of folks on the staff, and we have identified a number of issues there, which are -- I wouldn't say they are -- I mean, they are significant issues, but I think there's resolution paths.

We just need to get them addressed by GE in terms of making the -- I think making the availability controls clear in terms of what they require and what they don't require, and also to make them consistent with assumptions they have made in the PRA.

I would say overall -- I think overall where we stand with RTNSS is we think they follow the process. We think they are identifying the right systems. I think our concerns have been in the area of treatment. Overall, I think, you know, their treatment is -- you know, my opinion is their overall treatment is fine.

They have identified stuff that goes in tech specs, that seems appropriate. They have identified stuff -- they have identified availability controls for the other things, and everything gets covered under this design reliability assurance program, which they have committed to implement through the maintenance rule.

The design reliability assurance program is reviewed by us, too. It's reviewed in Chapter 17.

We reviewed it, accepted it. It has been briefed in front of your Committee. It talks about the treatment of these systems in terms of design control, organization, quality assurance, all those aspects. But I think the real powerful piece is the fact that it will be implemented through the maintenance rule, which really is -- provides, you know, a strong regulatory source for treating availability and reliability.

So I think there is an overall good argument as to why their approach is acceptable. We just have some particular concerns in some areas about the availability controls and some of the requirements of the -- for the Criterion B systems.

So I think that's -- I think that's where we stand.

CHAIRMAN CORRADINI: Questions?

(No response.)

Thank you very much. Should we go around the table -- I'll start with Mario -- just to get people's reactions. And I'll try to -- I'll try to document what I hear from everybody.

MEMBER BONACA: As you know, I am not an official member of this Subcommittee.

CHAIRMAN CORRADINI: But welcome at any

moment.

MEMBER BONACA: I always attend it, basically whenever I can. I think I'm qualified to make a comment. I would like to see some more detail in the PRA. I understand it has been promised, and we will be seeing that.

I was intrigued by the issues of interactions between active systems and passive systems, and would like to understand better the downsides of that. But, in general, I think I am reasonably impressed by the progress.

I have no further comments.

CHAIRMAN CORRADINI: tom?

MR. KRESS: I am pretty much in agreement with what Mario said. Clearly, to me the PRA appears to be of acceptable quality, and they used it in such a way as I think they pretty much met that list of Commission objectives with it.

And I think it clearly shows, with the absolute values, that ESBWR has a level of safety that is much better than the existing plants. So, you know, it's a good thing. I have to agree with George, though, that we shouldn't be quoting values for digital I&C failure probabilities. I don't think it's a meaningful number yet. But you have to deal with it in some way in the PRA.

I was glad to see -- I guess it was Ed Fuller that mentioned the use of MELCOR to audit several of the severe accident sequences. I was glad to see that. I was going to suggest as a probability -- I hadn't seen the results of that comparison. I think we ought to look at them some time.

I was quite interested in the 10^{-6} goal for LRF, because I consider an LRF to be a potential surrogate for a societal risk goal, which we have never had before. So I'm anxious to see if we can relate the 10^{-6} to some sort of acceptable societal risk.

MEMBER POWERS: I am stunned that you would be interested in that at all.

MR. KRESS: You know, I am going after the new --

(Laughter.)

No matter what, I have to say that. Is that a surprise?

MEMBER POWERS: Yes. I'm -- it has taken me aback. I am going to take some -- several days to recover from the shock.

MR. KRESS: To really take that one in. At one time, there was an attempt to model passive systems thermal hydraulically, and use the model in an uncertainty way to look at the various parameters in it, and vary them, and to the extent to see when you might expect failure in the passive systems.

I don't know what ever happened to that study. I wonder if we can find out whether it came to any conclusion or is still going on.

CHAIRMAN CORRADINI: Actually, Bill mentioned that in an e-mail a couple days ago about that study. Do you remember?

MEMBER SHACK: No, no. It was Harold.

CHAIRMAN CORRADINI: Was it Harold? So Harold is the one that mentioned it.

MR. VANDER MOLEN: Yes. We can try and find the -- find the details of that, but it goes back 10, 15 years or so. I remember Art Bussick was the project manager and he is retired now. So it will take a little bit of research, but we can see if we can find it.

MEMBER APOSTOLAKIS: Why do you have to go so far back? I'm telling you --

CHAIRMAN CORRADINI: History is good.

MEMBER APOSTOLAKIS: But, you know, BNRPS is only a few years old and does all of this stuff. It's published in the literature, nuclear engineering design and nuclear technology.

MR. KRESS: I think we ought to look at that.

MEMBER APOSTOLAKIS: Yes. A good starting place is this EPRI summary.

MR. KRESS: I was intrigued by the discussion we had that -- on the use of PRA to certify a plant. And then, all at once we decided when we got to COL stage we left something out that we might think is -- should have been in at the time. What do we do about that?

My view is that I like to think of certification of design as separate from siting. And once you certify a design, it's certified. You deal with things you left out of the PRA or things that were in the PRA but may not have been dealt with, it's in the design but it may not have been dealt with. You deal with those at the siting stage, the COL stage.

I guess I still have two outstanding items on my list that the staff has promised to give us answers to. You know, that's the question -- iodine pumping into containment continuously, and the other one is one I brought up, and I don't know if we have been promised anything on it or not.

That was when you inject boric acid as a backup system to prevent recriticality, and if you are low pressure and you are sitting there boiling away the water, it's my view that the boric acid goes with the steam. And pretty soon you deplete it, and the question is: do you have another recriticality issue after you've gotten rid of all of the boric acid?

There is a race between it and the build-in of the xenon from the decay. So it could very well be that the xenon race wins, but I don't know. I have never seen a study.

MS. CUBBAGE: The last -- the second of your two issues, that would be generic, right, to all of --

MR. KRESS: It's a generic. It has nothing to do with -- I mean, it's not specific. It's a generic issue. So those are -- I for one think I -- the PRA and its use in design was a good job. I like what I heard.

CHAIRMAN CORRADINI: Thanks Tom.

Sam?

MEMBER ARMIJO: Yes. I think the most important thing that I've gotten out of this is that the -- really the value in using the PRA in the design process rather than simply assessing a design plant, I think that has been done very well.

I think there is enough margin in all of these to the numerical goals of CDF and LRF that even though the plant isn't completely designed and enough detail isn't there to really state that you are meeting those numerical goals, there is enough margin that you have a pretty high assurance that when that time comes you will be post-goal. So I am very comfortable with that.

I think the staff and the -- and GE are rapidly converging on the PRA, and I don't see a big problem for the certification.

CHAIRMAN CORRADINI: Okay. Dana?

MEMBER POWERS: I've got some notes here in front of me.

CHAIRMAN CORRADINI: Do you want to say anything out loud?

MEMBER POWERS: No.

(Laughter.)

MR. KRESS: Can I do that?

MEMBER APOSTOLAKIS: Would you object to Dr. Corradini's reading the notes?

MEMBER POWERS: Yes.

(Laughter.)

CHAIRMAN CORRADINI: I knew it. I knew

it.

MEMBER APOSTOLAKIS: This is a public meeting.

(Laughter.)

MEMBER POWERS: I simply commented that I'm interested in some of the pictures of how they did the core degradation and the potential recriticalities. I am interested in how they are handling the issues of poisoning and choking on the passive catalytic hydrogen recombiners, and how we will look closely at how they handled the DBA and DDBA source terms.

CHAIRMAN CORRADINI: Thank you, Dana.

MEMBER SHACK: I have just -- you know, I think it's very interesting, the redundancy and the diversity of the systems that they have I think gives the system a lot of robustness. Whatever questions you may have about numbers of any particular item, there is just enough ways to do different things here that gives me high confidence that this is, in fact, a pretty safe reactor.

My one concern is the one that Mario brought up, and that is whether there isn't stacked some adverse interaction between these active systems and the passive systems, and just how this will be treated actually in a -- I'd like to see a set of procedures for how somebody would actually proceed in an accident. You know, he has got all of this choice of systems. You know, what is he actually going to do, and is there a potential that you are going to create problems as you are going through this? But --

MEMBER BONACA: That seems tricky.

MEMBER SHACK: It certainly gives you a lot of choices and a lot of ways to get success, or not.

CHAIRMAN CORRADINI: Said?

MEMBER ABDEL-KHALIK: Yes. I am also concerned about the interactions between active and passive systems, particularly since one wouldn't really know what is the best thing to do until you specify what equipment you have and what procedures you will have in place.

There is another concern that I would like to add to the comments raised by my colleagues, which is I would like to see the original source of failure rate data for squib valves. I think the database may be very small to justify that the numbers have been used were common cause failure.

MEMBER POWERS: Let me ask you what you mean by "database," and that --

MEMBER ABDEL-KHALIK: I think the source of the data is based on data for squib valves used in nuclear plants, and the only place that they are used is in the standby liquid control system. And I think that database is very small.

MEMBER POWERS: Well, again, I am interested in what you mean by "database," because if I am a manufacturer of squib valves, and I go out and test them a lot, I test the ones that go to the nuclear plant, is that a database that you accept, or is it only those that are actually in use and you can episodically go --

MEMBER ABDEL-KHALIK: Well, I'm sure any surveillance tests that have been done, any qualification tests that have been done, for the specific valve designs that are we are interested in would be applicable to that database.

MEMBER POWERS: Well, I bring it up because we certainly had a manufacturer come in here and discuss his quality assurance and his testing that he did, and he has tested hundreds of these things. But I don't know whether you count that as qualifying. I can certainly imagine an argument that --

MEMBER SIEBER: The biggest user is NASA, and that's where the database is coming from.

MEMBER POWERS: Well, I mean, this guy had built these things for NASA. He came in here and talked to us, and, I mean, they are basically cheap. So he goes off and he tests hundreds of them.

MEMBER ABDEL-KHALIK: But the claim that has been made here is that these numbers are based on nuclear-related data.

MEMBER POWERS: These are nuclear devices. I mean, he sells them to the nuclear industry. He tests them. I just don't know whether they -- that qualifies as an acceptable database for you.

MEMBER ABDEL-KHALIK: Sure. I mean, any -- as I said, any surveillance data, any equipment qualification data, etcetera, that would go into establishing these failure rates would fall within that database, provided of course that, you know, one can establish that the data would be applicable to any unique valve designs that may be used in this particular plant.

MEMBER ABDEL-KHALIK: I was also struck by the fact that sometimes, you know, issues are brought up, and then they say, "Well, there is an ITAAC that will check that." An example of that would be, you know, things like a check valve installed backwards.

MS. CUBBAGE: Right.

MEMBER ABDEL-KHALIK: Okay. There is an ITAAC. Is that something that is really doable? Can you actually establish with the configuration that we have that these check valves will operate and will be installed in the manner that they are supposed to?

MS. CUBBAGE: If you are questioning whether it would be feasible to verify that particular --

MEMBER ABDEL-KHALIK: Right. I mean --

MS. CUBBAGE: -- aspect by an ITAAC? I mean, I think in the case of the GDCS they are going to have to verify that they are going to get the flow rate through the line. So if the check valve is in backwards, they are not going to get it.

MEMBER ABDEL-KHALIK: And things like whether or not the lines are implied in the correct configuration, so that any -- to preclude the possibility of, you know, non-condensable gas accumulation.

Well, can you -- how can you say that you will always do this correctly, so that the probability that you will have enough gas accumulated that would cause the gravity-driven system to not function correctly is zero?

MS. CUBBAGE: Well, if there is a specific

ITAAC for an item, and I'm not aware of one on the slope of the lines, but we can look into that, but if there's an ITAAC, that would say that they have to send us a letter that says that they verified that every line meets that criteria. And until we get that, and we can inspect, then they are not allowed to load fuel.

MEMBER ABDEL-KHALIK: Yes. Those are my comments.

CHAIRMAN CORRADINI: Thanks.

MR. WACKOWIAK: And that was one of the issues with Tier 1 that we continue to struggle with is that just because we put something in there, like you said, doesn't mean you can do the test. Just because you write the test down doesn't -- or write the acceptance down doesn't mean you can do the test.

So one of my objectives in Tier 1 area is to make sure that every test that we write down in that -- in that column actually can be performed under the conditions that we're going to have prior to fuel load. So that's a big part of making Tier 1 actually work.

CHAIRMAN CORRADINI: Jack?

MEMBER SIEBER: Okay. Basically, from my examination of the DCD application and the draft document -- and the staff's SER -- I did not reveal any -- or identify any PRA concerns that the staff has not already picked up. And so that issue, as that review finishes and as the request for additional information responses come in and are accepted, I think that's okay.

I note during this morning's presentation that we really didn't cover Slides 55 to 70, which is severe accident management. And I think some time in the future we ought to run through that.

One of the issues that strikes me in that realm is the BiMAC. Now, about two years ago it seems to me that we had a presentation on the design of the BiMAC as it existed at the time. And I seem to remember some pretty old studies, and perhaps Dr. Powers can help us remember that.

But it seems to me that when you get 4,000-degree molten core that goes down onto a refractory surface, then the refractory loses the battle so to speak, and then you have all of these pipes of water underneath. And, you know, are you going to get a steam explosion out of that, or just exactly, you know, what is the issue there?

But a molten core is very hot, and you may be better off, you know -- molten core in a BWR is probably oxygen-starved also. So you are going to oxidize a lot of things once you get out into a more oxygenated atmosphere.

The question is: are you better off with BiMAC, knowing what we know? Or without it? It seemed to me the ABWR just had a bigger spreading area, and that was an attempt at reducing the amount of heat capacity that the molten core presented itself to whatever surface it rests on.

But I think that's something I'd like to know more about. I have a concern about it. I guess I don't have a concern if somebody can tell me that containment integrity will be preserved whether it works or not, and then whatever you want to put in there is okay to say.

But it seems to me the reason why you're putting it in is because you have some concern that the containment may be vulnerable should an accident progress to the point of melting through the vessel. And I think that at least for me I would either like to have a reference, that I could study it more, or perhaps add it to one of our future presentations, so that we can learn about it.

When you first -- on another subject, when you first look at the way design certifications and construction and operating licenses are issued compared to the old days, and you look at what safety systems and what are not safety systems, I think there is a pretty good consistency between what we're doing now and what we used to do.

The difference is that the number of components that comprise the safety system in a passive core protection scheme are pretty small. When you -- several people have talked about the interaction between active systems and passive systems. And I think this is important, because if the operator sits back and folds his arms and says, "I don't have to do anything for three days, so I'm just going to wait for shift turnover" --

(Laughter.)

-- which is -- that's an approach. On the other hand he said that "I'm going to be unemployed in three days, because we are going to ruin the plant." And so he is going to do his best to use the active systems in order to keep from screwing up the plant any more than he would have to.

And then, that makes the importance of answering whatever interactions there are between the operation of the passive systems, upon which we rely for solving design basis accidents, and an operator in there trying to pump water and open valves, and things like that, I think that that -- I think that's a legitimate concern and perhaps deserves more attention.

Other than that, I think there were a lot of slides. I think everybody made good presentations. I think I learned some things. I think the documentation that we got in advance was good enough to -- for us to prepare for this meeting.

So that would be my comments.

CHAIRMAN CORRADINI: Thank you, Jack.

Otto?

MEMBER MAYNARD: Well, I continue to be impressed with the use of the PRA throughout the design process. I think it has been obvious to me that design changes have been made, and because it has been an integral process through the design.

I think the challenge -- and it needs to be that this continues through the development of the procedures and stuff. I think the COL stage, it's going to be very important that this continue and get into the procedures and other things down the road, too.

But anyway, I think that's like -- overall, I think the PRA has done -- it's very good for meeting the purpose of the PRA for the design certification. And that is to address primarily the Commission objectives for the PRA.

And I think it has done that. I think that there are some improvements to be made. I think you need to be careful before you start just believing all of the numbers and everything, but I think that even with the -- including some things that I am not sure why they are not in there, like locked-open valves, you know, a failure of some of those valves and stuff in the GDCS system, and, you know, treating those somehow, even if you include them, I don't think that it would get to the point where we're starting to come close to eating away all of the margin that is needed for the Commission policy there.

I think that before we start trying to use the PRA to do other things, I think we would need to refine those things. So I think it's going to be an important aspect of -- I mean, what is it being used for? And I think for the purpose of addressing the Commission objectives, I am satisfied with that.

I've got mixed emotions on including the numbers in the design -- in the digital control systems. You know, first of all, I think we have to be careful we don't believe the numbers. You know, this is all a new area and everything. But at some point you've got to put some numbers in, and then start, as lessons get learned, to make adjustments and stuff there.

And I'm not sure how you show compliance with Commission objectives without putting some type of number in here. And I know there are some other things we don't have numbers for. So I've got some mixed emotions about it.

I think that it's a problem probably that we have within the NRC. If we are not happy with what is being done by the applicants, I think we need to provide some additional guidance, or what do we really expect in this area, rather than just have them just keep throwing things at us, and we'll kind of tell them what we like when we see it. But at some point, you do have to put some numbers in there, and then start making some adjustments there.

I think it's going to be important to clarify at the COL stage what some of the requirements are in complying with this, and I really get -- this is where I get into the operation of the systems, the safety systems, and any interactions they may have with the passive systems and things.

You know, what things kind of come out of this that carry over to that that we need to make sure that we -- somehow we capture and we take care of that at some point before a license is actually issued for -- to allow people to operate the plant?

Those are my comments, overall, I think were the objectives of the meeting.

CHAIRMAN CORRADINI: Good. Thank you.

And now to murderer's row.

(Laughter.)

Starting with Dennis.

MEMBER BLEY: Very good presentations today, and I am very impressed and pleased with the way the PRA has been used in the design process, and the way -- using a traditional PRA approach and generic data to see what were dominant contributors and design your way past them. And I think that's a great approach and one we need to do. And it no doubt has led to a safer design, and probably much safer.

On the other hand, when I get to the PRA, I have got a couple of significant concerns. The first one is, as you move the design to more and more a passive system, and something less like what we've been operating, maybe the way we've been doing PRA isn't the whole answer. We have got a lot of experience with current kinds of LWRs, and we had a lot more than we have on this when we did WASH-1400.

And back when we did that one, there was a lot of questioning and a lot of things kind of like HazOps saying, "What could go wrong? How could things go wrong?" What I see in the PRA is looking at existing PRAs and gathering up the initiating events, doing a review of systems and somehow mentally defining things that in those systems could lead to initiators.

What has been missing I think is a real thorough look at the passive systems, what they need to do, and a real hard questioning, like a HazOp, what kind of things could make this not work the way we think it is? Anything from things of aging to contaminants getting in to something a maintenance person could do, the whole variety, and laying out that deep questioning process to see if there is something we're missing, because it's a new design and I haven't seen that kind of digging.

I'm hoping, from what you guys told us today, that what you did on going through success criteria with respect to the gates and the fault trees may really be addressing that or beginning to address it. I really hope so, and I'm looking forward to seeing that.

I have some concerns about the fidelity of the fault trees to the system design descriptions, and we are going to get into that later in some detailed meetings I hope.

I certainly agree with everything people have said about the interactions of passive and active systems, and even active and active systems, which we haven't talked about, and operators with both kind of systems. And the thing we haven't talked about is including their control systems and how they might assist or preclude operations of some, and that is an area you probably won't get into in its full depth at this stage. But eventually, as those systems get better defined, that has got to be looked at real hard.

Overall, it looks like it -- my gut feeling is things are really good, but I have these things that haven't looked at it systematically enough for me at the new areas that I'm a little concerned about.

CHAIRMAN CORRADINI: Mr. Stetkar?

MEMBER STETKAR: Well, first of all, I echo a lot of the things that Dennis said. I guess I spent more time probably than some of the others looking -- doing some spot checks of details, and I think that what troubles me -- and I do think we need a couple of additional sessions on this -- is that in most places that I looked it was quite easy to find things that were not there.

I tend to look -- I don't tend to look at what's there. I look at what's not there. And most of everything that I looked at I could find things quite easily that were not there, and I mentioned a few of them this morning. I did not mention a large number of other things. And that was not from a comprehensive review of the whole PRA; it was looking at one system in particular who was doing a sort of one-day look through of initiating events.

And what makes me a bit uneasy about the whole process is that this PRA has extremely small numbers. And by virtue of the fact that the numbers are very small, this PRA, contrary to any other PRA that has probably been done, has raised the bar in terms of level of detail and completeness to support the risk estimate.

Now, do I believe that things have been left out that will cause the core damage frequency to increase by three orders of magnitude? No, I don't. And in this forum, I am not going to estimate how much I think it might increase. But I know that this is a lower bound estimate of the actual core damage frequency. Just because of the things that have been left out that I know about that are small things.

I'm a bit concerned about the staff's review of the PRA in the context of looking for things systematically that have not been included in the PRA. And this is not esoteric things about digital I&C, it's not different ways of developing new initiating events, this is kind of PRA 101.

It's the question of: is the level of detail and completeness of the PRA models, given the design information that we already have, adequate to model the plant design? According to criteria and standards that we have in place already -- modeling maintenance unavailabilities, modeling normally open valves that might spuriously close, and several other things.

So I think that for me personally to feel more confident about the robustness of this PRA to actually characterize the risk and its contributors -- and I'm not talking about now an overall number, I'm talking about the relative contributions to risk, the relative importance of systems, perhaps maintenance testing, those types of things.

I think we need to delve into some more of the details, and I don't know how to do that. I think that's something that we need to look at, because I am concerned that once the design is certified, and once the PRA is accepted, that PRA will take on a life of its own. It will become the PRA. People will look at changes to the PRA, if there are small changes to the design when the plant is constructed, they will never go back and look at things that are not there. That's one of my bigger concerns.

CHAIRMAN CORRADINI: George?

MEMBER APOSTOLAKIS: Well, I agree with almost everything I have heard. I think we should not talk too much about meeting the Commission's goals, because we cannot demonstrate that. But the objectives that were on one of their slides, I think we can make a very good case that we are actually meeting those, if we have not already met them. There may be some things to resolve, but I think we are very -- we are well on our way.

Now, the digital I&C issue, I don't think it is unique -- especially Otto said, you know, that his trouble -- he can't see how, unless you put a number there, you can show that you meet the goals. And my point is that I don't need numbers to show that I meet the goals.

The seismic analysis they do doesn't help me in trying to demonstrate I meet the goals. All they are telling me is that there is a very high probability of a very low failure probability at a certain earthquake. Okay? Double the SSC, or whatever the number is now. They are not telling me what the risk is.

Why, then, should I demand that the digital I&C part should tell me what the contribution to risk is? I can equally well there say, using a bounding deterministic analysis, that this is good enough, without putting a number on it.

I am troubled by the very low numbers, but I don't see any way to raise it.

(Laughter.)

I agree with Tom. I would like to understand better -- I know that Powers -- well, I can repeat it now that he is not here. That 10^{-6} and what LRF means -- I also agree with everybody's concern regarding the active-passive interactions and how you go from one to the other.

I believe that the way we are handling the passive cooling systems is deficient in the sense that we are not using the extensive work that has been published in the literature. We are not operating independently of the literature.

Dennis mentioned HazOps and asking questions, you know, what can go wrong? There are papers from 2003 that propose HazOp analysis. Okay? They have not identified any, but they are giving you things.

Well, GE, though, being the real expert on this design, can use this kind of approach and make a good case that, well, the reliability of the convective heat transfer from the core is one, is it not? Forget about valves opening, but the reliability of the physical phenomenon of removing heat through convection is taken to be equal to unity. And we are not questioning that.

And I think there are papers in the literature -- and I repeat, a good review is this EPRI document from last December. So I really think we should come up to speed.

Now, do I expect that we are going to find something earth-shaking? No. But I really think we ought to do a good job there in questioning and have the thermal hydraulic colleagues raise questions, and so on. But you need that framework, and I think the European Union has put it together.

I do support the idea of having focused

subcommittees, more detailed things, and we will have to talk about them. And I think I'm done.

So take out the numbers, please. Oh. I am really troubled by the way we are using sensitivity analysis. I mean, as long as it works everything is fine. I mean, we set the human reliability numbers equal to zero, and it's 10^{-6} I think the number you get. That's great. The next guy who tries that may get into trouble.

MEMBER SHACK: That's his problem.

MEMBER APOSTOLAKIS: And then, we start playing games with failure rates, you know, multiply it by five, multiply by 10. You guys could have done a better job there and include a lot of that stuff in the uncertainty evaluations.

You see, the problem is that we still carry the interpretation of the word "sensitivity analysis." In the old days, before PRA, "sensitivity" then meant, well, you have taken the number here to be three. What happens if it's five? Now it's a different world. Now you are dealing with a probabilistic world where presumably you have curves, distribution functions. So what does sensitivity mean now?

Well, one of the things it means, for

example, is there are assumptions you can make somewhere. Okay? But does it -- it doesn't mean anymore to take one number and multiply it by five or 10 or whatever. And I remember there was a case with 50.69 where they multiplied -- I think it was an NEI document. In an early version, we saw they multiplied by 10.

MEMBER SHACK: Texas could multiply by 10. Other people couldn't.

MEMBER APOSTOLAKIS: Yes, right. Other people couldn't.

(Laughter.)

I'm glad you reminded me. A factor of 10 worked very well.

(Laughter.)

Then, the NEI document says it's fine. Why? We thought about it.

(Laughter.)

You know, this is not a serious way of doing business. I mean, there ought to be a better way.

Now, overall though, I really think that changing the style of the presentation, both from GE and you guys, the staff, you know, instead of focusing on we are meeting the goals of the Commission, no, if you show that you are meeting those six or seven or eight goals, objectives, I think you can do that, and doing that involves both PRA and the deterministic requirements that the agency has.

So you don't feel that burden that, my God, the goal says 10^{-6} for early fatalities. I really have to show I meet it. No, you don't, because if you claim you do, then some of us will claim that you haven't. So that's my input, Monsieur la Presidente.

CHAIRMAN CORRADINI: Thank you, Professor Apostolakis.

MEMBER APOSTOLAKIS: Mister.

PARTICIPANT: You're a Professor Doctor.

(Laughter.)

CHAIRMAN CORRADINI: Thank you, George.

(Laughter.)

Let me thank GEH and the staff --

MEMBER APOSTOLAKIS: Well, what do you think?

CHAIRMAN CORRADINI: I'm not there yet.

MEMBER APOSTOLAKIS: Oh.

CHAIRMAN CORRADINI: Let me thank GEH and the staff for their presentations today. I guess I heard a number of things, which I tried to capture on one page with some notes. I think what the Committee owes the staff and GEH, though, is we have a time period somewhere in the range of a few months where we can take our time and schedule detailed -- more detailed Subcommittee meetings on certain topics.

So I'd like to ask those of you -- I made notes, and I thought I captured some things, such as a Subcommittee meeting strictly on severe accident management. That is, we skipped -- purposely skipped it here. The Committee said they were going to get us -- give me some questions from what they had read, so I can transmit them to Amy and to Rick about severe accident management. So that's a potential meeting.

Another one I heard I think from the gentleman over here on the right, some sort of meeting on system design analysis for the Level 1. At lunch, I think one of you made the comment that I think was important, that perhaps we can pick -- I think Rick actually gave us a handful, maybe five or six of the dominant sequences, and take three -- two, three of those and walk through them, and then maybe investigate the data analysis that went into them, the analysis -- the fault tree analysis that went into them, and then essentially use those as surrogates to try to probe and understand it at some detailed level.

I guess I don't know what the right word for that is, but I would call it some sort of selective accident sequence analysis review.

MEMBER APOSTOLAKIS: If we do two or three, I don't think all of them should be dominant sequences.

MEMBER STETKAR: That is my whole point. You want to pick -- you don't want to pick the ones that everybody has looked at. Everybody has looked at the dominant sequences.

CHAIRMAN CORRADINI: So then I'm looking --

MEMBER STETKAR: You want to randomly pick a few high-pressure transients, for example.

CHAIRMAN CORRADINI: I think at dinner tonight you will put your heads together and you will give me a couple.

MEMBER APOSTOLAKIS: Or a few.

CHAIRMAN CORRADINI: All right. Beyond that, I guess the one thing that I was writing down somewhere in my list here was that I guess I want to understand a bit -- I guess I want to thank the staff and GEH. Last time we were together we kind of beat up them a bit about just quoting numbers, and I think to their credit they identified things that there were open items that were tough versus those that were doable, a path forward.

And the one that I wrote down which I want to understand a bit more is this seismic spectrum and how that is going to be resolved. I think that is an important one. I think the issue about the iodine pumping that Tom has brought up is one that has kind of come back up.

And I do want to understand a bit about some of the physical processes for the -- for Level 2. Since that is my interest area, I guess I am going to particularly look at that relative to a Subcommittee meeting. I think in terms of data analysis, Said's point about squib failure rate, but basically failure rates in particular but using the squib valves as an example case is good.

I guess I'd kind of turn to GEH about that. You guys are going to have to tell us a bit more about what your database is. Is it nuclear? Is it the vendors testing data? Is it actual operational data upon demand, what it is? Because I think that will essentially potentially give us more confidence.

Other than that, I just want to thank everybody. We were a bit late, but I think it all went pretty well.

MS. CUBBAGE: Just to clarify before you end. I assume you mean we are not going to come back to full Committee before you have these additional Subcommittee meetings?

CHAIRMAN CORRADINI: I think I sense we will not. That's my sense of it, by talking to my colleagues at lunch, and at breaks. Is that a fair statement, gentlemen?

MEMBER APOSTOLAKIS: Yes. When does GE plan -- or GEH plan to submit this response to the passive systems? You said there is partly --

CHAIRMAN CORRADINI: It's partly in Level -- in the Rev 3.

MEMBER APOSTOLAKIS: That would be a more complete response.

MS. CUBBAGE: The thermal hydraulic?

MR. WACKOWIAK: The thermal hydraulic uncertainty? Yes. Well, now that the DCD has been submitted, I believe I know have access to some TRACG resources again that were not available to us over the last couple of months. So we'll be getting that picked back up.

Just to let you know where we are, the calculations have been run. And when we had to move on to other things, we were in the middle of writing up our response on why we thought that TRACG and MAAP were giving us the same results with respect to the PRA.

Where we kind of got stuck is that we -- my group didn't understand some of the things that was -- that were going on in the TRACG runs. And we are getting -- in the middle of getting clarification on those things, and we will have a writeup on why things look the way they do, and we will discuss that.

In the end, I think it comes down to something that you may have talked about in previous meetings with GEH, in that the selection of models in TRACG are not -- they are bounding rather than best estimate. And that led to a little bit of our confusion about what TRACG was doing versus what MAAP was doing. And it was deliberately doing it that way for a reason based on design basis calculation. More bounding model.

So we are fairly close. I think it is just a couple weeks away from getting that response out to Hossein, so that they can start taking a look at that, and then we should be able to come in and talk about it.

CHAIRMAN CORRADINI: So to get back -- thank you very much, Rick. To get back to you, Amy, about timing, I guess I am just reflecting that we had expected to consider a letter in July. I think, unless you want a letter that is going to have an awful lot of provisos in it, I don't see there is a necessary rush on this one, particularly because --

MS. CUBBAGE: It's not a necessary rush to get a letter in July, but I would say that these Subcommittees need to be done pretty quickly, because the staff and GE, as you heard here today, are quickly converging. And we're going to be going to a final SER at the -- you know, in a draft form very soon. And then, we'll be finishing it up.

CHAIRMAN CORRADINI: So, then, let me ask you -- so, then, I guess I have no problem with having a Subcommittee meeting in July and August, but I've got to check with my colleagues to have it populated.

(Laughter.)

Besides just me --

MS. CUBBAGE: I'm not seeing it happen.

MEMBER APOSTOLAKIS: That is not the only problem. If we come back here and say again the EPRI report, and I draw blanks, they are not ready. I mean, we have to give them some time to think about these things. So it's not only us.

CHAIRMAN CORRADINI: No, I understand

that. But I guess I want to just at least lay it out that, over the next couple months is a relatively slower time, but I think other things are going to take priority for other things on the Committee.

MS. CUBBAGE: Right. I just don't want it to hit the back burner.

CHAIRMAN CORRADINI: No, I understand that.

MS. CUBBAGE: It's not a year from now.

CHAIRMAN CORRADINI: No, no, no.

MS. CUBBAGE: It's not nine months from now. It's --

CHAIRMAN CORRADINI: No, no, I understand that. But I guess what I'm saying -- let me just say it more just bluntly. It seems to me on the GE side is a response relative to the TRAC versus MAAP calculations. We have to look at the BiMAC result, which just arrived, and we have got to digest it. You've got to digest it.

They have got to think about things relative to passive safety systems, that George has suggested and has volunteered to give it to them. Whether or not he can is a different question.

The EPRI report -- that sort of back and forth, that is at least a month, if not six, seven weeks.

MS. CUBBAGE: We could go to September/October. I'm just --

CHAIRMAN CORRADINI: But just to -- the last thing I guess I want to leave to you, and we have talked about it privately, is I do think, though, we'd like to know from you what -- how it looks after the summertime in September, October, November, December, because it seems to me we still have opportunity in those few months to have two or three Subcommittee meetings strictly on things related to this and some outstanding thermal hydraulic -- I'm pointing to him because there are a couple of his issues, and Sanjoy is nobody to point to around here -- but thermal hydraulic issues. But between those two, two or three meetings are going to probably be necessary.

MEMBER APOSTOLAKIS: Well, let me ask you this, though. Wouldn't it be wise to have a two- or three-day meeting so the guys from GEH don't have to fly here just --

CHAIRMAN CORRADINI: I agree.

MEMBER APOSTOLAKIS: And then, you know, have maybe half a day on this, half a day on that, three hours on this.

CHAIRMAN CORRADINI: But I just have a

feeling --

MEMBER APOSTOLAKIS: They can go over everything.

CHAIRMAN CORRADINI: But I don't want to be overly -- just this is me, I don't want to be overly zealous, because I have tried these with the thermal hydraulics, and we say, "Oh, we can do a couple accident sequences." Well, six hours later we were through one accident sequence. Okay?

(Laughter.)

So my thought is if we are going to have something on PRA, it might be a different group of -- the different part of the team, and you might want to have a day on severe accident management, a day on system design, these sequences, and maybe take a couple of days and take within those two days two or three sequences and just clean out all of the issues -- at least we think we will -- for over a two- or three-day time span there. And then, another one on thermal hydraulics, which we still have yet to do.

MEMBER APOSTOLAKIS: Good work. Good work.

MR. HAMZEHEE: How many PRA Subcommittee meetings do you envision we would need before we are ready to --

CHAIRMAN CORRADINI: I can see three days would be a good start.

MR. HAMZEHEE: Three days.

MEMBER APOSTOLAKIS: I think we need to get together in the next two or three days.

CHAIRMAN CORRADINI: And get you an answer.

MEMBER APOSTOLAKIS: Identify the areas.

CHAIRMAN CORRADINI: And Amy is already checking out the future and is going to tell me a bit.

MS. CUBBAGE: And this is only one design center. That's --

MEMBER APOSTOLAKIS: I don't see how we can --

MS. CUBBAGE: You all are going to be busy.

MEMBER APOSTOLAKIS: -- method over PRA before December.

CHAIRMAN CORRADINI: Excuse me? We can't do it in July. That's what I told --

MEMBER APOSTOLAKIS: That's for sure.

CHAIRMAN CORRADINI: Well, and it's very difficult to do it before December -- September, if you don't do it in July.

MEMBER SHACK: He said December.

CHAIRMAN CORRADINI: Oh, he said December.

MEMBER SHACK: Yes. That's why I didn't want to accept that as --

MEMBER SIEBER: Not August, please.

CHAIRMAN CORRADINI: We can't -- I don't think we will be able to do it in July. I think that's a fair statement.

MEMBER APOSTOLAKIS: If you have any hopes for September, you'd better come down to earth. Because July/August is very hard to set up Subcommittee meetings.

MS. CUBBAGE: Keep in mind we have to do Chapters 7 and 14 in September.

MEMBER SIEBER: Pick a date and see who shows up.

(Laughter.)

CHAIRMAN CORRADINI: So we will -- we owe you some discussions, and we'll get back to you, and then we'll see each other later this week, no doubt.

MS. CUBBAGE: Yes.

CHAIRMAN CORRADINI: So thank you all. Thank you, Rick. Thank your team. Amy, thank you very much. Hossein, thank you very much.

MR. HAMZEHEE: You're welcome.

CHAIRMAN CORRADINI: All right. We're

done.

(Whereupon, at 6:21 p.m., the proceedings in the foregoing matter were adjourned.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of: ESBWR Subcommittee

Name of Proceeding: Advisory Committee on Reactor Safeguards

Docket Number: n/a

Location: Rockville, MD

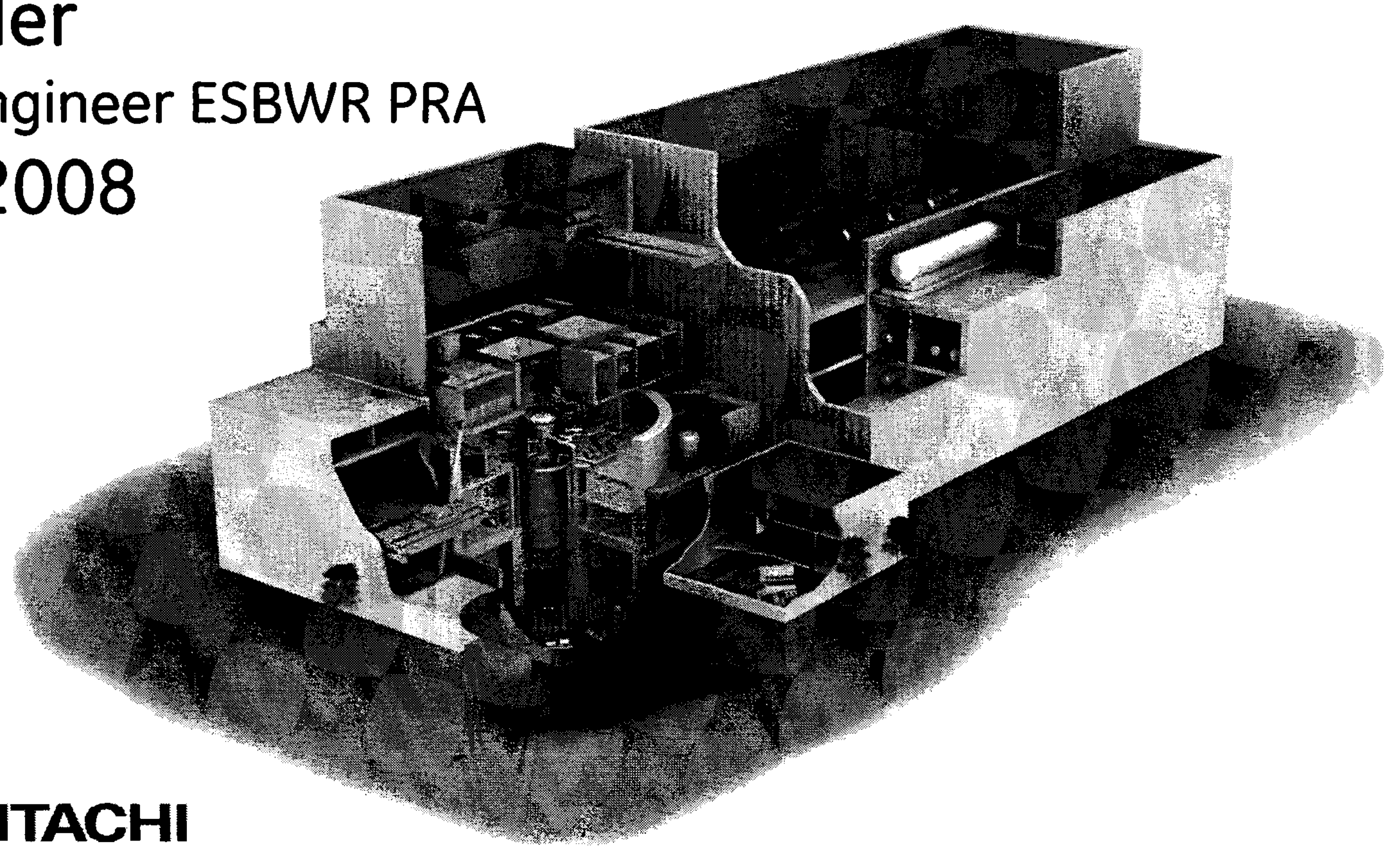
were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Charles Morrison
Official Reporter
Neal R. Gross & Co., Inc.

ESBWR Regulatory Treatment of Non-Safety Systems

Rick Wachowiak
Technical Lead ESBWR PRA
Gary Miller
Principal Engineer ESBWR PRA

June 3, 2008



HITACHI

NRC RTNSS Criteria

A SSC functions relied upon to meet beyond design basis deterministic NRC performance requirements such as 10CFR50.62 for anticipated transient without scram (ATWS) mitigation and 10CFR50.63 for station blackout

B SSC functions relied upon to resolve long-term safety (beyond 72 hours) and to address seismic events

C SSC functions relied upon under power-operating and shutdown conditions to meet the Commission's safety goal guidelines of a core damage frequency of less than 1.0E-4 each reactor year and large release frequency of less than 1.0E-6 each reactor year

D SSC functions needed to meet the containment performance goal (SECY-93-087, Issue I.J), including containment bypass (SECY-93-087, Issue II.G), during severe accidents

E SSC functions relied upon to prevent significant adverse systems interactions

HITACHI

RTNSS A: Deterministic

ATWS

- Diverse Protection System Functions
  - Alternate Rod Insertion
  - Feedwater Runback
- Safety Related SLCS Actuation

Station Blackout

- Safety-related components

GE | HITACHI

RTNSS B: Long Term Safety and Seismic

Core Cooling

- Need makeup water to IC/PCCS Pools after 72 hours
- Fire Protection Water supplied by
  - Diesel fire pump
  - Electric fire pump
    - Powered by Ancillary Diesel Generators

RTNSS B: Long Term Safety and Seismic

Containment Integrity

- Also need makeup to IC/PCCS Pools after 72 hours
- Long Term Containment Pressure Reduction
  - PCCS vent fans
  - Passive autocatalytic recombiners

HITACHI

RTNSS B: Long Term Safety and Seismic

Control Room Habitability

- Long term Dose Protection
  - Emergency filter units
    - Powered by Q-DCIS
    - Supplied by Ancillary Diesel Generators Long Term
- Long Term Temperature Control
  - Heating/Cooling Units in Air Handling Units
    - Powered by Q-DCIS
    - Supplied by Ancillary Diesel Generators Long Term

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RTNSS B: Long Term Safety and Seismic

Post Accident Monitoring

- Provided by Q-DCIS
- Emergency Lighting
  - Supplied by Ancillary Diesel Generators Long Term

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RTNSS B Design Treatment

Redundant Functions

Fire and flood protected

Hurricane category 5 missile protection

Designed for accident environment

Seismic Category II

Quality suppliers (not Appendix B)

Availability Controls Manual

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RTNSS C: Probabilistic

Focused PRA

- ESBWR that considers only safety-related and RTNSS equipment
- Determine significance by removing one function-train at a time
  - If CDF or LRF goals are exceeded, the function is considered significant
  - Significant functions are included in Technical Specifications
- All equipment in the focused model requires treatment
- DPS functions needed to meet CDF and LRF goals
  - GDCS Actuation
  - ADS Actuation
  - Isolation of RWCU/SDC Valves
  - Opening of IC/PCCS Pool Cross-Connect Valves

RTNSS C: Probabilistic

- Assessment of Uncertainty
  - FAPCS Low Pressure Injection
  - FAPCS Suppression Pool Cooling
- Supporting Functions for FAPCS
  - Standby Diesel Generators and PIP buses
  - Nonsafety-related DCIS (N-DCIS) to operate FAPCS
  - HVAC for buildings containing identified N-DCIS and FAPCS
  - RCCWS and Nuclear Island Chilled Water to cool FAPCS, HVAC, and SDGs
  - Service Water to cool RCCWS

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RTNSS C Design Treatment

Redundant active components

Fire and flood protected

Hurricane category 5 missile protection

Designed for accident environment

Quality suppliers (not Appendix B)

Technical Specifications for SSCs Needed to Meet CDF and LRF Goals

Availability Controls Manual for Frontline Systems

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RTNSS D: Containment

- BiMAC and GDCS Deluge Valves

RTNSS E: Adverse Systems Interactions

- RBHVAC Purge Exhaust Charcoal Filters
- Drywell Hatches

RTNSS Open Items

- Some SSCs needed for post-72 hour safety housed in structures designed to a standard that may not guarantee functionality post-earthquake
  - In DCD rev 5, all post-72 hour safety function equipment located in Cat II or better structures. This should close the item
- Additional information on structure design needed to enable the staff confirm RTNSS systems have been adequately protected from flood-related effects associated with both natural phenomena and system and component failures
  - Response provided in DCD rev 5. Post-72 hour safety functions are protected

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RTNSS Open Items

- ACs did not state the associated instrumentation functions and the number of required divisions in the AC LCOs for some functions
- AC bases do not explicitly state the minimum level of system degradation that corresponds to a function being unavailable, or the number of divisions used to determine the test interval for each required division (or component) for AC surveillance requirements
- No AC Surveillance Requirements provided for FAPCS pumps
- AC LCOs for FAPCS and EDGs inconsistent with PRA assumptions

These questions were provided after DCD rev 5 was well into production. Answers will be provided in a followup letter.

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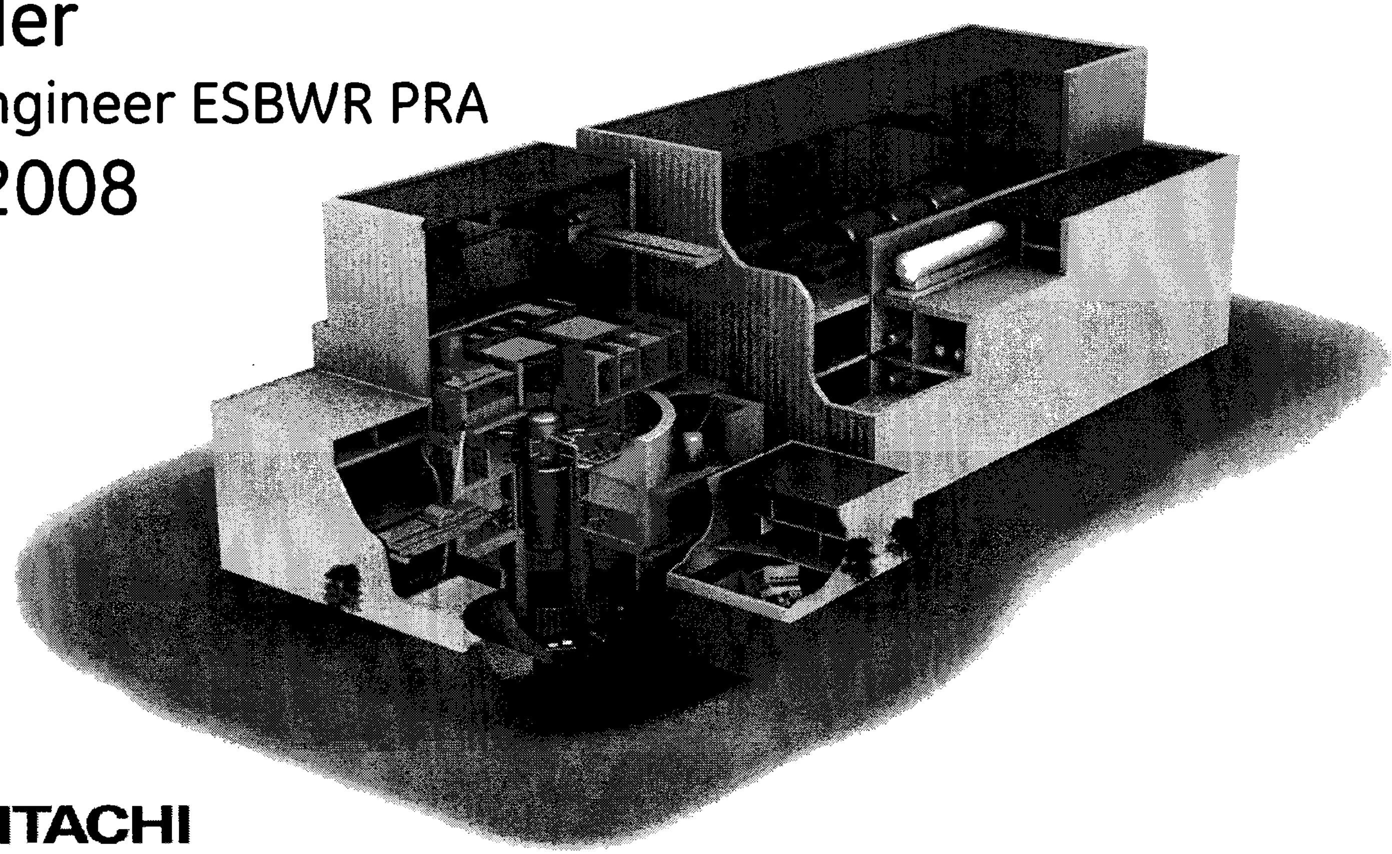
ESBWR PRA and Severe Accident Management

Rick Wachowiak
Technical Lead ESBWR PRA
Gary Miller
Principal Engineer ESBWR PRA

June 3, 2008



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PRA For A New Reactor Design

Determine risk management strategy

Consider all aspects in the design

- Core damage and releases
- Severe accident phenomena
- Internal and external events
- All modes

Design PRA provides a bounding assessment

- Provides the safety case for the plant license

Make risk assessment an integral part of the overall design process

Updated As-Built PRA prior to fuel load is required

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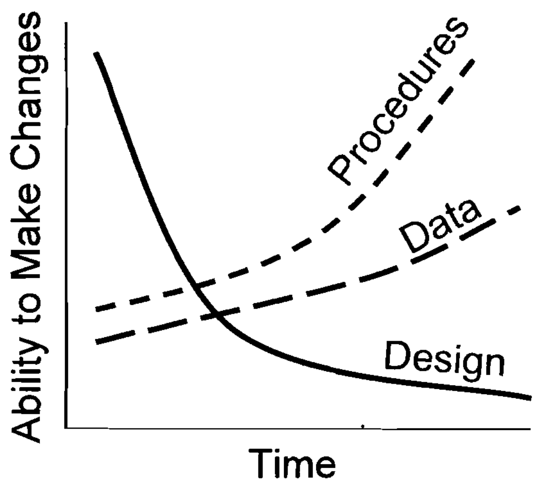
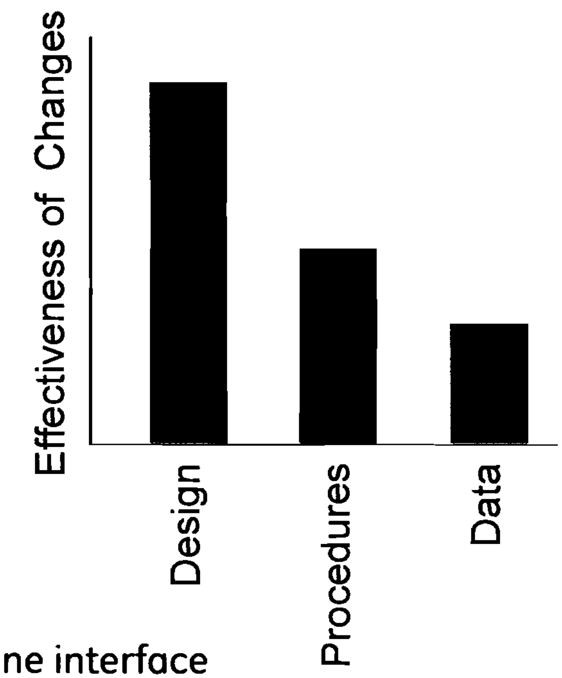
Three Chief Methods to Affect Calculated Risk





Procedures include the entire man-machine interface

Data includes methods as well as reliability programs

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Using a PRA early provides maximum benefit

PRA as a Design Tool

Eliminate Severe Accident Vulnerabilities

- PRA provides a systematic means for finding vulnerabilities
- GE utilizes the PRA as an integral element of the design process
- Make corrections in design phase
- Quantitative and Qualitative PRA tools are used

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Key Features of ESBWR Design Risk Management

Passive safety systems

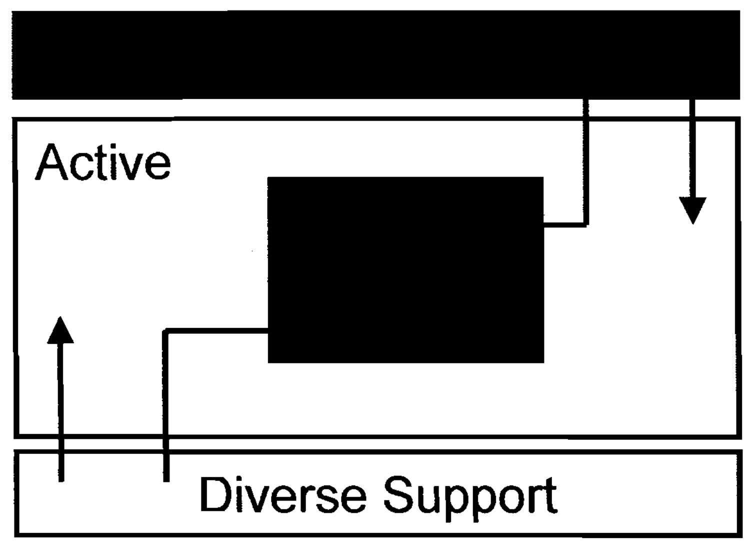
Active asset protection systems

Support system diversity

Minimize reliance on human actions

Use historical data

Target configuration for core damage prevention functions



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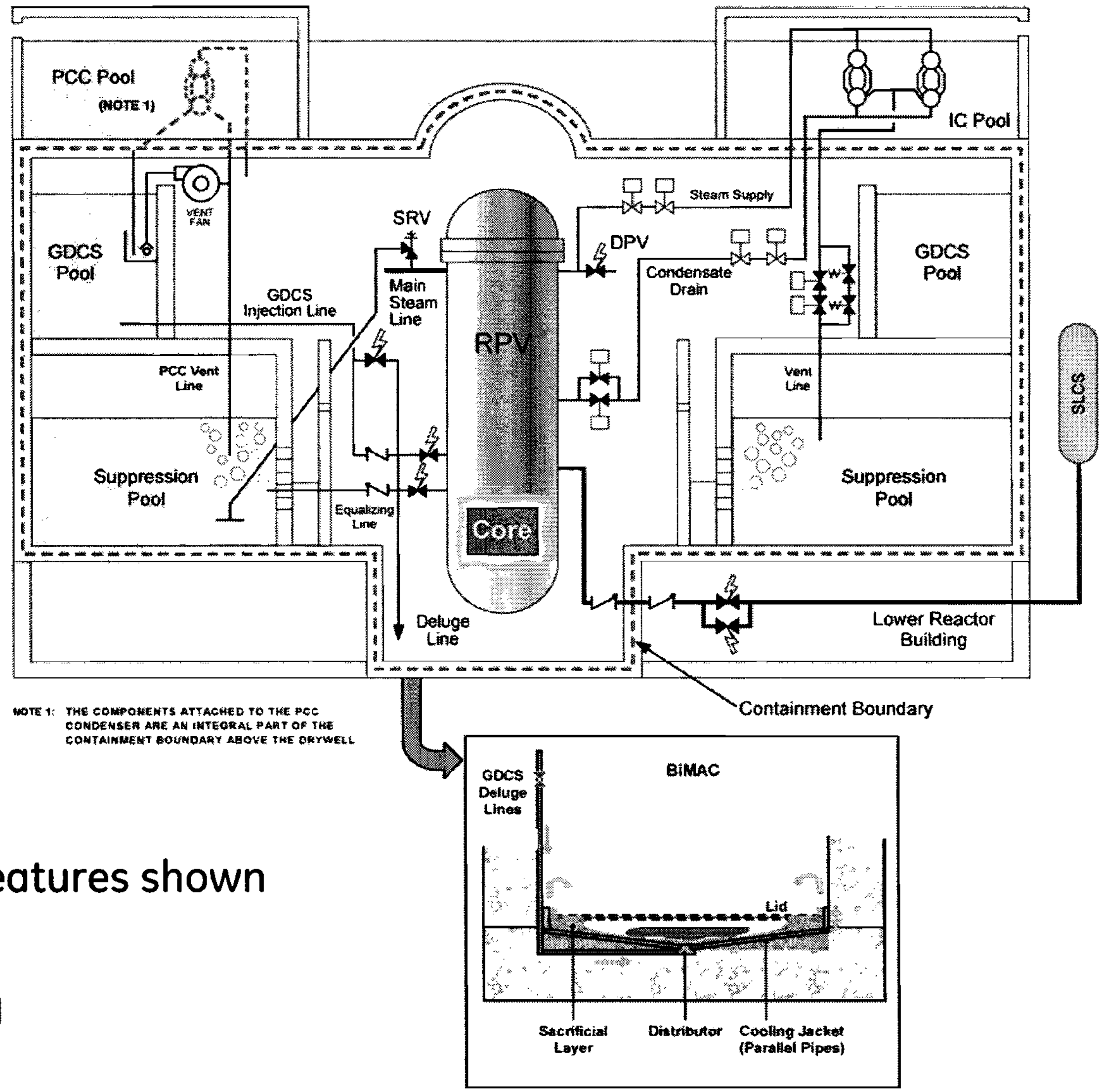
Key Features of ESBWR



Passive features shown

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Features of ESBWR PRA

Detailed Fault Tree / Event Tree Models

Level 1, 2, and 3

Internal & External Events

All Modes

Seismic Margins

Generic Data

Historical Initiating Event Frequencies

Parametric Uncertainty

Systematic Search for Key Modeling Uncertainties

Internal review for compliance with ASME-RA-Sb-2005

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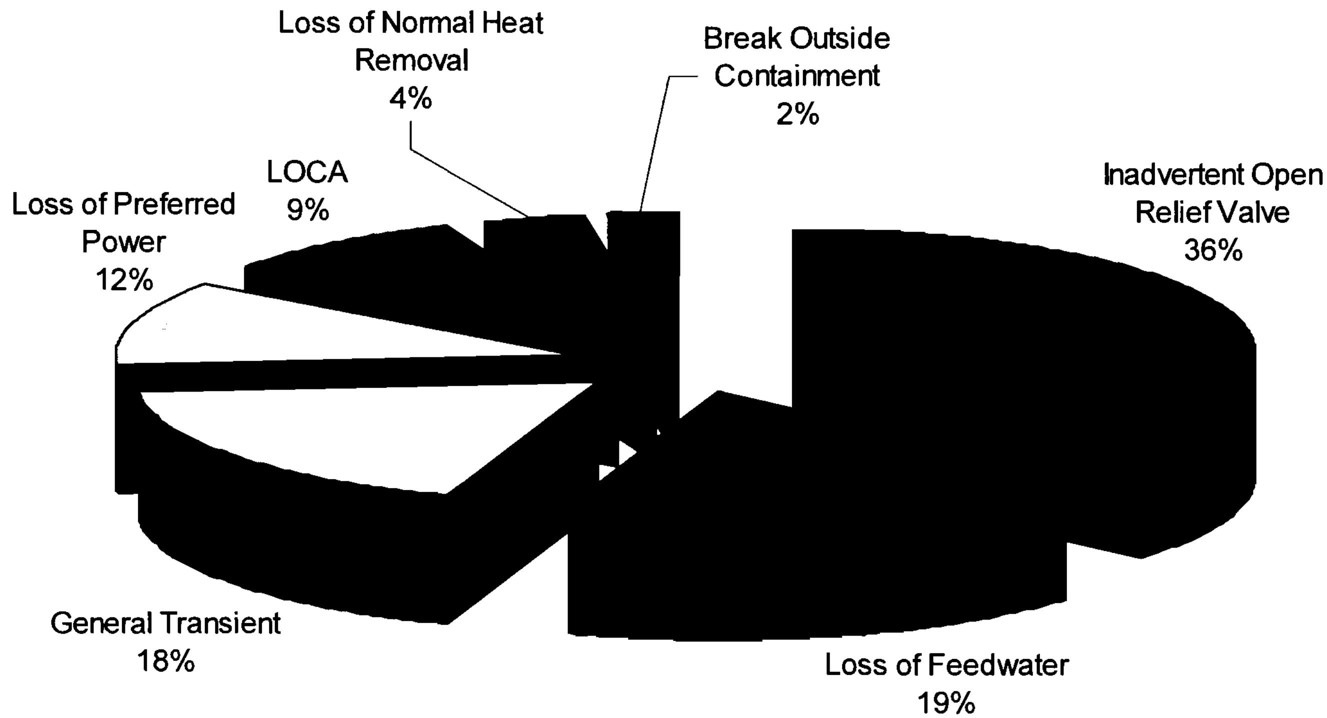
ESBWR Core Damage Risk Profile



$$CDF_{pe} = 1.2\times10^{-8} /yr$$

$$CDF_{mean} = 1.1\times10^{-8} /yr$$

At power internal events

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Overall Results

	Internal Events	Fire	Flood	High Winds
At-Power CDF	1.22×10^{-8}	8.06×10^{-9}	1.62×10^{-9}	1.34×10^{-9}
Shutdown CDF	9.37×10^{-9}	2.71×10^{-8}	5.24×10^{-9}	1.19×10^{-9}
At-Power LRF	9.6×10^{-10}	5×10^{-10}	2×10^{-10}	3×10^{-11}
Shutdown LRF	9.37×10^{-9}	2.71×10^{-8}	5.24×10^{-9}	1.19×10^{-9}

Point Estimate Values
Units are (1/yr)

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Initiating Events Analysis

Transients based on historical BWR data

- NUREG-5750
- General, Loss of PCS, Loss of Feedwater, IORV

Loss of offsite power based historical data

- NUREG/CR-6890
- Plant, Switchyard, Grid, Weather related events

Loss of coolant accidents

- NUREG-5750 scaled for ESBWR piping arrangement
- Includes inadvertent ADS, spurious DPV & multiple spurious SRV
- Includes vessel rupture (NUREG-1806)

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Initiating Events Analysis

Breaks outside containment

- NUREG-5750
- Main steam, Feedwater, RWCU, ICS

Interfacing systems LOCA

- Two candidates are subsumed into other scenarios

Special initiators

- NUREG-5750
- Loss of service water, Loss of instrument air

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Initiating Events Analysis

Significant open items

- none

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Accident Sequence Analysis

Linked fault tree methodology

Front line systems (passive and active) included as headings

Success criteria based on thermal-hydraulic calculations

- MAAP 4.06, TRACG
- In general, single bounding criterion applied all event trees
- Sensitivity analyses confirm success criteria
- MAAP case performed for each success end state

Six end states to support containment analyses

Success Criteria - LLOCA

	PRA	Minimum
GDCS Valves	2	< 1
GDCS Pools	2	1
Equ Valves	1	0
PCCS	4	< 2

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Success Criteria - MLOCA

	PRA	Minimum
GDCS Valves	2	< 1
GDCS Pools	2	1
Equ Valves	1	0
PCCS	4	< 2
DPV	4	< 3

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Accident Sequence Analysis

Mission time

- Passive design requires very long mission time analysis
  - Evaluation consider safe, stable state as success
  - Not necessarily cold shutdown
- Event sequences consider entire mission time
- Data for components uses maximum 24 hour mission time

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Accident Sequence Analysis

Significant open items

- Thermal-Hydraulic analysis for passive system success criteria
  - Cases used for TRACG/MAAP4 comparisons did not cover scenarios where the water level dropped below TAF
  - TRACG models for calculating clad temperature need to be described
  - Responses are being developed for these issues
- Rationale for selection of limiting accident scenarios not provided
  - Roadmap to this information provided in an RAI response
- Treatment of parameters affecting T-H uncertainty not provided
  - Information provided in an RAI response and in rev 3

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Systems Analysis

Fault trees used to model system functions

- 29 Systems
  - 12 Front line systems
  - 17 Support systems
- 39 Functions

Based on descriptions in DCD Tier 2, Topical Reports, and internal design specifications

Typical maintenance schedule assumed

Multiple plant configurations included in the model

- Single configuration included in the results

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Systems Analysis

Significant open items

- none

Data Analysis

Bounding analysis

- Generic data representative of operating BWRs
  - ALWR URD, GE generic database, engineering judgment
  - Passive component failure rates adjusted for long maintenance intervals
- Uncertainty distributions included for all data
- Increased squib valve failure rates
- High end digital system failures
- Screening values for limited operator actions

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Data Analysis

Common Cause Failures

Multiple Greek Letter methodology

Generic sources

- ALWR URD
- NUREG/CR-5497
- EPRI TR-100382
- NUREG/CR-5801

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Data Analysis

Significant open items

- none

Human Reliability Analysis

ESBWR design PRA minimizes reliance on operator actions

- Type A – Pre-initiating event actions
  - Significant parameters addressed in HFE
- Type B – Human action induced initiating events
  - Included in historical data
- Type C – Post-initiating event actions
  - Limited set – also addressed in detailed HFE
  - Screening values used based on time required to perform the action
- Dependency analysis included

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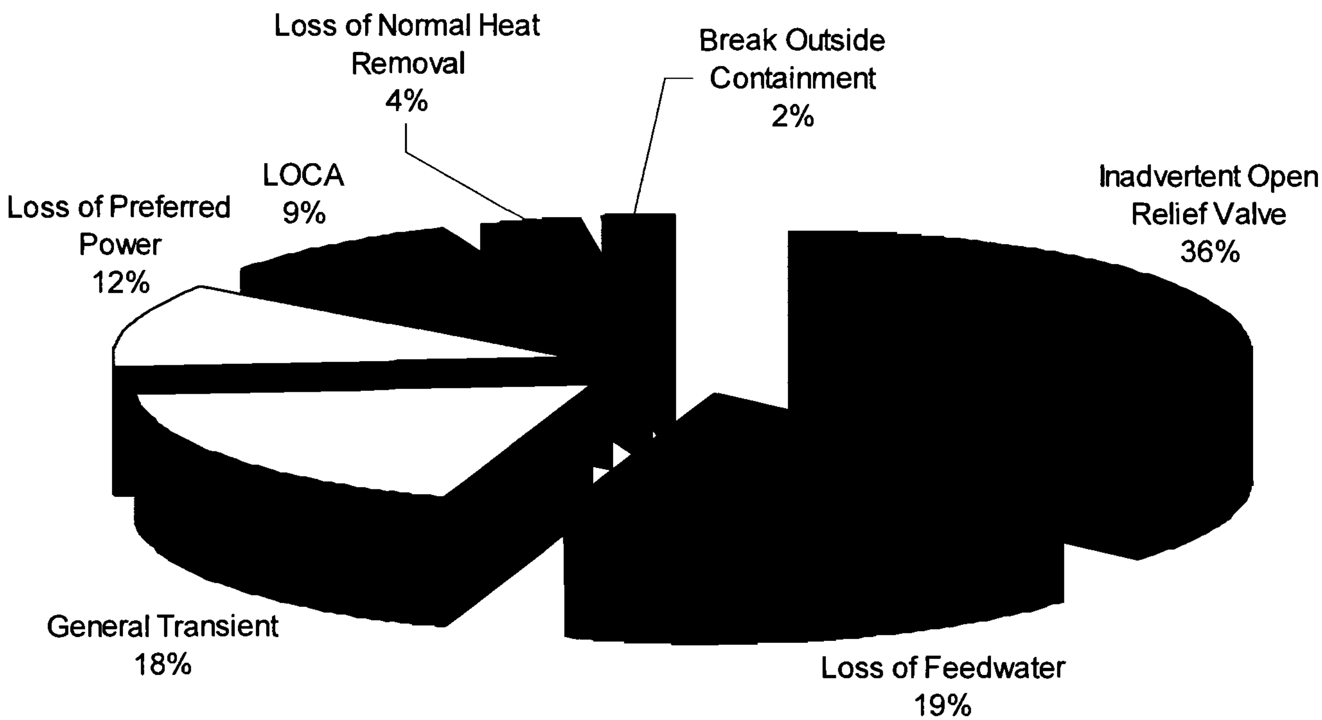
Human Reliability Analysis

Significant open items

- none

Level 1 Results



PRA rev 2

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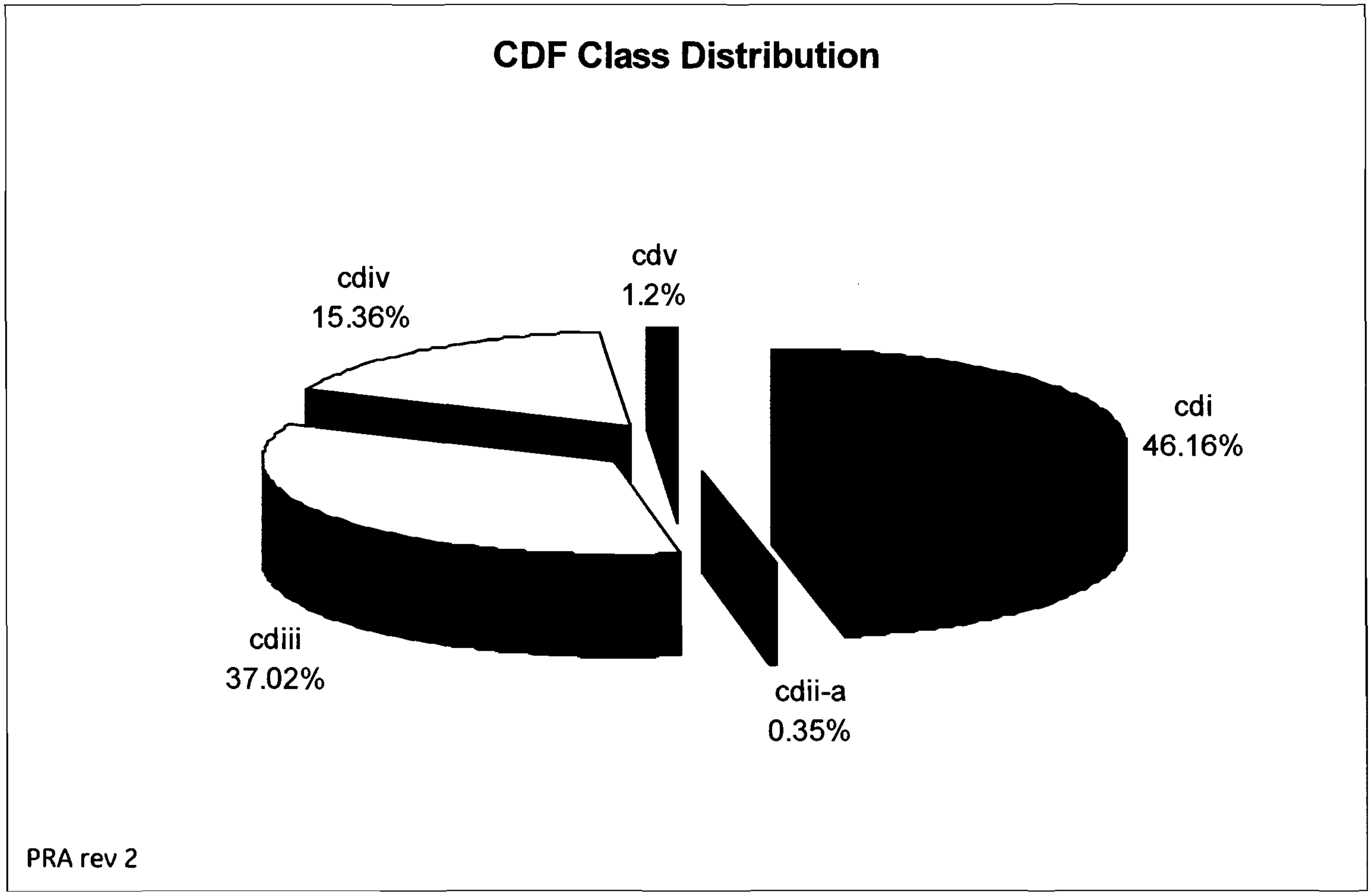
Level 1 Results



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Level 1 Results

Sequence T-IORV063		Sequence No. 1
CDF	2.06E-09	
% of Class I CDF	36.61%	
% of total CDF	16.90%	
Initiating event	Inadvertent Open Relief Valve	

Scram is successful

Feedwater Injection Fails

Both CRD Pumps fail to restore level

Failure to Manually Depressurize with SRVs

ADS Depressurization with DPVs is successful

DW/WW vacuum breakers suppress containment pressure

Low Pressure Injection with GDCS, FAPCS, and Firewater fail

Vessel fails at low pressure

Lower drywell water level is LOW

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Level 1 Results

Sequence AT-T-GEN023 Sequence No. 2

CDF 1.3E-09

% of Class IV CDF 69.66%

% of total CDF 10.70%

Initiating event General Transient (e.g. turbine trip)

Scram fails

Feedwater Runback is successful

SRVs lift and overpressure protection is successful

ADS Inhibit is successful

One of two trains of SLC fails

Vessel fails at low pressure*

Lower drywell water level is LOW

*It is assumed that operators depressurize once core damage is imminent.

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Level 1 Results

Sequence	T-FDW050	Sequence No. 3
CDF	1.14E-09	
% of Class I CDF		20.26%
% of total CDF		9.35%
Initiating event		Loss of Feedwater

Scram is successful

Isolation Condensers fail to provide overpressure protection

SRVs lift - overpressure protection is successful

All SRVs reclose

ADS is successful using DPVs

DW/WW vacuum breakers are successful - pressure suppression is successful

GDCS fails

Low pressure injection using FAPCS, Firewater and CRD fail

Vessel fails at low pressure

Lower drywell water level is LOW

Level 1 Results

Sequence	T-IORV018	Sequence No. 4
CDF	9.02E-10	
% of Class III CDF		19.98%
% of total CDF		7.39%
Initiating event		Inadvertent Open Relief Valve

Scram success

Feedwater injection fails

Both CRD fail to restore level

Manual Depressurization using SRVs is successful

Low pressure injection with FAPCS and Firewater fail

ADS fails to depressurize using DPVsVessel fails at low pressure*

Lower drywell water level is LOW

*Pressure is low prior to RPV failure due to IORV

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Level 1 Results

Sequence AT-T-GEN021 Sequence No. 5

CDF 8.78E-10

% of Class III CDF 19.46%

% of total CDF 7.20%

Initiating event General Transient (e.g. turbine trip)

Scram fails

Feedwater runback success

SRVs lift – overpressure protection is successful, but one or more SRVs sticks open

ADS Inhibit is successful

SLC is successful

Feedwater and CRD fail to maintain reduced levelVessel fails at low pressure *

Lower drywell water level is LOW

*It is assumed that operators depressurize once core damage is imminent or pressure is low prior to RPV failure due to IORV.

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Containment Performance Analysis

Level 2 based on the severe accident phenomena evaluation which uses ROAAM

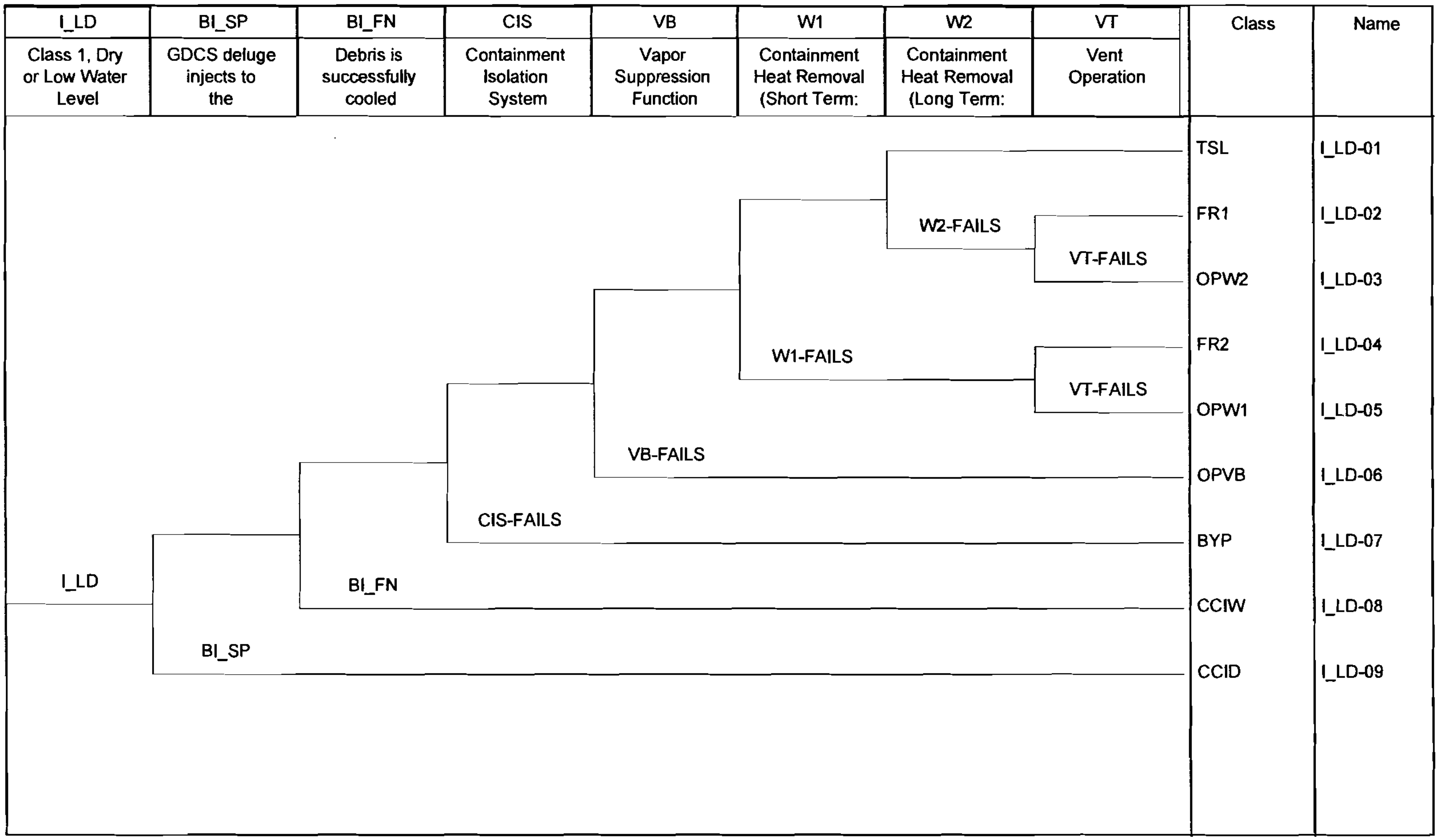
- Phenomena discussed in Severe Accident section

Containment system models incorporated

Fully linked model

Any release larger than "allowed leakage" is considered Large

Level 2 – Class I With Low DW Water Level



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Level 2 Results

Release category	Frequency (per year)
TSL	1.12E-8
FR	< 1E-12
BYP	5.6E-11
OPVB	1.6E-11
OPW1	3.2E-11
OPW2	< 1E-12
CCIW	9.9E-11
CCID	1E-12
EVE	6.10E-10
DCH	Physically Unreasonable
BOC	1.47E-10

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Level 2

Significant open item

- Further information was requested on vacuum breaker design, coverage in DCD and ITAAC, and on emergency procedures related to failed vacuum breakers
  - Responses to RAIs 19.2-6, 19.2-10, and 19.2-11 address these issues
  - VB design discussed in Chapter 6 review
  - COL item established to develop emergency procedures

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Source Terms

15 Release categories evaluated

Representative sequences cover all core damage end states

Magnitude and timing of releases described

Significant open items

- none

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Offsite Consequences

Calculated using MAACS2

Population and climate derived from ALWR URD

Dose results mostly from containment intact sequences

- 58% TSL
- 29% EVE

Individual risk is 8.2e-11 /yr

- 72% from EVE
- 6% from BYP

Societal risk is 1.1e-11 /yr

- 50% from EVE
- 22% from BYP
- 12% from BOC

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Offsite Consequences

Significant open items

- none

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Uncertainty And Sensitivity Analyses

Systematic process for determining sensitivities

Two categories

- Data estimates
- Modeling

Reviewed all assumptions and insights

Results presented in Section 11

- Level 1 – 16 cases
- Level 2 – 3 cases
- RTNSS – 9 cases
- Fire – 8 cases
- Other external events – 5 cases

Uncertainty and Sensitivity Analyses

Significant open items

- Thermal-hydraulic uncertainty
  - Discussed in accident sequence slides
  - Resolution has both probabilistic and deterministic attributes
    - Probabilistic justification presented on next 3 slides

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Thermal-Hydraulic Sensitivities

Adjusted success criteria in event trees

- GDCS valves
- DPV valves
- PCCS heat exchangers

Design basis criteria (single failure allowed)

Added redundancy until CDF reached baseline

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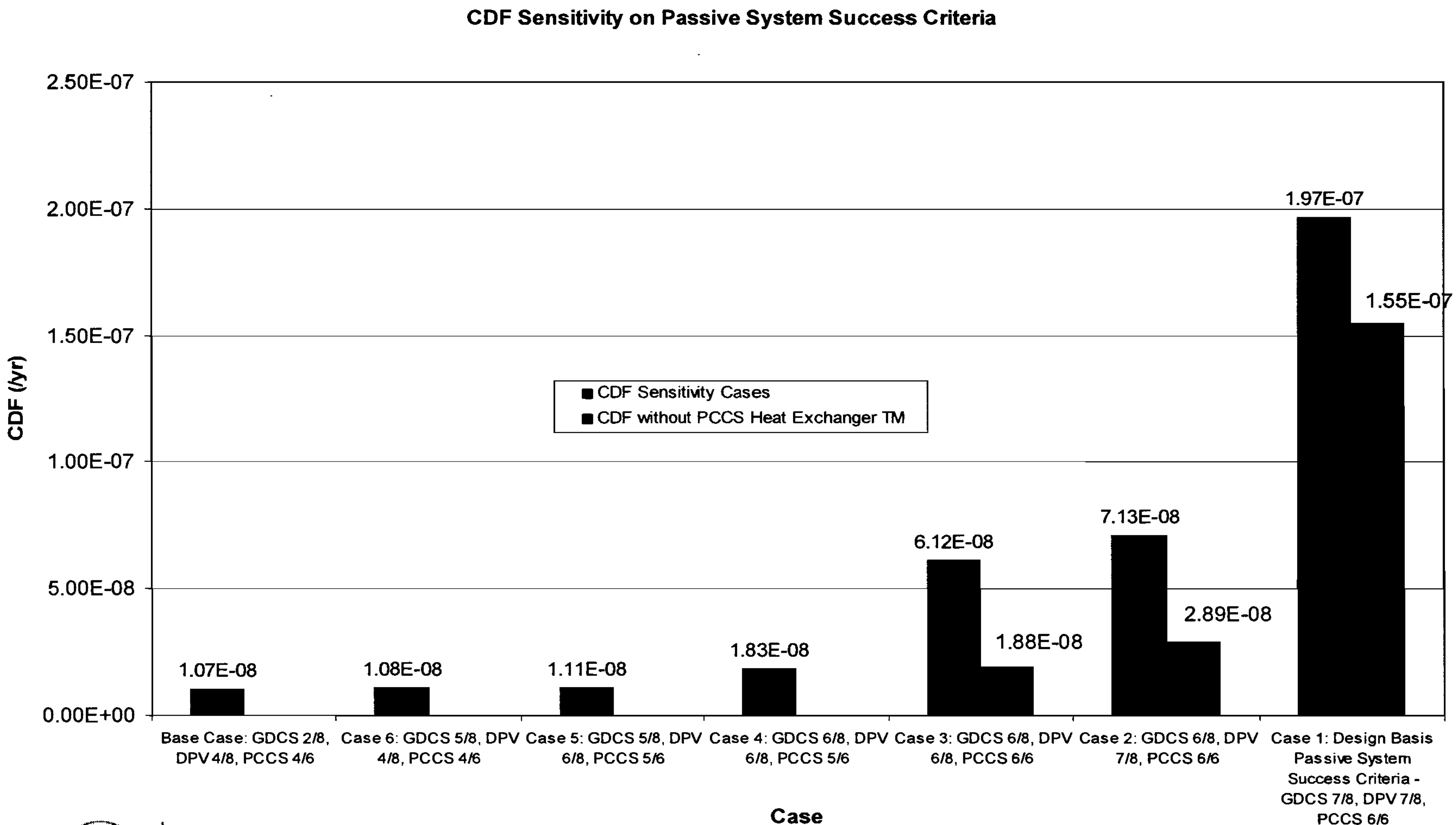
CDF Sensitivity on Passive System Success Criteria
2.50E-07
2.00E-07
1.50E-07
1.00E-07
5.00E-08
0.00E+00
CDF (/yr)
CDF Sensitivity Cases
CDF without PCCS Heat Exchanger TM
1.07E-08
1.08E-08
1.11E-08
1.83E-08
6.12E-08
1.88E-08
7.13E-08
2.89E-08
1.97E-07
1.55E-07
Base Case: GDCS 2/8, DPV 4/8, PCCS 4/6
Case 6: GDCS 5/8, DPV 4/8, PCCS 4/6
Case 5: GDCS 5/8, DPV 6/8, PCCS 5/6
Case 4: GDCS 6/8, DPV 6/8, PCCS 5/6
Case 3: GDCS 6/8, DPV 6/8, PCCS 6/6
Case 2: GDCS 6/8, DPV 7/8, PCCS 6/6
Case 1: Design Basis Passive System Success Criteria - GDCS 7/8, DPV 7/8, PCCS 6/6
Case

Thermal-Hydraulic Sensitivity Results

GDCS success not significant until 6 of 8

PCCS success not significant until 6 of 6

- Test and maintenance assumption is key

DPV success not significant until 7 of 8

Any redundancy allows for acceptable CDF

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Fire Risk Assessment

Analysis is based on NUREG/CR-6850 methods

Simplifying assumptions

- All fires grow to be "fully developed" and affect whole area
- No credit for suppression
- I&C design precludes spurious actuations, however fires in the reactor building that spread to multiple barriers include a non-mechanistic spurious SRV actuation

Fire Risk Assessment

Spurious actuations

- ESBWR design precludes hot shorts
  - Fiber optic connections
  - Actuation devices in multiple separated areas
  - Requirements on digital components to be qualified to prevent spurious operations in presence of fire and smoke

Strict adherence to separation is key to low fire risk

Calculated fire risk is expected to be reduced when as-built information is available to enable fire modeling

Calculated fire risk is expected to be reduced when fire mitigation procedures are developed

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Fire Risk Assessment

Significant open items

- none

Flood Risk Assessment

Floods are assumed to drain entire reservoir

Fire doors do not provide flood protection

No credit for operator actions to mitigate floods

Flood is not a significant contributor to risk

Significant open items

- none

High Winds Risk Assessment

Seismic Cat I buildings are assumed to withstand hurricane and tornado events

Seismic Cat II buildings are assumed to withstand hurricane events

Non-seismic buildings that house RTNSS C equipment can withstand hurricane events

Event frequencies are based on historical data

- Hurricanes include only coastal plant data

Given the above assumptions, ESBWR risk is low with respect to high winds

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High Winds Risk Assessment

Significant open items

- Justification for assumed conditional probability of zero that Category 4 or 5 hurricanes can damage structures
  - Loads on Cat I and II structures is bounded by seismic events by an order of magnitude
- Not clear whether credit was taken for equipment in Seismic Category II structures hit by tornado missiles
  - GEH failed equipment in Cat II structures for F5 Tornados
- Staff questions declarations that tornado and hurricane assessments are bounding
  - Analyses show that risk is not sensitive to tornado frequency
  - Insights from ESBWR analysis indicates that designing for hurricanes is important. All reasonable protection is provided in the design
- Responses are being developed for these items

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Seismic Margins Analysis

Framework for margins has been established

Only credits seismic Cat I structures and equipment located in Cat 1 structures

Capability of structures can be inferred based on Cat I design requirements

Capability of systems is assumed

As-built information is needed to confirm capability

COL item commits to confirm 1.67 x SSE capability for buildings and equipment

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Seismic Margins Analysis

Significant open issues

- GEH used a spectrum shape different from the Certified Seismic Design Response Spectra (CSDRS) for HCLPF estimates
  - Performance based response spectrum used
  - Bounds all potential ESBWR sites
  - GEH believes GMRS is the correct spectrum to use for as-built seismic margins capability assessment
- Seismic margins SSE has not been defined as CSDRS
  - See above
- Fault-tree for Fire Protection Water System does not model all of the components in the system that must survive the earthquake
  - Revision 3 identifies all of these components

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Shutdown Risk Analysis

Modes 2, 3, and 4 assumed to be bounded by full power analysis

Modes 5 and 6 needed to be split to account for unique behavior

- Mode 5 head on
- Mode 5 head off
- Mode 6 unflooded
- Mode 6 flooded

No credit for containment in shutdown PRA

LOCA during shutdown is more than 90% of CDF

- Lower Drywell hatch needs to be controlled during outages

Shutdown Risk Analysis

Significant open items

- GEH needs to define Technical Specification for DPVs during Modes 5 and 6 w/vessel head on
  - Revision 5 TS specifies 6 DPVs are required
- Staff questions ability of Isolation Condenser to function effectively for some operational conditions in Mode 5
  - Water level above the ICS steam nozzle is the issue
  - This analysis will be provided in an RAI response

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Shutdown Risk Analysis

- GEH must determine range of conditions (temperature and level) for which the RWCU/SDC can adequately remove decay heat in Modes 4, 5, and 6 (with the RPV head installed)
  - Response is under review
  - RWCU/SDC can maintained subcooled conditions as long as the suction nozzle is covered
- Staff concerned that RWCU/SDC injection may by-pass the core due to inadequate mixing in downcomer
  - Response is under review
  - Configuration is similar to ABWR

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Severe Accident Management

Threat	Failure Mode	Mitigative System
[redacted]		

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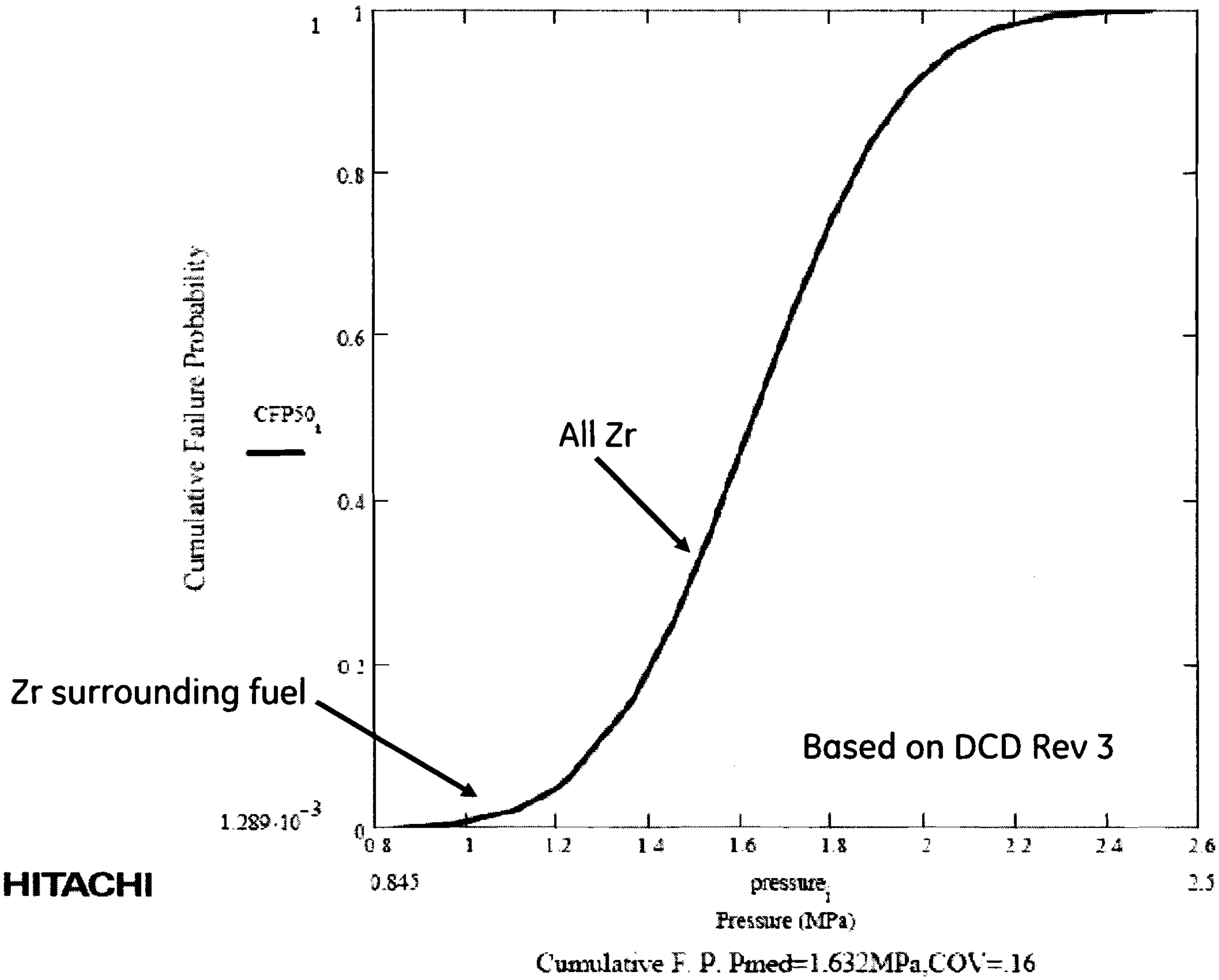
Containment Fragility – Composite Curve



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Containment Fragility

Significant open item

- Calculated upper drywell liner strain appears to exceed Level-C limit under conditions of 100% metal/water reaction
  - The documentation is not clear that service level C is presented in gauge while the metal/water results are presented in absolute
- Temperature boundary condition for drywell head in finite element model set at 110 °F versus drywell air space temp of 500 °F
  - Analysis using 500 °F is presented in rev 5 of the DCD

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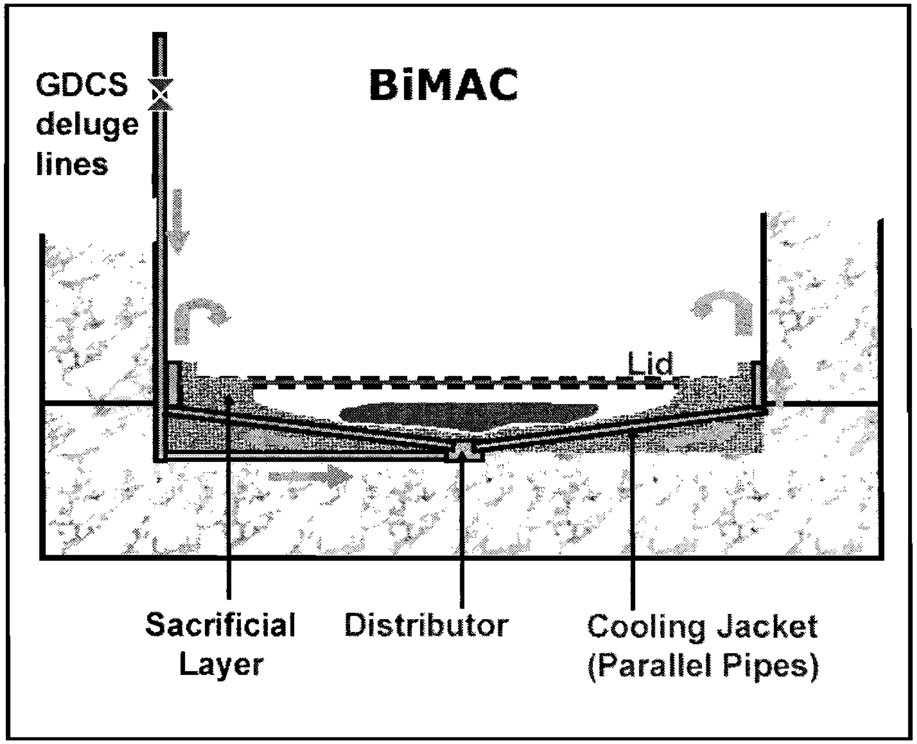
The Basemat internal Melt Arrest and Coolability (BiMAC) device



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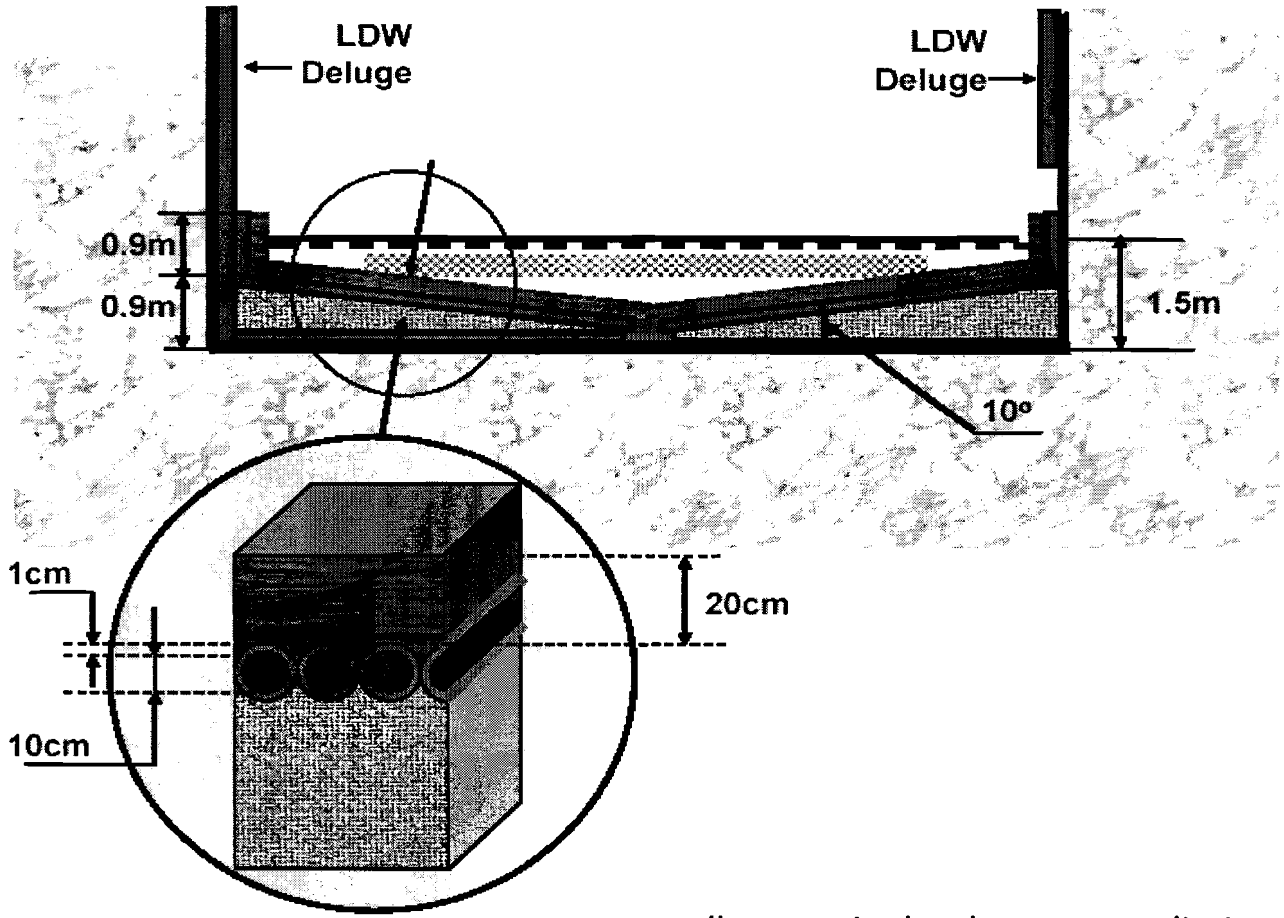
BiMAC Configuration



All Numerical Values are Preliminary

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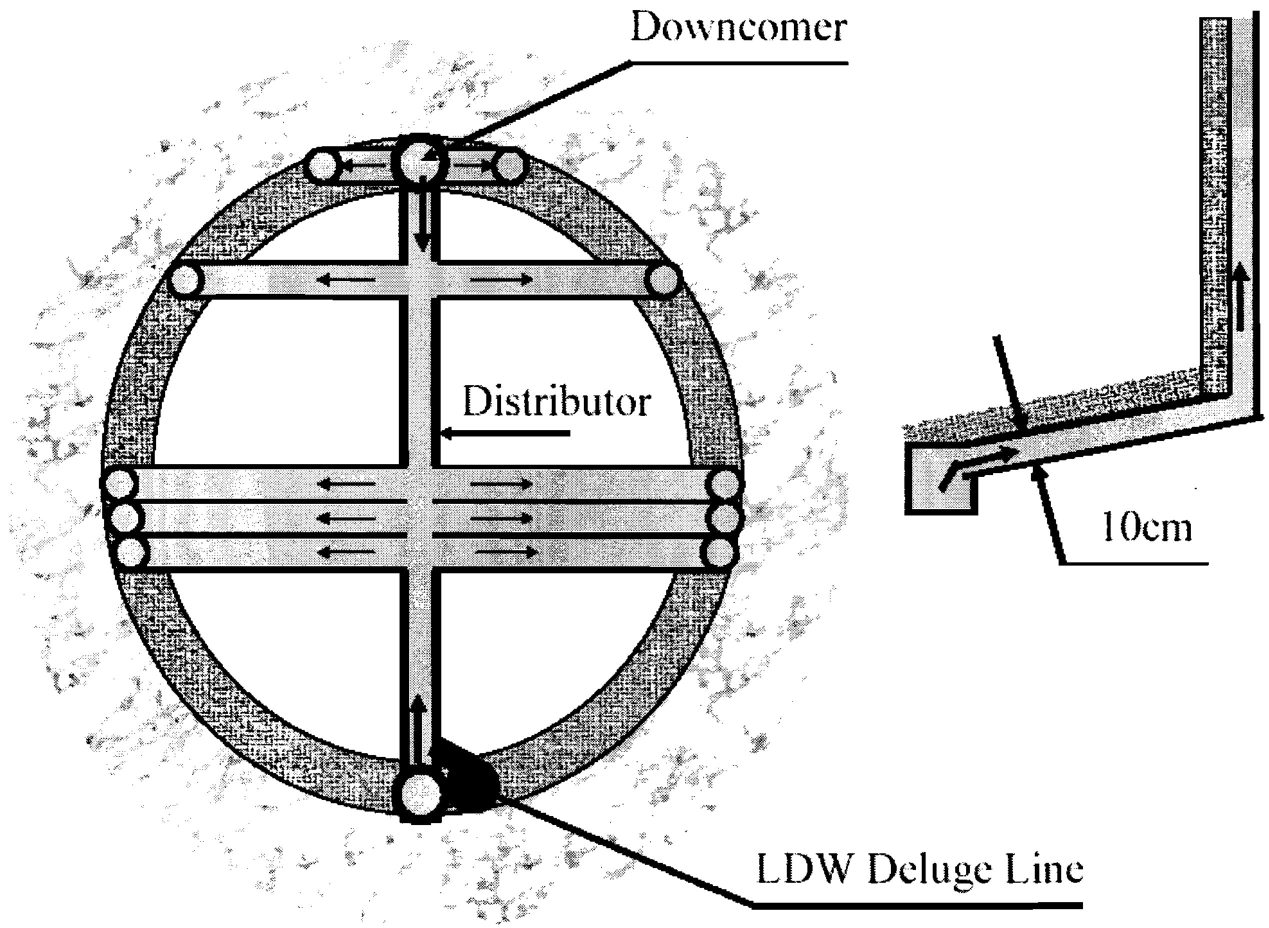
BiMAC Flow Path



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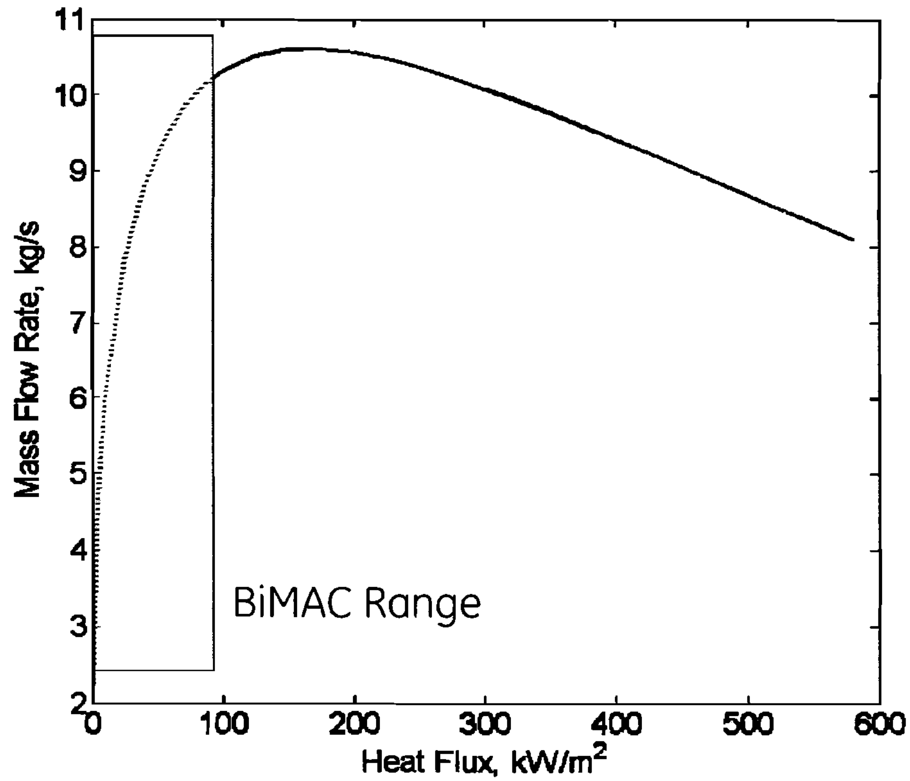
Natural Convection in BiMAC



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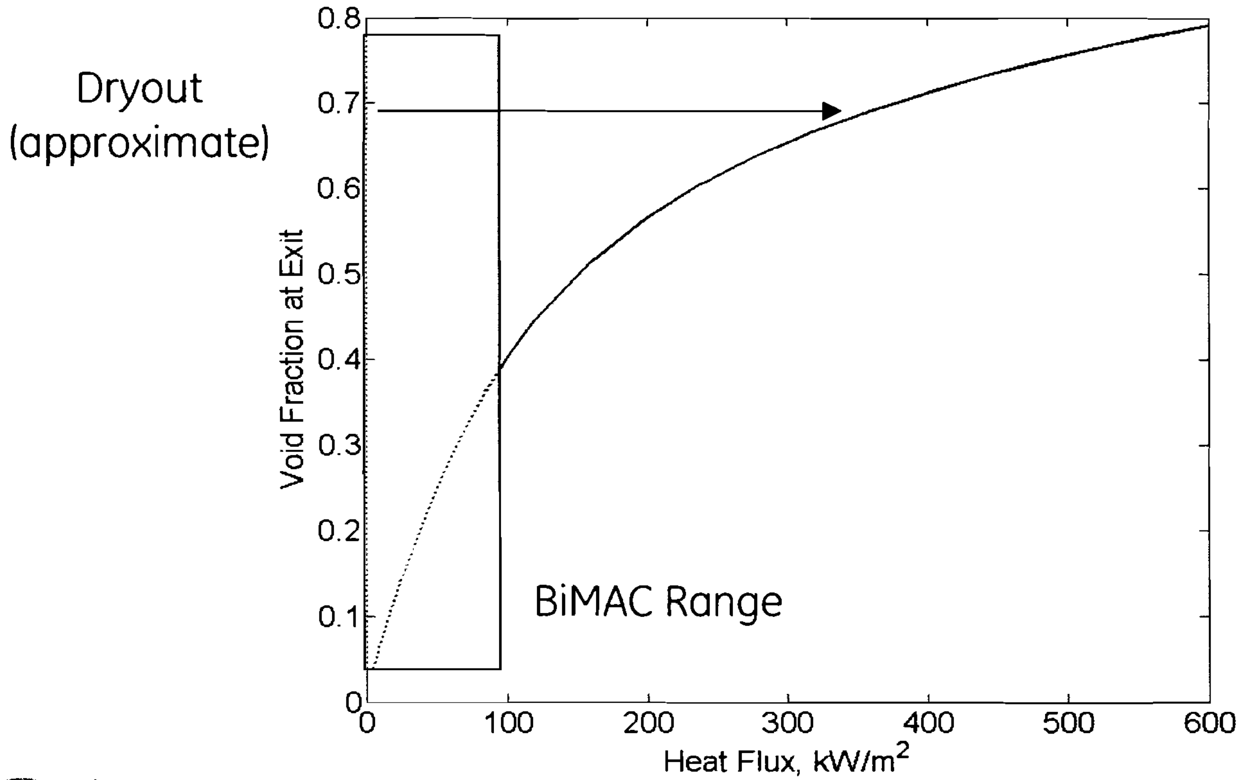
Wetting of BiMAC Horizontal Channels



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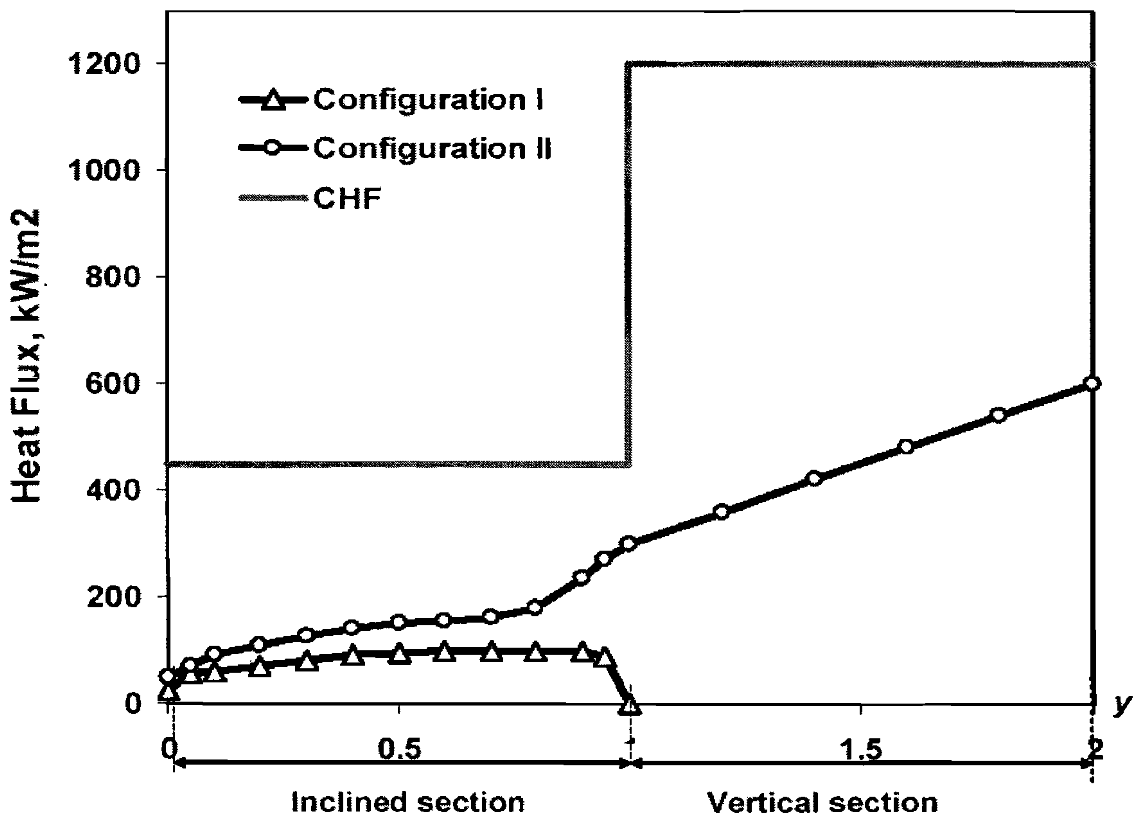
Thermal Loads against Coolability Limits in BiMAC Channels



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BiMAC Thermal-Hydraulic Testing

Results provided in NEDE-33392P

- Demonstrates that the analytical results presented on the previous slides are bounding
- Even a few degrees of subcooling greatly enhances the performance of the BiMAC
- Staff is reviewing this document to close a significant open item

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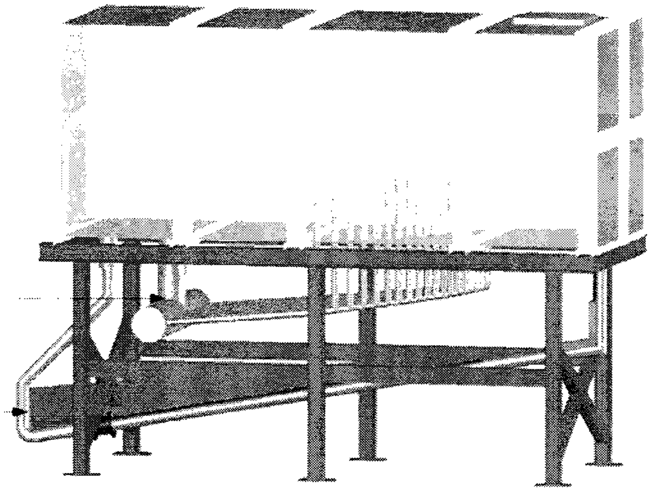
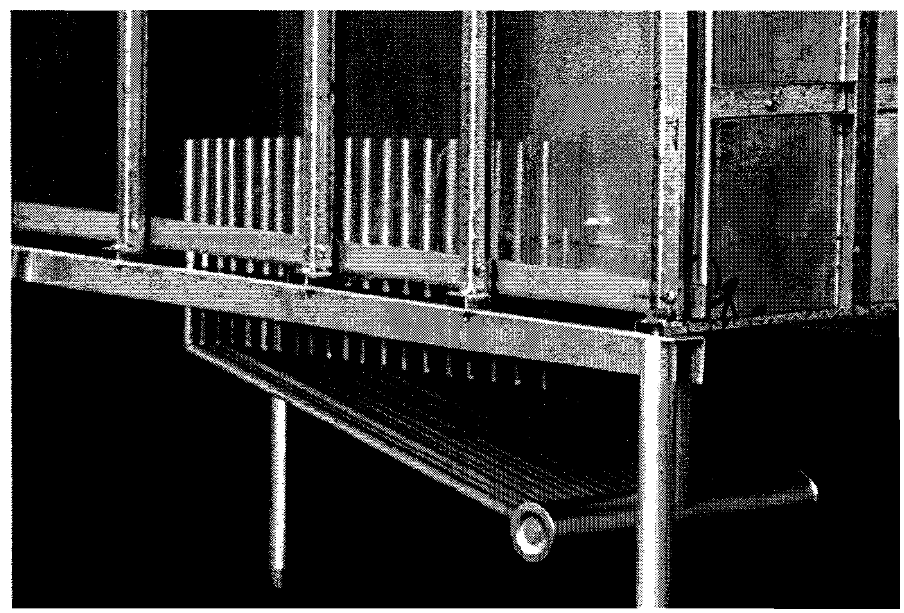
Test Overview

Systems Effects (SE)
[½ scale, ¼ symmetry]

Single Channel (SC)
[Full scale tests]



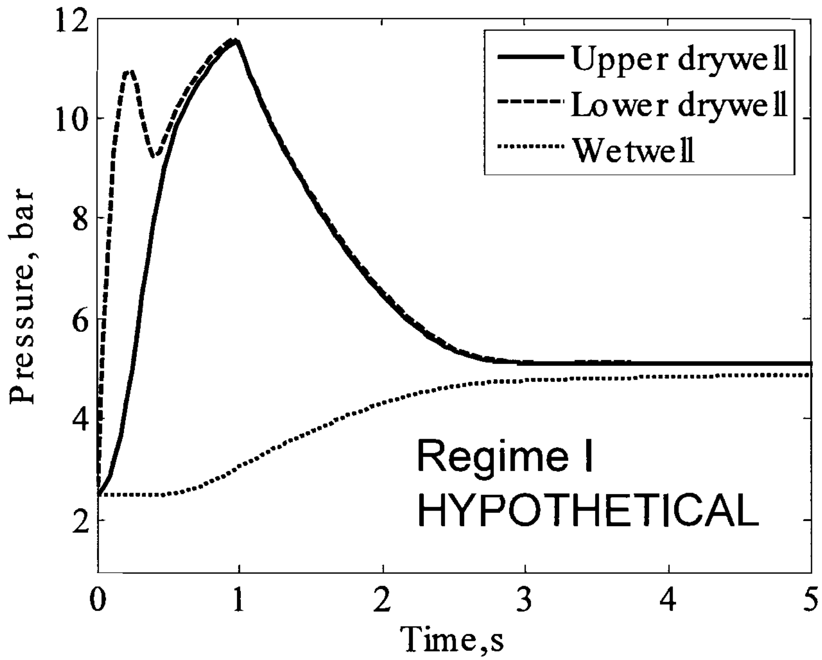


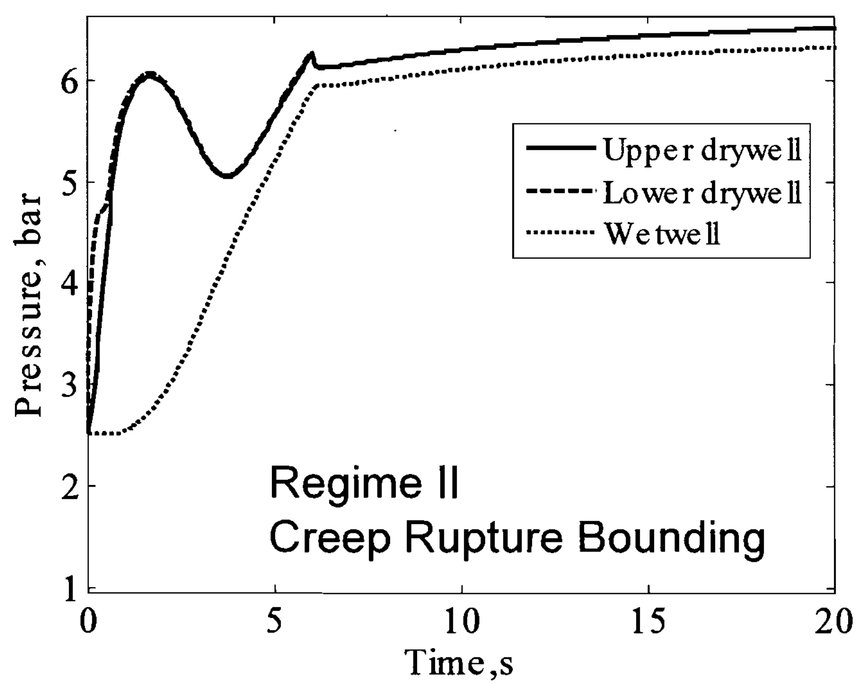
HITACHI

Quantification of DCH Loads

Identified Three Dynamic Regimes

Used Complete Space (up to all fuel, Zr, and SS) to Bound Independently each Failure Mode

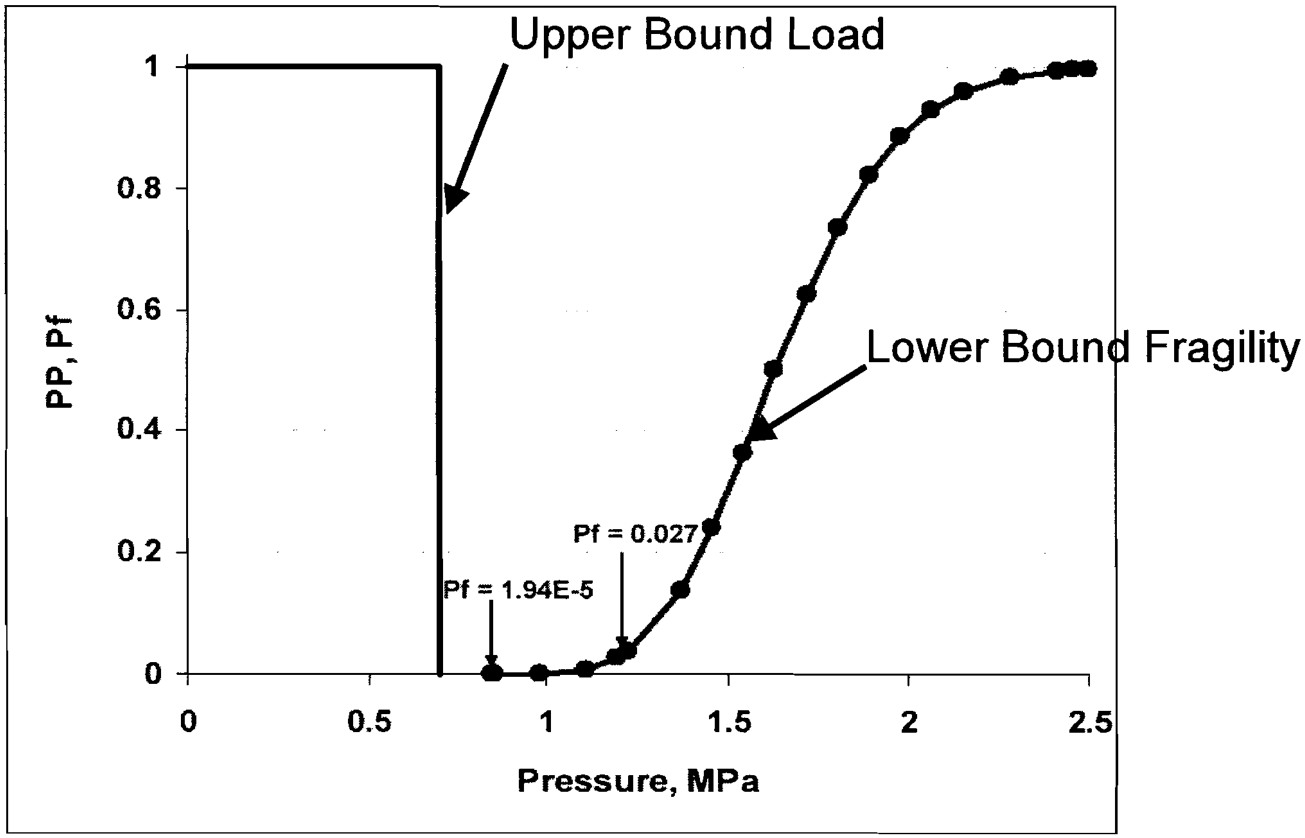




HITACHI

Regime III Expected (not shown)

Minimum (bounding) Margins to Energetic DCH Failure



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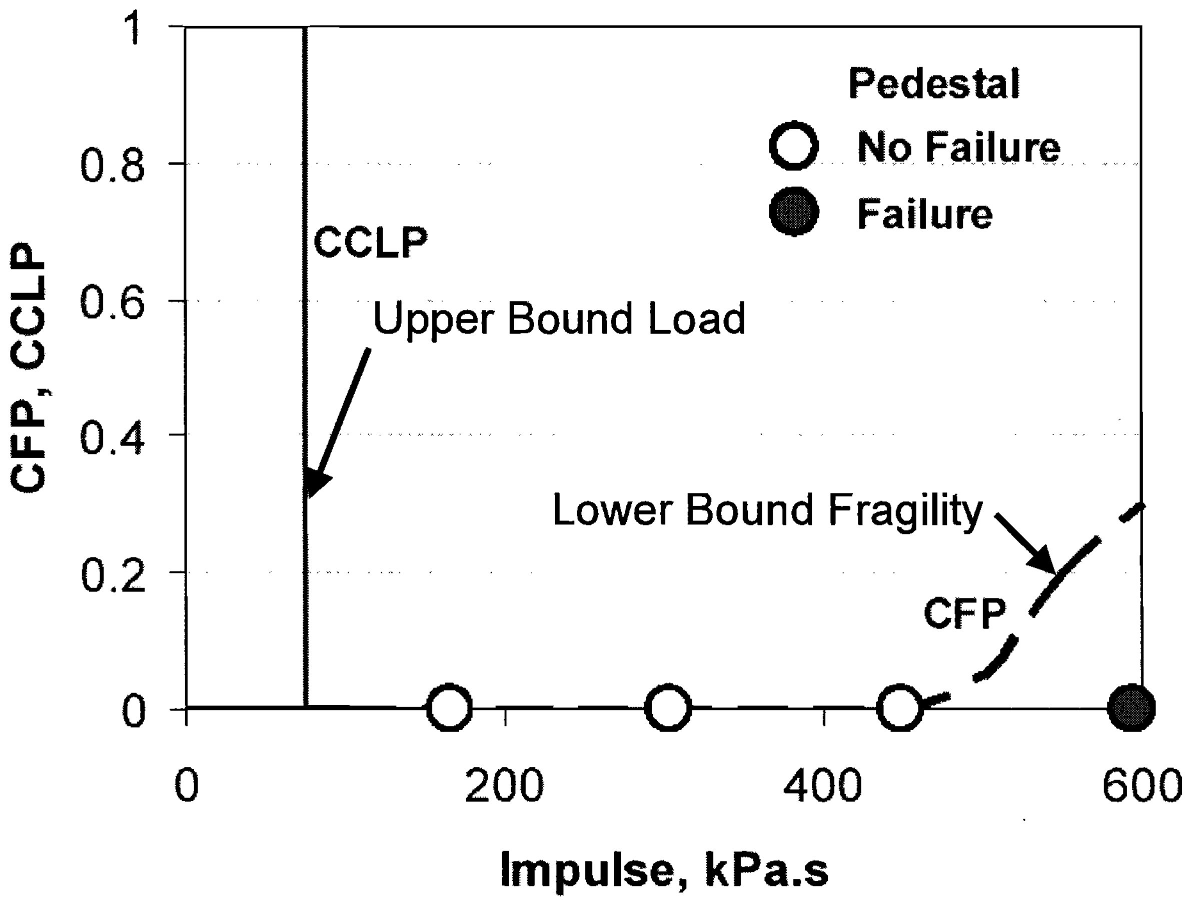
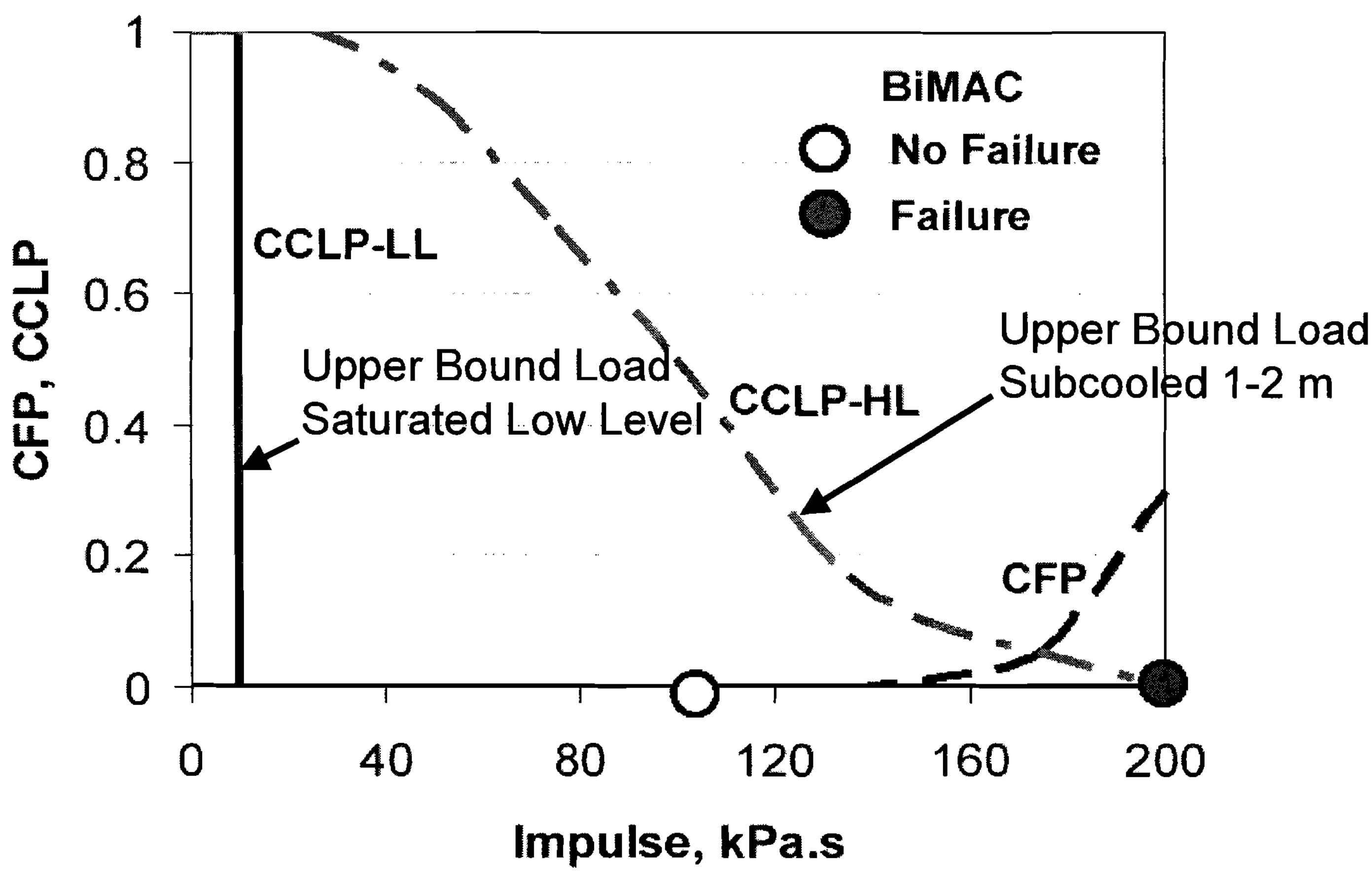
Pedestal Failure Margins to EVE

1 to 2 m Subcooled Pools



BiMAC Failure Margins Due to EVE
1-2 m subcooled pools



Additional Open Items

- The staff requested additional information on the process that will be used by GEH to develop the Severe Accident Guidelines (SAGs)
  - A description of how this is being addressed within the HFE process was provided as a response
- Applicant's basis for ensuring PRA quality is adequate for design certification not provided in DCD
  - The results of the self assessment of the PRA with respect to ASME-RA-Sb-2005 was presented to the staff. This is now considered closed

HITACHI

ESBWR Design PRA Revision 3

Submitted June 1, 2008

Reviewed differences between PRA rev 2 model and DCD rev 5 configuration

No significant change in the risk assessment results and insights

Added Section 22 to describe the differences and any sensitivity analyses needed to support our conclusions

HITACHI

Presentation to the ACRS Subcommittee

ESBWR Design Certification Review
Chapter 19

Presented by
NRO/DNRL/NGE1 and NRO/SPLB

June 3, 2008

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

Purpose:

Brief the Subcommittee on the results of the staff's review of the ESBWR DCD application, Chapter 19

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

Review Team for Chapter 19:

- Lead Project Manager
  - Rocky D. Foster, Project Manager
- Lead Technical Reviewer
  - Mark Caruso, Sr. Risk & Reliability Engineer
- Technical Reviewers
  - Edward Fuller, Sr. Risk & Reliability Engineer
  - Marie Pohida, Sr. Risk & Reliability Engineer
  - Glenn Kelly, Sr. Risk & Reliability Engineer
  - John Lai, Risk & Reliability Engineer
  - Jim Xu, Sr. Structural Engineer

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

Outline of Presentation:

RAI Status Summary

Applicable Regulations

SER Technical Topics

Significant Open Items

COL Action Items

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

RAI Status Summary:

289 RAIs

272 RAIs resolved

17 Open Items

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

Regulatory Requirements:

- 10 CFR 52.47(a)(8) – comply with TMI requirements
- 10 CFR 52.47(a)(21) - resolve USI/GSI
- 10 CFR 52.47(a)(23) – provide description and analysis of design features for prevention and mitigation of severe accidents
- 10 CFR 52.47(a)(27) – provide description of PRA and results

Regulatory Guidance:

- Policy Statements on Severe Accidents and Use of PRA
- SECY-93-087, SECY-96-128, and SECY-97-044 - guidance for implementing features in new designs to prevent or mitigate severe accidents
- Regulatory Guide 1.206 and SRP Chapters 19.0 and 19.1

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

Commission's Objectives:

Use the PRA to identify and address potential design features and plant operational vulnerabilities.

Use the PRA to reduce or eliminate the significant risk contributors

Use the PRA to select among alternative features and design options.

Identify risk-informed safety insights

Determine how the risk associated with the design compares against the Commission's goals of less than 1x10-4/yr for CDF and less than 1x10-6/yr for LRF and containment performance goals

Assess the balance between severe accident prevention and mitigation.

Determine whether the plant design represents a reduction in risk compared to existing operating plants

Demonstrate compliance with 10 CFR 50.34(f)(1)(i) (i.e., perform a PRA)

Use PRA in support of programs and processes (e.g., RTNSS, RAP)

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.2 Quality of PRA

Technical Topics:

Success Criteria and Passive System Uncertainty
Treatment of Common-Cause Failures
Probabilistic Risk Assessment Technical Adequacy
PRA Maintenance Program

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.2 Quality of PRA

Significant Open Items:

Thermal-Hydraulic analysis for passive system success criteria

- cases used for TRACG/MAAP4 comparisons not appropriate
- rationale for selection of limiting accident scenarios not provided
- treatment of parameters affecting T-H uncertainty not provided
- TRACG models for calculating clad temperature need justification
- GEH provided partial response to RAI 19.1-1, Supplement 1, staff is evaluating

Applicant's basis for ensuring PRA quality is adequate for design certification not provided in DCD

- GEH response to RAI 19.1-155 acceptable, issue now closed

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.3 Design Features

Technical Topics:

Features for Preventing Core Damage

Features for Mitigating the Consequences of Core Damage and Preventing Releases from Containment

Features for Mitigating Releases from Containment

Uses of the PRA in the Design Process

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.3 Design Features

Significant Open Items:

None

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.4 Internal Events At-Power PRA

Technical Topics:

Level 1 PRA Insights
Level 2 PRA Insights

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.4 Insights from Internal Events At-Power PRA

Significant Open Items:

None

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.5 External Events At-Power PRA

Technical Topics:

Seismic Margins Analysis
High Winds Analysis
Internal Fires Analysis
Internal Floods Analysis

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.5.1 Seismic Margins Analysis

Significant Open Items:

GEH used a spectrum shape different from the Certified Seismic Design Response Spectra (CSDRS) for HCLPF* estimates.

Majority of SSCs treated in SMA assume a HCLPF equal to the limit of 1.67xSSE; however, the SSE has not been defined as CSDRS in the DCD.

- Awaiting response to RAI 19.2-92 from GEH

Fault-tree for Fire Protection Water System does not model all of the components in the system that must survive the earthquake

- Awaiting response to RAI 19.2-91 from GEH

*High Confidence of Low Probability of Failure defined as: Earthquake level at which, with high confidence (95 percent), it is unlikely (probability less than 5x10-2) that failure of the SSC will occur.

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.5.1 Seismic Margins Analysis

COL Action Item:

COL Holder shall compare the as-built SSC HCLPFs* to those assumed in the ESBWR seismic margin analysis. Deviations from the HCLPF values or other assumptions in the seismic margins evaluation shall be analyzed to determine if any new vulnerabilities have been introduced.

*High Confidence of Low Probability of Failure defined as: Earthquake level at which, with high confidence (95 percent), it is unlikely (probability less than 5x10-2) that failure of the SSC will occur.

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.5.4 High Winds Analysis

Significant Open Items:

Assumed conditional probability of zero that Category 4 or 5 hurricanes can damage structures not justified

Not clear whether credit was taken for equipment in Seismic Category II structures hit by tornado missiles

Staff questions declarations that tornado and hurricane assessments are bounding

Status: Awaiting responses to RAIs 19.1-165, 19.1-166, 19.1-167 and 19.1-169 Supplement 1 from GEH

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.6 PRA for Other Operational Modes

Technical Topics:

RCS vent capability in Modes 5 and 6

Capability of decay heat removal systems in Modes 4, 5 and 6

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.6 PRA for Other Operational Modes

Significant Open Items:

GEH needs to define Technical Specification for DPVs during Modes 5 and 6 w/vessel head on

- Awaiting response from GEH for RAI 19.1-143

Staff questions ability of Isolation Condenser to function effectively for some operational conditions in Mode 5

- Awaiting response from GEH for RAI 19.1-94 Supp. 1

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.1.6 PRA for Other Operational Modes

Significant Open Items (continued):

GEH must determine range of conditions (temperature and level) for which the RWCU/SDC can adequately remove decay heat in Modes 4, 5, and 6 (with the RPV head installed)

- response from GEH for RAI 19.1-96 Supplement 1 under staff review

Staff concerned that RWCU/SDC injection may by-pass the core due to inadequate mixing in downcomer

- response from GEH RAI 19.1-144 Supplement 1 under staff review

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.2 Severe Accidents

Technical Topics:

19.2.2	Severe Accident Prevention
19.2.3	Severe Accident Mitigation
19.2.4	Containment Performance Capability
19.2.5	Accident Management
19.2.6	Severe Accident Mitigation Design Alternatives

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.2.3 Severe Accident Mitigation

Significant Open Items:

BiMAC performance test report

- Response to RAIs19.2-23 S02 and 19.2-25 S02 included a topical report documenting the results of the BiMAC tests.
- Topical report NEDE-33392 is currently under staff review

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.2.3 Severe Accident Mitigation

Significant Open Items:

Vacuum breaker performance

- Further information was requested on vacuum breaker design, coverage in DCD and ITAAC, and on emergency procedures related to failed vacuum breakers.
- Responses to RAIs 19.2-6, 19.2-10, and 19.2-11 have recently been received and are acceptable.

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.2.4 Containment Performance Capability

Significant Open Items:

Calculated upper drywell liner strain exceeds Level-C limit under conditions of 100% metal/water reaction

- Awaiting response from GEH for RAI 19.2-86

Temperature boundary condition for drywell head in finite element model set incorrectly at 110 °F versus drywell air space temp of 500 °F

- Awaiting response from GEH for RAI 19.2-41 Supplement 2

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

19.2.5 Accident Management

Significant Open Items:

Description of the process for developing Severe Accident Guidelines

- The staff requested additional information on the process that will be used by GEH to develop the Severe Accident Guidelines (SAGs) in RAI 19.2.4-1 and its supplements.
- Response from GEH is under staff review

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19

<u>Discussion / Questions</u>

Presentation to the ACRS Subcommittee

ESBWR Design Certification Review
Chapter 19A (SER Chapter 22)

Presented by
NRO/DNRL/NGE1 and NRO/DSRA/SPLB

June 3, 2008

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19A (SER Chap. 22)

Purpose:

Brief the Subcommittee on the results of the staff's review of the ESBWR DCD application, Chapter 19A (SER Chapter 22)

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19A (SER Chap. 22)

Review Team for Chapter 19A (SER Chap. 22):

Lead Project Manager
- Rocky D. Foster, Project Manager

Lead Technical Reviewer
- Mark Caruso, Sr. Risk & Reliability Engineer

Technical Reviewers

- Eugene Eagle, Instrumentation and Controls Engineer
- Craig Harbuck, Sr. Operations Engineer
- Thomas Scarbrough, Sr. Mechanical Engineer
- Mohamed Shams, Structural Engineer
- David Shum, Sr. Reactor Systems Engineer
- George Thomas, Sr. Reactor Systems Engineer
- Hanry Wagage, Sr. Reactor Engineer

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19A (SER Chap. 22)

Outline of Presentation:

RAI Status Summary

Applicable Regulations

SER Technical Topics

Significant Open Items

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19A (SER Chap. 22)

RAI Status Summary:

24 RAIs

16 RAIs Resolved

8 Open Items

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19A (SER Chap. 22)

Regulatory Guidance:

SECY-94-084, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs," dated March 28, 1994.

SECY-95-132, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs," dated May 22, 1995.

SECY-96-128, " Policy and Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design," dated February 18, 1997.

Regulatory Requirements:

10 CFR 50.36(c)(2)(ii) – Technical Specifications

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19A (SER Chap. 22)

Regulatory Treatment of Non-Safety Systems (RTNSS)

CRITERIA FOR SELECTING RTNSS SSCs:

Non-safety SSC relied on to meet ATWS and SBO rules.

Non-safety SSC needed for core cooling, containment heat removal or control room habitability beyond 72 hours post accident.

Non-safety SSC that provides diagnostic info beyond 72 hours post accident.

Non-safety SSC relied on to meet Commission's safety goals

Non-safety SSC relied on to meet containment performance goals.

Non-safety SSC relied upon to prevent significant adverse interaction with passive safety system.

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19A (SER Chap. 22)

Regulatory Treatment of Non-Safety Systems

Technical Topics of Interest:

22.5.1	Focused PRA
22.5.2	Containment Performance Assessment
22.5.3	Seismic Consideration
22.5.4	Beyond Design Basis Evaluation -ATWS/SBO
22.5.5	Adverse Systems Interaction
22.5.6	Post-72 Hours Actions and Equipment
22.5.7	Regulatory Treatment
22.5.8	Technical Specifications
22.5.9	Availability Controls

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19A (SER Chap. 22)

22.5.5 Adverse Systems Interaction

Significant Open Items:

Staff requested additional details to explain and clarify the systematic approach to evaluate adverse system interactions between passive and active systems.

- GEH response to RAI 22.5-17 Supplement 1 acceptable, issue is closed

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19A (SER Chap. 22)

22.5.6 Post-72 Hours Actions and Equipment Augmented Design Standards

Significant Open Items:

Some SSCs needed for post-72 hour safety, housed in structures designed to a standard that may not guarantee functionality post-earthquake

- GEH response to RAI 22.5- 6 Supplement 1 under review

Additional information on structure design needed to enable the staff confirm RTNSS systems have been adequately protected from flood-related effects associated with both natural phenomena and system and component failures.

- Awaiting response to RAI 22.5-5 Supplement 1 from GEH

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19A (SER Chap. 22)

22.5.9 Availability Controls (AC)

Significant Open Items:

ACs did not state the associated instrumentation functions and the number of required divisions in the AC LCOs for some functions

- Awaiting GEH response to RAI 22.5-22

AC bases do not explicitly state the minimum level of system degradation that corresponds to a function being unavailable, or the number of divisions used to determine the test interval for each required division (or component) for AC surveillance requirements

- Awaiting GEH response to RAI 22.5-22

No AC Surveillance Requirements provided for FAPCS pumps

- Awaiting GEH response to RAI 22.5-23

AC LCOs for FAPCS and EDGs inconsistent with PRA assumptions

- Awaiting GEH response to RAI 22.5-24

ACRS Subcommittee Presentation
ESBWR Design Certification Review
Chapter 19A (SER Chap. 22)

Discussion / Questions