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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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RELIABILITY AND PROBABILISTIC RISK ASSESSMENT (PRA)

SUBCOMMITTEE

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OPEN SESSION

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WEDNESDAY, FEBRUARY 19, 2014

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ROCKVILLE, MARYLAND

The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., John W. Stetkar, Chairman, presiding.

COMMITTEE MEMBERS:

JOHN W. STETKAR, Chairman

DENNIS C. BLEY, Member

RONALD G. BALLINGER, Member

MICHAEL L. CORRADINI, Member*

JOY REMPE, Member*

STEPHEN P. SCHULTZ, Member

*Present via telephone

DESIGNATED FEDERAL OFFICIAL:

JOHN LAI

ALSO PRESENT:

KEITH COMPTON, NRC

SUSAN COOPER, NRC

RICHARD CORREIA, NRC

TINA GHOSH, NRC

FELIX GONZALEZ, NRC

DON HELTON, NRC

CHRIS HUNTER, NRC

ALAN KURITZKY, NRC

RICHARD LEE, NRC

OWEN SCOTT, Southern Nuclear Company

NATHAN SIU, NRC

MARGARET TOBIN, NRC

JEFF WOOD, NRC

MOHSEN KHATIB-RAHBAR, Energy Research, Inc.

MIKE ZAVISCA, Energy Research, Inc.

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P R O C E E D I N G S

(8:32 a.m.)

CHAIRMAN STETKAR: The meeting will now come to order. This is a meeting of the Reliability and PRA Subcommittee. I am John Stetkar, Chairman of the Subcommittee meeting. ACRS members in attendance are Dennis Bley, Ron Ballinger, and Steve Schultz. Mike Corradini and Joy Rempe will be joining us online. I believe that Joy is online now and Mike will join us sometime later.

MEMBER REMPE: John, can someone turn up a volume somewhere? It is very hard to hear you.

CHAIRMAN STETKAR: Joy, we are limited by the location of the microphones. Listen carefully.

MEMBER REMPE: Okay. At some point I need you to --

CHAIRMAN STETKAR: Joy, let me finish the introduction stuff. You will get to say -- to deliver your conflict of interest statement.

There will be a phone bridge line. To preclude interruption of the meeting, the phone will be placed I a listen-in mode during the presentations and committee discussions. A portion of this meeting will be closed in order to discuss and protect information designated as proprietary by the NRC pursuant to 5 USC 552(b)(c)(4).

By the way, I will ask all of the participants if during the open session of the meeting we start treading into areas that we are discussing proprietary information, just alert us and we will postpone that discussion or the answers until later in the afternoon when we do have the closed session.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's meeting. The subcommittee will gather information, analyze relevant issues and facts and formulate proposed positions and actions as appropriate for deliberation by the full committee.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously posted in the *Federal Register*. A transcript of the meeting is being kept and will be made available as stated in the *Federal Register* notice. Therefore, we request that participants in this meeting use the microphones located throughout the meeting room when addressing the subcommittee.

The participants should first identify themselves and speak with sufficient clarity and volume so they may be readily heard.

As some of you may notice, I have a bad cold. I hope my voice holds out for the remainder of the meeting. You hope it doesn't. I may have to turn it over Dennis if I have real problems.

And now, I believe that Dr. Rempe, you have a conflict of interest statement that you need to put on the record?

MEMBER REMPE: Yes. Due to some work -- although I didn't participate in the research done by my organization, there are individuals from my organization that participated in this project, so I will need to limit my comments at some portions of this meeting.

CHAIRMAN STETKAR: Okay. Thank you very much.

We will now proceed with the meeting and I call upon Rich Correia of the NRC staff to begin. Rich?

MR. CORREIA: Thank you. Good morning. Thank you for meeting with us. This is the fifth subcommittee briefing on the Level 3 PRA Project and we appreciate the feedback we have received so far.

We have turned the corner on this project and we have transitioned from establishing a project infrastructure to making significant progress on the technical work and 2014 promises to be an important production year for the project. We appreciate the substantial assistance being provided by Southern Nuclear Operating Company in supporting this work.

As you will hear shortly, we have staff and contractors across a number of technical disciplines highly engaged in the project and we are now making headway in all of the technical areas.

Besides providing an overview of the current status of the project, today's meeting gives an opportunity to brief the subcommittee in detail on the Level 2 and Level 3 portions of the study, as well as provide the framework for how some of the different parts of the study will fit together and we look forward to the subcommittee's feedback on the project.

And now I will turn it over to Alan Kuritzky for project status.

MR. KURITZKY: Thank you, Rich. And I would like to echo Rich's sentiments, too. We thank you and appreciate the opportunity to meet with the subcommittee because it has been a valuable part of our project since its inception and we look forward to getting more feedback today.

I would like to just introduce again myself. I am Alan Kuritzky from the Office of Research. Presenting today with me will be Felix Gonzalez, Don Helton, and Keith Compton will be coming up later, all from the Office of Research, as well as Mike Zavisca from our contractor, Energy Research Incorporated.

Later in the closed session, we will also be joined by Chris Hunter from the Office of Research to discussion some of the Level 1 PRA work to date.

So, in my presentation I just want to kind of get you up to speed on where we stand on all parts of the project. Okay, I wasn't expecting that slide. There we go. Okay, back on track.

Okay, so I want to just bring you up to date n all the different major parts of the project that we have been working on so far. The main thing that we have been doing so far is the reactor at-power work. Level 1 analyses for a number of different hazard groups, the internal events and floods, internal fires, seismic and the like, what I would refer to as HFOs. If you were from the IPEEE days you know high winds, floods, and other external events. I will euphemistically refer to them as HFOs.

We will also bring you up to date on where we are with the low-power shutdown work, as well as the Level 2 and 3 work for the internal event, internal flood PRA. Spent fuel pool, dry cask storage, integrated site risk, we will give you some updates on all of that. And lastly, I am just going to mention a little bit about our status in pursuing industry-led peer reviews of the work that we are doing.

And for each of these topics, I will go over what work -- what the current status of the work is now, what are the larger challenges that we are envisioning that we either are facing now that we envision that we will have to confront soon, as well as what type of work we hope to accomplish in the current calendar year.

So beginning with the internal event and internal floods, we have converted over the licensee's PRA model, as you recall from previous briefings. We are leveraging the licensee's PRAs to the extent possible. They have a peer reviewed internal event and internal flood PRA, Level 1 PRA;

also a peer reviewed internal fire PRA; and they are currently working on a seismic PRA. So, we are trying to take maximum advantage of that work that has already been done.

As such, for the Level 1 internal event and flood model, we convert over their CAFTA model. They have used the CAFTA software. And with the CAFTA, they have what is called the one top fault tree, where the entire model, including sequence definition and system models are all under a big, large fault tree. So we have converted that over into our SAPHIRE code, which has a more traditional event tree/fault tree structure and so we had to break apart that fault tree to map it into the different event trees and bring over the systems.

The system model we will also need various modifications to that model when we convert it over. One of the main things that we want to do is make it consistent, in some regards, to the SPAR models that we work with. So there is certain SPAR modeling conventions we want to include into our Level 3 PRA model.

CHAIRMAN STETKAR: Alan, let me interrupt you there for just a second to make sure I understood something you said.

You said that the staff took the CAFTA model and you basically created the event tree logic structure for the Level 1 PRA. Is that correct?

MR. KURITZKY: Well, the logic --

CHAIRMAN STETKAR: I mean in principle it is equivalent.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: But I mean you basically own the event tree logic.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: But it is all spelled out in fault tree terms in the CAFTA.

CHAIRMAN STETKAR: Okay, I just wanted to make sure I understood that.

MR. KURITZKY: Yes.

CHAIRMAN STETKAR: Thank you.

MR. KURITZKY: So in SAPHIRE now, we have actual event trees for everything, not in that fault tree.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: So going back to some of the things from SPAR that we wanted to include in our model, the treatment of loss of offsite power is one thing that we convert over and change from what the licensee had. One example is the fact that the licensee had one general LOOP category, loss of offsite power category. We broke them down to the four types of loss of offsite power, switchyard-related, plant-centered, grid-related, and severe weather-related. So, we have broken that out into four different categories.

We also have switched things over for the Support System Initiator events, we made some changes that are more consistent with how we do things traditionally in our SPAR models, also in the modeling of the anticipated transients without scram, another area that we want to make consistent with our SPAR models.

In addition, we have a MELCOR model for Vogtle that we have put together and we ran that MELCOR model to check out some of the success criteria. And based on those results, we have modified some of the success criteria, the system success criteria that are in our version of the model, as opposed to what the licensee had.

And the last one I wanted to point is that in redoing their human reliability analysis, we also identified some things where we are unable to understand or completely get onboard with the technical basis for how the licensee did some for their HRA. So we have gone and we have calculated roughly 20 or so human failure events, you know human error probabilities and updated those in our model.

Another thing that we switched over, once we got the model in-house was the data set. Because we want to own this PRA, we were more comfortable with using the data that we have at Idaho National Lab that we used for the SPAR models. We have a standard SPAR model template data. And then we did a Bayesian update using Vogtle-specific data.

All the INL data, both for the template and for the building specific is primarily based from data obtained from EPIX but there is also some reviews of LERs and other types of data sources.

CHAIRMAN STETKAR: Just out of curiosity, are you going to talk more about that later or not?

MR. KURITZKY: No.

CHAIRMAN STETKAR: This is just a personal curiosity. When you did that, --

MR. KURITZKY: Cross-check?

CHAIRMAN STETKAR: Yes, cross-check. Were there large differences?

MR. KURITZKY: You know actually that is in the later session when Chris Hunter is here.

CHAIRMAN STETKAR: Okay. That's fine.

MR. KURITZKY: He probably knows more than I do.

CHAIRMAN STETKAR: That's fine. We will wait.

MR. KURITZKY: But I will mention one thing. One year that I have noticed just ad hoc, not from a detailed look, is some of the common cause failure fires have significant differences. And it is particularly those with large common cause failure groups. And I think that is because the modeling differences can be bigger there. And also because there is such little, the alpha factors or whatever approach you use, there is a lot uncertainty. There Is not a lot of data. So you can get some fairly vastly results.

CHAIRMAN STETKAR: Let's talk a little bit more about that in the closed session, where we can get into details and the numbers and the methods that are more appropriate there.

And as I said, it is more of a curiosity. As you said, this is the NRC staff's PRA. You own the models. You own the data. And I was just curious because people always look at numbers.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: It is you use my numbers, you get my results.

MR. KURITZKY: And without doing a comparison of event by event, I would just say nothing in looking at the dominant cut sets, we never saw something except in some of the common cause failure events that really jumped out and said hey, this is high in our model but not theirs and vice versa. So, I don't think there is major differences.

CHAIRMAN STETKAR: So there is no, at least from that kind of sanity check, there doesn't appear to be any large systematic biases in either data set, for example.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: Okay, thanks.

MEMBER BLEY: I have another data question. Has the plant been keeping their PRA up to date, current with -- as they get new data and that sort of thing?

MR. KURITZKY: Yes, I mean, Southern's going to present later in the day and they can give you a much more accurate answer to that. But I think they have some process for routinely updating the PRA. I don't know where in this cycle they are.

MEMBER BLEY: I will ask them this, too, but it is related to you. I think you said you got their plant-specific data from EPIX?

MR. KURITZKY: Yes, for us. For our data set.

MEMBER BLEY: For your data. You don't know if that is what they use or if they have --

MR. KURITZKY: I do not know what they --

MEMBER BLEY: Okay.

MR. KURITZKY: I don't know what they do.

MEMBER SCHULTZ: Alan, before we move on, and you can answer this by saying we are going to cover some in detail later. I am interested about the differences that you identified in the human reliability analysis. Is that something we are going to discuss today? We have talked to the staff about the HRA that is ongoing but we haven't heard the details in comparison to what the licensee may have provided earlier.

MR. KURITZKY: That's not an area that we are necessary going to delve into too much later. We can put that on for another meeting. We probably will touch on -- you are probably going to hear from Southern in the afternoon about some of the issues where we have taken exception to some of the stuff they have done. HRA was one of the main areas where we have had some disagreements. So you may hear something from them this afternoon and then in the closed session we might discuss some of it.

MEMBER SCHULTZ: That would be fine.

CHAIRMAN STETKAR: And I think, as Rich said, we have had a number of subcommittee --

MEMBER REMPE: Before you move on, I have a question.

CHAIRMAN STETKAR: Sure.

MEMBER REMPE: On the MELCOR analysis that was used to update the success criteria, information I have read indicates that the current status of the MELCOR model is that it is a bit of a hodgepodge of different plant information because there was an inability to get all of the plant parameters that you need for modeling Vogtle.

How much confidence do you have when start updating success criteria when you have not really finalized the MELCOR model?

MR. HELTON: This is Don Helton of the staff. The MELCOR model that we have for Vogtle, the starting point for that was the model for a closely related four-loop Westinghouse plant.

So we did have site visits and interactions with SNC to get information that was Vogtle-specific. And there are a number of cases where we didn't sufficient Vogtle-specific information such that we had to use information from like I said the plant that we started with, which is a very similar plant or other information sources.

But as you know, that is typical of building out a thermal-hydraulic model. We have high confidence that the results we are obtaining are good. We have done a number of analyses for Vogtle and other plants to get a feel for what the uncertainties are. In fact, we are about to publish a NUREG/CR-7177 that goes into a lot of the different modeling issues that can drive success criteria analyses. And in addition to that, we didn't run the MELCOR model and then blindly change success criteria. The success criteria changes that we made were a result of studying the licensee's success criteria, their underlying MAP analyses, looking at our MELCOR analyses for Vogtle as well as the MELCOR analyses we have performed for other plants, and then taking that information as a whole on which to -- as the basis to make changes or to retain the existing success criteria.

MEMBER REMPE: Thank you.

MR. KURITZKY: Okay. Also for -- just moving on to the internal flood model, again, we were leveraging the licensee's model. So, we have brought over their internal flooding model. Some of the things that we did change, however, was we have updated the initiating event frequencies based on newer information, both generic and plant-specific. And in doing so, some of the values for some of the flooding sequences have increased. And because of that, some of the flooding sequences that Southern had quantified but then left out of the model because they were very low contributors, we have screened some of those back in just because of the increased value. Again, internal flooding does not make much of a contribution to the risk profile at Vogtle. But nonetheless, we have added a few more of these scenarios into our model.

And the last thing I will mention on the internal flooding is we did go down last summer and have a plant visit, a walk down to confirm the modeling assumptions for the flooding analysis.

Probably the biggest challenge that we are facing right now for the internal event and flood model, Level 1 at-power deals with the interfacing system's LOCA. In the Vogtle model, the ISLOCA frequencies -- well, I can't say whether they are high or low. They are probably reasonable compared to many other PRAs, however, they do not consider common cause failure of check valves, MOVs, to leak, significant leakage back behind the reverse leakage of the check valves or the MOVs.

And in our model, we did go an include the failure mode of common cause leakage, significant leakage. And we based those values on data that INL had, I think it was NUREG/CR-6928 was the original source that data is updated in 2010. It has not published as a NUREG/CR but I think it is on the website there that you can go to, the update data website. And if you use those values, you get a substantially higher ISLOCA contribution than you do if you don't consider a common cause failure, substantially. I mean it goes from something that you almost can screen it out because the frequency is so low, even though the consequences are higher than a typical accident to becoming the dominant risk contributor in the whole study.

So, this is one that we felt needed a little additional effort on our part. So we have decided to perform an expert elicitation on the frequency and locations for these ISLOCAs. And we are right now working on the contract paperwork to get that going.

MEMBER BLEY: I would toss a couple thoughts your way on that one.

Some people looking at this failure have extrapolated small leakage rates into very large ones, which physically doesn't make much sense to me. The kind of failures, at least for the really good sized PWR ISLOCAs are almost catastrophic rupture of the disk kind of things, which is a completely different kind of failure mode. So, I hope your group has some real valve experts and material experts to consider what the failure modes and it should really define well what this failure is.

Back in the work that was done on the last study, I think the elicitation got into some trouble because those things weren't defined well enough and because perhaps we didn't have the right experts on some of those panels. So, really define what this failure is, as a part of the elicitation.

MR. KURITZKY: Yes and that is one of the reasons we get into trouble, too, with the data is because there is every little data on large leaks and just catastrophic ruptures. And what happens is I think the way the data is broken down in the Idaho report is small leaks are less than 50 GPM and large leaks are greater than 50 GPM. But the event reports don't give you the leakage rate. A lot of that is people just making judgments as to whether or not they felt this was a --

MEMBER BLEY: Okay, I will go a little further. I suggest you at least get one person or more, if you can, who have been involved with valve manufacturers and testing programs on new valves. In those, there have been some of these kinds of failures that occur for the larger ones. You know the small ones I don't think it is such a big deal how you handle those. But for the larger ones, those kind of people have seen those kind of failures. You don't see them in the nuclear industry yet. And you don't see them much elsewhere. But you certainly see them in testing programs and they know the kinds of problems that have led to those failures. Usually, they get designed out. But at least they will have knowledge of those kind of failures.

MR. KURITZKY: I appreciate that.

CHAIRMAN STETKAR: By the way, Alan and Rich also, one of the things I wanted to discuss at the end of the day, presuming that we have some amount of time, is future interactions with the subcommittee. We talked a little bit, I think, informally, of perhaps having a more -- I don't want to call it informal, but a more technically focused set of meetings where we can give you feedback on not only the whole project but perhaps focused issues. And it is one of the things I thought of when Steve brought up the HRA. If ISLOCA and the treatment of common cause failures for the initiating event frequency is a significant technical issue that you have identified, we may want to develop an earlier exchange on those topics once you get your expert elicitation process underway. So, we will talk a little bit more about that at the end of the day how we want to structure these future subcommittee interactions.

MR. KURITZKY: Okay. So again, that right now is the single biggest loose end, I would say in the Level 1 internal events, internal flood modeling.

Our work that we are going to do in 2014, we are pretty much just revising and updating the documentation for that model. We are going to get ready for the industry-led peer review, which we hoped would take place, I think in the summertime. And of course, we will be constantly having to fine tune the model to some extent, as the various other scope elements, scope pieces are completed and we have to insert them into our base model out there, you know take care of the interfaces out there.

Going on to internal fires, the fire PRA, right now we are not doing much in the way of work on the fire PRA. We had started some work within the last year. Because of resource issues, we have had to put that on hold. The same contractor that is doing the fire is doing the seismic and the high winds. We decided to go ahead with the seismic and high winds first, to get that done and then do the fire PRA.

So we are hopeful that by the middle of the year we would be able to start back up with the fire work, once the seismic work starts to get wrapped up.

We will be using, again, as I mentioned, the licensee's fire PRA will be the basis of our fire PRA. Again, we are mapping their scenarios, fire scenarios into our model. Also, their fire PRA -- I don't know what was but we have lost power, basically.

CHAIRMAN STETKAR: It's fine. The next thing that we will have is some sort of earthquake as best as I can tell. So, go on.

MR. KURITZKY: We have contact with Sandia National Labs to do a review of the licensee's fire PRA, focusing a lot on some of the deterministic assumptions in the fire analysis. We had that report in from Sandia and we are currently going through it and working on the comments.

MEMBER SCHULTZ: But you mentioned, Alan, that the seismic work then is going on in parallel. The licensee is preparing seismic PRA and --

MR. KURITZKY: Yes, and I will talk -- the next one will be the seismic.

MEMBER SCHULTZ: Okay, I will wait.

MR. KURITZKY: In fact, in hindsight I was thinking I should actually have put seismic first but I will get to seismic in a second.

The major challenges with the fire PRA that we see is mapping over the scenarios from the licensee's model into ours. Actually, in this case so far, our preliminary work shows that that is probably not going to be as big an issue as we were concerned about. Because even though there was a lot of scenarios in the fire PRA, because we can take advantage of having that results of that fire PRA, we can be smarter about getting some of those fire scenarios. And so far it looks like we have the mapping but the initial work we haven't done in the mapping, it seemed to show that it was working fairly efficiently.

A bigger concern is going to be some of the fire scenario parameters and modeling assumptions that are in their PRA, which forms the basis of our PRA. Because even though Southern Nuclear is not -- excuse me -- Vogtle is not an NFPA 805 plant, they do perform this fire PRA for other risk informed initiatives. And the fire PRA that they have used, some of the modeling assumptions are very similar to ones that have been used for other plants that have NFPA 805 submittals. And some of those assumptions are ones that NRR is having some concern about. And so there is a lot of discussion going on between the NRC industry and a lot of these modeling assumptions. And those same assumptions are here in the Vogtle PRA. So, that has the potential to be an area of -- a problematic area for us as we decide how we need to resolve or overcome those differences. And we will know more about that once we finish going through the Sandia report and reengage on doing the fire PRA work.

In terms of the time line for the 2014, we hope to, as I said before we get going, when the seismic work is completed, which hopefully the initial seismic model will be done in the middle of the year and then we can turn it over to the fire PRA in the summer and hopefully have at least initial work done on that by the end of the calendar year.

So, now I am going over to the seismic. We are already working on creating the seismic PRA model. It is based a lot on licensee information. As we mentioned there, they are doing a seismic PRA right now. Ideally, their PRA would be done before we had to do ours so we could leverage a lot of that information. But nonetheless, we are still getting a fair amount that they have done for their work already.

The hazard curve, the hazard information that was submitted for Units 3 and 4 at the NRO, we have taken advantage of that information and we are using those seismicity curves. And also we have gotten some preliminary plant-specific fragilities for Units 1 and 2, which will the form the basis of our model.

Now, I will get to it in my next slide about accepting that information but at least is something that we really needed because we didn't have the resources or time to sit there and do a lot of plant-specific fragility calculations on our own. So, that is a big benefit to us.

Also, we performed a plant walkdown, I think in March of last year. And looking at a lot of the structural analysis aspects of the plant and did not find any concerns from that walkdown that would jeopardize some of the findings or calculations of the seismic work.

MEMBER SCHULTZ: Is that what you would call specifically a seismic walkdown?

MR. KURITZKY: You know, I don't know if I would call it that. And I am not a seismic expert but I think back to the IPEEE days when we had like the A46 and the SQUG and the special walkdowns for seismic. I think it was based on -- a lot of the walkdown procedure we used was based in part on a lot of those documents and guidance from back then but I wouldn't necessarily call it an official seismic walkdown.

MEMBER SCHULTZ: Based on it but it wasn't like a IPEEE seismic walkdown, the type of expertise that were on the team.

MR. KURITZKY: Now, I don't want to overstate but people who do that walkdown could probably give a better response to that. But I just get the feeling that it wasn't quite as official. I mean that had a very strong regulatory impact. Actually it was much more regulated. And I think that we were probably similar in many ways but I wouldn't want to claim that we were at the same pedigree as that.

MEMBER SCHULTZ: Thank you.

MR. KURITZKY: Okay, so the major challenges for the seismic PRA that we envision, again, the key put inputs to the model and it is the plant-specific fragilities that are of most concern because if we are okay with the approach that the licensee has used to come up with those fragilities and spot check some of them and we are comfortable with them, then we are good to go. If some reason we are not comfortable with what they have done, obviously then we are going to be in trouble. Because like I said, we are doing a whole bunch of practices in fragility. This is not something we are going to be able to, you know calculation is something we are going to be able to undertake. And we could be forced to use more generic information which would be not very accurate. And so we just have to wait and see. When we get a chance to review that, the licensee's work, we will have a better feel for that.

But that leads to our other major challenge, which is staff availability. And particularly there, we are talking about the structural analyst. Those are the ones that we are having a hard time getting time from because of the other activities going on in the agency dealing with seismic and structural aspects. So, they are in high demand and it is hard to get them free to do work on this project. We are ever hopeful that they will becoming more and more involved as time goes on and we will just have to see how that plays out over the next few months.

Anyway, as far as the coming calendar year, we will complete the construction and documentation of the initial seismic PRA model. I will then go through some internal review and do the self-assessment and get prepared for an industry-led peer review probably sometime in the beginning of 2015.

Okay, the HFO, as I refer to it, analysis. We have already put together four preliminary event trees for high wind scenarios. We had one high wind initiator and three tornado initiator, tornado categories. We have already included them into the base PRA models. We are currently documenting that analysis. That really is the only -- as of right now, that appears to be the only HFO that we are going to quantitatively model and include into the PRA. All of the other external hazards, including external flooding, we had preliminary screened out.

MEMBER BLEY: Now, there are about 50 miles from the coast. Is that right?

MR. KURITZKY: They are pretty far from the coast. Their issue is the Savannah River.

MEMBER BLEY: Yes. So, hurricanes don't --

MR. KURITZKY: As far as hurricanes -- yes, it peters out.

MEMBER BLEY: I'm sorry?

MR. KURITZKY: It peters out. They are not impervious to hurricanes. Obviously, there will be hurricanes that have some impact on it but it is not -- and again, I don't know exactly what the high wind scenario that we have looked at is like. For the most part, they are not a coastal plant. So they definitely have the protection of distance in that regard.

CHAIRMAN STETKAR: Have you thought -- and again, if this is too much detail, just put it off. There is one thing about screening out some of these hazards from the perspective of core damage frequency. There is an entirely different perspective from overall Level 3 risk. So, for example, if some of these hazards might have an area of low frequency compared to other causes for core damage, the consequences might be more significant. Because, for example, you might have offsite power destroyed for a week or more in some of these very severe events, so that you are facing a very protracted loss of offsite power situation, which can have implications, probably more implications on the Level 3 type models, if you will, than just core damage frequency.

So, I would be interested to see, you know, if you say you have screened out everything except high winds, have thought about that?

MR. KURITZKY: Yes, I can't speak to the specifics. There is some examples here of --

CHAIRMAN STETKAR: That is part of the perspective of doing a Level 3 PRA --

MR. KURITZKY: Right.

CHAIRMAN STETKAR: -- is that traditionally people who just looked at initiating event frequency and compared to sort of a ballpark estimate of what core damage frequency might be and say well, this is a couple of orders of magnitude smaller, so it won't be important to core damage, which may very well be true but not necessarily compared to the integrated site list.

MR. HELTON: So, I can address that.

MR. KURITZKY: Okay, go ahead.

MR. HELTON: So, to your point, I have reviewed the screening analysis from the perspective of the Level 2 PRA and the spent fuel pool PRA. That is that question is does the screening inherently bias you away from or towards screening out things that may crop up later for other reasons. And so I have noted a few of the hazards where basically once we have got a model developed and we have quantitative information in the Level 2 and the spent fuel pool to compare it to, we can go back and do that sanity check and make sure.

CHAIRMAN STETKAR: Okay.

MR. HELTON: So, most of the things would screen out even from that perspective but there are a couple that we will need to revisit and we have documented those to do that.

CHAIRMAN STETKAR: Thanks, Don. That is good to hear. Thanks.

MR. KURITZKY: Thank you, Don.

Okay, so right now we don't envision any major challenges for the HFO portion of the study. That seems to be moving along fairly smoothly.

In this coming year, we will finalize the high wind models, you know preview documentation, do the internal reviews, internal self-assessment. And we hope to have an industry-led peer review of that portion of the study done sometime in maybe the fall is what we are targeting right now.

MEMBER BLEY: Is that going to be a peer review according to the standard?

MR. KURITZKY: Yes, it would be a peer review according to the standard.

Excuse me when I talk about -- and I have a couple of slides here at the end about this but the industry-led peer reviews I am referring to are the ASME/ANS PRA-based, PRA standard-based peer reviews. So that is what we are calling them. And that is one level of review that we are doing for the study. There will be other reviews also but that is one that we are finding.

MEMBER BLEY: I think that is the first time. Right?

MR. KURITZKY: For high winds?

MEMBER BLEY: No, for an NRC study.

MR. KURITZKY: Oh, okay.

CHAIRMAN STETKAR: We had SPAR models reviewed. Right? Two SPAR models were reviewed.

MEMBER BLEY: Oh, did you? Okay, I didn't know that.

CHAIRMAN STETKAR: I think they are still working on responses to the comments but they did have two SPAR models reviewed.

MR. KURITZKY: That is correct.

Okay, low-power shutdown, we have reviewed some of the past Vogtle outage reports to come up with some ideas onto how to lay out the low-power shutdown modeling. We have defined some low-power shutdown plant operating states for a representative of a fuel outage, a refueling outage based on some high-level assumptions on plant evolutions and the timing of those evolutions.

We have also reviewed several documents. Southern Nuclear actually had initiated an effort for a lower power shutdown period for some years back but then aborted the effort because there was no standard for low-power shutdown at the time and there may have been other reasons. So, they put it on the shelf.

But they did have a contractor come up with some -- they did some work on plant operating states and initiating events. And so they provided that to us. So, we had that as a starting point. So we had to look at that information.

There were a couple of -- two versions of an EPRI report that looks into initiators for low-power shutdown. The first one has actual frequencies in it. The second one just deals, I think, with event, operational events. It doesn't actually calculate numbers.

CHAIRMAN STETKAR: Okay. I mean some of the generic stuff is good but my experience is low power shutdown is very, very plant specific. Not so much the data as far as failures of equipment but mapping the plant operating states and equipment unavailabilities, essentially mapping the evolution of the outage is very, very plant specific. It is how Vogtle does business during that outage.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: So my only caution would be don't rely too heavily -- read the generic reports because they can provide useful information and let's say insights to things that have happened that you might not think about otherwise. But base that model on the evolution of Vogtle's outages and basically how they do work during the outages.

The good news is it has been operating for a long time. And these days people tend to have their outage plans, unless there are untoward problems that you run into that require additional equipment repairs or something like that. But they tend to be pretty doggone standard. So, looking at three or four outages, fairly recent ones, should give you a pretty decent picture of how they organize from an operational perspective and how they organize their maintenance, when they do certain types of maintenance on equipment, during what plant operating state, for example. And that can be very, very --

MEMBER BLEY: I think these people haven't done a very good job. The coordinated maintenance you really have to keep track of.

CHAIRMAN STETKAR: Yes.

MEMBER BLEY: Because whole trains disappear.

CHAIRMAN STETKAR: But some people -- well, enough said.

There is plant to plant variability in terms of how well people think about doing that sort of thing.

MR. KURITZKY: Right. And I would go back to first of all, we have -- I think we maybe had like six or seven outage reports from Vogtle. So it is based on how they do business.

CHAIRMAN STETKAR: Do those outage reports also tell you when equipment is out of service or it is just simply the time evolution of cool down, depressurize, whatever you do, open up the head, all that kind of stuff?

MR. KURITZKY: I am actually going to have to yield to Jeff. Jeff, do you want to step to the mike a second? Maybe you can speak to that.

CHAIRMAN STETKAR: I think part of our message is if it doesn't have the information that overlays when they do sort of most of their plant anyway and routinely scheduled maintenance, you need that information because you need to develop that matrix early on. Otherwise, you are going to have problems.

MEMBER SCHULTZ: I would be surprised to find that Vogtle is not doing a fairly robust, risk-informed outage planning approach at this time, which is probably a lot different than what they were doing four or five years ago. But all of that ought be taken into account.

CHAIRMAN STETKAR: Yes, that's right.

MR. WOOD: This is Jeff Wood, Office of Research.

As Alan said, we do have several of their outage reports and they do contain information on equipment outages.

CHAIRMAN STETKAR: Good. Good, that is important.

MR. WOOD: But we may need another level of detail when it comes to the actual modeling but we will have to follow up this and see.

But those outage reports are pretty through.

CHAIRMAN STETKAR: Good. Good because as Dennis mentioned, getting the right maintenance configurations in the right plant operating states can be a real challenge. It is conceptually not difficult but it is a bookkeeping challenge and it is important for the models because if certain pieces of equipment are always out of service together at the same time, a model has to treat it that way. It is not random independent unavailable --

MR. KURITZKY: Or averaged out.

CHAIRMAN STETKAR: -- or averaged out over some system level thing.

MR. KURITZKY: Yes, we understand. Thank you.

MR. HELTON: Just a final point to Dr. Schultz's point. Vogtle did go through a shift in their outage planning and activities back about five years ago, maybe six years ago now. But we did have early discussions with them to make sure we understood what was -- in terms of looking outage reports, what came before that shift, and what was after that shift to get to your point about the fact that the newer information is more germane to what they are actually doing now.

MEMBER SCHULTZ: Good, I'm glad to hear that. Thank you.

MR. KURITZKY: Thank you, Don.

Okay, so jumping back to the initiating events and frequency information, as I was mentioning, EPRI has two versions of a report on that. The earlier version had frequencies. The second version, I think, just talks, just has the data but it still gives us some information to go on. We also have access to the Seabrook low-power shutdown PRA, which is another source of information.

So yes, we understand that breaking down the outage does require a very plant-specific look at the what gets done when. In terms of data, we will obviously take whatever data we can get and factor that in accordingly.

We also have detailed procedures from Vogtle for the lower power shutdown operations and that is, obviously, a big piece of modeling the low-power shutdown configurations also.

In terms of challenges, staff availability is a big one here. Again, our lead for the low-power shutdown work we just heard from is pulled in a lot of different directions. So, his time available to work on this particular aspect of the study has been somewhat limited.

Also another issue we have is with all the different plant outage states and configurations, et cetera, you can end up with a lot of different pieces to have to analyze. And so we need to keep the modeling to a manageable size. So, we need to have some kind of limitations on what we are going to include in the model. That is going to be an issue for this as well as a few other aspects of the study.

Also, while we are fairly comfortable with low-power shutdown PRA modeling for internal events, when it comes to internal fires and seismic, et cetera, there is not a lot of experience in that area. There is some but not a lot. But that also presents a fairly potential for a significant challenge, depending on how complex that becomes in terms of potential scenarios.

Last, I want to mention that for the HRA low-power shutdown, there isn't a lot of established formal HRA approaches for a low-power shutdown operations but it can be fairly similar to different approaches that are out there already. However, different aspects have to be considered. Different contexts have to be considered. A lot of that would be greatly informed by interviewing operators and doing some additional analyses. And because of our limited resources, we hope to be able to do some of that but we will never probably be able to do as much as we would really like to in this regard. So, that is just another challenge we will have to deal with.

In terms of what we hope to accomplish in calendar year '14, we are going to complete the refinement of our plant operating states and the scenarios that we want to include in the model. We will put the infrastructure together for the model, the event trees, and the fault tress, et cetera. We will do this analysis on the initiating event frequencies and, of course, documenting everything as we go along.

And probably the actual Level 1 low-power shutdown modeling for internal hazards will probably not get completed until sometime in the early mid-2015. And later in the day, we will go over the schedule for the overall project. You will get a better feel for how the different pieces or fitting together time-wise.

Okay, for the Level 2 and Level 3, I am just going to quickly go through these because you are going to get a more detailed presentation on each of these two aspects later in the day. So, just to quickly point out, for the Level 2 we have come up with our plant damage dates. We have quantified our plant damage dates. We have a preliminary event tree structure and release category framework. We are now currently using MELCOR to run representative sequences for the different plant damage states. And so we are moving along fairly well in the Level 2 arena. Again, you will get more detail shortly.

Some of the major challenges that we are going to have with Level 2 or we experienced and will continue to experience, getting some plant-specific information. There is a lot of detailed information that we would really like to have to make the model as good as it can be. We have gotten a lot of information from Southern for doing the modeling but there is still some key information that we are still hoping to get and we are cautious and optimistic that we will get it in a time frame that will allow us to get it into the model. Obviously, the clock is starting to run out on that.

Computational challenges, both the computer code and some mathematical issues are there for putting the Level 2 and the Level 1 together. We are going to try and put together a somewhat seamless Level 1 and Level 2 integrated model. So cuts in information will be carried right through the Level 2 all the way up to the release categories. Getting the code, you will be able to handle all of that in a mathematically precise way or a mathematically reasonable way. It is still causing some challenges but we are working through them.

MEMBER BLEY: Let me -- you may want to answer this at another time but I want to get it on the table. If you are really going to do that, and I hope you do, then I don't understand when I look at the Level 1 to 2 connection why you break out station blackout separately. If you are going to carry through all of the Level 1, you will know what power state you are in. You won't be thinking blackout or all power. It will be all ranges of one bus to all your buses there.

So, I'm not sure why you need that separation if you are going to carry it through.

CHAIRMAN STETKAR: And what I would suggest is let's wait until we close the meeting because there is some details of the model --

MEMBER BLEY: That's probably true. I just wanted to get it out there, so you are thinking about it.

CHAIRMAN STETKAR: I want to address that issue from kind of the front end Level 1 part of the modeling also.

MEMBER BLEY: Okay.

CHAIRMAN STETKAR: And I think it is more fruitful if we save that for some of the details.

MEMBER BLEY: I think that takes care of a lot of problems if you can do that.

MR. KURITZKY: Okay, so we will table that for this afternoon.

CHAIRMAN STETKAR: But we won't forget.

MR. KURITZKY: I'm sure you won't. Okay, as far as -- oh, and the last challenge that we are having, that we are facing with the Level 2 is also an HRA approach because this is more guidance and knowledge-based decision making as opposed to procedure driven. It is a different take on what is typical in the HRA to date. And so we have -- we are working on putting together an approach for doing a Level 2 HRA and is something that we will talk with you about at another meeting. But that is one of the areas that it is kind of a cutting edge thing.

MEMBER BLEY: I saw you had a few slides on that.

MR. KURITZKY: Yes.

MEMBER BLEY: There wasn't anything in the stuff we pulled off of your SharePoint study, I don't think.

MR. KURITZKY: No, no, that stuff hasn't even -- no.

MEMBER BLEY: Okay.

MR. KURITZKY: That is really raw. I mean, because HRA and down to Level 2 are kind of just tossing this stuff around more. But with Don, we will talk about a screening approach that they put together that we will use also.

Okay, as far as calendar year 2014, we hope to complete the internal flood Level 2 model sometime in the middle of the year and we will hand off the release categories to the Level 3, the consequence analysis team to do a Level 3. We also will then type the documentation, perform our internal reviews and internal self-assessment and hopefully be ready for an industry-led peer review sometime in, I guess, probably early fall is what we targeted.

MEMBER BLEY: That's a word I don't recall seeing this morning, uncertainty.

MR. KURITZKY: Oh, no. We know everything exactly.

(Laughter.)

CHAIRMAN STETKAR: You mentioned mathematical precision earlier and I was going to say -- I generally strive for accuracy.

MR. KURITZKY: Right, I backed off of that. You will check the transcript. I backed off to mathematically adequate or something.

MEMBER BLEY: So I know you say you are going to deal with uncertainty in Level 1. And in Level 2, I have seen some of it.

MR. KURITZKY: Right.

MEMBER BLEY: Have you given some thought to how you are going to deal with uncertainty in Level 3? I haven't seen anybody do that very well yet.

MR. KURITZKY: Well, we do hear from Keith Compton later in the day on the Level 3 stuff. So, he will give you more details on what our proposed approach is there. Obviously, SOARCA has done a lot of work on Level 3 uncertainty analyses and we will use insights from that work to help guide us to some extent. Obviously, we are not going to spend the amount of effort in doing that certainty analysis that they are doing. They are looking at different aspects than we are when we are looking holistically at a probabilistic model but we are definitely going to be addressing uncertainty in the Level 3 area to some degree within resources. And it may be a lot of a sensitivity studies, et cetera but I am going to leave that for Keith Compton to talk to you about when he does the Level 3 presentation.

Okay, moving on to the Level 3. Again, I will just quickly touch on these because Keith will be talking later. We have completed the review of some prior studies, Level 3 consequence studies. We have obtained virtually, I think, everything that we need data-wise to put MACCS2 model together so we can do the MACCS2 production run for Vogtle.

Also, in parallel to the work we are doing with the Level 3 PRA, the Vogtle -- the research is also doing some MACCS2 development work. And you know for other reasons but some of that work it is going to increase the capabilities of MACCS2 and some of those may be of benefit for us when we do the consequence work for Vogtle. You know it may benefit from that depending on the timing of when those things are complete.

Obviously, at some point, we are going to have to say we need to use this version of the code right now and anything that is ready and road tested right now, we can take. Anything further on will have to be left out. Maybe at the end of the project, hopefully we have an opportunity we could bring some additional features in if they have been embedded in MACCS2 but we are, obviously, going to have pick some point in which we are going to say this is the version we are going to use and that is that.

The biggest challenge we have with the Level 3 work is really defining which risk metrics we want to calculate and report. And it is a very important aspect. Besides that there is some strong opinions around the agency as to what are the appropriate things to calculate and to report. It also drives many of the other issues that we have to deal with. For instance, what distances do we calculate out the results for? What exposures pathways do we consider? So, getting some kind of closure on that is important for getting work in the consequence area.

So, this is an area that we have raised with our technical advisory group. We are going to reengage with them shortly on it. I think the plan is that they are going to put a little work group together to look into the issue. We certainly will welcome input from the subcommittee on that. You are going to get a more detailed look at this in Keith's presentation. He has some slides on this specific topic. So, don't feel a need to have to jump in now but you are going to get ample opportunity to discuss it and we will welcome any feedback you guys can give us on that when Keith comes up to talk about this issue.

In terms of what we are going to try and accomplish in 2014, we want to complete the consequence analysis for the reactor internal event at-power model probably late in the year, early beginning of next year. And then we will use that as the basis for the basic MACCS model. They will be used for the other pieces of the project just adjusting various parameters as necessary.

Okay, spent fuel pool PRA, we have performed the site characterization and some limited walk downs. Because the Unit 1 and Unit 2 spent fuel pools spent most of their time, as far as we know, our understanding is they spend most of the time hydraulically connected. So we have decided to include them both in a single model, which makes sense from a thermal hydraulic point of view.

We have also started developing site operating phases to encompass the different spent fuel pool configurations. You are going to hear more about that when Felix gives his talk after me about our whole Joint Plant Operating State work for the integrated site risk. You will see the various radiological sources at the site and how the different operating phases fit in with each other.

We have also done work on identifying some of the hazards to consider for the spent fuel pool PRA. We have a simplified MELCOR model for the spent fuel pool, which we have used to do some initial calculations to come up with sequence timing information. We will obviously expand out that model to a more complete MELCOR model, as time goes on.

We have started developing some of the accent sequence for the level and accent sequences for the spent fuel pool also.

CHAIRMAN STETKAR: Alan, and if Felix is going to cover this later, you said you are going to discuss a little bit some of the site-level plant operating states?

MR. KURITZKY: Uh-huh.

CHAIRMAN STETKAR: Okay. Because I was just sort of thinking about some of the discussion we had earlier about low-power shutdown and mapping maintenance configurations. And you talked a little bit about quantifying initiating event frequencies. Those all are interrelated. So, a bit of a warning is don't necessarily sign off on plant level plant operating states until you have a good picture of single unit level plant operating states throughout the operating cycle. And the reason I bring it up is that some of the experience we had, if indeed loss of offsite power and loss of electric power are important contributors to risk, some of our experience has been that during times when people are working on switchyards, which tends to be during some portion of an outage, the conditional probability of a loss of offsite power, which then can cascade into station blackout perhaps on both units affecting spent fuel pool cooling and such, it might be important to keep track of those things. But you don't necessarily know that until you have developed the plant operating states and that maintenance matrix for the low-power and shutdown study. So this is just a warning of don't necessarily go too far, I guess, on site level plant operating states from only the perspective of the link to spent fuel pools, without that additional information. You may need to go back and redo work and you don't have time to do much redo on this project.

MR. KURITZKY: That I agree with. And I agree with everything you have said.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: Something Felix is going to talk about is more of a higher level.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: It doesn't concern the maintenance matrix and things like that. And there is going to be, even though obviously we are very limited in resources time, whatever, certain amount of innovation is just going to have to have happen. And we can't, unfortunately, wait for everything to be done before we move forward.

CHAIRMAN STETKAR: No. The only message is, as long as it is at a high level and pretty coarse so that you can subdivide things, that is fine.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: Going back together later and piecing things together and subdividing in other locations is very, very, very inefficient.

MR. KURITZKY: Right. That is good advice. Thank you.

Okay. As far as challenges for the spent fuel pool PRA, this is kind of a repetitive theme here for major challenges. You are going see in a lot of the areas that staff availability, particularly the team lead, we getting pool in a lot of places. Don Helton is our team lead for spent fuel pool PRA. He is our team lead for Level 2 and he also has many other things that the agency wants him to work on. So staff availability is a big issue for this area, as well as many of the other areas.

Again, managing the scope, because there are many configurations and scenarios and stuff that could be addressed, we have to obviously focus on the most risk significant ones to make the problem manageable. So, that is something that we have to just keep in mind as we go forward to work.

And again, there is a lot of specific information that we need for the model that we need to get from the licensee. We have gotten a lot of information again from the licensee for spent fuel pools. But again, there are still things that we need to get or that would be very beneficial to get.

MEMBER BLEY: Now, you have raised staff availability a lot, which I understand, but you have used contractors for some of this work.

MR. KURITZKY: Right.

MEMBER BLEY: I know you have for the Level 2 work. Have you done much for Level 1 or is that mostly in-house?

MR. KURITZKY: No, Level 1 we actually used Idaho National Lab.

MEMBER BLEY: You did, okay.

MR. KURITZKY: Substantially for the Level 1 work, yes.

MEMBER BLEY: Okay. So all of the work you are using --

MR. KURITZKY: Yes, it is a mixture of staff and contractors for, I think, just about everything.

The dry cask storage actually that Felix is leading, that one is primarily in-house. As I will discuss in a slide or two, we are going to be using some contractors' report for some of the structural analysis. But a lot of the accident and probabilistic work is being done in-house.

But most of it is a combination of contractors and in-house.

Okay, as far as 2014, we want to do some structural analysis for the spent fuel pool. Some of the probabilistic modeling for the higher priority items will flesh out our simplified MELCOR model to a more detailed MELCOR model. And we need to also come up with an HRA approach. Again, for the spent fuel pool, this is something that will probably be, I think, driven primarily by guidance-related decision making and some procedure.

You know guidance related in terms of I think SAMGs or EDMGs and procedure-based at normal operating procedures is what will drive a lot of the actions here. So, we hope to be able to borrow a Level 1 and Level 2 HRA approaches to come up with our approach for the spent fuel pool.

The dry cask storage we had a good opportunity in November this past year to go down and observe a loading campaign. Felix and some of his team went down there. It was very beneficial. They learned a lot in observing and talking to the people down there. So, that was a very good aspect of a strong theme for the study.

We also have received most of the information from the licensee that we need for doing the dry cask PRA. So, we are in pretty good shape there. There is a little bit of information on cranes that we would like to have but I don't know that we will get it. We may have to do without it. But in any case, that work is moving along very well.

We have identified the initiating events that we think can affect dry cask storage loading and operations. As I mentioned before, we are going to put out a contract. Actually, we have a contract with Pacific Northwest Labs to do some structural work, actually. NMSS has a contract with them to do similar work and we can use their contract. The only thing they need from us is the money and right now we didn't have it. We don't have it but it should be coming soon and we will be able to turn them on, hopefully, shortly.

CHAIRMAN STETKAR: Spend NMSS' money. They have got a lot of it.

MR. KURITZKY: Apparently they want to use it themselves. I don't know.

MR. CORREIA: We tried.

MR. KURITZKY: As far as challenges for the dry cask storage PRA, the analysis itself, we are in pretty good shape. Probably the biggest challenge we have, because there is no dry cask storage PRA standard, so the peer review is an area that we have some problems to overcome.

So what we need to do is come up with some peer review criteria. And our plan right now is to work with the PWR Owners Group, as well as probably some of our own contractors to come up with some criteria for reviewing the dry cask storage PRA. And I will talk a little bit more about that when we discuss the peer review stuff on the next slides.

Planned activities for 2014, we want to complete essentially do all the deterministic and probabilistic accident modeling this coming year, as well as -- and culminating getting the source term frequencies and source term characterizations. So essentially the whole Level 1 -- what would be corresponding to a Level 1 and Level 2 PRA we will get completed this year and then we will pass that on to the consequence team probably early 2015 for them to do the Level 3 work on that.

CHAIRMAN STETKAR: Alan, something I have just thought of and maybe you can give me some feedback. We are talking about dry cask storage PRA and you are talking about a lot of focused activities. Earlier we had a little bit of discussion that you have screened out entirely external flooding as a whole category of events that could affect the site because you don't think it is very important. Are you spending too much emphasis on this particular part of the study without keeping that integrated risk perspective?

MR. KURITZKY: That is a good question and that is something that we have wrestled with since the beginning because one of the things that I am thinking maybe in an ACRS letter early on on this project, before the project actually got going, talking about doing things on a level playing field. And you know, a level playing field can mean different things to different people in a different context. So, someone might view a level playing field that says every radiological source needs to be looked at levelly.

That is not a PRA works. The benefit of a PRA is to focus on that which is most risk significant and don't waste resources on that which is not. So, we clearly did not take our budget pie and parse it out equally to the various aspects.

Actually, as I mentioned before, the dry cask storage, there is very little that we are putting in terms of contractor dollars to dry cask storage PRA. We are going to have the structural analysis work done by PNNL but really most of the other work is being done in-house, would service the objectives of training staff up and doing this and increasing our knowledge base.

So, I don't think that we have put too much emphasis on the dry cask storage PRA. I mean it should not come out to be a driver. Everything that we know to date about dry cask storage risk would indicate that it will not be a risk factor but we want to at least --

CHAIRMAN STETKAR: That is my whole point is could a smart person sitting in a room for a couple of hours come up with a reasonably bounding assessment with perhaps very large uncertainties that might be good enough and take the resources, you said PNNL is doing structural analyses. You mentioned earlier concerns about having site-specific structural fragilities for some equipment for the seismic work. You know structural engineers tend to be structural engineers. If you give them money, they will give you numbers on pretty much anything.

It is just -- you know --

MR. KURITZKY: I understand where you are coming from. And part of me would say yes, I could certainly use that money for other parts of the study but I don't think in doing an integrative site risk PRA and looking at all the radiological sources it would be good to have just kind of a back to the envelope for the dry cask storage. I want to have at least enough of a --

CHAIRMAN STETKAR: You got worse than a back of the envelope for external flooding. It isn't even in there.

MR. KURITZKY: Well but flooding we have some very physical reasons why flooding is not considered to be a concern at the site. So, I am more comfortable ruling out flooding than giving short trip to dry cask storage PRA.

CHAIRMAN STETKAR: Okay. That's --

MR. KURITZKY: But again, if this was a major driver, if this was a major fund, a sink for funds, I would definitely want to relook at it. But it has not been a major resource drain. To date there are some things that our dry cask storage team has identified in how Southern does their loading that has made us want to look to some sequence that haven't been looked at in previous shutdowns in dry cask storage PRAs.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: So, I don't know. Felix, did you --

MR. GONZALEZ: Most of the dry cask storage PRA we are getting a lot of the information from NUREG-1864, which was the NRC's prior PRA on dry cask storage. Now, that PRA uses the same dry cask storage system as Vogtle is using.

So I mean in terms of the assumptions, if the assumptions are still the same, the 1864 should be valid for -- or the results of 1864 should mostly be valid.

Now one of the areas where we spent a lot of time at the beginning was try to identify areas of 1864 that we could improve with as little resources as possible and that is where PNNL's work, it is really happening.

CHAIRMAN STETKAR: Okay. Well, one of the reasons -- I mean I understand. Believe me, I understand. Anything new you tend to spend a lot of time on because you want to try to get it right. It is just that, for example, on the slide that we have in front of us here, it says major challenges: development of peer review criteria. My experience, that can become a big time and money sink really fast.

MR. KURITZKY: Yes.

CHAIRMAN STETKAR: So, if you are developing detailed peer review criteria for an area that there are no criteria, which may not necessarily need very sophisticated analyses and models, it doesn't strike me that that is necessarily a very important allocation of resources. That is sort of where I was headed with this issue.

You certainly need to look at the issue but in the perspective of the entire site risk model.

MR. KURITZKY: Right. And that is very valid. And that is good advice right now. When we go to do that peer review criteria, we will need to keep in mind not to spend too much money on developing it. Right. There is no point in spending $300,000 on peer review criteria to review a $200,000 study. It doesn't make sense.

But so yes, we need to come up with something that at last allows us to check the box and make it look like -- to give it some validity. But keeping things within the big picture are less important.

CHAIRMAN STETKAR: Well, that is what Dennis mentioned earlier. The uncertainties might be broad but even with large uncertainties, if it doesn't seem to be an important contributor, so be it.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: If the uncertainties are broad, the models are approximate. You can always fine-tune things later once you get things stitched together.

MR. KURITZKY: Right.

MEMBER SCHULTZ: It may be a different way in which to provide a robust evaluation as well as pinpointed focused analyses where you find it to be important in this new area. That is, doing what John had indicated earlier, spending a short period of the time, focus time with the planning aspect of what needs to be done. And I know that you have done that already, just based on the slide. But that would also prioritize the technical areas that are of importance and the resources that should be allocated to them.

For example, you have at the technical area, fuel performance structural analysis. That could be a huge money sink or resource sink for little value, in terms of a risk evaluation associated with dry cask storage.

If you put together a detailed long-term plan associated with the whole project, you might be able to identify that you developed a very robust approach to evaluating this aspect of the Level 3 PRA impact associated with dry cask storage and come away feeling very good about moving forward with the technology but putting off some of those things that might be important that are probably not to a later time.

MR. KURITZKY: That is good advice. Again, as Felix mentioned, specifically for what we are doing with PNL for this, there are some things that came out of 1864 and also I guess the EPRI statement, too, but it was the fuel failure issues that are critical to the analysis. And there is big difference in how the NRC and the industry studies address them.

And so we wanted to spend -- we wanted to try and get a little better handle on that. And again, it is not a significant amount of money in terms of the project and we do think it is something that will definitely improve dry cask storage modeling. And so we want to go down that road.

If they came back to us and said okay, well, we have spent what you gave us and here is your answer but we have ten questions for every answer we are giving you and we need more money to do more detailed work, we would obviously have to -- that is it. We would not be able to go down that road anymore. And that would be up to someone else to pursue separate from this project. But at least we have enough desire to resolve a few questions right now and it seems like it is a reasonable resource expansion that we would want to pursue it.

MEMBER BLEY: Alan, one thing that you haven't talked about at all. One of your goals was staff training in doing this project. And with a lot of the work being done by contractors, how are you accomplishing that?

MR. KURITZKY: Well, as I mentioned before, it is a lot of staff and contractors work that we are doing. So, I would say definitely probably more than half the work is being done by staff and staff at all different levels. We have team leaders that are generally more senior people and more experienced but we have a lot of people supporting them that are either junior level, you know more early career people, or mid-career people that have some knowledge of PRA but haven't done a lot of hands on or people that are just getting --

MEMBER BLEY: So they are getting involved?

MR. KURITZKY: Oh, yes, definitely.

CHAIRMAN STETKAR: And it is hands-on modeling. It is not simply running contracts and reviewing contractor results.

MR. KURITZKY: No, no, it is getting involved.

Now again, the fault trees were all developed before. We imported over the fault trees from the licensees. So in general, we haven't developed fault trees from scratch. There was a couple for the containment isolation or sprayer, or something where we did some in-house fault tree development but primarily we took those over.

But there was a lot of other stuff in terms of going through the model, running the model, looking to cut sets, trying to adjust different things in the model and see how it turns out doing various sensitivity studies and hunting down issues where you really have to get into the PRA code and work with it.

And so we have had a lot of people doing work in that area, as well as doing even reviewing screening of external hazards or supporting low-power shutdown period. There is a lot of junior and mid-period people that are working in those areas and are picking up a lot of information and experience in doing work there.

MEMBER BLEY: Is it possible or have you thought of allowing some of those people to spend some time in the contractor's offices where they really would be completely involved in developing some of the modeling?

MR. KURITZKY: We have considered those possibilities. Right now, our Level 2 contractor is local.

MEMBER BLEY: That's right. They are just up the street.

MR. KURITZKY: Right. So, we are able to work -- we have people in-house doing some work in that area. And we have a contractor. We meet with them regularly so there is no real need to shift people.

MEMBER BLEY: Okay.

MR. KURITZKY: Idaho would have been one area. Had we actually been doing, and one of the things we initially envisioned possibly was doing the fault trees ourselves, that would have been something we were considering sending people over to Idaho to work with them to develop the fault trees.

Because we ended up just importing over those fault trees, that opportunity kind of disappeared. So it really wasn't as much of an opportunity there.

CHAIRMAN STETKAR: Did only Idaho folks do the translation from the CAFTA to the SAPHIRE event tree structure?

MR. KURITZKY: Yes.

CHAIRMAN STETKAR: That was solely Idaho?

MR. KURITZKY: Right. They have like a semi-automated routine that kind of took the actual code and parsed it into SAPHIRE except for some of the various changes that I discussed earlier. It actually was kind of an automated routine that they used.

MR. HELTON: Can I give a few examples that might help and I don't mean to -- there are a lot of examples and so this is just a few so nobody should be offended that they are not the one I mentioned.

But we have a mid-level engineer in research, Margaret Tobin, who spent time at Idaho last year as part of a professional development program and now is one of the go-to people for doing these quick quantifications of the Vogtle model to scope out issues. That is one example where her time at Idaho wasn't part of this but we certainly benefited from that as part of what she did for another program.

There is an engineer in the audience named James Corson who developed this simplified MELCOR model for the spent fuel pool and did the sequence timing analysis for that.

And to your point about interactions with the contractors, we actually had our contractor, Energy Research, do the QA of his model so that we got some of that interaction.

And then a third example would be there is a mid-level engineer in NSIR, the Nuclear Security Incident Response, named Todd Smith who ran RASCAL calculations to support some of the analysis that we did for when the technical support center would enter to specific SAMG strategies that are based on site dose, rather than plant parameters.

So again, those are intended to be some examples of where we are utilizing those types of opportunities to train junior and mid-level staff.

MR. CORREIA: If I could add also, we use RSLs Marty Stutsky, Nathan Siu, Don Helton, Mary Drouin, very senior people to do a lot of coaching and mentoring also.

CHAIRMAN STETKAR: The problem is the senior people are senior people and if they are lucky, eventually they are going to retire. Part of the goals for the project, I think, were to develop more of a hands-on PRA experience among the junior staff so that you don't have to constantly say well, Mary is the expert in that area or Marty or Don or somebody else.

MR. KURITZKY: Right. And I think that is what Richard was getting at was that those senior people are coaching and mentoring these other people to bring them up.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: Okay, I am a little bit behind schedule so let me quickly just go over integrated site risk.

MEMBER REMPE: Before you leave this slide, I had a question, if I could interrupt.

On this slide, as well as in some other slides when you are talking about the source terms, for example, at the plant I believe it says with the MELCOR model in it they are looking at maybe eight to ten cases. And I am just struggling with how you are actually setting up the calculational model.

Because here, even though you have used a simplified MELCOR analysis, you use the phrase release fractions, which for me triggers the old XSOR code, where you have a real -- and I see that other places in some of the documentation I read to prepare for this meeting.

And so when you finally finish your MELCOR analyses are you doing something like the old XSOR, where you have release fractions from the core, from the containment, or in this case, the dry cask storage area? How is the model constructed at a high level?

MR. GONZALEZ: Well right now we haven't actually got into that part. The release fraction is one of the places that we have some issues that we are trying to -- Don did you have anything that you want to --

MR. HELTON: Yes. I guess let me take a crack at that Dr. Rempe, and let me know if I am missing the thrust of your question.

For the reactor and the spent fuel pool, the intent is to use source terms generated by the MELCOR code. And when we use the term release fraction in describing that, we use those terms to mean time-dependent release fractions from the various chemical classes.

TELEPHONE RECORDING: Please pardon the interruption. Your conference contains less than three participants at this time. If you would like to continue, press *1 now or the conference will be --

CHAIRMAN STETKAR: Thank you, God. And thank you, too.

MR. GONZALEZ: So, I think the operator finished my answer for you. So everything should be clear now. Right?

CHAIRMAN STETKAR: Got it?

MEMBER REMPE: This is helpful because I --

MR. HELTON: Yes, I in particular used the term release fraction, even when I am talking about MELCOR results to denote the time-dependent fractional release either from the fuel or to the environment of the various chemical classes that MELCOR tracks that are then translated into the various radionuclides that MACCS2 analyzes.

So, in that sense, release fraction is a part of the overall source term, which also of course has to include things like particle size and plume energy and the release point.

Now the dry cask storage is, as I believe Felix is about to say is a little upstream of that decision point right now. And so, take what I said to apply to the reactor in the spent fuel pool and for the dry cask storage, exactly how that is handled is to be determined.

MR. GONZALEZ: Yes, I mean in a similar way, the release fraction is a fraction of fuel that is coming from the spent fuel pool cladding into the cavity of the dry cask, adding to the environment. And that could be handled by -- you know we have explored in the past about we could handle that through a MELCOR model but that seems to be seen yet because we haven't gotten to that point yet.

MEMBER REMPE: So you are going to use a more mechanistic approach than what was done decades ago with that SOAR but at some point are you going to have to say okay, this is the only release for MELCOR versus the label is? You are going to have to lump it into goods. Right?

MR. HELTON: Well, to some extent but the translation from MELCOR to MACCS through the MELMACCS interface allows for the definition for plumes, numerous plume segments --

MEMBER REMPE: Right.

MR. HELTON: -- that allows you to discretize the release as a function of time. So, there is no gross lumping. You know you would be computationally limited to some extent, in terms of the number of plume segments you define but I don't think that there is the type of gross lumping that you are referring to.

MEMBER REMPE: Okay, this helps. Thank you.

MR. KURITZKY: Okay, so integrated site risk. We have a simplified approach for doing integrated site risk that we have documented in our technical analysis approach plan, Chapter 17, that is publicly available. It recognizes the fact that trying to jam everything together from the whole integrated site model would be too computationally intensive. So we are going to have to be smart about building out that integrated model using the single source models and risk insights from those single source models to put together an integrated site model.

We have also done some experimentation with SAPHIRE trying to quantify multi-unit sequences to see how well we can do that. So far, it is seen that we can in fact combine sequence in different units and get SAPHIRE to set them out, whether we could or want to do that for a huge model but at least we are adding all the different types of hazard categories is doubtful. That is why we are approaching it with a more simplified modeling scheme.

We have also been looking for dependencies between the different radiological sources on-site. That is the key issue for determining how complex the modeling will be. Obviously, if every source was independent, it would make it a lot easier and it was actually fortunate with Vogtle that was a tremendous amount of independence between, for instance, Unit 1 and Unit 2. There are very few systems I don't think -- in fact there are no real safety systems that are shared between the two units. You have more like offsite power, something like that is where you get your dependencies.

But one thing you do have to consider is common cost of similar equipment in both units. And in doing that, you are going to end up with some common cost failure groups that are going to get fairly large, which can become a problem for PRA code, if it exceeds what it can handle. Plus, there is not going to be very much data. Each of the units has, I believe, I think there are six NSCW pumps. And if you want to have a common cause, you know, 12, you have a lot of models out there or data for doing something like that.

So, obviously you can come up with some kind of a beta factor, some kind of simplified approach to deal with very large numbers like that.

But in any case, common cause fair modeling across units is going to become something we will have to deal with.

As far as getting work done on the integrated site risk model, we want to get the single source models done first so we can then use the insights from them to help build out the integrated model.

The major challenges? No surprise here, staff availability. The team lead in particular is Marty Stutsky. He is pulled in many different directions. So getting his time to focus on this is a challenge. We have other people supporting him that have helped carry the water but we, of course, need to have a sufficient amount of his time to keep things moving forward.

Also as in many of the other areas that we have talked about keeping the model of a practical size is important. Obviously, we need to talk about bringing everything together. So you are going to have to some type of prioritized scheme. And that is what we discussed n that TAP section.

In terms of 2014, we want to develop an quantify the simplified logic models that will build out the integrated site risk model and they will be built out as we get the single source models completed. Right now, we are looking at getting the internal event and flood Level 1 model done. Essentially, that one will be -- the model itself is pretty much done, outside of, of course, the ISLOCA issue and it will get peer reviewed hopefully early next year so we can start working with that one.

The then high wind model will show up several months later. We can start building that one into there. Aside from the event model, it should also show up a few months after that, we can start building that one into there. And then other things will just get added in as the single source models get completed.

Okay, the last thing I want to talk about is just some of our industry-based or industry-led PRA standard based peer reviews. And again as I mentioned before, that is just one of the review levels that we called for in our PRA plan. We have talked with the PWR Owners Group about these. They are very interested. They have actually committed funds in 2014 to support these peer reviews. They will be led industry contractors, supported by other licensee volunteers, as well as NRC staff, at least SRAs will be the main people we will supply to the review teams.

We are currently working with them to lay out the schedule and the scope of the various reviews for 2014. Let's see, do I have that on here? Yes.

Okay, so just jumping down to 2014, we hope to have, as I mentioned, the Level 1 reactor model for internal events and floods. That should be ready for peer review. I think right now the plan is in the summertime. They need a few months -- once everything is documented and put together, they need a few months' lead time to get everything set up. So, we are targeting summer for that peer review.

The Level 2 for internal events and floods is now a target for, I think, the very early fall, late September time frame.

The Level 1 PRA for high winds and other external hazards, I think will probably be sometime in the November time frame. Those are the three that we are fairly confident we can get done this year. What we will also do is because the PWR Owners Group had funding for up to four. So, we are thinking of working with them to come up with some review criteria for the spent fuel pool and dry cask storage.

Again, we are not trying to put a tremendous amount of effort into some aspects of it. But that is something we do need to do and we will pursue that probably late in 2014.

Going to some of the challenges, back up to the top, again, there are a few of these areas where we don't have a PRA standard and that is dry cask storage, that is spent fuel pool, and that is integrated site risks. So those are the ones that we still need to come up with some kind of review criteria for.

Also, just the sheer number of peer reviews. Because there are so many pieces to this project, there are many peer reviews we would like to do. It was very generous of the peer owners' group to fund for peer reviews this year. We don't know whether or not that is something they would be willing to fund after 2014 because there are obviously more areas that we want to have peer reviewed. And so getting PWR Owners Group or other people to do those peer reviews is just something we are just going to have to -- it is a challenge we have to face just because of the total number.

MEMBER BLEY: Is there any standards work on spent fuel pool risk?

MR. KURITZKY: That is where I really wish Mary was sitting right next to me today.

MR. HELTON: There is -- I'm not sure if Brian Wagner is in the audience but there is, I believe, a writing group that has been stood up.

MEMBER BLEY: Just starting?

MR. HELTON: I believe that that is the case.

CHAIRMAN STETKAR: It will probably make the tremendous progress that we have had on the low-power and shutdown stuff. So, only after we are dead.

MEMBER BLEY: So it is not going to be one by the end of the year?

(Laughter.)

MEMBER BLEY: Thank you.

MEMBER SCHULTZ: Alan, just one final comment related to the peer review. And I know you are not doing this but don't underestimate the resources. The value of investing resources to support the peer reviews and the amount of resource that ought to be assigned to that activity, both before and during the peer review process. And then, of course, as you know from -- I would think from industry peer reviews, the follow-up activities can be quite substantial also on making sure that you capture the appropriate lessons learned in the work itself.

MR. KURITZKY: Right, thank you. And that goes back to Dr. Stetkar's comment before about we are still responding to comments from our SPAR model, --

MEMBER SCHULTZ: Right.

MR. KURITZKY: -- peer reviews -- understood. Thank you very much.

Okay, so any other questions on the project status before I turn it over to --

CHAIRMAN STETKAR: Before we take a break, you mean?

MR. KURITZKY: Right.

CHAIRMAN STETKAR: What I would like to do, we are running a little behind schedule and Felix, I doubt you will be able to cover your stuff in 15 minutes because we are not very disciplined. So, what I would like to do is take a break and we will reconvene at 10:15.

(Whereupon, the foregoing matter went off the record at 10:01 a.m. and went back on the record at 10:18 a.m.)

CHAIRMAN STETKAR: We are back in session. And we will hear about the joint plant operating states.

MR. GONZALEZ: Good morning, my name is Felix Gonzalez. I am going to be discussing the joint plant operating states that we are going to be using for the integrated site risk analyses. Specifically, I am going to be discussing the site matrix that we have developed and the proposal approach and the assumptions that we have used to develop this matrix.

As I said, the purpose of this, the site risk analysis is to assess the total risk and to identify important contributors to total site risk. Two things that we know we need to do for developing this integrated site risk is to create a multi-source accident sequences that is going to be combining the different single-source PRA models that include the two units, spent fuel pools, and the dry cask storage.

Also in order to accomplish this, we have developed these Joint Plant Operating State Matrix that I will be spending most of my time of the presentation. The slide is at the end. I am going to be discussing most of the assumptions for the different plant operating states and the different single-source PRA models that are going to be input into the matrix.

Some of the general joint plant operating state matrix assumptions are listed below. You know, first we are considering the site operation operating configuration by superimposing operating configurations, define within each other a single-source PRA models. We are going to be forming site radiological release states by combining the states obtaining from each other single-source PRA models and adjusting for logically impossible combinations. Like how we see a unit cannot be in shutdown at the same time as in power and any combinations are prohibited by tech specs.

Just to recap from what we have said in previous presentations, these are the different key interface considerations. First, reactor on the spent fuel pool, the physical boundary between the containment and the fuel handling building is interfaced between where one, the reactor PRA finishes and the spent fuel pool PRA starts. In the same line of thinking, the spent fuel pool and the dry cask storage, they are divided in the Part 50 and the Part 72, where the cask loading belongs to the dry cask storage and cask drop effects of the spent fuel pool belong to the spent fuel pool PRA.

Some of the general considerations, you know reactor at-power, reactor low-power shutdown configuration, spent fuel pool, the different spent fuel pool configurations, and then dry cask storage PRAs must be coordinated and we are working through the different team leads to coordinate different effects of each on the other.

Also, we have defined our representative 18-month operating cycle for the site where it starts when one unit starts at the refueling outage, goes through the other unit refueling outage, and then at the beginning of the first unit refueling outage, which ends up being approximately 550 days.

Then there are the considerations for the spent fuel pool. The time since the last core offload has a significant impact on the decay heat level and we have developed different configurations that we are tracking through the matrix that track the different heat levels. These last core offload has an effect on the boil-off duration and the fuel behavior following recovery.

Both the Unit 1 and Unit 2 have high density racks. Still, both of those racks are a different configuration in which the Unit 2 spent fuel pool has a higher fuel assembly capacity.

Both the spent fuel pools are contained within the same physical space. In the bottom right picture, you can see in the same space for the fuel handling building, you can see both units. They are both hydraulically connected most of the time. From what I have seen one of the few times where they are actually separated when they are doing any lists of a dry cask storage and preparing for the cask pit for loading a cask or taking the cask out of the cask-loading pit.

CHAIRMAN STETKAR: Just out of curiosity on that picture, is the cask-loading pit that central section there between the two pools, I would assume?

MR. GONZALEZ: This is a Unit 2 spent fuel pool, where the cask-loading pit which is right here.

CHAIRMAN STETKAR: Yes, okay.

MR. GONZALEZ: That is Unit 1 spent fuel pool.

CHAIRMAN STETKAR: Okay, good. Thanks.

MR. GONZALEZ: Then continuing on the spent fuel pool consideration, we have defined the spent fuel pool operating cycle as nominal, outage entry, refueling, post-refueling, and cask-loading.

And then there is different plant activities that affect the decay heat and the number of assemblies in the spent fuel pool. These days dividing the different operating cycles so that the calculation of the large modeling may be using only -- may be done using only a single decay heat and assembly population for each of the phases.

Going to the dry cask storage consideration, it has been based mostly on prior experience and our experience on the site visit. Approximately six casks would need to be loaded and that was our assumption for the whole cycle of the site. This is also to keep similar spent fuel pool inventory through the life of the plant. For example, we are not are going to be considering expedited transfer.

Each dry cask loading takes between five to seven days, depending on the heat, decay heat of the cask and cooling times. Then, the integration matrix assumes 40 days for dry cask storage operation and phases are defined as either cask-loading or storage for in terms of the matrix.

Now these are the different individual radiological source plant-operating states. The reactor, each of the units has their own at-power and low-power shutdown, which is also separates it into 14 separate states. The spent fuel pool, as I mentioned, has a nominal outage entry, refueling, post-refueling. The nominal operating states includes five separate timeframes and the dry cask storage operating states are dividing nominal and cask-loading operations.

CHAIRMAN STETKAR: Do you need -- you are going to show us --

MR. GONZALEZ: Yes, this is the last slide.

CHAIRMAN STETKAR: You are going to show us a big matrix or something like that.

MR. GONZALEZ: That's right.

CHAIRMAN STETKAR: Just out of curiosity, you mentioned you have got five separate time frames for the normal operating state for the spent fuel. Do you need all that detail?

MR. GONZALEZ: Yes.

CHAIRMAN STETKAR: I know that --

MR. GONZALEZ: I will mention it right now.

CHAIRMAN STETKAR: Okay.

MR. GONZALEZ: We have it and it is basically -- and Don correct me if I am wrong -- the different states are nominal, depending on decay heat --

CHAIRMAN STETKAR: Right.

MR. GONZALEZ: -- throughout the life of the --

CHAIRMAN STETKAR: I mean we have seen the spent fuel pools open study.

MR. GONZALEZ: Exactly.

CHAIRMAN STETKAR: And again, at a high level, bookkeeping can become important as you are recognizing. And the question is, do you need all of that?

MR. HELTON: So, in that respect, think about the fact that the pools are routinely hydraulically connected. And so during that 18-month period, you have two outages that occur. So you have got two different times to decay heat. And that collective has dramatically changed.

CHAIRMAN STETKAR: Sure. But I am asking about the -- you know -- it is fine. You have thought about it.

MR. HELTON: So and to your point, the spent fuel pool PRA itself, as a single-source PRA, is basically prioritizing into different tiers, based on the timing aspects and the hazards. So a combination of the hazards, the fragilities, which I am using loosely here, and the exposure times in these different phases in order to get at your point that not all combinations of those are created equal. Some will be much more important than others.

CHAIRMAN STETKAR: Right.

MR. HELTON: And so they are being tiered and we are addressing them in a phased approach so that we are addressing the more risk-significant or what we believe to be the more risk-significant combinations of those first.

CHAIRMAN STETKAR: Okay. Okay, thanks.

MR. GONZALEZ: Now going back to the slide, this is the representative matrix that we have developed so far. The current stage only one on the spent fuel pool analysis has really used it somewhat. The different timeframes are mostly based on the outage and the refueling and the different spent fuel pool configurations.

It has a 34-unit joint plant operating states. In these states, the first 14 include the low-power shutdown for the Unit 1 reactor and then it goes into nominal and at-power configurations. Dry cask storage includes all the different storage throughout the life of the cycle and also the cask-loading at the bottom.

Now, you can see you know we basically put the Unit 1 and Unit 2, if it is one, it is at-power. The other one could be either low-power configuration.

CHAIRMAN STETKAR: Why is it not possible that ever at the Vogtle site both units can be shut down at the same time?

MR. GONZALEZ: That question, I don't know. Alan do you or Don?

MR. HELTON: It is possible.

CHAIRMAN STETKAR: Why aren't we evaluating that configuration?

MR. HELTON: This matrix is intended to capture a representative 18-month cycle. And then we would have to separately evaluate off -- configurations that are not captured by that. So, one plant is in shutdown and the other one trips and gets you into the situation you were talking about.

This is intended to be the first pass at what the technical 18-month period at this site would look like.

CHAIRMAN STETKAR: Okay, got it. But my whole point is there might be and probably will be, in a full-scope PRA, other line items than this 34. It is one of the reasons why I keep emphasizing this notion of subdividing this list finer and finer and finer. There are things that are not on this list that you will need to add and you don't have a lot of time and energy to add a lot of stuff.

MR. HELTON: Some do it now. Some do it later. I mean --

CHAIRMAN STETKAR: Well, okay. But it is a site-level risk assessment and there is a measurable fraction of time, small, but measurable, where both units indeed will be in cold shutdown simultaneously. And it isn't necessarily from just one unit of power and it trips while the other unit is shutdown. There can be things that happen that shut both of the units down.

MR. KURITZKY: Right. Loss of offsite power, that takes it --

CHAIRMAN STETKAR: That is more -- yes.

MR. KURITZKY: Yes, I guess to echo what Don said, I mean this isn't necessarily to be our framework and we are just going to plug everything in here but it is a starting point.

CHAIRMAN STETKAR: No, no, no. And it is a good starting point. I mean you obviously need to do this. It is just be cognizant of -- the finer you subdivide things in this context still has to be treated with a vision that there are additional configurations that need to be added at some point.

MEMBER BLEY: But as they go forward, you will probably find that some -- they will collapse some of these as well.

CHAIRMAN STETKAR: I would hope so.

MEMBER BLEY: I mean the Level 2 assumes the units are identical right now.

But I don't know about Level 1. Are there separate models for the two units are they identical?

MR. KURITZKY: We have separate models for Unit 1 and 2, two different models.

MEMBER BLEY: Are they different or you just have two identical models?

CHAIRMAN STETKAR: We can probably get to difference --

MR. KURITZKY: Well I think they are pretty much identical. I mean they have different basic event needs for the Unit 1 and 2 but I don't think there was anything --

MEMBER BLEY: No design differences.

MR. KURITZKY: I don't think there were any design difference.

Maggie, I hate to put you on the spot but would you mind stepping to the mike for a moment?

CHAIRMAN STETKAR: Well, I mean there is some philosophy of do you collapse things or do you keep them coarse and then expand them later as necessary?

MR. KURITZKY: Maggie, do you know if there are any differences between the two, the Unit 1 and Unit 2 models?

MS. TOBIN: So far as I know, there is no differences between the two models. The only exception is there is some basic events that are in both models for common cause groups and things like that.

CHAIRMAN STETKAR: Maggie, just give us your full name so we have it for the record.

MS. TOBIN: Margaret Tobin.

CHAIRMAN STETKAR: Thank you.

MR. GONZALEZ: Going back to that, we also know that there is going to be some challenges. And we have identified potential symmetries with respect to this matrix and could simplify the analysis eventually.

Any questions?

MR. KURITZKY: Ready?

CHAIRMAN STETKAR: You've learned silence for more than five seconds means plunge ahead.

MR. KURITZKY: All right. I wasn't sure if you are looking in detail at the matrix.

Okay, moving on to the Level 2 PRA, Don Helton and Mike Zavisca from ERI will now present our work on Level 2 PRA Status.

MR. HELTON: Thank you very much. I just want to real briefly acknowledge Mike Zavisca from Energy Research sitting at my left, who will answer all the hard questions. And then the Level 2 has benefited from contributions from a number of individuals. I won't name any more specific names but there have been contributions from multiple -- numerous NRC staff members, Energy Research

Incorporated, as well as limited support from Idaho National Labs, Sandia National Labs, and Oak Ridge National Labs on specific pieces of the Level 2. Next slide please.

I will go through a few background slides and then I will basically structure this presentation around the technical elements within the draft Level 2 PRA standard. If you get lost along the way, please look in the upper right-hand corner and that will try to tell you where on this overview we are currently at. Next slide, please.

So, the first thing I wanted to touch upon in terms of background is the licensee does have a LERF model that is part of their Level 1 LERF. And in fact they have more than that. They have a simplified Level 2 model that was originally put together for their severe accident mitigation alternative analysis for license renewal. So, I just wanted to touch upon why we have elected in our study to develop a somewhat independent Level 2 PRA. And there are four basic factors playing into that decision.

The first is that the simplified Level 2 model is focused -- was originally conceived as a LERF model and the Level 2 model itself was developed for SAMA. And those were found to be acceptable for those purposes but we felt that there were some aspects where additional realism needed to be built in and we could do that more efficiently by developing, again, a somewhat independent level.

In addition to that, because of the scope of the model in its applications, as well as the lack of an existing endorsed Level 2 PRA standard, Southern Nuclear's LERF model and simplified Level 2 model have only been peer reviewed against the LERF elements within the Level 1 LERF standards. So that puts it on a somewhat different footing as compared to their Level 1 internal events and floods model, which has been peer reviewed against the full standard.

In addition, the simplified model that I mentioned that was developed for the severe accident mitigation alternatives analysis was developed using WCAP-16341 as the primary basis. And that is a document that is not readily available to the NRC staff. It has not been submitted to the staff. And the NRC handles questions about that methodology in the context of SAMA through requests for additional information. So that is another reason why weren't on the same footing with respect to adopting the Level 2 model as we would have been with the Level 1 model.

And finally, the experience with the Level 1 migration was that extensive work was needed to convert it over to SAPHIRE, as well as to understand all of the various modeling assumptions that go into it. And so again, the totality of that was a decision on our part that it made sense to develop a somewhat independent model. Next slide, please.

The other thing I want to touch upon with respect to background is the relationship between plant damage states and Level 2 sequences because I think if we don't cover this up-front, then it could get a little confusing.

It has already been mentioned that our objective here is to develop an integrated SAPHIRE Level 1, Level 2 model. And as such, it does not explicitly require plant damage states as the traditional pinch point between a Level 1 and Level 2 model but nevertheless, they are still necessary. And the reason that they are necessary is because they provide a number of elements that we need, including the narrative understanding of post-core damage plant response, sequence timing aspects for the containment event tree, phenomenological evaluations, again, to support the containment event tree, equipment and instrument survivability, inhabitability considerations, the context for the human reliability analysis, the source terms that we spoke of earlier in response to Dr. Rempe's question. And finally, they are the first step in the investigation of model uncertainty.

Nevertheless, as we build out a containment event tree and these related elements using this information, the actual quantification of release categories in terms of a probabilistic model would not utilize the plant damage states. And the next two slides attempt to convey that information in cartoon form.

The first slide here is a cartoon of the separated Level 1, 2 model and the things that I want to point out are sort of a separate set of thermal hydraulic analyses to support Level 1 success criteria from those that are used to support the development of the containment event tree. Plant damage states are defined as a pinch point and then, in a sense, thrown over the wall to a start of the Level 2 model. And finally, the HRA is somewhat decoupled between the Level 1 and Level 2.

Obviously, I am presenting sort of two extremes or two ends of the spectrum here. There are certainly ways that you can devise things that are in-between these two. But again, this is just intended to give you a conceptual understanding of what we are doing and why we are doing it.

MEMBER BLEY: Let me sneak a couple questions in here, Don.

MR. HELTON: Sure.

MEMBER BLEY: I have tried to line these things up and figure out just what you are doing and I think I have.

Up here you show the bridge tree, the containment systems. That is pretty clear. And that just hooks onto the Level 1 trees in your process this one way. Then where all these funny arrows are going to the plant damage states, there is a thing called a plant damage set of event trees that really just I think are a set of rules for mapping each of those sequences into one of your plant damage states. That's true?

MR. HELTON: That's true.

MEMBER BLEY: And then you come over to the containment tree. There are a couple of things that get added in, I think it is the plant damage state event tree, which seems a little funny to me. One of them is about do I depressurize and yes or no. Is the primary depressurized on the core I think.

Then over in the containment tree, you ask is the pressure high, medium, or low. And it would seem those two could link up such that you could have had that distinguishing in the plant damage state event tree and then it would just knock into the containment tree. Or am I missing something?

MR. HELTON: So the plant damage state tree is a sorting tree. It basically takes the golf balls and paints them different colors and drops them into different buckets. It doesn't change the frequency of the cut sets.

The containment event tree, like the Level 1, is actually branching on failure probabilities and is changing the frequencies, adding additional elements to the cut set.

MEMBER BLEY: Well, if I have sorted into pressurized depressurized, if I pressurize them when I get in the containment tree, if I came in pressurized, then there is a question if I am high or medium. And if I come over depressurized, the pressure is low. Is that true or how does that map?

I couldn't quite track that, didn't find the words to tell me. And maybe it is in the fault trees and I could couldn't sort them all out either.

MR. ZAVISCA: Mike Zavisca, ERI. The top event that you are referring to in the PDS tree refers strictly to operator actions to depressurize.

MEMBER BLEY: Oh, it is?

MR. ZAVISCA: Yes.

MEMBER BLEY: Okay.

MR. ZAVISCA: So the top event in the containment event tree simply asks what pressure are you at and that preceding top event will be one element that helps determine it.

MEMBER BLEY: Okay.

MR. ZAVISCA: So if operators depressurize through secondary site cooldown or some other means, then you are at low pressure.

MEMBER BLEY: One thing that I think would have helped me, but I am not sure because you have got an awful lot of these, you had some things that are called plant damage state matrices but you were really tracking the sequences, you selected, I think through that. But a matrix like that kind of lays out the stuff that is in the bridge tree and in the plant damage state tree.

And if that matrix could somehow tell us the conditions that we are passing on to the containment, I think it would make a really nice MAP to help people understand. When I come through and find 119, or whatever it is, plant damage states, it is kind of hard to look at it and understand where I am and the space that we are passing on the containment about timing and pressures and all that sort of thing. It's just a comment. I think it would have helped me, although it is an awfully big matrix and maybe it would be confusing if you tried to do it there. I have seen people try that in the past where you get at least groups of here are the high pressure ones, here are the low pressure ones, here are the early, the late, and that kind of thing that helps you map it.

I'm sure you did a good job of it but it is real hard to read through it and kind of track where we are going. At least that was my experience.

MR. ZAVISCA: One comment on this is at the time we were putting together the plant damage state categorization and the start of the containment event tree, we were unsure for some sequences exactly what pressure you would be at when core damage began. And we were depending on the deterministic analysis to help guide us in that. And those are not, for the most part they are not completed at this time.

So, for some of them, we could not clearly establish yes, this one is going to be an intermediate pressure versus low pressures.

MEMBER BLEY: Oh, okay. Eventually, that might be a useful thing in your documentation.

When these pass on, although that plant damage state tree is a sorting tree, you could just look at the matrix and decide where all of these things are going, I guess.

You build in a fault tree that helps you do that sorting. Right? So that is all done automatically. Is that true?

MR. ZAVISCA: Each end state of the plant damage state event tree is a plant damage state.

MEMBER BLEY: That's right. But you actually use that tree as a tree. You would couple that tree onto the bridge tree, the containment tree -- the containment systems tree.

MR. ZAVISCA: Well, each end stage of the PDS tree links or transfers into the CET.

MEMBER BLEY: I'm not saying it right.

MR. KURITZKY: But if I understand it correctly, that is correct. Mike is saying that by the PDS transferring to the CET, it is just passing information along. So you have the Level 1 tree. You have the containment, the extended containment system tree, the other maps in the PDS, and the those PDS are directly linked into the containment event tree.

MEMBER BLEY: The PDS tree is an event tree and its top events are fault trees but with information that is already decided back in the Level 1 analysis.

MR. KURITZKY: Right, or the containment, the actual containment systems.

MEMBER BLEY: Right.

MR. KURITZKY: And they need that information for answering some of the questions in the containment event tree.

MEMBER BLEY: But it is actually fed in as --

MR. KURITZKY: Right. It is physically part of it. The information is passed along. Right?

MR. ZAVISCA: That's correct.

CHAIRMAN STETKAR: You didn't talk much about the bridge tree. I didn't see any slides on it.

MR. HELTON: Yes, we will talk about it. There is a slide on it in a little bit.

CHAIRMAN STETKAR: Okay, I'll wait.

MEMBER BLEY: It's pretty small.

CHAIRMAN STETKAR: I know. I wanted to ask -- I didn't have enough time to read everything. I'll wait.

MR. HELTON: Moving to this slide. Again, this is just intended to give you a cartoon sense of what we are doing relative to the separated model covered in the previous slide. The one thing I couldn't get across in this slide format was the fact that we do still have a set of deterministic calculations to support Level 1 success criteria. But in this case, we also have the deterministic calculations that are used to support the Level 2 analysis and those began at the initiating event and carry through the Level 1s. They provide additional information on the scenario from a pre-core damage perspective to the Level 2 PRA.

But here, as we have already discussed, you still need the plant damage states as a pinch point for the deterministic analyses that you are going to perform to support the various things that I spoke about previously. But from a probabilistic modeling standpoint you are now transferring cut sets directly from the Level 1 into the containment event tree and the combination of those things, the line at the bottom is intended to denote an enhanced ability to pass HRA-related information across the Level 1/Level 2 interface.

Okay, so now that we have --

MEMBER BLEY: If you do this the way you are saying, the idea of a Level 1/Level 2 interface, although we are talking about it and is a construct that is useful for discussion and understanding, these will all be one giant or several giant linked event trees across Level 1, the bridge tree, the plant damage state tree, and the containment tree.

MR. HELTON: Right.

MEMBER BLEY: So we won't actually be passing. We will be solving for cut sets of the whole -- each sequence.

CHAIRMAN STETKAR: That's right. But I mean still the Level 2 analyses, they can't do a detailed Level 2 analysis for every cut set. So you still have to --

MEMBER BLEY: Right. And the plant damage states condition the containment tree.

CHAIRMAN STETKAR: Right. The entry --

MR. HELTON: Correct.

CHAIRMAN STETKAR: The entry criteria for the Level 2 progression. You might -- you know you will do an end to end analysis but for some sequence that you select in each of those plant damage states as the quote/unquote representative sequence. Right?

MR. HELTON: Yes. Everything you just said is correct.

CHAIRMAN STETKAR: And that analysis will apply for every cut set that is dumped into -- that has that label on the monitor or whatever -- however the bookkeeping is done. Is that right?

MR. HELTON: Yes.

CHAIRMAN STETKAR: Yes, okay.

MEMBER BLEY: I had one kind of minor question. I think it is just where you stand in the analysis. I didn't see it in the containment tree but in the plant damage state event tree, coming into it you say that for several very reasonable reasons, not all of the possible branches will apply in all cases. And in a few cases, you prune the tree because of that and things don't branch. In a couple of other cases you put an APP sign at the end and don't count it. And I am guessing that is just where you were as you were running through the analysis that you won't have dummy sequences in the final model.

You are looking like you don't even remember what I am talking about. So, we can do it offline.

MR. HELTON: Okay, yes.

MR. ZAVISCA: I can't think of specific examples.

MEMBER BLEY: I can show you offline. We don't need to do it here.

MR. HELTON: Yes, I mean the structure -- you are talking about the plant damage state tree, right?

MEMBER BLEY: Yes, that is the only place I saw this. There were a few sequences where you didn't count it as a plant damage state but you put an APP sign or some symbol at the end of it. And the reason was that it wasn't a possible branch.

CHAIRMAN STETKAR: Yes, we would have to go back and look at those specific cases.

MEMBER BLEY: I think it is just an editing job but I just found it a curiosity. Let's not do it now.

MR. HELTON: Okay. So now that we have talked about some of the background, we will go into some of the specifics about the model we are actually doing and so we will start with the first technical element within the Level 2 PRA standard.

MEMBER BLEY: I'm sorry. I have got to ask you one more because I brought it up earlier.

MR. HELTON: Okay.

MEMBER BLEY: You have a plant damage state event tree for each class of initiating events. And the one I don't conceptually get is why you have a station blackout tree. I mean it is clear when you draw the tree that certain things can't occur. But in the transient tree, those same things might not be allowed to occur, depending on the status of the electric power system, which would include station blackout scenarios.

So, I am kind of confused. it seems an artificial construct that ought to lead to double counting if you are really counting the trees altogether.

CHAIRMAN STETKAR: Yes, and do we want to talk about this or save it for later?

MEMBER BLEY: I don't care.

CHAIRMAN STETKAR: Because I have questions on --

MEMBER BLEY: I want to talk about it sometime.

CHAIRMAN STETKAR: I have looked at a lot of the front-end, the Level 1 models.

MEMBER BLEY: He is going to tie it altogether, okay.

CHAIRMAN STETKAR: I would like to tie it altogether sometime. And it is probably better to get the staff --

MEMBER BLEY: What bothered me in the Level 1 and 2 part because it didn't --

CHAIRMAN STETKAR: It bothered me in the Level 1 part, too. So, it is probably detailed enough that we can postpone it but we do need to address it later this afternoon because it is kind of a common thread, I think, between both of the stuff that I looked at and the stuff that Dennis looked at.

Let's just leave it at that. Let the staff get through kind of this level of presentation because I don't think we can solve that issue in a short time period.

MEMBER BLEY: Okay.

MR. HELTON: All right, so moving forward with, again, some of the specific work we are doing for Vogtle. I wanted to bring up a few points germane to the Level 1, Level 2 interface and these are intended to sort of get you oriented in some of the decision making as we go forward with this.

One part of it is the typical ambiguities in Level 1 that you now have to address. Level 1 was done like all Level 1s from the perspective of identifying core damage versus non-core damage. And that leads you to certain modeling assumptions that lead to ambiguities in the Level 2. And so in some cases we have worked around those to address things like RWST availability and also to look at steam line flooding in the case of steam generator tube rupture.

In addition, there were changes made to the Level 1 to accommodate some of the things that we needed or some of the concerns that we had. The two examples I cite here are the ISLOCA frequency that Alan has already spoke about and, in addition, the human error probability associated with manual turbine-driven aux feed operation, following battery depletion during a station blackout was also reevaluated and updated.

In addition to that, there are other challenges in translating the Level 1 cut sets into the type of information that is needed for the Level 2. And you will see elements of this later on in the plant damage state bending and the definition of representative sequences but typical things that I don't think are going to be very surprising to those that have done this before, things related to station blackout, battery depletion, turbine-driven aux feed operation, plant cooldown assumptions. ISLOCA, break size and location, which Alan has already touched upon. And then in some cases, procedural actions that were not important to the determination of core damage versus non-core damage but can have some bearing on the Level 2.

So the next slide is focused on the bridge tree. So, this would queue up the question for Dr. Stetkar. Basically, there are three tops, top events in the bridge tree, dealing with the three major containment systems. The first is the containment isolation system. And here, we based our model primarily on the Southern Nuclear model. It handles active isolation failures for pipes greater than two inches and handles preexisting liner and maintenance errors that would result in a leakage size of roughly greater than 1.2 inches.

In addition to that -- in addition to adopting their model, we also did an independent investigation of the reasonable threshold between small and large isolation failures, looking at containment pressurization as a function of leakage and fission product releases, a function of leakage. And we found that these, that the two-inch was a reasonable demarcation point.

CHAIRMAN STETKAR: Anything greater than two-inch is sufficient for depressurization?

MR. HELTON: It is not necessarily sufficient for depressurization but it precludes long-term over pressure failure of the containment.

CHAIRMAN STETKAR: Okay.

MR. HELTON: In other words, above two inches the containment just could not -- under sustained MCCI conditions, the containment did not further pressurize.

CHAIRMAN STETKAR: Well, one of the questions that I had is if you are on the failure branch from that containment isolation failure in the bridge tree, what does that mean? Physically, what does that mean?

MR. HELTON: It means that you have had either an active isolation failure of a pipe greater than two inches, or you have had a preexisting maintenance or tear resulting in a leak greater than 1.2 inches.

CHAIRMAN STETKAR: And are those two different -- are those criteria different for the Level 2 or Level 3 models?

MR. HELTON: Right now they both represent a containment isolation failure.

CHAIRMAN STETKAR: I understand the words. I am saying in other models that I have seen, people have differentiated two or three different hole sizes and locations. Is it an air space isolation? Is it something like a containment drain sump isolation and two or three different sizes? You can't do that with just a bimodal isolation yes or no.

MR. HELTON: Right.

CHAIRMAN STETKAR: Unless you are doing cut set sorts.

MR. HELTON: The logic model doesn't give us a sense of the distribution in leakage size. And so that is something --

CHAIRMAN STETKAR: And what I am asking you is, is the distribution -- I am not a Level 2 person, nor am I a Level 3 person -- is the distribution in leakage size important to the Level 2 or 3 results?

For example, do they have a normally operating containment vent system with something on the order of eight- to ten-inch isolation valves. And would that give you a different response if that didn't isolate compared to a two-inch valve in the containment waste drain sump line?

MR. HELTON: The answer is it can make a difference and that is something we will have to revisit. But right now the containment isolation failures are showing, you will see this in a little bit, are showing up very low in the frequency. And so that sort of change can be accommodated within a frequency as low as it currently is. If that frequency were to come up, then it could no longer be accommodating and it probably would have to be broken up.

CHAIRMAN STETKAR: That's a good lead into my second question. The second question is who is developing the fault trees for the bridge tree?

MR. HELTON: For these three?

CHAIRMAN STETKAR: Right.

MR. HELTON: So they are a mix. The containment isolation fault tree is primarily adopted from this other nuclear model. The containment cooling fault tree is primarily adopted from the Southern Nuclear model.

CHAIRMAN STETKAR: Okay.

MR. HELTON: The containment spray fault tree, we started with the Southern model but it did not have the full scope that we needed for our Level 2. And so pieces of that were developed by the staff.

CHAIRMAN STETKAR: All right. I am sure that this is bookkeeping but I have seen this in the past so it is worth asking. You are naming basic events precisely the same in the Level 1 model and the containment bridge tree model. Is that correct?

Or are you physically linking -- for example, if I have loss of power from battery XYZ37, that basic event is named precisely the same throughout the PRA. Is that correct?

MR. KURITZKY: Yes, I have not seen that fault tree but I would have to say that it has to be true.

CHAIRMAN STETKAR: No, it ought to be true. I'm saying that in experience it sometimes isn't true. And the reason I bring this up is Don's comment is right now containment isolation failure isn't looking very big. In my experience, if you look at piecemeal parts of these analyses, some of the things don't look very big until you start to piece them together and find out that, oh, my God, in the sequences where I lose DC power, for example, which has an effect on isolation signals and safeguard signals, and tripping new reactor signals and you name it signals, that is where you see these linkages. You don't see them until you piece everything together but they are down in the noise, perhaps, at core damage, if I am only looking at core damage. And it might be down in the noise if I am only solving this bridge tree model for the containment isolation function. But in the integrated model, they can be important.

MEMBER BLEY: Unless you give them different names.

CHAIRMAN STETKAR: Unless you give them different names, which sometimes happens. Or if you take an approximate thing where you give a basic -- you say well, I am going to lump all of this stuff together because the model is getting too big and I will just put a number in for no DC power available, which is not the way to do it.

MR. KURITZKY: In the afternoon session, one of the people who was involved in putting together the containment spray tree, at least, will be here.

CHAIRMAN STETKAR: Okay, good.

MR. KURITZKY: And you can ask him --

CHAIRMAN STETKAR: We can talk about that. But it is one of the things that kind of has popped out in previous studies that if you are not careful when you stitch it together. The reason I ask about it doesn't make too much of a difference whether it is a two-inch or an eight-inch hole. Sometimes there are differences in terms of the dependencies for those different isolation pathways. And you don't necessarily see that until you piece everything together. Thanks.

The other thing that you did mention is that the Level 1 models do take credit for the containment cooling units to mitigate core damage. So it is really, really important that those models are fully integrated correctly throughout this bridge tree because I know you are using different success criteria in different places but getting the basic events named the same way is really important.

MEMBER BLEY: Since you just said those words, I have gotten back to this. Since you can be using different success criteria, you need to have something built into logic, and maybe we can look this afternoon, so that we are consistent between the two trees. You know, if it is yes/no and it has failed in the Level 1 tree and the Level 2 tree breaks it into three possibilities, you need some way to make sure that if it is failed in the Level 1 tree, it is in that same state and the bridge tree.

CHAIRMAN STETKAR: Well, I don't know how SAPHIRE works and maybe this afternoon is the time for a bit of education. I know how other codes work. But do you effectively solve the Level 1 and bridge tree integrated model in a SAPHIRE run? In other words, essentially linking all of those fault trees together. So that in the Level 1 model if I say I get core damage if I have less than M out of eight fan coolers working but I am okay in the bridge tree if I have only one out eight working, well, if it is really integrated, then the concern that Dennis raised really doesn't make any difference because the and and/or logic in this wonderfully integrated big fault tree will sort that out.

MEMBER BLEY: Will take care of that, yes.

MR. ZAVISCA: Right, the answer is yes.

CHAIRMAN STETKAR: It is. Okay. That is a good answer. Thanks.

MR. HELTON: Okay, the next slide starts on the plant damage --

MEMBER REMPE: Before you leave that slide, just for my own recollection, tell me about the SNC models. Were they just based on what they did back to the ITEs or have they been updated? What is the history of their models that you started with?

MR. HELTON: For the bridge tree?

MEMBER REMPE: For the containment sprays, for the liner tears. Was the original work like on the containment based on what they did back at the ITE days?

MR. HELTON: I would assume that was probably the origin of it and I would have to go back and look to get a precise answer. But I mean for instance I remember looking at the, I think it was the containment isolation system notebook recently and it had been updated in 2009. So, I mean they have been --

MEMBER REMPE: Maintaining. Okay.

MR. HELTON: -- maintaining those along with the -- because they are a part of their Level 1 LERF model. So, they are part of their peer review model.

MEMBER REMPE: Okay, thanks.

MR. HELTON: The next slide deals with the plant damage state logic and quantification. So, in addition to the things that are covered in the bridge tree, the other information is parsed by the plant damage state tree or the accident type, the steam generator cooling, the primary-side depressurization and the availability of the RWST and the emergency core cooling system.

We did the quantification in January for the internal events model. Quantification was based on the R01 December 2013. I may have just misspoke. We did the quantification in January 2014, based on the December 2013 Level 1 model. Level 1 model has

122,000 cut sets. And when we do that quantification, the PDS frequency ends up being 17 percent higher than the core damage frequency. It would, ideally, be equal to the core damage frequency. However, there are a couple of issues that lead to that not being the case. And the primary one is the fact that the core damage frequency is minimized to cross all cut sets, whereas, the plant damage states, you are now doing the cut set minimization across the different -- across different plant damage states or within different plant damage states and, therefore, you will end up with non-minimal CDF cut sets in some of your plant damage states because their minimal cut set doesn't belong to the same plant damage state.

MR. KURITZKY: Got it?

CHAIRMAN STETKAR: No, but --

MR. KURITZKY: If you have in one plant damage that you may have systems A and B failing. Okay? And that leads to that plant damage state. In another plant damage state, A and B fail and also C. So, if C doesn't fail -- you have to have C fail in order to get to this second plant damage state. So, you have A, B, C in the second plant damage state.

If you look at all core damage trees for the plant --

MEMBER BLEY: But SAPHIRE is not doing the one minus.

CHAIRMAN STETKAR: Oh, okay.

MR. KURITZKY: Yes, it doesn't do the one minus. Exactly, it is because you don't have the one minus.

CHAIRMAN STETKAR: That's okay. Never mind. I got it. I got it.

MEMBER BLEY: Because there was that option that it will take care of --

MR. KURITZKY: Looking in -- I don't think -- I mean you can have it do its minimization which you know are anything you want to select.

MEMBER BLEY: I thought they had an option so you didn't have to use a rare event approximation. Because you get into that a lot in the Level 2 -- I mean in the containment tree.

MR. HELTON: You are talking about carrying the success path?

MEMBER BLEY: Yes, because you get things that are 50-50 over there in the phenomenological areas.

MR. HELTON: You can choose to carry the success term.

MEMBER BLEY: That is what I thought.

MR. HELTON: You can.

MEMBER BLEY: So if you did that, that would fix this.

MR. HELTON: You do it on a fault tree basis. And so when you make that decision on a Level 1, that is a very rare thing for you to do.

MEMBER BLEY: Yes.

MR. HELTON: And so that is what we end up with with this.

MEMBER BLEY: Does it really blow up the calculation? I mean because that would fix this last problem.

MR. HELTON: It does. You are asking why not just turn it on all the --

MEMBER BLEY: It would become unwieldy?

MR. HELTON: Yes, it does. If you were to turn on carrying of the success term for all fault trees just to give yourself a more exact solution, it would blow up computationally.

MEMBER BLEY: We are going to have to do it for some in the containment tree.

MR. HELTON: Yes, you will have to do it and the decision is on a case by case basis.

MEMBER BLEY: Okay.

CHAIRMAN STETKAR: Does it do it in the context of the event tree logic or does it actually do it at the fault tree level? I mean I have seen people build models but they have had to physically construct the model that says A and B failed in a basic event and not C versus A and B and C failed.

MR. HELTON: Right.

CHAIRMAN STETKAR: And that is a different basic event or a complement logic in the fault tree itself that some poor analyst has to go in and mechanically insert. That is really tedious.

There are some codes that do a complement at the event sequence level. So, they will take the not whatever the top is failed and carry that through but that doesn't give you the pump A and B versus A and B and C issue.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: So, how does SAPHIRE do it?

MR. KURITZKY: I think Don was mentioning that it was at the fault tree level. So, you would have to select it in the fault tree level.

MEMBER BLEY: When I was reading the Level 2 stuff, I think I read a line in there that said that the probabilities on branches in the containment tree are either fault tree solutions are they are split fractions. Does it give you an option to just put in a number instead of a fault tree? I mean and are you thinking of doing that for these that are 30 percent and 70 percent kind of branches?

MR. HELTON: The containment event tree is each containment event tree top node is supported by a unique decomposition event tree. And the decomposition event tree is --

MEMBER BLEY: It is still an event tree.

MR. HELTON: It is an event tree. It is a different logic construct to replace a fault tree in that same -- or to actually replace a series of fault trees that you would have to use in that same context.

The decomposition event trees rely on can those tops, they are basic events in terms of what they are adding to the cut set but those basic events can be split fractions.

MEMBER BLEY: Aha! So, that is where it comes in. So, that is what I wanted to ask you. So, you don't actually plug that decomposition tree into the SAPHIRE model. You plug the results of the calculation on that tree, possibly as a split fraction into the --

MR. HELTON: No, no, no. SAPHIRE takes the Boolean result of that decomposition event tree and plugs that into the containment event tree top. It is the Boolean result as opposed to a split fraction.

MEMBER BLEY: Yes, okay. But it runs it separately and then just moves that up. Okay.

MR. HELTON: Okay. This slide was just an attempt to add another cartoon, more color to the presentation.

We have got, basically, if you look at the plant damage state tree and all the logical combinations, you could end up with 1100 plant damage states. Thankfully, that is not what happens.

We end up, when we do the quantification for the current model, we end up with about 100 plant damage states that are above the truncation of 10 to the negative 12 per year and, fortunately from a pinch point perspective, the top 11 of those contribute 94 percent of the plant damage state frequency.

Some general observations about those plant damage states or at least about the top 11 that contribute to that 94 percent of the plant damage state frequency, most are station blackouts and transients. Most involve primary-side depressurization either not being successful or not having been queried. It is common for ECCS in containment cooling and sprays to not be available, due to the number of plant damage states involving electrical and service water failures.

Isolation is successful in all of those top plant damage states. And finally, you do not see pipe ruptures in those top plant damage states.

CHAIRMAN STETKAR: Don, and I promise that we will discuss more of the details this afternoon but this afternoon is a closed session, there is something I want to get on the record.

The first sub-bullet there uses the three letters SBO. My question is are SBO cut sets only cut sets that evolve from the SBO event tree?

MR. HELTON: They are cut sets, if I understood you correctly, they are cut sets that originate from the Level 1's loss of offsite power event tree and are transferred into the station blackout sub-tree in the Level 1 model.

CHAIRMAN STETKAR: Okay, thank you. We will discuss a lot more of that this afternoon because there are some problems with that. Let me just, for the record, say that.

MR. HELTON: Okay.

MEMBER BLEY: Can you back up to your little triangle again? Out of these 89 that aren't in the top 11 -- well, you had like 119 plant damage states. When I look at this, the top 11 are the top 11 plant damage states. Right? And then we have another 90 or so, maybe a few more than that that are lower frequency. If you have been able to look, are there any plant damage states among that larger number, 90 or more, that really have bad outcomes in the containment tree? And how are you worrying about those?

MR. HELTON: Right, so we will touch upon that in a minute in a following slide but let me go ahead and address it here.

So I recall that we are doing the plant damage states in order to guide the representative sequences in the deterministic analysis that supports all of that other stuff. So, you will see in a minute that we haven't just chosen the top 11 and gone forward with those and ignored everything else. What we have done is we have actually taken a subset of those top 11 that give us, that cover the sort of phase space, if you will, that we need to, in terms of the deterministic analysis. And when we have reached down into that lower part of the triangle and grabbed two plant damage states that are below that frequency but that are traditional higher conditional consequence plant damage states.

MEMBER BLEY: Okay.

MEMBER SCHULTZ: And Don, that was done by examining the whole suite of results or you saw something in the cases that caused you to choose two? I mean is it experiential or was it analytical?

MR. HELTON: It is, I would say, mainly experience based. Basically, when we looked at the top cut sets, we started looking for ISLOCA, steam generator tube rupture, and -- ISLOCA, steam generator tube rupture, and containment isolation failure. And when didn't see those, we went hunting for them. So, it was basically from the collective past experience in the last 20 years of doing Level

2 PRAs. There were certain things we were looking for and when we didn't see them, we went and found them and brought them forward.

MEMBER SCHULTZ: Thank you.

MR. HELTON: I have already mentioned that pipe ruptures are not a large contributor. There is a medium LOCA plant damage state that you will see in a minute that is the highest of the plant damage states. And in addition to that, based on Level 1 results, ATWS is not a high contributor either.

To the point we just talked about, steam generator tube ruptures and containment isolation failure also fall into that bin of not being high contributors. Nevertheless, we have carried them forward anyway because of the chance that they will represent high conditional consequences.

I won't walk through this in any detail but this slide is intended to just give you a snapshot of what you would expect to see, hopefully, based on what I have already told you, which is a lot of different combinations of station blackout, transients, electrical transients, and losses of nuclear service cooling water, in addition to the interfacing systems LOCA.

MEMBER BLEY: And I have lost my anchor. This is in the Level 1 part of this analysis, it is just internal events.

MR. HELTON: Yes, it is internal events and floods but the internal floods don't rise to this level.

MEMBER BLEY: Okay.

MR. HELTON: Okay, the next slide, now we are taking that set of plant damage states and trying to decide okay, in terms of the deterministic analysis, what do we need to do to cover the landscape. And so we have selected representative sequences because they either contribute a significant portion of CDF, they have potentially high conditional consequences, or they yield data for phenomenological insights that are important to the containment event tree modeling.

The detailed specification of the representative sequences for the purpose of the MELCOR analyses and its other uses is based on scrutiny of the cut set contributions to each of the individual plant damage states.

And finally eight basic representative sequences were chosen and I will touch upon those in a moment. And in addition to that, a number of variations on those basic representative sequences have been chosen for the deterministic analysis that is ongoing now.

Again, another eye test. The only point here is that this is the same thing that you saw earlier for the plant damage state. Now, we are talking about representative sequences. And this is intended to denote that we picked up the top six or so of the plant damage states as base representative sequences and we have essentially captured two more of them as variations off of the highest contributing station blackout plant damage state. So, those are six of the basic representative sequences as well as two of the variations. And then in addition to that, at the bottom are the two that we spoke of earlier, the steam generator tube rupture and the containment isolation failure that are being pulled forward, despite having a low contribution because of their potential for high conditional consequences.

The next slide just touches upon the variations that I spoke of. So, there are a number of representative sequences where there are important variations that we need to study for the station blackout. These involved aux feedwater treatment, hydrogen combustion, and RCP seal leakage. In addition to that, we are looking at the issue of induced RCS failures during core damage and post-core damage, including the effect of in-core instrument tube failure.

We are looking at the effects of assumptions on the ISLOCA break submergence, the break location, and the break size. And we are doing that in parallel, of course, to the expert elicitation process that Alan spoke of earlier.

We are looking at variation on the intrusion of containment water past the vessel flange into the cavity potentially being present in the cavity at the time of vessel failure. We are looking at assumptions related to steam generator isolation.

And then finally, depending on whether or not they are important to the results, we may look at variations related to valve seizure and to operator-induced cool down.

MEMBER BLEY: I have a question that is really Level 1 but I forgot to raise it earlier.

TELEPHONE RECORDING: Please pardon the interruption. Your conference contains less than three participants at this time. If you would like to continue, press *1 now or the conference --

MEMBER BLEY: Thank you. What was I going to say? Reactor coolant pump seals, there has been a lot of improvement in the seals since the days of 1150. What did you do for modeling seal failure? Have there been substantially more experiments? Do you have a bigger information base? I know the seals have changed dramatically.

MR. KURITZKY: We used the WOG 2000 seal model. We actually initially because Vogtle was supposed to install these new high-temperature seals.

MEMBER BLEY: They have not?

MR. HELTON: Well, they -- sorry. Just to make sure we get the -- in the old vernacular, Vogtle has high-temperature seals. What Alan is about to talk about are the shutdown seals that are the potentially next generation beyond the high-temperature seals.

MR. KURITZKY: And that actually was because that would make such a huge difference in the risk profile of Level 1 because RCP seal LOCAS were dominating the risk profile. So, we actually were going to make that the base case and have the existing seal design be a sensitivity based. The point being that all your other sensitivity cases are being based on the base case. We felt that was really what the plant was going to have that was supposed to be done I think last year and this year and next year would be the two units or something.

But then all the problems showed up with the seals. And luckily, we had actually made a decision fortuitously right before then that based on criteria we have for whether we include something in our model that isn't yet in the plant, it didn't make the cut. So we decided to stick with the base case being the existing seals and that as a sensitivity study, we can do the new seal design.

Vogtle isn't actually -- in the SAPHIRE model it has them both right now.

MEMBER BLEY: Okay.

MR. KURITZKY: So I am glad that our base case is the existing seals that were used, the WOG 2000 model.

MEMBER BLEY: Okay.

MEMBER REMPE: So, I need to interrupt. Are you talking about the seals for seal LOCAs and the fact of the assumptions of the flow rate space and that they have gone to the higher temperature elastomers?

MEMBER BLEY: Yes.

MEMBER REMPE: Okay. And they are going to change that in some of the documents we have read and change what their base case is --

MEMBER BLEY: No.

MEMBER REMPE: -- is what I think I am hearing?

MEMBER BLEY: No.

MR. HELTON: Let me take a crack at this. This is Don Helton of the staff.

In terms of modeling reactor coolant pump seal behavior following a loss of seal cooling and/or loss of seal injection, there are, I guess three sort of things that I would think of.

There are those seals that are governed by the Rhodes model, which tend to be the older seals.

There are those seals that are governed, whose response is governed at least in PRA space by the WOG 2000 model as appended by the NRC safety evaluation report that endorses the WOG 2000 model. And then there are what are termed, we call them shutdown seals but I think Westinghouse actually has a different licensed name for them and I am drawing a blank at the moment.

But those are seals that have only been installed in a few or have one plant to date and there is a topical related to their treatment under review by the NRC. I believe it is still under review.

So think in terms of those three broad classes of RCP seals in terms of their treatment in PRAs. Vogtle currently has the second of those. It has the high temperature seals governed by the WOG 2000 model and that is what we are modeling in our PRA.

MEMBER REMPE: Okay, this helps. I have a different question, too.

It appears that you are going to do a different sort of instrument tube failure model than the standard version that has been in MELCOR, at least what -- MELCOR. Is this a new change to MELCOR that you are doing by considering in-core instrument tube failures? Or is this something that you are just doing for this plant? Or is this going to be the standard MELCOR model now? Or what is going on with this instrument tube failure model?

MR. HELTON: The instrument tube failure model that we are using right now is an enhancement of the instrument tube model that was previously used to study in-core instrument tube failure for Zion. And in fact the model that is in the Vogtle input model was developed by energy research, who also developed the predecessor model, input model that was in the Zion model. I think it is premature to say that this is the MELCOR default. This is simply what we believe to be the best modeling of that issue at this time.

MEMBER REMPE: It used to be in the IPEs at Zion hot melt would come down to -- well, I guess this was MAP model but you had high temperature stuff come down, hit the instrument tube. And whether it was the weld or whatever, just the high temperature would cause it to eject out immediately.

Are you looking at is it a tube rupture? Are you looking at weld failure? I remember reading something last night where somebody is averaging the stainless steel temperature. And I want to make sure that that is indeed what the instrument tube is because sometimes there is Inconel ones and it wasn't clear how much information they had from the plant on that. But they were averaging the temperature of the silver indium cadmium and the stainless steel and coming up with that. It appears to be a melting temperature. And again, I would like more details of this model and what it is -- what specific mechanism they are trying to assess.

Because again, if you have a high pressure inside the reactor vessel, you might have a failure occurring earlier in the melting temperature, although I am not sure I would average when silver indium cadmium and stainless steel melt, I wouldn't model that.

So, can I have a little more details about this model and what you are trying to simulate?

MR. KHATIB-RAHBAR: Let me address this question. This is Mohsen Khatib-Rahbar. I think you are confusing two issues here.

You are looking at the instrument tube failure in the lower panel. What Don is referring to is not instrument tube failure in the lower panel. We are referring to an in-core instrument tube failure inside the core, as it was conjectured to have happened at TMI. So, we are not looking at instrument tube failure after relocation. We are looking at instrument tube failure prior to relocation.

Does this help you?

MEMBER REMPE: So, it is all about a radiation release, perhaps, maybe a little bit of depressurization. But that is all you are going to have. It is not really a full-fledged RCS failure, then.

MR. KHATIB-RAHBAR: No, no. You can have -- depending on the number of tubes that fail, you could actually depressurize the system. We looked at this for Zion. For TMI type events, instrument tubes are relatively smaller. You could no depressurize.

But for Westinghouse --

MEMBER REMPE: So, is the only mechanism you are assuming to cause that failure melt-off from hot core -- hot fuel up in the core?

MR. KHATIB-RAHBAR: I'm sorry. Could you repeat that? I couldn't quite hear that.

MEMBER REMPE: What causes the in-core instrument tube failures? Is it melt-off due to high temperatures in the core?

MR. KHATIB-RAHBAR: Absolutely.

MEMBER REMPE: Okay.

MR. KHATIB-RAHBAR: That is steel. And you are talking about melt-off of U02, which is a much higher temperature.

MEMBER REMPE: Okay. Again, in some of the notebook I was given, and maybe we should talk about that this afternoon, I saw something a little bit different that I would like to ask more questions about. But I think that is more for later on this afternoon.

MR. KHATIB-RAHBAR: Yes, there is an NRC Tech Report on what we did for Zion several years ago. That could probably help you to see how this was modeled within the MELCOR framework.

MEMBER REMPE: Okay.

MR. KHATIB-RAHBAR: If it helps, maybe somebody can send it to you.

MEMBER REMPE: Again, when we get into the details this afternoon, I do have a question kind of down in the leaves that I would like to discuss on that.

MR. HELTON: Thank you, Mohsen.

All right, if there are no more questions at this point, I am going to shift gears a little bit and we are going to proceed to the second technical element, which is the structural analysis, containment capacity analysis. I will be brief on this because a lot of this work is still underway.

But we have reviewed the failure characterization from the licensee's IPEEE analysis and performed additional analysis with the LS-DYNA software to further refine the characterization of the basemat junction failure and the hatch overpressure failure that we are seeing in that analysis.

In addition to that, we looked specifically at the issue of steam line flooding and its potential effect at deforming the steam line and creating a cascading failure of the containment isolation -- or not containment isolation, but a failure of the steam line itself that would significantly change the progress of a steam generator tube rupture accident.

Like I said, there is additional work in this area ongoing to look at actually the characterization of the fragility. But in the meantime, we think we have sufficient information about the structural response and sufficient confidence in the preexisting information in order to model this response in MELCOR.

Quickly on the topic of the fuel fission product characterization. This was the involvement from Oak Ridge National Labs. They utilized the scale code to develop the decay heats, radionuclide inventories, and radionuclide activities that MELCOR and MACCS2 need to perform the analysis. This was done with the TRITON and ORIGEN models. I regret that Dr. Powers isn't here to be happy that we are finally calling out the specific modules set in scale, rather than just talking about the entire code.

CHAIRMAN STETKAR: You really don't regret that he is not here. Come on, Don!

MR. HELTON: Yes, that was maybe an overstatement.

(Laughter.)

MR. HELTON: The investigative uncertainties in that are listed there and are characterized in the report.

And finally, just to note that it is the same tool set that is being used to characterize the information or the assemblies in the spent fuel pool at Vogtle as well. And this is an area where Southern provided a tremendous amount of information in order to be able to carry out these calculations.

The next slide is intended to briefly cover the MELCOR model development. It sounds like we have some questions on that that we will address during the closed session. But at a high level, the MELCOR model is utilizing MELCOR 2.1 is a model of Unit 1, although at the level that MELCOR and for that matter the PRA resolve the two units, they are nearly identical.

It is based on a number of different sources, including Vogtle-specific FSAR tech spec and licensee-provided information, as well as MELCOR models and trace models that we have put together for similar plants.

It does utilize, whenever possible, the State-of-the-Art Reactor Consequence Analyses best practices. It uses the detailed modelization of the reactor pressure vessel, the reactor coolant system, and the containment. It models the reactor protection system, the emergency core cooling system, containment systems, and other important systems, as well as the simplified balance of plant.

And finally there is what I am terming a stylized model of the adjacent structures with sufficient resolution to probe at issues related to survivability, habitability, hydrogen combustion, and fission product retention effects.

Go ahead, Dr. Rempe.

CHAIRMAN STETKAR: Hearing silence for five seconds, continue.

MR. HELTON: Okay. The next slide is on the MELCOR analysis. All of the aforementioned representative sequence analysis and variations --

MEMBER REMPE: I'm sorry. I got cut off. Could I try again? I'm sorry, Don, to interrupt you.

MR. HELTON: No, that's okay. Go ahead.

MEMBER REMPE: I noticed that some of the new PHEBUS data is coming into the MELCOR like the cesium molybdate. I'm probably not saying that quite right with my chemistry but are you seeing much differences due to some of the new data and the changes for MELCOR that are being considered?

MR. HELTON: I guess I would, at this point, hold off on saying anything with respect to the --

MR. LEE: Don.

MR. HELTON: Okay, Richard Lee is going to field that one.

MR. LEE: The change in this model has been long time ago. So there is nothing new here.

MEMBER REMPE: So the cesium molybdate, any sort of new changes due to the species of iodine have been in MELCOR for a long time?

MR. LEE: Yes, it doesn't do anything with iodine. This is about the cesium transport.

MEMBER REMPE: Okay. But you have got to include it in any of the new data about species coming off of the pools of iodine being released from the fuel.

MR. LEE: No, it has nothing to do with the iodine.

MEMBER REMPE: None of that information is in the MELCOR at this point.

MR. LEE: Joy, this has nothing to do with iodine. This is about aerosol transport.

MEMBER REMPE: Okay, and the cesium molybdate has been in there for quite a while.

MR. LEE: Correct.

MEMBER REMPE: Okay.

MR. HELTON: Okay, the next slide deals with the MELCOR analysis. So there have been some side studies with the Vogtle MELCOR model to inform some specific issues as we have proceeded and those include things like the instrument tube failure effects that we mentioned earlier, hydrogen combustion, consequential steam generated tube rupture modeling, and the containment isolation size issues that I mentioned earlier.

The analysis for the representative sequences and variations that we walked through earlier is ongoing.

Okay, the next slide just deals with the issue of instrument and equipment survivability. In this area we have reviewed what we believe to be the range of past approaches and methodologies. Our focus here to restrict the scope to something manageable will be on instruments that are needed to handle the SMAG navigation and we will talk a little bit more about the SAMGs later, as well as the equipment used for accident management purposes.

CHAIRMAN STETKAR: Don, can I interrupt you just for a second to handle an administrative thing because I heard the phone system beep up there.

MR. HELTON: Sure.

CHAIRMAN STETKAR: Joy, are you still on the line?

MEMBER REMPE: Yes, I am.

CHAIRMAN STETKAR: Okay. Mike, are you on the line now?

MEMBER CORRADINI: Yes, sir.

CHAIRMAN STETKAR: Thank you. I just wanted to make sure it wasn't something where we lost Joy irretrievably. Thank you.

MR. HELTON: The basic approach here is going to be one for the deterministic analyses, the representative sequences that we have, decomposing those by physical location and accident phase to try to arrive at what I term here as location, time, and scenario-specific loads.

CHAIRMAN STETKAR: Don, let me just -- Mike, if you have a set of the slides to orient you where we are, we are on slide number 55.

MEMBER CORRADINI: Thank you.

CHAIRMAN STETKAR: You're welcome. Sorry.

MR. HELTON: That load information would then be compared to the environmental qualification envelope for the instrument or equipment. And basically, that would give us a coarse bending of the instrument or piece of equipment is likely to survive, it is likely to fail, or it is at that level indeterminate. And that would allow us then to isolate the specific cases where more work would be needed to understand something that is particularly important to the Level 2 results.

Finally, just a point that we will likely have to make some simplifying assumptions related to cable routing, since we don't have all the cable routing information that we would need to handle that very precisely.

MEMBER REMPE: And so this is work that is not yet completed. Right, Don?

MR. HELTON: That is correct. It is work that is ongoing now. So basically what we are doing now is developing the load information from the MELCOR analyses that are ongoing and separately developing, I guess the capacity information from the environmental qualification information that is resident in the FSAR.

MEMBER REMPE: And who are the experts going to be, staff or staff and from the Vogtle folks?

MR. HELTON: Right now, the folks involved are myself in developing the load information and Paul Rebstock of the RES staff in terms of developing capacity information. And Paul works with Russ Sydnor also in research. And then we will reach out from there, as necessary.

MEMBER REMPE: Okay.

CHAIRMAN STETKAR: Don, just out of curiosity and you don't need to answer this if it is irrelevant. But the last bullet about cable routing information. Is in-containment cable routing information available for the fire PRA models?

MR. HELTON: That is a tricky question to answer.

CHAIRMAN STETKAR: Okay, we can wait until later, then.

MR. HELTON: The next slide deals with some of the preparatory work we are doing to support the human reliability analysis. There is development of Level 2 HRA basis underway. We will talk in a minute about the screening -- identification and screening HEP methodology that we intend to use. And that work also extends into scoping more detailed HEP quantification as well as the behavior models, decision making, and team coordination that go into that.

Relevant information from the fire HRA work under 1921, I believe, is the correct number is being pulled forward. In addition to that, we are also leveraging from other HRA activities where possible.

Walkdowns of relevant parts of the plant, as well as discussions with Vogtle staff were conducted in March and July to support the preparatory work on this. In addition, we were also able to obtain from the licensee a synopsis or a detailed summary of an emergency preparedness drill that was conducted in 2012 that included limited use of the SAMG as well as the extensive damage mitigation guidelines.

Some of the -- this slide is just intended to give a flavor of some of the things that you would have to worry about and some of these things have come up in past discussions with the ACRS. Obviously, modeling of dependency between Level 1 and Level 2 is very important. In addition to that, things like modeling complexities in terms of taking remote actions, like the need for HP and security escorts, looking into the communications between the operations support center, the technical support center, and the control room during post-core damage accident management.

The allocating of resources, preferences, biases in terms of the different approaches that can be taken in terms of recovering equipment that was out for service, repairing equipment that was damaged, or going with other strategies that may rely solely on available equipment.

And finally, just the familiarity and competency that the plant staff has with both the extensive damage mitigation guidelines as well as the severe management accident guidelines.

The next slide is intended just to be a 30 second on the Westinghouse SAMG structure, just so that the following slides make a little more sense.

There are two sort of high-level documents called the SACRG, Severe Accident Control Room Guidelines, that the control room staff uses. One governs the control room's activities before the technical support center has stood up and the other guides the control room activities after the technical support center has stood up and has provided a strategy.

And as far as the technical support center is concerned, there are two diagnostic charts in the current evolutions of the Westinghouse SAMGs that govern their prioritization of activities. And those are the diagnostic flow chart and the severe challenge status tree. Each of those diagnostic charts is supported by a set of guideline documents that once the entrance criteria for a particular severe challenge guideline or a particular severe accident guideline has been entered, then that underlying document provides them the process for evaluating what strategies are viable, as well as what are the pros and cons associated with taking that strategy.

So, in terms of the initial identification of accident management actions, this slide provides the criteria that we are using for that. First, both the Severe Accident Management Guidelines and the Extensive Damage Mitigation Guidelines are in play in terms of post-core accident management actions. There is an activity that most of you are probably familiar with related to recommendation eight of the Japan Lessons Learned activities that may change the relationship between these various procedures. But nevertheless, we are modeling the plant as it was operated in 2012. So in that sense, both procedure sets or guidance sets are in play and they don't have -- so they are both in play. And the way that we have chosen to model them now for this project is that the Severe Accident Management Guidelines provide the roadmap for us and the Extensive Damage Mitigation Guidelines provide an underpinning for certain strategies in the severe accident management guidelines. And that is an approach that we think is justifiable, given the type of actions that we think will be taken in Level 2 space for this site. We are not intending that this is the way that you should view all sites under all conditions but this site for this project, this is a reasonable approach to take.

MEMBER CORRADINI: Can you give me an example of something that is a guideline that is within the SAMG versus the EDMG? I know what you just said but can you give me a specific example of where they would fall?

MR. HELTON: I would like to defer that until the closed session, just because the contents of the Extensive Damage Mitigation Guidelines are considered Official Use Only.

MEMBER CORRADINI: Okay, that's fine. Thank you.

MR. HELTON: But if we can remember to come back to that, I can provide you a couple of examples.

The reason I went over the previous slide was to give you the notion that the SAMGs are hierarchical. This is not a grab bag of different strategies. There are a total of 12, when you count up the severe accident guidelines and the severe challenge guidelines and they are prioritized within the SAMGs. And so that is very important for our ability to identify actions that are more likely to be taken or more likely to be attempted.

We are planning on leveraging the MELCOR analyses to help with the prioritization of which actions are in play and how long they would be in play. And to that end, the MELCOR model has been set up to put out data streams that allow us to create something that I will touch upon in a moment, which basically just gives us that first flavor of those 12 potential strategies, what time periods are in they in play, so that we can then, like I said, focus in on ones that are more likely to be attempted.

In terms of the specific criteria that we plan on using for the identification screening, those involve a combination of consideration of the priority of the action, how long it is one of the high priorities, and in addition, whether or not the areas needed to be accessed are potentially habitable.

The next slide is just I don't really want you to try to take away anything from this. It is just a conceptual slide. But basically what it is trying to show you is is you can take the deterministic analyses and port those conditions over to a time line of the fact that some of these strategies you are in the entire time. In this case, the one to the far right. You are in that. You have met the entrance criteria for that strategy the entire time. That also happens to be the lowest priority of all of your strategies.

There are other ones that you are in early for a little while and then you no longer have the entrance criteria. So for instance, there are some that don't make sense and are not applicable after the vessel has failed.

And then there are other ones where you may be in it briefly and then back out of it, depending on changing the playing conditions or you may not be in it until later in the accident. So, for instance, rising containment pressure may have you not enter the severe challenge guideline on high containment pressure until later in the accident.

So again, this is just intended to sort of show you that this prioritization is a transient behavior and we need to meld the deterministic analyses with the hierarchical nature of the SAMGs in order to get that feel for which actions are more likely to be taken during which timeframes.

MEMBER REMPE: So when you discussed and you talked about the fact that you are going to consider which sensors are beyond their operating envelope, which doesn't necessarily mean you need an accident-altering event to have occurred. It is just you might be at a higher temperature than what a sensor can deal with or you might be in a depressurization situation and you will consider that when you -- this is just an example but when you get down to doing it, you are going to be looking at a more complicated situation. Right?

MR. HELTON: I agree with the concern and I hope that we can get to that level of resolution. I don't think I can commit to getting to that level of resolution right now.

MEMBER REMPE: Okay.

MR. HELTON: We will either have to get to that level of resolution or we will have to clearly state simplifying assumptions in that regard.

MEMBER REMPE: Okay.

MR. HELTON: The next slide describes our screening human error probability criteria. And again, these are a mix of some of the same considerations that we were talking about earlier. As a simplifying assumption, we are saying that from a screening perspective, that if DC power is unavailable, we will assume that that action is not successful.

Then for an HEP of 0.9, which is a very high HEP, that uses, again, covered on this slide, a mix of things related to priority, dependency and the time at which it is a high priority, as well as this concept of an accident-altering event as something that may perturb the diagnosis or implementation of the action.

And then we have similar criteria for a case of HEP equals 0.1. This is the case where we have higher confidence that the action would be successfully diagnosed and implemented. And then finally, the uninformed, if you will, 0.5.

These screening HEPs would be fed into the Level 2 model, and it would be quantified. And then at that point we would focus in on the subset of human error probabilities that needed to be refined by a more detailed approach.

MEMBER BLEY: Are some of these in the -- I forget what you call them but the embedded event trees or are they all top events in the containment event tree, the human actions?

MR. HELTON: For the decomposition event trees?

MEMBER BLEY: Yes, are they embedded in the decomposition event? What I am really getting at is how many of these could be strung together in a containment event tree sequence?

MR. HELTON: So Mike can jump in. I think the answer is it will likely be a mix. They will likely show up, I guess more primarily, within the decomposition event tree but it is a little premature to say with any confidence exactly how that will fall out.

What is going to be more limiting to the number of these that show up is likely going to be the identification criteria themselves, which we are going to focus on the higher priority actions where there is sufficient time available and there is habitability -- you know we don't have habitability concerns.

So, I suspect that if I am understanding your question correctly, you are not going to see five or six of these in a cut set simply because we are not going to be studying that many actions within a given scenario.

MEMBER BLEY: That is what I was worrying about. That if you string very many of them together, these conservative numbers stop being so conservative.

CHAIRMAN STETKAR: Yes, 4.1s would be a small number.

MEMBER BLEY: Would be a really small number.

CHAIRMAN STETKAR: Don, --

MEMBER BLEY: And 4.9s would be -- so that is not too bad.

CHAIRMAN STETKAR: -- there is something I just thought about. And again, this is probably too much detail to discuss here because I think we will probably have another more extensive discussion on HRA in general. But if I understand it, you are doing the crosswalk or crosstalk or whatever cross you are doing on SAMGs for -- correct me if I am wrong -- each representative sequence from each plant damage state. Is that correct?

MR. HELTON: That is correct.

CHAIRMAN STETKAR: Okay. I will ask the question and see what initial response I get. I don't know what criteria are used to select the representative sequences from each plant damage state. We will discuss more of that, I suspect, this afternoon. I will just note that perhaps the results could be effected by the criteria -- if I were to select the sequences that were most challenging to operator performance, those sequences might be different than the sequences that are most challenging to physics. I don't know that they would be but they might be.

So in a sense of saying well, we have done a screening or scoping type of assessment, a quote-unquote conservative screening or scoping assessment to treat the SAMGs for the representative sequences, there should be some assurance that we have not -- and that scoping analysis affects the overall results of the study, obviously. It will affect the overall Level 2 PRA results and Level 3, that we have judiciously selected those scenarios so that we have treated both the human and hardware -- all three now -- human and hardware and physics aspects of the scenario progression appropriately.

MR. KURITZKY: Yes, I mean, Don, you had discussed earlier on some of the criteria that went into the selection of the representative sequence. I don't know to what extent how challenging it is to the operation was part of that selection.

CHAIRMAN STETKAR: I mean that is my whole point is that the same way that we have said that it is very, very important where you are developing the Level 1 models to integrate the operator performances you are developing those models, the same holds true here. You don't necessarily just pick out a sequence that you select based on one set of criteria and force fit into that sequence an operator response model because that might give you optimistic results for another sequence that it might have been just slightly lower in frequency but it would have gotten a lot worse because it was really more challenging to the operators.

MR. KURITZKY: Right.

MR. HELTON: Yes, I think we will just take that as a --

CHAIRMAN STETKAR: Yes, I mean that is just not -- and I just literally thought about it. So, it is --

MR. HELTON: Yes, I think conceptually I understand where you are going. I think we will only know or only have a sense after the fact as to how clearly we have covered the landscape in that regard.

CHAIRMAN STETKAR: Yes, okay.

MEMBER BLEY: From that chart, it doesn't even really dug through all these SAMGs and have looked at all the kind of things they are recommending and all these different SAMGs. That's true.

But what I wanted to ask you have you run across anything in here that would really be such a departure from what operators normally think of doing and what the kind of mythology of good operations would tell us is things you can do and never should do that could get them in a spot where it would be real difficult for them to follow the direction. Have you seen anything like that? Have you thought about that, even that concept?

MR. HELTON: Let me try to answer this.

MEMBER CORRADINI: Can you say that louder, Dennis? I'm sorry.

MEMBER BLEY: Yes, are there any guidelines suggestions that could get you out of trouble that would really be so diametrically opposed to what operators think of as good practice, that it would be real hard to carry it out?

CHAIRMAN STETKAR: Simple example --

MEMBER CORRADINI: That would make a situation worse because of uncertainty of the condition of a plant.

MEMBER BLEY: Well that is a different issue but that is an important one, too, yes.

MR. HELTON: I mean let me take a crack at both of those and we can iterate, if need be.

I mean the SAMGs right off the bat, page one, if you are here, you are invoking 5054X and 5054Y. You are out of your operator licensing domain. You are now taking actions to protect public health and safety.

MEMBER BLEY: And logically, that is clear and makes sense but emotionally maybe not.

MR. HELTON: Sure. And in addition to that, you are now transferring at least in the Westinghouse SAMG context, the decision making to the technical support center and the operators are taking the role of implementers.

So, I don't want to suggest that what you are speculating there can't happen. But you have transitioned into a very different dynamic. There are certainly things where the operators will take actions that are different than the actions that they would take in the EOPs. They may be directed not to turn on containment sprays, even though containment pressure is rising, which is going to be different than what they are trained to do. But they are being told to do that because of concerns about hydrogen combustion under certain situations.

So I mean I think as a concept it is a reasonable concern to have. Have I seen that line in the SAMGs where I say wow, it is great it says that on paper but no operator is ever going to do that? Personally, I haven't encountered that.

MEMBER BLEY: Okay.

MR. HELTON: Okay.

MEMBER BLEY: But Mike raised the other issue. What if we kind of misdiagnose where we are and carry out some of the actions here? Have you thought about places where that might exacerbate the situation?

MR. HELTON: Yes. I mean, the SAMGs are constructed in a way as to essentially -- we are not sure how you got here but you got here. And now you need to look at the plant conditions as best you can diagnose them right now. And each strategy includes a step of here are the pros, the general pros of taking the strategy; here are the general cons. You need to evaluate which of these apply in your situation and you need to make it a determination that in your particular situation, the pros outweigh the cons.

So, there certainly can be situations where an action could be carried out that would exacerbate one part of the accident. And in fact any action that is taken out is likely to have a combination of positive and negative effects. But it is being carried out because overall, in terms of protecting public health and safety, it is viewed to be a positive response.

MEMBER BLEY: And the last thing I have about this, I know two or three years ago there was a revision on the guidance on actually writing SAMGs that came out. I don't know if that was published by EPRI. I think it was. Has that been implemented or are the SAMGs now kind of revised according to that or are they what they were four or five years ago?

MR. HELTON: So, let me answer that in the following.

MEMBER BLEY: Well, especially at the plant that you are looking at.

MR. HELTON: Sure. So in I believe it was November 2012, EPRI published an update to the Severe Accident Management Technical Basis. I believe it is EPRI TR-1025295, maybe.

CHAIRMAN STETKAR: You are a real scary person.

(Laughter.)

CHAIRMAN STETKAR: I just had to put that on the record.

MR. HELTON: I could be wrong about that. But it is a two-volume document and is publicly available. And that is the basis by which the PWR Owners Group and the BWR Owners Group are in the process of revising their SAMGs. And I believe generally speaking and there is information in the public domain about this, but I believe generally speaking they either are nearing the completion or have completed the revisions to the Generic Owners Group SAMGs.

MEMBER BLEY: Okay.

MR. HELTON: And we will be promulgating those going forward on a plant-specific basis. And I am not sure of the exact schedule of that.

Nevertheless, we are studying Vogtle as it existed in 2012 and so we are using the Severe Accident Management Guidelines that preceded that update. And in fact, even today the Vogtle SAMGs that are in place today would be roughly the same as they were in 2012. But there is a significant change coming. But that is downstream of what we are doing.

MEMBER SCHULTZ: Don, do you feel that implementation of the new guidelines which are being worked on now as a result of post-Fukushima activities that that would be a surmountable task to implement them? In other words, is the evaluation and modeling associated with integrating the SAMGs into the overall approach, so integrated that it would be very, very difficult to implement a new set of guidance or do you feel that it would be reasonable to be able to integrate that into the future?

MR. HELTON: From what I have seen, the changes that are being made to the Westinghouse SAMGs are -- for instance, the diagnostic flow chart and the severe challenge status tree are being combined. So that creates a small structural change but nothing so -- not something that is conceptually difficult to deal with in terms of how we are modeling this.

The strategies themselves are being changed to address multi-unit hazards and other aspects associated with the update to the severe accident management technical basis. I think it is certainly not insurmountable from a structural perspective but it is not a trivial matter either. So, it is something that can be done. Whether or not the resources and motivation would exist to do it is indeterminate or to be determined, in terms of this particular project.

MR. KURITZKY: Right. And that is one of the kind of thing we have the potential sensitivity studies, your potential modifications. We have a list of them that we are maintaining and those are things that we will consider late in the project when we see how much time, how much resources are left. We will prioritize those items to determine which of them we can go ahead and implement for the study.

MEMBER CORRADINI: Can I ask a question at this point about -- and I am not sure this is the right forum. You can delay me.

But I guess Dennis is the expert and John are the experts, maybe Steve, I think I heard Steve there, on human performance and operator actions. But I want to ask a question about unwrapping a result.

Let's say you do all this and to the uninitiated, they want to unwrap the result. So, if I take a particular sequence and I will call it unmitigated. So, I will use some SOARCA language. So I have some sort of sequence and I have an unmitigated sequence like a station blackout unmitigated for this design. And I would have done it in NUREG-1150 land and I can't remember what the large dry plant was, I think it was Zion.

And now you did it here. And except for design changes in the plant, which are minimal, at least as far as I know in terms of the plant geometries, the only difference between what you did then and what you do here is you are using a modeling tool which is MELCOR in Level 2 to deterministically take it through a path. Right? And so there is a difference. And that difference is going to be ascribed to some sort of modeling improvement.

Now, I go to the next step and I now do some operator actions that when I enter into this space, either by the SAMGs or the EDMGs or whatever, things become even more favorable in terms of source term release because the output of this it source term. Is that going to be described in some deterministic way in this PRA? Because what worries me is we are going to see a result and at least my inclination is I want to unwrap it to understand is it because we model the events supposedly better or is it because we are now smarter in terms of how the operators will respond to the plant state and make the situation better.

And we are going back and forth between those, at least in my mind. And I am trying to understand how you are going to eventually describe it so that somebody can understand. Is it the model or is it the operator actions based on the model, if the model results are presented? Do you understand my question?

MR. HELTON: I do and unfortunately, I don't have a good answer for it.

MEMBER CORRADINI: Because and I will just emphasize this. To me, this is crucial because it goes back to I think Joy asked it -- somebody asked it -- if I have uncertainties in the model, that means I don't have a point or a plant damage state but I have a potential range of plant damage states or a potential range of times for this same end gain. And that will affect things. And I guess it would seem, at least somewhere in this PRA from an illustrative point of view, you have got to show that so people can understand not just the roll-up of all of the probabilities and all of the source terms but also if I took me past the sequence, historically I was here and now I am here. And the reason because I went from here to here is partly better modeling or partly more informed operator actions. Do you see my point?

MR. HELTON: I do. And I mean certainly the PRA structure allows you to decompose operator actions from phenomena, from systems within the results of that PRA.

MEMBER CORRADINI: Okay. So, the question maybe should be is that out of scope for the resources you have and the time you have? Is doing something like that -- because my concern is you are going to do this and somebody is going to ask this question. So, if I were you, I would be prepared to answer it on some key accident sequences.

CHAIRMAN STETKAR: Mike, this is Stetkar. It is my perspective you are asking about slicing and dicing the results from a different perspective. You can slice and dice results from a PRA for many, many, different perspectives. Yours is one.

MEMBER CORRADINI: Right.

CHAIRMAN STETKAR: But you don't --

MEMBER CORRADINI: If I am off topic, you can postpone me. Or if it is really out of scope, I will --

CHAIRMAN STETKAR: But --

MEMBER CORRADINI: -- but I just have this sense of that when all this is done, to the non-practitioner you are going to get asked this question. So, you should anticipate and be ready for it with some sort of sample.

CHAIRMAN STETKAR: It is probably all of the above and things that you haven't even mentioned because we modeled plants better than we used to model.

So, if you are saying well, are the results of this PRA in, pick a year, 2015, '16, '17 compared to a PRA that was done for pick a plant, Zion 35 years ago, why are there differences? Well, the plants are different. We have learned a lot about modeling stuff. The scope of the PRA is different. The tools have become more refined. Our treatment of human --

You know on a set of results at a very broad level, you might be able to say things like well, large early fatality risk is substantially different because we now understand these things. But I think it is really, really difficult to say well, is that in the scope of this PRA because --

MEMBER CORRADINI: Well, I brought up the topic. I just wanted to make sure I got it out because I think everything -- I have been reviewing things because I was not around the first part of the meeting. And what you are planning didn't make sense. I am just trying to figure out from the standpoint of presenting the results, this is one of the things that I would logically want to look at so I could gauge the unwrapping of it is what was affecting what.

MEMBER REMPE: And I think it may not even be with a comparison between the PRA years ago versus today. It could just be trying to understand the differences from the SOARCA Surry analysis versus this analysis for Vogtle because of some differences in the modeling or operator actions or whatever. And again, I know it is a different plant design but -- raise -- recent study

CHAIRMAN STETKAR: Well, yes, and that is important, isn't it? I mean that is my whole point.

My whole point is that this is a PRA done in 2014, '15, '16, '17 of the Vogtle plant at the Vogtle site, using the tools and models that we have today. Comparing it to an analysis that was done for a different purpose for a completely different type of plant is kind of, in my mind, irrelevant.

MEMBER CORRADINI: Well, is what, John?

CHAIRMAN STETKAR: Irrelevant and --

MEMBER CORRADINI: Okay. I just wanted to make sure that my question about unwrapping the results got on the record. That's all.

CHAIRMAN STETKAR: It is important to be able to do that because if, indeed, the results are being driven by something like uncertainties in a particular, whether it is phenomena, whether it is human response, whether it is seismic hazard or what have you, it is important to understand that.

MR. KURITZKY: This is Alan Kuritzky. I just want to clarify and follow on to what Dr. Stetkar is talking about. The PRA, we have incorporated many, many assumptions. There are many, many changes. If you go back to the objectives of the project, we wanted to see what a current state of practice PRA, Level 3 PRA would be today as compared to something that may have been before. There are changes in modeling tools, in data, in plant configurations and equipment and procedures. All these things are wrapped up into it and we are going to get some output measures that we are going to compare back to there and see how it is changed. To try to parse into what are the drivers there, that is the insights part which we really would like to have but that is something that is going to be done -- I don't want to say ad hoc, but it is really you are going to look to things, you are going to dig into things to try and parse out as part of your insight what is driving this change here. What is driving that change there?

Whether that scratches -- there is a thousand people with a thousand itches. I mean we are going to scratch a few of them and we are not going to scratch the bulk of them.

MEMBER CORRADINI: Okay, that's fair. That is a fair answer.

So, I just got my itch exposed.

MR. KURITZKY: Thank you.

MS. COOPER: I just wanted to add something. This is Susan Cooper, Office of Research. As Don mentioned, we are still working out some of the details on how to approach the HRA for Level 2. But there are some very specific things that I learned and I think Don learned some too, but mostly I learned when I went on the site visit about how they implement their SAMGs and how they have planned for post-accident response that I hope that we will be addressing and incorporating in our approach.

Some of that implementation strategy is, I would say, ahead of some of the post-Fukushima ideas about how we might integrate procedures and so on and so forth. And that is going to be embedded in some of the assumptions. But I think that it might be possible at some point in time to peel away some of those assumptions and see how it might be different if you didn't do things that particular way.

So, I think there might be some room there to try to examine how operator response might be different. But we are going to be trying to reflect what we think we understand about Vogtle specifically.

MEMBER SCHULTZ: I appreciate the comment from Susan and I think that what we are likely to find in this human performance evaluation, comparing what is going to happen in the future to what has happened now, what comes about from Fukushima, what is happening as a result of the EPRI work, where that should have its largest impact is going to be in reducing uncertainties.

So, if we capture uncertainties appropriately through the work that we are doing here, then that might be the way in which one could present the future applications, the future developments and capturing the expected results from those.

But I am glad to hear that you are following what is happening as a result of these activities in the human performance evaluations here.

MR. HELTON: Okay, I know we are nearing the lunch hour. I have just got two slides left and then I will actually be ahead of schedule for once, but we won't tell anybody.

This slide is just to provide some background. Obviously, the accident progression logic model, namely the containment event tree is still in early phases and will be informed by the ongoing deterministic analyses that we talked about earlier. But we do have a straw man in place of both the containment event tree and its supporting decomposition event trees, as well as the release categories coming out of the containment event tree.

We have already touched upon this but in the case of this Level 2, rather than using fault trees to support the containment event tree top events, we are using decomposition event trees because we believe that they give us additional flexibilities in terms of the Level 2 logic model.

There are quantification challenges ahead of us both --

MEMBER BLEY: Is there any way to explain that a little bit? The logics are clearly equivalent. So, what is it that makes it hopeful for you?

MR. HELTON: So the decomposition event tree allows you to continue to think in an event tree context in terms of the things that are influencing the outcome and --

MEMBER BLEY: Thinking sequentially kind of?

MR. HELTON: Thinking sequentially and allowing you to assign different end states to the same outcome or different paths to the same outcome.

So if you think in terms of containment pressure is high or low, for example, there may be different combinations of things that can make it higher, can make it low. And so a decomposition event tree at its most basic, just think of an event tree with three top events, leading to eight end states and end states 1, 3, and 8 all go too high and the others all go too low.

You can represent that same logic via fault trees from a Boolean perspective but you have to use a bunch of fault trees to do it.

So, it is just a different approach that we view as more efficient for that reason.

MEMBER BLEY: Okay, thanks.

MR. HELTON: There are quantification challenges ahead of us, not only the size of the model but also the high failure probability issue that would be the case for any PRA code when doing a Level 2 or a seismic or a low-power shutdown PRA. It is just the nature of the beast.

With regard to uncertainty, the goal is to treat it as analogous to the Level 1 PRA uncertainty as we can. And to that end, the intent is to define primary certainty distributions and separately to identify model uncertainties and perform limited sensitive analyses to characterize those model uncertainties.

And then the final slide is just a nod to some of the technical elements that were not far enough along to present a lot on today but we have been doing some limited investigation of source term estimation and also shaking down the handoff of that information from the Level 2 PRA to the Level 3 PRA team. And then finally, as Alan talked about earlier, we are planning for an industry-led peer review of the Level 2 PRA internal events and floods Level 2 PRA in the September-October time frame.

So that is actually my presentation, up including the part that was scheduled for after the break, after the lunch break.

MEMBER BLEY: When you say you want to treat the uncertainties similar to Level 1, I am not quite sure what that means but I do know in at least some of the branches that are typical in containment event trees, were almost purely epistemic uncertainty, if we say that. You don't know the right answer but if you run the experiment once and get the right answer, you know that is the right answer. It won't distribute randomly, which leads you to delta function probability distributions, rather than a smooth curve over the other.

So have you thought about that and where you need to treat the distributions differently? It can make a big difference in the calculations, depending on how you do those.

MR. HELTON: Yes. So, let me say a few things and I am just speaking candidly. They don't necessarily reflect the views of the whole team because we are still deliberating on a lot of that. But just a few thoughts on that.

The first is I think I have spent roughly half of my life arguing about the difference between aleatory and epistemic uncertainty. And so here what I am advocating is a very simple stupid approach of if there is a parameter in the PRA model, it is a parameter uncertainty. And if there is not a parameter in the PRA model, it is a model uncertainty.

And that doesn't address your point. It actually exacerbates the point. That means that at times you are actually combining aleatory and epistemic uncertainties, --

MEMBER BLEY: And sometimes that can happen.

MR. HELTON: -- which very much bothers some people.

So, I think the issues that you are raising are important ones. There is not a clear cut approach to handling them that everyone is going to agree on. And we are trying to be as practical as possible in how we treat them here, so that we don't end up wrapped around the axle with now characterization of uncertainty. You know, I am aiming for a characterization of uncertainty that exists and that we can then throw rocks at.

MEMBER BLEY: We will see what you come up with.

MEMBER REMPE: Don, I brought it up earlier in this context of the success criteria but I feel obligated to bring it up again.

At the beginning or some of the earlier documents I reviewed indicated there was uncertainty as to what control materials were used in the reactor. I am looking at a document that is dated December 2013 and flow volumes, a lot of geometry information, it is indicated that it is not available in the model development. And I know and well-recognize the need that you build off another plant when you --

What is the schedule for getting that information? Has it been obtained and are you in the process of updating the MELCOR calculations to reflect precise data for Vogtle or what is happening with this?

MR. HELTON: So we do continue to interact with Southern Nuclear to obtain newer and better information and we will refine the model if new significant information becomes available. But nevertheless, we have made a judgment that the information that we have in hand is sufficient for the modeling that we are doing right now and we are moving forward with the version of the model that you just referenced.

MEMBER REMPE: So, basically, you would be happy with just going with the model you have in hand to even do the math calculations and keep going on the PRA.

MR. HELTON: That is correct. The things that you have pointed out are things that are reducible uncertainties but that may not be reduced in the schedule of this particular project.

MEMBER REMPE: Okay.

CHAIRMAN STETKAR: Any other questions for the staff? If not, Don, I have one question. It is just driving me nuts. Rattle off the EPRI report number on the SAMG technical basis again.

(Laughter.)

MEMBER BALLINGER: He was absolutely --

CHAIRMAN STETKAR: No, I have got it. I just want to see. I am testing him whether or not I have to really feel humble.

MEMBER BALLINGER: He was absolutely correct.

CHAIRMAN STETKAR: Yes, that is what I thought. You are a really scary person.

With that, I am going to be hard-nosed about this. We will break for lunch and let's reconvene at 1:15. I know I am not giving you the full hour but that is the way I am.

So, we will reconvene at 1:15.

(Whereupon, at 12:22 p.m., a lunch recess was taken.)

A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

(1:17 p.m.)

CHAIRMAN STETKAR: We are back in session. Alan?

MR. KURITZKY: Thank you. So, next we are going to talk about the consequence analysis portion of the project, the Level 3 portion. And for that, we have Keith Compton from the Division of System Analysis.

MR. COMPTON: Thank you. I'm Keith Compton. I'm the team lead for the offsite consequence analysis team for the Level 3.

And what I wanted to do is to give you an overview of what we have been doing to prepare for when we get the source, the MELCOR source terms from Don to do the consequence analysis. And I also wanted to talk about some of the issues that we are facing, that we need to address, particularly an issue of output measures, the question of exactly what it is that we are going to quantify and how are we going to quantify it. That is a question that is needing a fair amount of attention. So, I am going to share some of what we have been doing.

Again, the first half of the presentation is to talk about the work that we have been doing to develop and document the MACCS2 input parameters. We have been spending a lot of time up front thinking about documentation. The idea is that is going to help make the internal reviews, external reviews, and any future use a lot easier if we spend time thinking about how to document it. And it would help us make sure that we do the analysis right the first time, instead of having to go back and fix things.

The second half of the presentation is are some issues in the discussion of output measures. And a lot of what we have been doing over the last year has been reviewing past analyses, past PRA analyses, past consequence studies, just a lot of review, a lot of document review.

I have put a partial list at the end of the presentation so you can get a feel for the documents that we have been looking at and that we have been drawing from from this.

So, okay. As I said before, we have been spending a lot of time reading and reviewing past documents. Something that I noticed is that over the span of 20, 30 years they have had different strengths and weaknesses with regard to traceability and transparency. I have been trying to go through and really understand where the parameter values came from. But in general, there has been a trend towards better traceability and transparency. And so a lot of what we are trying to do right now is to come up with the standard format and content that would pick up on the strengths of the different reports. There is no one that I could say is kind of the best. But all of them have good points.

Organizing our documentation by input data and technical elements is actually, it was surprisingly similar to what was done in WASH-1400 and in NUREG-1150 as I have gotten back into the actual consequence analysis documentation. That is Appendix 6, so WASH-1400 and NUREG/CR-4551, Volume II, Part 7 and then the others. There are some they did follow this approach.

And again, by going through parameter by parameter, it is going to help us make sure that we have addressed all of assumptions and conceptual models and that we haven't kind of skipped over something just because it is a kind of a standard default parameter. This is, I think, a good time to go over and just touch everything that is in our analysis and make sure we know where it is coming from.

And just as an example, this is for illustrative purposes. I am not expecting anyone to read this but it is just an example of the Table of Contents of our draft documentation. And we are continuing to drill down what goes in each section. But a lot of the work is figuring out what discussions go where.

And I am going to talk mainly today about the documentation for the reactor at-power internal scope piece. The logic that we are doing is that we want to get this documentation done to a pretty good level first, because this will serve as the basis for expanding into the other scope pieces. So this is kind of our pileup volume. If we think we have done this well, then when we go to do other scenarios, we can fairly systematically go through and say with this change for external events, the dosimetry files probably wouldn't change. We wouldn't have to readdress those. Meteorology wouldn't. The protective protection parameters, though, would change. And so the idea is that if you have a fairly complete set, you can systematically address the rest of them.

MEMBER BLEY: I am going to ask you at this point but you can answer it later, if you prefer. Are you going to talk about how you are considering and addressing uncertainty both with respect to parameters and models.

MR. COMPTON: I will talk to it on the next slide, I think.

MEMBER BLEY: Okay.

MR. COMPTON: Not a lot. Not in a lot of detail but I do have a spot to address it.

So, on the next slide just to go a little bit more into what is going on into each of these sections. And each of these sections is based on technical elements that are from the TAP and also from the draft Level 3 standard, which will help, I think, in the reviews that it kind of falls out in the same structure. That makes it easier to trace.

I was thinking though that MACCS2 integrates a wide variety of conceptual models and technical disciplines from meteorology, dispersion modeling, emergency response, dosimetry, health effects. There is a lot of different conceptual models that are integrated into the MACCS code. And a lot of the work that we are doing is not just doing the calculation. It is not just running the code. It is making sure that your conceptual model and your parameter values are justified. You may not change a parameter value but you need to go through it and make sure that it is appropriate for the situation that you are studying.

And so from that point of view, it is important to say something about what the conceptual model in the code actually is. That would help a reviewer understand why this parameter value. And it really has to be evaluated against how it is being used in the model. So I think explaining that, instead of just pointing back to a code manual that they would have to look up, giving some sense up front would be helpful.

We are also going to try to, to the extent that we can, trace our bases back to primary references.

MEMBER BLEY: That would be great.

MR. COMPTON: Well, we will see how far we can go but this is, again, in reviewing a document, often you find that you go back and you look at the citation and you go back and that doesn't really explain where it comes from. And that is also something that I noticed that was very distinct in WASH-1400 and in NUREG-1150 is that the citations went back to the literature, as opposed to the compilations.

So, and to me that is a transparency issue. The citations are good for traceability but being transparent will be helpful in the review.

Okay, again, each section we have a tabular summary of the input parameters, again, to make sure we have addressed everything, and then a link back to the section where you would find the qualitative discussion. So again, trying to make the documentation so that you can navigate around it and find your way to the technical basis fairly easily.

Then under the quality assurance discussion, there is two elements that would go into this. One is the high level -- is talking about how we have addressed the high level and supporting requirements from the draft standard. So, again, to make it easy, that is essentially part of our self-assessment but we just bake into how we are writing it.

And then this is the section that we would most likely address uncertainties. Right now, our thought of how we will address this is to draw on the SOARCA uncertainty analysis. This is a place, if we are organizing by input parameters, we can talk about a little bit about how sensitive, how the uncertainty analysis found them to be sensitive, so that you can get some sense of whether these parameters are important or not very important and such. And then also at that point, have a discussion of the model, any particular uncertainties.

MEMBER BLEY: Yes, I am trying to remember. I know they did a lot of work on parameter uncertainty. Did they do a lot on model uncertainty?

MR. COMPTON: I am not sure. I would have to --

MEMBER BLEY: I can't remember from our discussion.

MEMBER CORRADINI: Can I ask a question about you are kind of going down what I will call a -- I don't know if you are at the QA bullet or not but I had something relative to essentially the bases. And you can tell me if you want this postponed.

So MACCS is a method of computing offsite consequences, given a source term. There is other models. In fact, NRC uses a different model for emergency planning. Is there going to be some discussion about why MACCS or another way of saying it, it doesn't really matter, MACCS is just with its model structure and assumptions the same as what is used for evacuation emergency planning? Do you know what I am asking?

MR. COMPTON: I think so. I will take a shot at answering it.

MEMBER CORRADINI: I am thinking of RASCAL. Isn't RASCAL what is being used for emergency planning?

MR. COMPTON: RASCAL is used for incident response but it is --

MEMBER CORRADINI: I'm sorry. You said it right and I was incorrect.

MR. COMPTON: Yes, that's fine. To step back a little bit, I think at the very beginning and I hadn't talked much about this but I think it is useful at the very -- and I got a section, an outlined section that is not filled out to say a little bit -- we are going to use the MACCS code. And to say a little bit about why we are using it, the short answer would be is that that is the code that we use for these kinds of analyses. But largely, it can address a wide variety of output measures. RASCAL does not have the ability to do some of the other, the long-term protective action, so on and so forth. It just kind of stops it.

MEMBER CORRADINI: Right. RASCAL does more early phase and intermediate phase.

MR. COMPTON: Right. Well, it is designed for a particular purpose. It is designed for helping inform the discussion on what particular emergency incident response actions to take. MACCS is more of a, I think of it as more a risk assessment code. But that is certainly something that is worth -- MACCS would be more comparable to something like a PC COSIMA or some other type codes but it would worth talking about why did we use this code. It is not just that is the only thing that we can ever use. There is a reason that we use it.

MEMBER CORRADINI: Okay, that is all I was trying to get at.

MR. COMPTON: Sure.

MEMBER CORRADINI: Thank you very much.

MR. COMPTON: Sure.

MEMBER SCHULTZ: A follow question, Keith. Well the first one you have incorporated uncertainty evaluation as a bullet under quality assurance discussion. And I would be interested to know why you chose that place for it.

MR. COMPTON: Right now, and I should say at the outset, we are still very much in the process of sorting about what actually goes where. And part of the exercise is going to be once I write it, I will find out whether it fits there or whether it is a forced fit.

CHAIRMAN STETKAR: Keith, I think a little bit of what Steve and some of our concerns is uncertainty analysis isn't a backend, patch it on. It ought to be done throughout the analysis. So, it is not part of QA. It is not part of something that you do after you are done. It is something that you ought to do throughout the analysis. And that is a different way of thinking about things and people who are very deterministic don't like to think that way. But, indeed, you need to.

MR. COMPTON: Actually, and again, this will be, as I write it and see, what I was particularly struck by is and I can't remember if it was WASH-1400 or NUREG-1150, there tended to be a discussion of a parameter and then it would talk about ranges. And then it would give the recommended value to use for the analysis.

So, in a sense it was some of the discussion of the uncertainty was baked into the discussion of the basis. And in some cases and just of the top of my head, I can't remember the specific things but it would give a range and then say and this is the value for the base case. That is probably a model that I am going to see if I can follow to have that discussion and similarly assumptions, the assumptions for each sub-model, I will call it, would probably be talked about in the context of that sub-model.

So again, we are thinking about it up-front. Part of this exercise is trying to figure out where to put it in. And then what I found is that I write it and then I realize it doesn't quite work the way I thought it was going to work.

MEMBER SCHULTZ: I would see it as a very robust part of, as you have described, a very robust part of either the technical discussion, you are focusing on input parameters but then you also -- as I finish my sentence, I would put in the technical discussion because you have also go model uncertainties.

MR. COMPTON: Right.

MEMBER SCHULTZ: And with that I wanted to follow up on Mike's point also and that is, if you are going to focus on identifying model uncertainties, then it would be valuable to take other methods, including RASCAL, perhaps, and others as well to identify differences that are seen when applying different industry models to offsite consequence evaluations because that is very important information to have side by side by side, even if the applications are different. In the industry, people think of the offsite consequence evaluation techniques and models in a similar way. They may be applied in a certain way at the NRC but in fact they were developed to do offsite consequence analysis and evaluation.

So, if you are going to come at model uncertainty, one of the ways to do that is to do side by side model comparisons and find out what the differences are for your parameter set.

MR. COMPTON: I think if I understand you right the idea is that may be a way to explore the significance of model uncertainty.

MEMBER SCHULTZ: That's right.

MR. COMPTON: And to a certain extent, some --

MEMBER SCHULTZ: And also identify for the broad industry body of individuals that use different methods what the differences in fact are, as compared to what has been chosen here, MACCS2.

MR. COMPTON: Yes. And that is where, again, I think that goes back to why I feel strongly about saying what the conceptual model is because that is a logical place to say here is why this is or is not -- this is appropriate for the scenario that we are studying and that is a logical place to say this could be done different ways. Instead of a Gaussian plume model, one could use a particle tracking model. But for reasons X, Y, and Z, we believe this is adequate at hand. But it is a place to talk about all of that.

MEMBER SCHULTZ: I agree that is very important in a five-year approach.

MR. COMPTON: And I think --

CHAIRMAN STETKAR: Tina?

MS. GHOSH: Yes, this is Tina Ghosh. I work with Keith and I wanted to answer Dr. Bley's earlier question regarding the SOARCA uncertainty analysis. So, we have talked to the committee before about the Peach Bottom uncertainty analysis. And your recollection was correct that we basically focused on, in terms of the integrated quantification, we focused on just the epistemic parameter uncertainty. And then separately there is also the weather uncertainty.

With one exception in terms of model uncertainty, and that is we looked at the three alternative dose response models. So, we did LNT plus what we call -- okay, the SOARCA terminology so to define in a particular way that the Health Physics Society and the natural background plus medical.

That was the one exception. And for that, we have some quantitative information not only on how does that affect your results but how the important other epistemic parameters change, depending on which model you use for the dose response.

So, that was the one exception. But the only thing I want to point out is the SOARCA heating mass so far is done for Peach Bottom. That is one site. We were in the process of doing a second one for Surry. So, we will have a second set of data in terms of the integrated parameter uncertainties. But since more and more people are trying to do more offsite consequence analyses and the NRC is doing more regulatory analyses, we are slowly getting more and more sources of information in terms of what potentially important sources of model uncertainty might be.

So there are a few that we already know about and we have looked at. I will give you another example. So, other than the dose response model, which we know has a huge effect on your end consequences, in the MACCS code we use essentially a Gaussian plume segment model for what we call the ATD model, the atmospheric transport and deposition. There are certainly other alternatives out there and that has been looked at in sort of a benchmarking study. So, they benchmarked against the RASCAL model as well as another one.

So, that is another example where clearly you can have alternate models but right now those aren't integrated with the MACCS code which has all the other capabilities that Keith was talking about to do.

MEMBER CORRADINI: So I think I heard most of what you said. You were kind of far from a mike. But I think at least just to emphasize what Steve is asking, from my standpoint, I don't want you guys to go in a, and I will use the word off-scope or turn this into a thesis.

On the other hand, when you describe other models, if you can get to referencing that said this calculation or this scenario was done with these three things that indicated such and so. Just as long as you round out that, I think that really adds to the explanation to the read as to why this is logical for this purpose and, when compared, these are the comparative results.

MEMBER BLEY: Yes, I would offer something else, too, because I know Alan has told us many times you are not extending the state of the art in this work. But the approach you took, at least documenting where the uncertainties lie and trying to characterize them to the extent you can, I think is real important. You can do that. And who knows, that may let other people go further the next time. But trying to really capture characteristics of those uncertainties and the stuff that was done on pressurized thermal shock work really kind of set the standard for how to look throughout the model parameters to first characterize uncertainties and then try to deal with them. It is worth taking a look at.

MR. COMPTON: Okay, I will take a look at it. I appreciate actually all this discussion because this is getting a good characterization of the model, a very good characterization of what the model, its applicability, its uncertainty and why we picked that. That starts becoming really the basis, to me the basis for your uncertainty analysis.

And again, as Tina mentioned, the benchmarking report, NUREG/CR-6853, which is a comparison of MACCS and RASCALL/RATCHET, and ADAPT/LODI and being able to say well, we looked at all these things and here is why we picked this one. And we have some discussion of we think that the ensemble averaging in MACCS, when we are using it in this mode, it is appropriate. It does not introduce large uncertainties.

If we were using it for kind of a single weather trial, which would be more of a RASCAL-type application, well, it may not be as appropriate for that. So, I have a hard time extracting these things separately sometimes because often, to me, it goes into the technical basis for your parameter.

So, that's it.

MEMBER BLEY: Thank you.

MR. COMPTON: Okay, I think we are done with that. Okay, so I am kind of done with the documentation part. What I will say is this is ongoing and it has been very helpful so far because we have been learning a lot of interesting things and where the origin of a lot of the fault parameters and assumptions really lie.

I want to take a few slides and go over the status of where we are in the documentation.

MEMBER BLEY: Just one quick question. Are you going to -- under consequences, are you going to look at land contamination?

MR. COMPTON: I will talk a lot about what measures we are going to take. And we haven't decided because this is an issue that basically takes a lot of thinking about.

MEMBER BLEY: But it is not state of the art.

MEMBER CORRADINI: Can I ask a question?

CHAIRMAN STETKAR: Hold on, Mike. Mike, stop for a second.

MEMBER BLEY: The first PRAs actually did do land contamination. So it has been around a long time.

MR. COMPTON: And we will make that -- yes, exactly.

CHAIRMAN STETKAR: Now, Dr. Corradini.

MEMBER CORRADINI: I just couldn't hear the question. I'm sorry.

CHAIRMAN STETKAR: Oh, okay.

MEMBER CORRADINI: Was it about land contamination?

GEN BRADY: I asked if they were doing land contamination. And they are going to tell us more about that later.

MEMBER CORRADINI: Okay, fine. Sorry. Thank you.

MR. COMPTON: Okay. But first I will just go through kind of where we are in terms of developing our input decks and just go through it technical element by technical element.

So for the transition from Level 2 to Level 3, that process is actually, as Don mentioned, we have been spending a lot of time kind of negotiating the handshake. It is really fairly straight forward, again, when you go back to previous analyses. We are going to be processing all the MELCOR outputs through MELMACCS to define individual source terms and then we will be running these source terms through MACCS2 to quantify the consequences that we select.

MEMBER BLEY: I should have probably asked this when Don was up but he didn't get there. So, since you talked about the Level 2 to Level 3, when I read, there was a little section on that. There was also in the Level 2 work, it identified what the release categories would be and I think there were 14. That is the number.

MR. COMPTON: That's about right.

MEMBER BLEY: But what I didn't see was the logic for how it came to those and why you were arranging them as you were to make a transition from Level 2 to Level 3. Maybe that has not been written yet.

MR. COMPTON: I will let Don address it and then I will follow-up with what we are going to do.

MR. HELTON: I think in the document you looked at you are correct, there were 14. I was thinking 13. But anyway, those are the end states for the containment event tree. So each containment event tree is going to end in one of those end states and so, it will be based on the sequence characteristics of the Level 2. A more detailed reckoning of that is still to come, as the containment event tree is built out.

MEMBER BLEY: I tried to read a lot of stuff for this meeting. I don't know if it was well documented how you condense to that set out of all the possibles. But one day, you need to explain that, if you haven't done it yet.

MR. HELTON: Yes, they are in the two points I have made. One is preliminary and it could change. And the other is to the extent it doesn't change, what is there now is predominately experience-based.

MEMBER BLEY: Okay.

MR. COMPTON: And to follow-up on that again, this is where we are reviewing NUREG-1150 and the details of the procedure since they used the XOR family of codes that generated many, many, many source terms and then they had a process for essentially betting on cesium release, iodine release, and then they subdivided by warning time. Those basic concepts of the iodine release driving the early fatalities, the cesium release also leading to particularly the longer term effect, and then the warning time, obviously, having a big influence on exposure. I think that the experience that we have gained tells us something about what kinds of source, the characteristics of source terms that are important.

What we can do, after we have gotten the source terms from Don and we have run them through the analysis, we can get some sense, and I don't have a very rigorous procedure at this point, but what I would be looking at is to see essentially whether we have covered the consequence base, whether we have a lot of things that are all basically giving us a very similar answer and that there is maybe some other space that just, wow, we don't have anything that is giving something else.

So, I don't have anything better for you at that point except to say we will do the analysis and then will look at it and see whether the experience base was reasonable or whether we have a whole in it.

MEMBER BLEY: Well, I reflect back on the earliest PRAs and there it was kind of the people who had the experience running the consequence code. We talked with them and say what things really matter? Elevation, temperature, whatever it is that matters, we will try to break it into categories that lump those things together. And I trust you are doing that.

They might miss something that matters to you, if you are not doing this together.

MR. COMPTON: That is true but we have been discussing it. And I think we have learned the things that tend to drive things. Another example would be things that you had some release that was maybe out of the norm, that you had say, I don't know what and I am not a thermal hydraulics person but maybe a core concrete interaction that released instead of just kind of your main cesium and iodine mobile gases that release some of the things or the other chemical groups more that might --

So, we are thinking about those kinds of things. We haven't developed a full algorithm for all of it.

MR. KURITZKY: And let me also just mention that in general, the main focus of this project is to make sure that the various teams are talking to each other. We have regularly scheduled team leader meetings where all the team leaders get together, so we could all get together and people can hear what the other people are doing. And that can trigger them to talk to one party or another. And then there is also for instance Level 2 and Level 3, or the success criteria person and the systems for Level 1 PRA person, or encourage them to talk to each other on a regular basis so that everybody is aware of what the other person is doing.

If there is any interface, the technical analysis approach plan that we have put together identifies interfaces between each part of the project, among other parts of the interfaces. So those people are supposed to be in regular communication with each other to make sure that there are smooth hand-offs in that type of information.

So, in this case Keith and Don --

MR. COMPTON: Don apparently recognizes the sound of my footsteps coming up to his cubicle. So, we have been talking a lot.

MEMBER SCHULTZ: Alan, were you saying that this runs vertically down into the groups, the technical participants as well? So, an individual and engineer working in the offsite kind of consequence area is also not only permitted but fully encouraged to be talking to Level 2 and Level 1?

MR. KURITZKY: Certainly anybody doing that kind of work would be encouraged to talk to any counterpart in any area. I can't speak for each individual.

MEMBER SCHULTZ: I didn't mean hypothetically. I meant structurally and organizationally.

MR. KURITZKY: Certainly, depending on the nature of the person. Some people are more naturally going to go to let's say if they work on a team, they are going to go talk with team leaders and say hey, I need information on this. And the team leader there will already know it and provide the information to them or will reach out to their counterpart or have the person who is asking the question go directly to their counterpart.

I know because on our floor, I sit amongst a lot of the people on the project and there are people coming up all the time talking from the different groups that talk to different people on the different areas.

So, I think we have engendered or fostered that type of open communication amongst the different teams.

MEMBER SCHULTZ: Good. Thank you.

MR. KURITZKY: I am pretty confident that we are going to have fairly smooth hand-offs.

MR. COMPTON: Just a follow-on, one of the things that we are working on is improving MACCS and MELMACCS to better handle the multi-source releases. So, we are doing some co-development work so that when we need to do those later in the project, we have that capability. The real issue is one of the things that we are facing right now is trying to get all the releases on a common time line so that you can actually do the consequence assessment. Essentially, it is the dangers but you know things that are very staggered, you have to do. But your exposure assessment is one time line. You have to put everything on a common basis so you can model it.

For weather data, we actually got fortunate in the project. There is five years of weather data from Vogtle's early site permit, so, from 1998 to 2002. And we have a staff meteorologist who is very familiar with that weather data and is going to be able to review it and help us understand it, fill out anything that is missing.

CHAIRMAN STETKAR: Keith, why do you feel that only five years' worth of data is reasonable to characterize the site?

MR. COMPTON: The weather file?

CHAIRMAN STETKAR: Right.

MEMBER CORRADINI: John, can you repeat that, please?

CHAIRMAN STETKAR: Why do you feel that only five years' worth of data are sufficient to fully characterize the site in terms of variability of whether, especially when these days it is fairly easy to go back. Maybe not exactly pinpoint the dot on the map that is Vogtle but derive weather data that go back 30, 40, 50, in some cases 100 years.

MR. COMPTON: A couple of reasons.

CHAIRMAN STETKAR: You hear all of these things about well this is the once in a century or once in a lifetime or storm of biblical proportions. I don't know how many times I have heard that in the last two years. One might not capture those storms in five years' worth of data.

MR. COMPTON: Sure. I will give a couple of answers and see if this is -- first off, is that again, the output measures that we do tend to be an ensemble average across all weather. So, trying to get the average right is, in some ways, a lot easier than trying to get all the tails for weather for the dispersion modeling.

Having five years gives us an idea of seeing how much did it vary from year to year. I mean, if the five years were completely different, I might start getting nervous that hey, there is none of these things seem like another.

Part of it would go back to the fact that we are fortunate to have a meteorologist who understands, I think the larger scale, the weather patterns that would drive it and being able to look at for example the wind rows. One of the more important things is making sure that you have gotten the wind directions, the wind speeds and the stability right. You can check that by looking at other, by looking at Augusta Bush Field or looking at other things and say is this about right? I mean, is this what a Southeast U.S. Coastal Plain site should look like?

So, part of it would be using judgment. Part of it would be five years is probably reasonable. The other part is that going beyond that, it does get challenging because MACCS needs hourly weather data and it needs data for stability class. And so you can get some observations by going to National Weather Service data. Some of the other ones may start getting harder and harder to find. So, it is kind of a balance between what you can do, how good it is, how much uncertainty -- what kind of uncertainty it can induce in the results.

CHAIRMAN STETKAR: That is what we were talking about a little bit earlier is thinking about uncertainty as you do each step of the analysis. And certain variability in the weather is a source of uncertainty. How much, how important it is, I am not a MACCS person at all, so I don't have an intuitive sense for that.

Something I just thought about, because I am not a MACCS person, how do you handle or how does the project handle -- we talked earlier about wind events, for example and they may be quantified or they may not be quantified. How does MACCS handle those types of issues?

For example, if I know that I have a cut set, sequence, scenario, whatever you want to call it, that was initiated by a tornado accompanied by severe thunderstorms that historically may persist for some period of time, not days but not necessarily one hour. How do we capture that in the results?

Because we can't average -- it can't be a sunshiny day in the back end of the analysis when we started this whole thing with a tornado.

MR. COMPTON: That is precisely right. And again, that is why the approach, the process that I have for that, and I don't know how it comes out, that is why I am wanting to be very systematic about touching every single parameter, is that what I can then do is that I can go through and start saying what of these things might be effected by my initiating event.

So and at some point, I may simply have, I could do it. I have seen analyses that have used it. Calculating dispersion and tornadoes, I am not sure that I would be -- you know make it very unstable and very high wind speeds. But it --

CHAIRMAN STETKAR: You know it is also because of that destruction. Whatever kind of sheltering models that you use and evacuation. I mean, I just used it -- we were talking about weather but it filters through the whole Level 3 analysis.

MR. COMPTON: It does. And that is exactly why I am trying to get really familiar with every parameter and what its basis is, so that you can really understand it and you don't inappropriately make conflicting assumptions. I mean, just as an example, I have even gone back to the technical basis for why we picked the 60 radionuclides that we typically pick in a MACCS analysis and it is from WASH-1400, largely. And it is very much based on reactor accidents.

When we go to look at the dry cask accident, that is one of those things you generally don't think a whole lot about. You use those. Those are the -- but we will have to look at it and make an informed judgment.

CHAIRMAN STETKAR: Thank you.

MR. SIU: Nathan Siu, staff. At the risk of speaking a little bit out of school here, does the issue of dependency between the initiating event and the consequences afterwards is a recognized weakness in general in the Level 3 PRA. There was a workshop on Level 3 PRA held by IEEA, I think it was last year or the year before, and this was one of the issues raised. That is just not handled.

So this gets back to the state of the art question and how far you want to push that.

MR. COMPTON: But it is -- right. But it is not terribly difficult to think about it. And if you go through it --

CHAIRMAN STETKAR: Well, when you say state of the art, it is not doing something that we know how to do is one thing. Not doing something that we don't know how to do is something else. I mean, the second is pushing the state of the art. The first is not pushing the state of the art. I was going to use a more pejorative term but --

MR. COMPTON: I guess right now all I can say is yes, this stuff is very much on our radar. And hopefully, in the documentation this will kind of come out and it will be seen.

So, the next slide, I think. The protective action models are being developed by Sandia National Laboratories. We just got our initial write-up in-house and we are reviewing it. But we have been looking, they have developed the population cohorts to account for not just residents but the special populations like schools, workers, Savannah River Site, the site is very close to the Savannah River Site and that has introduced an interesting aspect of the modeling.

We have three basic EP models that we are going to be applying to cover pretty much all of our analyses. And they really have to do with the size of the release how far out protective actions go. And essentially it is an EPZ evacuation and an expansion of the evacuation out to 15 miles and then another one, an expansion of the evacuation out to 20 miles. So, those are the basic EP models. And then well, actually, we won't be able to completely parameterize them until we have the source terms and so you can get the timings nailed down. But we kind of have the general outline of we are going to kind of put everything into these bends and that should cover us.

MEMBER BLEY: Well, let me interrupt you for something orthogonal to your presentation but to Alan.

We never talked about Savannah River site across the river. There must be things that could happen over there that could be of importance on the site as external events. Are you considering any of those?

MR. KURITZKY: Yes, I don't want to speak specifically to it.

MEMBER BLEY: Is there a talk about it or is it something we will talk about later?

MR. KURITZKY: Well, as I mentioned earlier, we have done the preliminary screening for other hazards, of which that should be --

MEMBER BLEY: Should be part of that.

MR. KURITZKY: -- a primary part of that. So, I will have to assume, without having looked at that report specifically that that has been covered in there.

MEMBER BLEY: Okay, sometime we will look for that.

MR. KURITZKY: Right.

MEMBER BLEY: Okay. Sorry.

MR. COMPTON: And one thing I will mention at this point and this, I won't be able to resolve it but I would point out that one of the things that we have to do in this element is to define our grid, our modeling grid, which means that we have decide how far out we want to model. And this brings us back into, squarely back into the discussion of uncertainty but it also brings us into the question of what output measures we are computing because some of them are very close in and you don't need it. Some of them may go very far out. The code has to account for all of these things.

For right now so that we can move forward, we are planning to have a model grid that goes out beyond 100 miles. And 100 miles, I tend to pick because of the NUREG/CR-6853, the benchmarking study that showed that we are in pretty good shape with the MACCS code and this, in our application up to about 100 miles. We will have to define how much further out we go. WASH-1400 went out I think 500 miles. NUREG-1150 had a modeling grid out to 1,000. You really start getting into uncertainty at that point.

And I am still, I don't have the table. I am still trying to sort out how to balance all of the various considerations on modeling grid at this point.

So, the last thing is we do hope to leverage ongoing work. We have got some other work going on in terms of updating decontamination plan parameters. And obviously, to the extent that things get done for other projects on our time line, we can incorporate them as appropriate. Next slide.

MEMBER SCHULTZ: Just one question. You have labeled it three standard evacuation models have been developed. And you know I am very familiar certainly with the ten-mile EPZ. So, when you say three standard evacuation models, does the same rigor apply to the 10-, 15-, 20-mile models as associated with all of the physical parameters, the population, the centers?

I know how detailed the ten-mile EPZ has been known and modeled. Once one gets outside that, there is -- I don't want to call it uncertainty but there is lack of information. I am just wondering what is being utilized for the 15 and 20. They seem to be characterized here as their three standard models. Well, I am not sure that each of them have the same pedigree.

MR. COMPTON: Right. They are -- and I should acknowledge at the outset that I am not the evacuation specialist. That was being done by Sandia who are more and they subcontracted to Louisiana and they had a subcontractor look at evacuation times. And they were looking at the network and making estimates.

So, without trying to go into all the details, I will say those other two, the ad hoc expansion models will have a pedigree and a fairly detailed pedigree. And we can get more information on exactly how those are done. Again, that will be in the documentation that we are reviewing.

MEMBER SCHULTZ: Yes, I am kind of combining the bullets three and -- four and five. The three standard evacuation models and then the relocation, introduction to decontamination models. They seem to go together but again, I want the report to characterize accurately how well those three areas are represented.

MR. COMPTON: That I do -- that is the largest single section of the report right now. I am still trying to sort it out and put it into our format but there is a lot of detail on the road networks and the expected travel speeds and the routing. Again, I haven't reviewed it in detail but there is going to be a pretty well-developed technical basis for that.

And then I think after looking at it one could make the judgment -- one thing I will note at this site. This is a fairly rural site. There is not a really high population density. I think what we are seeing when they did model it, they did look at these other evacuations and it is not going to be that hard. The evacuation times are not terribly long.

MEMBER SCHULTZ: Then we always ask is it initiating event-dependent, external event-dependent?

MR. COMPTON: And again, I will go back to that is where I have my process of going through everything. And when I say model, I have in my mind a very specific -- in my mind, that is essentially an equation or an algorithm together with a set of input parameters that say here is how this would actually change. The value of the delay coefficient for adverse weather is this because of whatever. And the idea is to look at all of those and see.

Like for seismic events you may change your network routing. You may say oh, this bridge is gone so the path doesn't go this way. It goes that way. But that would have to be explained.

MEMBER SCHULTZ: Thank you.

MR. COMPTON: Okay, dosimetry. Dosimetry and health effects are pretty straight-forward. They are going to be based on what was done in SOARCA. A lot of the work here is just working on the documentation, being very clear about how the dose conversion factors, which are an input file for MACCS were developed. We do expect to use one alternate dose model, at least one, based on the health physics HPS position statement, so that we can gain some insights into how much of the health effects are affected by low dose projections. So this is one case where I am pretty confident we are going to do at least this one case.

And again, we have also got some work to be done to improve our documentation on the dosimetry and the health effects models and we will incorporate that as it becomes available.

And that pretty much brings me to the last few technical elements, which is the quantification reporting risk integration. And this really is the $100 million question: So, what do we actually compute? Because a lot of your modeling choices have to be made by reference to what it is that you are actually trying to calculate.

And last spring, I think, Marty presented the candidate metrics that we were considering reporting and those are in the TAP. I am now at the spot where I actually have to figure out what we are going to compute. So, I am pressing the issue and it raises a lot of questions. And so what we have been doing is really kind of trying to go through and get a better-informed decision. I will tell you a little bit about what we have done.

I will make the statement that all of the measures are based on quantitative MACCS outputs. And we have to write an output control statement for everything that we want. There is not a default parameter that it just computes all the time. I actually have to tell it exactly what I want it to compute.

And so, therefore, we have to make a decision and because we don't want to have to redo the analysis if we change our mind down the line and realize, oops, we didn't save that output. Now, we have to go and rerun absolutely everything to get these particular things.

I am going to summarize what we have been doing in three categories. First, I am going to give you an idea of what MACCS can do. I am going to talk about some of the applications that actually use the quantified consequence results. And then I am going to talk about what I have picked up from past studies.

So, the first thing for MACCS, as I said, there is no default set. I have to tell it what it can compute. You write this statement in the input deck. And this is just a list of all the possible things that you can get out MACCS, the types of results. And so you can see, there is a lot of -- you can ask MACCS a lot of questions. You have to decide what you want it to know.

MEMBER BLEY: There is one I don't see up there and this came up in some other discussions a while back. At least prior to MACCS, some of the earlier consequence codes was an interim result calculated isopleths. And then from that, they calculated the population doses and that sort of thing. But the isopleths themselves have been interesting for some purposes. Can you get those out of MACCS? Then let's do them internally.

MR. COMPTON: Yes, and I will talk about that kind of in the next slide. Yes, you can. You have to be careful because, as I said before, it is more meaningful in an ensemble average. Doing it for kind of a single weather trial, you have to be careful with.

But in principle, one could do it and I think we have seen -- I keep going back to NUREG/CR-6853, is they did that for the output measures that were common, the air concentration and the ground deposition. So, it takes some close processing. It is done natively but --

MEMBER BLEY: But you can get there.

MR. COMPTON: -- one could. It is not, again, it is not typical. But yes, I think that there might be a way to do it.

And I will make a point. With this number of output measures, this number of figures of merit, a modeling choice, trying to come up with a modeling choice, a technical basis that is optimum across all the figures of merit is really pretty challenging. And I will give the example that a certain modeling choice, say on deposition velocity, might be conservative for calculating early fatalities but because of that, it would be non-conservative for calculating the total area of land contamination.

The lesson that I take from that is that we have to just try to be as realistic as possible and not try to think -- just do the best we can on the choices. But the point is that it is very hard for me to say oh, this is conservative or blanket and making a blanket statement.

There are a lot of different things and you have to think about its effect not just on one but how choice might affect all of the different output measures.

Another thing that I would point is that, as I have mentioned, there are a lot of component models within MACCS. They have different ranges of applicability. In other words, for example, the atmospheric model, I feel fairly comfortable with at least out to 100 miles. You go from that and you start having questions about if I am starting to predict results out there, what do I do with them? I need to think about that. And sometimes I have to do my calculations and see whether I get something out there or not.

The same thing the latent health effects models are less uncertain at high doses. If you have an output that was giving you lots of low doses, it would induce some uncertainties.

The actual results that we get out of MACCS would have to be evaluated against kind of where the results are lying. You have to compare them against where the models are good.

So, outputs, so the next slide, just pointing out that these consequence measures are not just scale or quantities. They are distributed across space, across the region. They change with weather trials. You actually have to decide are you going to get an average. Are you going to integrate across and area? So, all of this is essentially saying that we can't just ask MACCS to make this decision for us. We have to put some thought in up-front as to what we are trying to compute.

So, that takes me to the next source of information, which is well, what are some of the places that we use quantified consequence measures. And this is not intended to be a complete list.

This is what we have been able to find, some of the applications for the consequence analysis and come up with a risk-informed decision making reg analysis, backfit analyses, and then environmental reviews.

I have included the risk-informed decision making, although they use CDF and LERF. Those are based on the quantitative health objectives, which are quantified health consequences that you get from something from MACCS.

And just to go to the next slide, the table, this is an example of some of the things that are computed in these different applications. I have tried to limit myself to things for which we have got guidance. We actually do this kind of regularly and we have a practice in here but the individual risk and the individual early and latent fatality risks, or essentially the QHO type measures. But as you start getting into reg analysis or backfit analysis, you start getting into calculating collective doses, offsite property damage. Then when you start getting into environmental assessments, you see a wider set of metrics. You start getting into not just individual risks but total impacts. You do start touching on land contamination.

This is -- right now I don't have a whole lot more to say about this except that there is a lot of different applications for which we use this and it is useful to know what different people are looking for from this vantage point.

So the next thing is to look at the past studies. As I mentioned, we looked at kind of the WASH-1400 era studies. We looked at NUREG-1150, and then more recently the SOARCA analyses. And I have characterized these. This is just to kind of help me group them in terms of being able to discuss them, kind of the era in which they were done, the tools that were used to compute them.

And this is a rather busy slide. But I would point out that there is a couple of things that I noticed in doing this review. First off, there is a hierarchy of reported results. There are typically main reports that have very digested distilled consequence measures. But when you go back into the basis for those documents, there is a lot more information. Depending on how far back you go, there is a great deal of information.

Furthermore, there were typically studies that came out after say WASH-1400 was done, there were a number of other studies that used the information from WASH-1400, the citing study, the report that used some of that information and did further calculations to inform decisions. Likewise, NUREG-1150 had the -- it produced a volume on guidance for across benefit analysis and NUREG/CR-

6359, which again, used the NUREG-1150 analyses but then provided more output measures and more detail.

So, in general, the observation from this is that there has been a wide variety of consequence measures. And this goes to your point is that in looking at WASH-1400 is that you see even in the -- I don't know if it is the executive summary or essentially the first chapter, there were, I think seven metrics. And I think it was in our Dickinson area, it was reported the land contamination was reported in terms of the are affected by protective actions. So, yes, there has been a lot of different things have done over the years. There is no clear set that is just always used all the time.

One of the things that has been useful about looking through the past analyses is that they gave a good format for presenting the results in our bookkeeping. One of the things that we are going to be facing in this project is that we are doing this, we have got lots of different release categories. We will be having different scope pieces. Just the bookkeeping of keeping track of all these numbers is going to be challenging. It has been useful to get some examples. And these are just some -- again, I am not expecting you to read them but this is NUREG/CR-45 -- the supporting document for NUREG-1150 that showed its by release category, the standard set of metrics that were used in NUREG-

1150, which allows you to trace the calculations, which has been very useful. And the ability to correlate these back to source terms and back to release categories has to me been a very valuable source of information to see whether okay, this particular source term group was a late release with a high cesium. You can pull all this information out and get some useful insight from it.

But again, I would say the history has been that the support analyses provide tabulated conditional results that are used to compute the frequency-weighted results at the higher level results, that you start, essentially with something like this.

I am going to skip over this briefly. This was the report on cost-benefit analysis but it provided a useful, for me, at least, this was a useful formulation of how to look at results at different distances. It was helpful because you can look at this and see what kind of measures change at long distances and what kind of measures, by comparing the different ranges, you can start seeing where the certain source terms leads to impacts.

Okay, that pretty much wraps it up. To summarize it, I will just tell you what I have said here, is that there has been a wide variety of output measures. They have been reported at a range of distances. The level of detail is dependent on where, which part of the document hierarchy you are in, if you are in a detailed or supporting report. And generally, we produced the conditional results and then those get frequency weighted or otherwise manipulated by the risk manipulation team.

So, in summary of the overall presentation is that we are working on a very consistent structured document format so that we can have good traceability, transparency, and also, I think it will help us in doing the other analyses that we can kind of systematically go through and look at things like seismic effects or look at other conceptual models.

And as I have said before, the consequence measures are varied but they have generally had health impacts and societal, individual health impacts, societal health impacts, and measures of economic or property damage. I will stop at that point, if anyone has any questions.

CHAIRMAN STETKAR: I don't think so, Keith. Joy or Mike?

MEMBER REMPE: I'm good.

MEMBER SCHULTZ: I guess I want to comment, Keith. I liked your approach and I think since there weren't any comments or questions right at this point where we have a general opportunity, I am just assuming that we all like most aspects of it, at least.

The part that I like especially, is that you are really delving into the clear identification of the input parameters and the analysis approach within the method, which will allow you then to do an evaluation of uncertainty as you go forward. And without that, without the background information that you sought to develop, without the research that you have done here to prepare you to do that, you would be doing a poorer job at accomplishing at what we intend to do here.

MR. COMPTON: I appreciate it. I do think it is important to go through it in detail and explain it because I think that hopefully this will help us not just in this particular study but, again, going back through, tracing through it, touching everything. I am hoping that this is going to be useful. Again, not just in two years and then it is done but you can keep coming back to it.

MEMBER SCHULTZ: And I am not saying that the work that we have done recently in this area hasn't been of extremely high quality. It has been. But again, this is one more opportunity to examine everything in the hole in order to put the Agency in a position of, as you said, we are documenting everything as we go appropriately. So, the bases for what we are doing in the hole are well-documented, well-understood. And where we don't understand something, we will document that, too, for work to be done later. And I think that is extremely important.

MR. KURITZKY: And Dr. Schultz, I just want to reemphasize that where they made objectives of the project is a focus on clear and complete documentation for transparency and usability of the study as we move forward.

So, while you have a very good taste of it in Keith's presentation how rigorously he is pursuing the documentation as he goes along, it is our expectation that all areas of the study are going to be similarly documented in that --

MEMBER SCHULTZ: I heard that this morning. I certainly had the sense from the presentations this morning. Even though it wasn't stated as clearly as what Keith did for this portion of it, it was clear from the presentations what is being done in the other areas as well.

CHAIRMAN STETKAR: Good. Anything else for Keith? If not, thanks.

Next up on the agenda, and I think we can fit it in before the break, what I would like to do is get the next two items finished before we break because we started a little bit late is I think Owen Scott from Southern Nuclear would like to make some comments about Vogtle's perspective or Southern

Nuclear's perspective on the project. So, we will have him come up.

MEMBER CORRADINI: John, could you just speak a little louder, please?

CHAIRMAN STETKAR: No, I can't. Mike, I have a really bad cold, so I can't, unfortunately. We don't seem able to get a longer cord to get the microphone closer to where the chairman sits. So, you will have to put up with it.

MEMBER CORRADINI: You are the chairman. You are the important.

CHAIRMAN STETKAR: Yes, I know.

MEMBER REMPE: To summarize, are you having a break now?

CHAIRMAN STETKAR: No, we are not. We are having Southern Nuclear come up now.

MEMBER REMPE: Thank you.

MR. SCOTT: So, I am controlling the slides from here?

CHAIRMAN STETKAR: Yes, we run a really high-budget operation here. Those are mikes. They are really sensitive. So, be careful if you are shuffling papers around you don't hit them because it explodes in our recorder's ear. That's close enough.

MEMBER CORRADINI: Yes, I hear paper shuffling better than I can hear John.

CHAIRMAN STETKAR: That's good. It is by design. Be nice, Owen. I haven't seen you in many years.

MR. SCOTT: Okay, good afternoon everyone. I am Owen Scott from Southern Nuclear. I am the supervisor of the PRA Models and Tools Group within Risk-Informed Engineer in Southern Nuclear, formerly known as PRA Services. So, we expanded our group a lot and we have incorporated risk-informed into the title of our department.

I am also serving as Vice Chair of the PWR Owners Group Risk Management Subcommittee. So, I have got a lot of insight into this project from both sides, from Southern Nuclear's perspective and also from the industry.

So again, I would like to thank the Level 3 team for the opportunity to be here today and to share Southern Nuclear's thoughts on the project.

So when Vogtle was selected to be the subject plant for this project, we were really excited at Southern Nuclear but knew it would be a challenge for us to provide all the information and do it in a timely fashion so the model builders wouldn't be held up by our slow processes, sometimes. So, although, we weren't doing any actual work, we consider ourselves a part of this team. We obviously have a stake in it and we were excited about it.

So, I will just start out with what we thought the benefits would be and our thoughts on what has happened and some positive and what were some challenges we have experienced so far and what we see going forward with this project.

I think initially we looked at it in terms of benefits like what is in it for us to be part of this. And we looked at it from a standpoint of industry benefits and also benefits to Southern Nuclear. So just to begin with, we think developing an all-modes, all-hazards, multi-unit model is going to have a lot of benefit as far as giving us a better understanding of different hazards and also updating our historical study. We have the NUREG-1150 for those of us who have been around for a while. And we view this as kind of significant on a PRA historical time line that would be taking PRA to the next level.

And in the process we will be getting, using methods and tools that have improved greatly since the NUREG-1150 study was done.

So starting with internal events model as the base model, this is showing how you build on that. And I think it is also going to kind of point out it is important the models be realistic and not have unnecessary conservatism which could compound in different models. So, you are starting with internal events and you are going to expand that into the fire and seismic and low-power and shutdown. So, all along the way you have an opportunity if you are too careful to double count and just end up with one particular hazard group totally dominating, which is in some way what we have seen with fire.

So, I think this freeze date is going to be very important. When you are working with series, it is important that your initial model be frozen as you start developing the other models, so you are avoiding a moving target and you don't have one hazard group to another using different versions of information. So, we think this project is going to highlight that point.

And the new risk insights in identifying safety improvements driven by these new hazard groups that we are not really that familiar with until we do the model. You kind of have an idea of how vulnerable you may be. But until you put it all together, you don't see the whole picture.

So, I think it is also going to benefit us in that we are going to be cooperating with each other, NRC and utilities, maybe more than we have in the past to move the state of knowledge forward. I think doing the peer reviews by the PRA Owners Group is a good example of that.

We have very limited budget. The last couple of years in the Owners Group has been dominated by Fukushima, responding to post-Fukushima initiatives. And also in PWR space, this Generic Issue 191. So, we have got to get beyond that. We have spent a lot of money doing the research and now it is time to take action on some of those. So, I think the fact that we have committed money in our budget for this year and next shows a real commitment on the industry's part to this as well. They realize the benefits and I think they are curious as to where this going also. So, they want to be involved just to see, okay, what are they going to do us next. So, I think that is not total motivation but I think there is a lot of curiosity about that.

So, I guess now you look at Southern Nuclear benefits. We are thinking wow, we are going to get a lot of new models out of this for Vogtle. So, the low-power shutdown, we started one of those five or six years ago and we kind of put it on hold. And the standard is out now, so this will kind of give us a head start, we think. So, it is going to be real positive for us.

Spent fuel pool, the same way, we have got in the Risk Management Subcommittee of the PWR Owners Group, we have got a pilot going on now. So, this will be an opportunity for us to see how this would work with one of our plants at Vogtle.

The same with the dry cask storage and high winds. You know it is an extremely important hazard in light of the recent tornadoes we have had in the last couple of years. You know we realized that what happened at TVA that hey, you can be without power for a long time and you had better be ready.

I guess we also feel like at Southern Nuclear that having an additional review of our models by some experts with a high-level of knowledge will result in making our models better, too. So, we have gone through the process we normally go through. But now let's have someone look at our models and point out areas we can improve in. So, we may not always like that but that is always a good thing.

Some more benefits. I think it has allowed us to continue a positive relationship that we have had with the staff. So, I am looking forward to continuing that. I think it gives us a chance to show the high level of knowledge and expertise that we have in-house in our risk-informed engineering staff at Southern Nuclear.

We performed three fire PRAs in-house. We have developed expertise to perform all the functions needed to do fire PRA. We have developed circuit analysis experts, fire modeling experts. We have got people who know how to route cables and see where those start, not just where they start and where they end but how they wander around through the plant.

And we have got seismic PRAs underway. We had started, committed to do seismic PRAs on all three of our plants before Fukushima happened. So, this will give us chance to again demonstrate, you know everyone the Level 3 project, our higher level of expertise and our commitment to that.

And we have feel like our partnering with the staff and our open communication on the Level 3 team is ongoing. We want to make sure we continue that. So, again, will give us a chance to show the high quality of the models. You have had a chance to review our internal events and our fire models. Both of these have undergone peer reviews in the industry.

Again, ASME standards, we have shown that we meet all the elements of the standard, a capability of Category 2 or better. And that makes them compliant with Reg Guide 1.200 or use in risk-informed applications, which we have a number of those LARs in now for risk-informed applications. We are at 805 on one of our plants, actually two plants now. We have got one of our submittals on 805 now. We have got submittals for the risk-informed tech specs and also 10 CFR 50.69.

So, you know we also have an industry leading seismic PRAs under development for Vogtle 1 and 2. So, I think this has given us a chance again. It is sort of an intangible benefit to show how much we can do in the quality of our models and to show that we are fully committed to risk-informed approaches.

And I think it will also give us a chance to show NRC and the staff how much work it is to keep models up to date and continue to maintain the standard. It is one thing to meet it during the peer review but going forward you have to make your model. It is not optional. And so you have to continue to meet the standard and you have to have processes and controls in place and infrastructure to maintain that. So, this is an opportunity, again, to demonstrate how well we do with that.

MEMBER SCHULTZ: Owen, you mentioned risk-informed tech specs. Is that something that you have done for Plant Vogtle?

MR. SCOTT: We have a submittal in now.

MEMBER SCHULTZ: The submittal is in. Okay.

MR. SCOTT: It is ready to go in review now.

MEMBER SCHULTZ: Good, under review.

MR. SCOTT: Yes.

MEMBER SCHULTZ: Thank you.

MR. SCOTT: And that integrates fire and seismic and internal events.

MEMBER SCHULTZ: That is why I was interested. Thank you.

MR. SCOTT: So you know now we are down to kind of what we think has happened so far. So, the staff has performed a very thorough review of the Vogtle internal events models and they have covered all areas and all aspects. You know we have given them a lot of information and shared everything that we had. So, they identified a few things they feel questioned the results of the current Vogtle model and they have communicated those with us and again, we welcome those challenges and we are committed to addressing.

We feel in a couple of cases the staff applied some conservative methods that maybe reflected preferences by individuals, rather than what would be considered by the broader PRA technical community to be acceptable in a peer review. So, we are working through those. As an example, we have got an HRA analysis that we did, the method we used, and then staff used a different method and we came up with some higher numbers and felt like maybe our method we used didn't consider time is as important as it should have been.

So, we went back and we recalculated using their method and working with an expert that we work with who maintains an HRA calculator for EPRI. And based on his look at it, he said it looks like they are a factor of ten or higher or more on some of them. So anyway, we have got to sort all that out. But this was timely for us because we have got an EPRI HRA underway as part of our normal update cycle. So, this gives us an opportunity to look and see if we need to change methods that were using CD, VT, and then maybe now we need to use this HCR/ORE method. So, we are looking at that. And this was a good exchange we had.

And so now also we don't think that the staff is really appreciating the role that model updates and upgrades play to address when you find errors early and something changes in state of knowledge. So you know errors are found in PRA models and we have a process in place to handle in disposition errors and things need to be changed.

And model refinements typically are driven by improvements in methods and tools. We have an upgrade of map code. And there has been improvements to the GOTHIC code that we use to evaluate room heat-up.

So, things change. The PWR Owners Group, we are looking at a method for incorporating the digital I&C into the model. So, things are going to change and we have a way that we handle those. If we make an upgrade, we have to do a peer review for that element. So, I think maybe going through this process will give the staff a better understanding of that. We hope it will sort of re-gauge their thinking on how important that is and how we deal with things when we do have things that we are made aware of.

MEMBER BLEY: Owen, these are all things that are under discussion now. Is that right?

MR. SCOTT: Yes.

MEMBER BLEY: Yes, okay.

MR. SCOTT: Yes. So, I mean there are some things that have happened, too. I will mention those in a minute.

But when you have an error in your model, I mean you can't just shut your model down until you fix the error. You know you have to have a model of record that you accumulate changes that have been identified and you have a way to determine the significance of those. And you have at threshold. If they don't cross over a threshold cumulatively, then you just stay on track and have your normal model update cycle. If you have some major error that has a huge impact, then your process requires that you stop and update the model and redo your applications.

MEMBER SCHULTZ: Owen, that is a program that you have within your team, specifically for the --

MR. SCOTT: We have the figures that -- we update our models every 18 months.

MEMBER SCHULTZ: Right. So, this is not part of the corrective action program. It generally isn't but I just wanted to validate.

MR. SCOTT: Yes but we do put errors in the model that go into our process through the corrective action program.

MEMBER SCHULTZ: Through the corrective action program.

MR. SCOTT: Yes, and then they may be closed in the corrective action program to our model change log. So, we have --

MEMBER SCHULTZ: That is what I am familiar with. Thank you.

MR. SCOTT: Yes, I won't get into any details here. But we do have processes in place to deal with issues because you are going to find errors in PRA models and you are going to find things that need to be changed. And you have got your normal update that is not optional. You know, it is required by your procedure to do that.

And if you try to change it every time that it came up, you would be revising your model often. And all the follow-on applications, you have got to have some start and stop points there along the way.

So, I think in some ways we feel like the staff is using some newer methods to maybe invalidate the old methods and call into question the adequacy of something that was done previously that maybe now they think doesn't provide sufficient risk insights for applications because maybe it is outdated or you haven't gotten around to updating it. So, there is a balance between that and having an appreciation for the process that is used to update the model. So that is a comment we have about what we think their perception is.

MEMBER SCHULTZ: I'm reading the bulletin now. As I read through all of it, I take it as a caution, an issue and a caution that one must not jump to conclusion but rather understand that this is a process.

MR. SCOTT: And just appreciate say you have an internal events model and you start doing your fire PRA. When you freeze the internal events model and then you go about doing your fire PRA and then 18 months go by and you have to update your events model. So, now you have got an internal events model that is out of sync with this model that you are using to develop the fire PRA. So, you have to go back and push those back together.

So, there is a process for doing that and you just have to understand day to day how that works to fully understand that we are not comfortable with having different versions of models and we don't intentionally use different versions of models but you have to have a process and it has to be worked properly.

MEMBER SCHULTZ: Are you tracking -- are you close enough to what the staff is doing so that you are tracking, able to track the differences that we have heard about today that are being identified by the staff's more contemporary models?

MR. SCOTT: Yes.

MEMBER SCHULTZ: And then what do you do with that? Do you immediately capture those within your program?

MR. SCOTT: They go on our list to be evaluated, yes.

MEMBER SCHULTZ: Okay.

MR. SCOTT: We have an update underway now. And some of the issues that have been identified, we have already made some changes but we have got others we have to go through the process of evaluating. And some of them were very timely because we have an update going on now.

It is always going to be when you have applications, you know, you are always going to have to have a certain reference frame that you do that in to where you don't get months after the update you haven't updated the application. So, all those have to be in sync.

And we have changes that affect like during an outage, if they make a change to the plant coming out of that outage, the model has to be reflecting the changes that were made during the outage. So, all this has to be planned and executed with all that in mind.

And the more you use it, the more work you have to do. So, that is the other side of the sword there.

So, I guess recently we had an issue where we had agreed at the beginning of this project that there would be a firewall between this project and other branches of NRC. So, we feel like recently it has kind of got out of line with that because they were important issues. They were identified with a staff memorandum to the licensing branch to make these issues that they identified to make them aware of that. And they were calling into question the results of the model. So, there is concern there that we kind of got away from what we had originally agreed on there.

And again, we want those comments and we want to deal with them and we want to put them, make the changes in our model if they need to be made but we thought that was kind of out of bounds, compared to what we had originally agreed to, to keep it within research but now it has gone out into licensing. So, I am sure we will be hearing from them trying to understand. And we will be glad to communicate with them but we hope it doesn't hold anything up because now we have got to maybe go through another process to make sure we close these out with another branch of the NRC. But we do have intentions on pursuing all of this.

And again, we welcome the challenges and we will change our model if we need to but it gets back to how you handle the errors. And again, you can't shut your model off, your use of it because you found some errors. You have got to go through your process.

And we think also we know this is a very challenging project with the budget that you have got to do this. And we are little concerned that you may be making some simplifications to make sure that you can meet your schedule and budget. And maybe with internal events, so far it hasn't been that big of an issue but when you start doing fire PRA and with seismic PRA you have got to make sure that you have got the realistic scenarios, particularly for seismic that you are using the proper seismic hazard.

When we started doing the seismic PRA for Vogtle 1 and 2 we had a moving target there with the current hazard and particularly for Vogtle 3 and 4 we wanted to make sure that we are using the same hazard because it is the same site. So let's not have different hazards for these. So, I mean that may be a challenge for you as well in this to make sure the hazard you are using is the one that is the correct one to use.

And I guess some more positive aspects to kind of get off the negative there, and we feel we have had really good communication. We have enjoyed discussing what the issues were and getting the information. We really enjoyed working with INL. They came to our office for a couple of days. And they are putting together the all hazards SPAR model using this information as well. So, we looked at that as being a really valuable tool for us to use in the future as another source for listing sites. And as you know, this Level 3 model will be similar but this will be something we can use easily now because they have rolled it out and they took our information from our seismic so far and they have put some of the seismic scenarios in there. So, we think this will be just another tool in the tool box.

And as part of that, we have also improved our ability to use SAPHIRE, which is good for some of our less experienced people. They have now gotten some experience with SAPHIRE. So, I think that has been real positive for this project also.

And in the process of retrieving all this information that has been requested, we have uncovered a lot of areas that we think we can improve in management of our documentation and improve our infrastructure for retrieving information. And that has been a positive for us also to go try to find a lot of information that you have asked for has helped us. So, it has been a lot of work.

MEMBER STETKAR: And you are getting old, right?

(Laughter.)

MR. SCOTT: This was fun, I guess, to kind of go back an revisit some of the foundation of that existing Vogtle model.

And I guess on the challenge side, getting the information was a little more burdensome than we had originally expected it to be. We have limited resources like everyone else. And I guess the full process that we use to protect the proprietary information was difficult and time consuming but I think we have been able to execute it. But I know we have probably held you up a couple of times at least.

And I think also we didn't really -- we expected probably to have more visits from you to get information. I thought in some ways that might have been easier if it could have been set up that way for you to come to our office for a day or so and get a lot of information at one time because it is hard to communicate over the phone with emails.

And a couple of walkdowns I think helped a lot but I wish we could have maybe had more visits to our office where we have the information. That was a little bit of a challenge.

So, I think going forward, if it is going to be required and this is what everyone in the industry is going to be anticipating and they are going to have to do a Level 3 model at some point, if there is incentives from developing these models, this thing is cost-effective and would be a safety improvement, but I think part of it will be what can we use this model for and will it be used for us. Or can we use it? Or will it be used to make us defend ourselves? Just how will this be used in the future?

And I think again we are going to be combining lots of different hazards together and need to make sure that everything I have seen today leads me to believe this is going to happen. But we have got to make sure if we are going to just come up with a number somewhere that it really reflects the importances of each hazard and it is not just one hazard that dominates the number. So, they have to be ready to b added together. You have got to have distributed means that are realistic that you can combine together, that you don't have one dominate and mask potential safety improvements or give you the wrong risk profile. And to get the best risk insights, you probably still need to look at relative risk from each hazard group so you can manage those.

And there is a lot of value in identifying what is driving a specific hazard, particularly for risk-managed actions if you get into some condition and want to know what your availability is to a fire or to some other hazard group to know how to compensate for that. You need to be able to break that out separately.

And we have gone through this in the PRW Owners Group trying to figure out how to add things together. And this Whole-Site Risk Workshop they had the CANDU Owners Group last month. They had a lot of thoughts on that. They have been doing this. They have units that are similar all side-by-side. Is it safer with one unit or eight units? So, there is some information, some guidance I think that they are going to provide to the PRW Owners Group that will give us their thoughts on how to combine it.

And an interesting comment that I never really thought this way that I heard from them was in an internal events model, you are adding different groups of initiators. So, it is really not different. You are adding LOCAs and losses of offsite power and transients altogether. Those are different groups of initiating events. We just need to make sure that we manage it properly by adding fire and seismic and high winds and do a good job of making sure we don't double count.

So, I guess that is about all I had here. And again, thanks for the opportunity to come and speak to you. And again, we are still excited about this project. We have got some things we need to get ironed out. But I think going forward there is going to be a lot of benefit to us and the industry.

MEMBER STETKAR: Thanks a lot. Anything for Owen?

I am really happy that you came to the meeting here and gave us some of the good side, some of the bad side.

And I know we, as a subcommittee and the ACRS as a full committee, although I really can't speak for the ACRS in a subcommittee meeting, we really appreciate the effort that Southern Company and Plant Vogtle has made to participate in this study because it is so important to provide that plant-specific risk perspective, rather than averaging for the Westinghouse Plant generic X. So, I would like to at least express my own thanks for the efforts that Southern Nuclear, the resources, and Plant Vogtle, in particular, have made to participate in this study and especially weathering the thorns that you mentioned.

MR. SCOTT: Well, we are fully committed and we are not going to let a couple of things get us off the path. I mean, we have got our site Vice President saw the value in this, Tom Tynan, he recognized this would be a good opportunity to continue our leadership role in the industry in risk-informed and risk assessment. So, we have enjoyed working with the Level 3 team. And there are some things I probably forgot to mention, some of the things we are doing with risk from executing our outages with our defense in-depth, shutdown risk assessment tool all the way to looking at new ways we can use risk. You know, I had someone call me actually about cyber security. You know, there is just a whole lot of areas that we can expand this and we are going to do that through the owners group and by dealing directly with our regulators and our shareholders, stakeholders.

MEMBER STETKAR: That's great. That is very good. Thank you.

MEMBER SCHULTZ: Owen, I really also appreciate the candid presentation that you have made here, as well as the insightful nature of your recommendations and conclusions. The lessons learned are very well presented.

I have one question and it goes because I appreciate that you are representing Southern Nuclear as well as the Owners Group here and that committee. So, then next comes the peer reviews of which the NRC is looking forward to. And I know it is not their first time but this might be a little bit different in terms because the peer reviews will be reviewing many different aspects of the work that is being done here. And it will be a different peer review team.

But where do you -- I presume you are not going to be sitting on the peer review side of the table. Maybe you are a third edge of the table in that process.

MR. SCOTT: Well, personally we will execute this like we have the other Reg Guide 1.200 peer reviews. We will have a peer review team lead and that will typically be members of the PRA community at large. It will be utility members who volunteer. I have had a number of people who are anxious to sit with us. We have got some vendors, you know our individuals that work for Westinghouse and that work for AREVA, they are all interested in this as well.

MEMBER SCHULTZ: Yes, in that respect, it is very unique.

MR. SCOTT: Yes.

MEMBER SCHULTZ: It is very unique. And you will -- the reason I ask about where you are going to be sitting at the table is there obviously will be some findings associated with the peer review, even though they are reviewing the NRC work here, it also reflects input from you, if not some aspect of the modeling that you have done in the past and some of the models have started with yours. So, you are going to need to integrate the lessons learned and associated with this, as you would with the peer review work to be done of your own PRA.

MR. SCOTT: We are just going to be the one sitting on the hot seat there during the peer review. They are doing the consensus, you know.

MEMBER SCHULTZ: Understood. But the presentation I feel, as John said, we can't reflect the reviews of the entire committee but on behalf of the subcommittee here, I think you provided us with some very good information about the nature of the project and the things that need to be examined, not only for the project but the going forward comments are very useful as well. But thank you very much.

MEMBER STETKAR: Thanks again. Alan, I think you have got ten minutes to tell us where you are headed.

MR. KURITZKY: Okay, just a few minutes here just to kind of go over our path forward for the project from this point forward.

All right, we have talked about this from the very beginning of the project that we thought was a very aggressive schedule and that we would be hard-pressed to accomplish all of the things within our scope within the time frame that was initially set out. And we are not very surprised by the fact that our fears have come to fruition.

The schedule you are seeing right now is our best estimate as of early this month. It reflects delays that have occurred up to this point. I think in previous meetings you probably have heard some of those reasons and we encapsulated them this morning. Staff availability, particularly the key staff, has been a major driver in our schedule slippage. Also funding issues have caused some hiccups in getting money to contractors at a steady rate. Funding is withheld, then it comes back again. By that time we have already lost X number of months. So, that has been another headache we have had to deal with.

And as I have mentioned and Owen has mentioned from the Southern Nuclear side, the information requests that we have been inundating Southern Nuclear with have been a lot more than we had anticipated, way more than they had anticipated. So, while they have provided us literally gigabytes of information and gigabyte after gigabyte of information, there are many more gigabytes that we would still like to have. And some cases you have heard today that we were just moving forward with the information we have, anything else comes later, we will try our best to incorporate if it is timely.

Other things we are still waiting for, they are a little more critical. So that has also had some impact on the schedule as well.

Just to kind of go over where we stand right now, if you look at this chart and I know it is a little bit small. You may have to look at your handouts but the reactor at-power internal event flood model, which is the first section up there, all three levels, Level 1, Level 2, Level 3, we all hope to have that work completed by the end of this calendar year.

When it gets to the filling in the internal fire and the seismic and other external hazards, we are hoping to have the Level 1 work done by the end of this year. The Level 2 and 3 work will show up at different points next year, hopefully wrapping up in the summer.

Again, as I mentioned earlier today, the fire is what is really going to drive that schedule. We hope to have the seismic and high wind stuff done earlier on and the fire one will be the one that holds up the completion there.

The low-power shutdown, that is really, again, if you look at the chart as a whole, that is really the long pole in the tent right now. That is the one that is probably going to drive our overall schedule slippage from this point forward. Again, the big issue there is staff availability. The lead for that work is heavily committed to other type of work. So, we haven't been able to move forward with that as fast as we would like. We hope to get the bulk of that work done -- we are going to be storing that work fairly heavily this year, very shortly, and hopefully to wrap up most of that Level 1, 2, and 3 over the course of 2015. But accordingly, a lot of the later things, the integration work and the risk insights and interpretation work will have to, while it can start before that is done, it will not wrap up until that work -- it needs the low-power shutdown input before it can totally wrap up. So, that is kind of pushing out the overall schedule.

Spent fuel pool and dry cask storage are both actually moving along fairly well. I think those are actually fairly close to the initial schedule. We hope that continues. I think the dry cask storage, we are fairly confident that that is on a good path. The spent fuel pool, it is a little bit slower going. Again, we have the team lead availability issue that is kind of dragging on that one. But we are still fairly optimistic at this point that we will get it done in early 2015.

MEMBER BLEY: Did you find any unique things associated with the spent fuel pool that are going to lead new analysis requirements?

Have you done the walkdown on it?

MR. KURITZKY: We have done some walkdowns on the spent fuel pool back in March of last year. We actually walked down the spent fuel pool. We had an opportunity to go inside containment. We did a Level 2 PRA walkdown, some spent fuel pool walkdown, as well as some seismic walkdowns all in that time frame.

I see Don creeping closer to the microphone. So, I will let him give you the real deal.

MR. HELTON: I guess if you could first repeat it, just to make sure that I intentionally answer the wrong question.

(Laughter.)

MEMBER BLEY: I just asked if in looking through the information you have in your visits, have you found anything unique with respect to this spent fuel pool that might lead to difficulties in modeling or lead to substantial differences from the kind of things that we saw in the spent fuel study that was recently completed.

MR. HELTON: Only, I guess the two things that come to mind that make you think a little harder about the way you are going to model in PRA, it is not that they are necessarily unique to this plant but they do sort of make you have to plan more.

One is the fact that the pools are routinely hydraulically connected. And so whereas it would be nice, like the spent fuel pool study to be able to isolate down to a single pool and focus on that as one radiological source, here you can't really do that.

MEMBER BLEY: Okay.

MR. HELTON: And in the end, we decided it was just impossible to treat them separately and then combine them. We had to treat them as one.

And then related to that is just the fact that the pools, the two pools, even though the reactors at Vogtle are nearly identical, the two pools are actually, in terms of the racks that are in them and the fuel loading that is in them, they are somewhat different. And even the third onto that is the fact that they even move fuel between the two pools.

So, there is just a lot of interconnectedness between the two pools and the fact that there are some design differences between the two pools. Like I said, it is not that it is necessarily unique to Vogtle. It is not an instrumental problem but it is something that you then have to scratch your head and figure out how you are going to treat it.

MEMBER BLEY: Anything about the design of the liner or the structure, or the piping systems connected to the pool that is different from things you have done before?

MR. HELTON: At this point, I am not aware of any.

MEMBER BLEY: Okay, thanks.

MR. KURITZKY: Thank you, Don.

So to jump to the bottom here, what is the overall impact of all these various schedule impacts? You can see that now the target data originally was for end of March 2016 for completing the entire study documentation insights for wrapping up the whole project. Now, we are looking at summer of 2017. And I certainly wouldn't want to put in stone that that is when the project is going to end because if doing the more routine or well-known parts of the project have resulted in this amount of slippage, there is no reason that I feel that when we get to the more cutting edge areas of the study that we are going to somehow be even more successful. So, that is our current target end date, pending further developments.

MEMBER REMPE: On the schedule, I don't see the peer reviews, unless it is under Item 24. Are you trying to do them all at the end or are they incorporated into each item up above?

MR. KURITZKY: They are not going to be done at the end. We are specifically going to do them as we go along. And in actually the next slide or the slide after that, I think, talks about the initial schedule for them. In one of the previous slides today actually discussed the schedule, too.

But the dates that you see on this chart are really for completion of the self-assessment. That is kind of like the target we have put down. Our work is done on that area of the study and then it becomes available for peer review. So, the peer reviews are not reflected on those individual lines but they will be occurring roughly, let's say, four months or so after the diamonds that you see on the chart.

MEMBER REMPE: Okay.

MR. KURITZKY: Okay, so some of the key milestones for the coming year, this kind of recaps what we discussed individually this morning but just in a single slide here. We have three industry-led peer reviews, going to Dr. Rempe's question, that are going to hopefully occur this year. The reactor Level 1, internal event, internal flood, we hope to get done in the summer of this year. The reactor Level 1 -- excuse me, the reactor internal event in flood Level 2 we hope to have done in the September - October time frame. And the high wind, Level 1 high wind PRA we hope to have done sometime probably in the November time frame.

So, those three things we hope to accomplish this year.

In terms of the other model pieces, the seismic PRA, Level 1 seismic PRA for the reactor we hope to have again completed in the summertime. We hope to have the Level 3 work done, the consequence analysis work done for the internal event and internal flood reactor PRA, done by the end of the calendar year.

And also the dry cask storage Level 1, Level 2, being the source term frequencies and characteristics completed by the end of the calendar year also. Both of those would then have their peer reviews hopefully done in the first few months of 2015.

The dry cask one really depends on whether we decide to wait for the Level 3 results before peer reviewing it or whether we decide to peer review the Level 1 and 2 part independent of the Level 3 part.

Some of the key meetings that are coming up and briefings that are coming up in this upcoming calendar year, we are planning to brief the ACRS full committee sometime -- the tentative date, I think, is in June of this year. We have not yet briefed the full committee at all on this project. So that will be the first time that we go in front of the full committee. And I think barring some change, I think early June is when the meeting will occur.

We also have our annual briefing to the Commissioner TAs in late September. That is something that is dictated by the SRM for the project. And we are also planning to hold a public meeting probably sometime in the fall of this year. We want to give the public an overview of where the project stands, the status, and also if we have any specific questions or issues that we want public feedback on, we can bring them up at that point and put them out there for comment.

And so I think this is the last slide and this goes to what Dr. Stetkar mentioned before. He wanted to talk a little bit about the future interactions. The full committee meeting, of course, we are hoping to have in June. Now the question comes to what should be the schedule for additional interactions with the subcommittee. And there is a couple of ways, there is a couple of formats, as was mentioned earlier. There is the traditional presentation of when things are done that we provide documents ahead of time to the subcommittee, they review them, and then we have a presentation on it. The advantage of that is the subcommittee has actually something to look at, as well as document. They have time to cogitate on it and we have a little more constructive discussion. The negative is that feedback comes after the work is essentially done. So, it is difficult to integrate it into what we have been doing.

The other scheme is similar to what is going to hopefully occur this afternoon in the closed session, where we give some fairly rare, unpolished, incomplete information to the subcommittee but that allows them to get into the work right there as it is happening. And then feedback, at that point, is much more easier to incorporate into the modeling.

So, as far as what is going to happen this coming year, just recapping what we have already discussed, but if were to meet late in the summer, we would likely have the initial results of the high wind PRA. We would hopefully have the peer review report for the Level 1 internal medicine and floods PRA. And we would possibly have the results of a Level 1 seismic PRA by then.

If that meeting occurs in early fall, there is a higher probability that those three things will in fact be done. Again, it is kind of guessing whether or not -- there is always, as we know with things like this, there is always slippage and whether or not something is ready 30 days before we schedule the meeting is an uncertainty.

Late fall, we would hope to have the peer review report completed for the Level 2 for internal events, as well as the initial results of our consequence analysis or Level 3 for the internal events.

So, that is some ideas of when things will be coming through. And then really the subcommittee can kind of weigh in on whether they want to wait for some of these formal things to come through or whether you want to have more of the informal in-progress type of meetings.

MEMBER STETKAR: And what I would like to do is postpone some of this discussion until after we have had the exchange in closed session this afternoon, without trying to make any judgments on which scheme, if you will, is preferable.

MR. KURITZKY: Or a combination of the both.

MEMBER STETKAR: Or a combination of the both, yes. But I think we should revisit this topic at the end of the afternoon, after we have had a chance to see how productive the exchange is in the closed session.

MR. KURITZKY: Okay.

MEMBER STETKAR: With that, I think that is your last slide. So I have a couple of things that I need to do here.

The first thing is are there any members of the public or anyone in the room here who would like to make any comments? What we will do in the interim, we are going to get the bridge line open.

I don't know who or how many people are out there on the bridge line. So, I will open up the bridge line for any comments from the public. That will take a couple of minutes.

It is open. We usually have this terrible noise and chatter. Just to confirm, is there anyone out on the bridge line, just anyone who is out there, just make some sort of utterance so we know we are actually open.

Yes, that is the problem. If there is silence, you don't know which of the two options. If there is anyone on the bridge line who would like to make a public comment, please identify yourself and do so.

Okay, hearing nothing, I am assuming that that is not going to happen.

While we are still in an open session, what I would like to do is, as we typically do, go around the table and ask each of the members if you have any closing comments or questions or statements you would like to make. And to make sure they don't feel left out, I will start with the folks who are out there on the ends of the bridge line.

So, Dr. Corradini, do you have anything that you would like to say? Dr. Corradini is apparently gone.

Mr. Rempe, do you have anything to say?

MEMBER REMPE: I have some questions for the closed session.

MEMBER STETKAR: Okay, that's fine.

MEMBER REMPE: They are a little more detailed. But again, I am curious a little bit about some of the models that seem to be used in this version of MELCOR. And although Don has clearly said he is happy enough with the input data that have been selected, actually some of the parameters that they have declared are uncertain are things I am surprised you couldn't get from the FSAR.

And so I am interested in hearing the answers to those questions, just because it is a little puzzling to me at this point.

MEMBER STETKAR: Okay, thank you. Ron?

MEMBER BALLINGER: Yes, well, I am not a PRA person so that is a very steep learning curve. But what struck me was the kind of level of detail, which I am thinking is going to be continuing this afternoon.

And with respect to the Southern Company presentation, I kind of look at that as a different perspective but also a kind of a rudder on some of the work. So, I think that was a very good thing to have these guys here.

MEMBER STETKAR: Thank you. Steve?

MEMBER SCHULTZ: Alan, I made some comments which already summarized kind of my closing remarks.

I did have one other thought associated with the point that Dennis made earlier with regard to the opportunity for using this work for staff training. And that opportunity is the peer review process that is going to be upcoming.

The benefit of having any staff that has worked on the PRA exposed to that peer review process, physically being at the meeting or hearing the results of the peer review as it is presented, is an invaluable learning and training experience. And so I wouldn't -- I would be sure that you don't limit that activity to senior level people who know everything about all the work that is being done but allow the staff that is relatively new to the area to be exposed to that. Because it is really going to be a very important learning opportunity to have people that have been working in this area hear what others have to say about it and listen intently to their comments.

And then as you know, that staff is going to have to respond to those comments and so, if they hear it first hand, it is extremely valuable and can accelerate the process of responding to the comments of the peer review teams.

MR. KURITZKY: Thank you for the feedback. Again, I have never been to one of those peer reviews. I am not sure of the logistics of it. Clearly, those people would not be serving on the panel but --

MEMBER SCHULTZ: Right, no.

MR. KURITZKY: -- except that they can sit in and listen to the deliberations. Yes, I agree, that would be useful. I will have to see how the logistics play out for that.

MEMBER SCHULTZ: It is well worth it to break them free from their day to day work activities to participate, to the extent that they can. That is, that they can see the interaction one on one.

MR. KURITZKY: Right. Thank you.

MEMBER SCHULTZ: Or one on many, I guess it would be.

MEMBER STETKAR: Dennis?

MEMBER BLEY: I guess I will follow that up. That is a good idea and I have seen some of them and they can be very valuable. Even if you have to go to GoToMeeting or something to let people sit in, I think it is really worth it.

At our last meeting, quite an informal meeting, we asked to get interim work product so we could look at it before this meeting. And you did it in spades. We got more than I could possibly get all through. But it was really helpful and I got a lot more out of today's meeting than I would have, if I hadn't had the opportunity to rummage through that material as much as I did.

I would say you did a great job today in helping me understand where you are and what you are doing. And already you alleviated some of the concerns that I was developing, but not all, which we will see in the closed session. But yes, I think it was a very valuable meeting and we will talk more later. But I think, my own feeling is, if we can have further informal discussions along the way, it will be certainly helpful for us and probably for you as well.

MEMBER STETKAR: Well again, from my perspective, I think my colleagues have said pretty much everything. I will thank the staff. I know it takes a lot of effort to pull material together for these meetings. And again, thanks a lot for all the material you did send us up-front because it was very, very useful.

And I think you covered all the technical issues very well today. So, I really appreciate the time and the information we received.

And with that, what I would like to do is we will take a break --

MEMBER BLEY: Mr. Chairman?

MEMBER STETKAR: Yes, sir?

MEMBER BLEY: You asked folks on the line if they had comments. I don't know if you asked people in the room.

MEMBER STETKAR: I actually did.

MEMBER BLEY: Did you? Okay, it slipped right past me.

MEMBER STETKAR: But thank you for the reminder. I appreciate that.

MEMBER BLEY: You are very welcome.

MEMBER STETKAR: I can ask again. No, I'm just kidding. It would be nice if somebody just said something to just placate you.

What I would like to do is we will take a break. For the purpose of anyone who may be out there, members of the public on the bridge line, we will reconvene in closed session. So, we will have the bridge line closed for the public for the rest of the afternoon.

Mike, and Joy, you are on a separate line. So, we will reconvene in closed session at 3:30.

(Whereupon, at 3:30 p.m., the foregoing matter went off the record and resumed in closed session.)

Full-Scope Site Level 3 PRA

Advisory Committee on Reactor Safeguards
Reliability and PRA Subcommittee

February 19, 2014
(Open Session)

Outline

- Open Session
  - Project status overview
  - Site operating phases
  - Level 2 PRA status
  - Level 3 PRA status
  - SNC perspectives
  - Path forward
- Closed Session
  - Technical discussions

Project Status Overview

February 19, 2014

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Scope Elements

- Reactor, at-power, Level 1, internal events and floods
- Reactor, at-power, Level 1, internal fires
- Reactor, at-power, Level 1, seismic events
- Reactor, at-power, Level 1, high winds, external flooding, and other hazards
- Reactor, low power and shutdown, Level 1, all hazards
- Reactor, at-power, Level 2, internal events and floods
- Reactor, at-power, Level 3, internal events and floods
- Spent fuel pool
- Dry cask storage
- Integrated site risk
- ASME/ANS PRA standard-based peer reviews

Reactor, At-Power, Level 1, Internal Events and Floods (1 of 2)

Current Status

- Converted licensee's PRA CAFTA model for internal events and floods (a single fault tree) into a SAPHIRE-based model (linked event tree-fault tree)
- Modified some portions of converted model:
  - Substituted SPAR methods for modeling loss of offsite power, support system initiating events, and ATWS
  - Revised some success criteria based on staff thermal-hydraulic analysis
  - Recalculated several human error probabilities based on staff review of licensee's human reliability analysis (HRA)
- Performed Bayesian update of standard SPAR model template data using Vogtle-specific data
- Completed internal flooding model – based on licensee's PRA model, with some modifications
  - Reevaluated IE frequencies with recent generic and plant-specific data
  - Reassessed screening methods resulting in additional scenarios being screened in
  - Performed plant visit and walk-down to confirm model assumptions

Reactor, At-Power, Level 1, Internal Events and Floods (2 of 2)

Major Challenges

- ISLOCA common cause valve leakage rates
  - Additional work needed to refine frequency estimates of large leak rates

Planned Activities for CY 2014

- Revise documentation
- Prepare for, and support, industry-led peer review
- Fine-tune the model to support additional scope elements (e.g., fire, seismic, low-power and shutdown, Level-2, dual-unit)

Reactor, At-Power, Level 1, Internal Fires (1 of 2)

Current Status

- Internal fire PRA (FPRA) model on hold pending availability of resources
- FPRA model will be created using available information from licensee's FPRA
- RES commissioned a review of licensee's FPRA by subject matter experts (SNL)
  - Draft report received by RES and currently being reviewed by RES/DRA/FRB

Reactor, At-Power, Level 1, Internal Fires (2 of 2)

Major Challenges

- Mapping of licensee’s FPRA model to Level 3 PRA project FPRA model
- Review and acceptance of key FPRA inputs (e.g., fire scenario parameters and fire analysis)

Planned Activities for CY 2014

- Construct and document FPRA model in second half of CY 2014 (work may start in first half of year if resources are available)

Reactor, At-Power, Level 1, Seismic Events (1 of 2)

Current Status

- Started creating seismic PRA (SPRA) model
- In creating initial SPRA model, only already available information will be used, including most recent hazard curves and expected to include preliminary plant-specific fragilities provided by the licensee
- Plant walkdown performed last year; report currently being finalized

Reactor, At-Power, Level 1, Seismic Events (2 of 2)

Major Challenges

- Review and acceptance of key SPRA inputs (e.g., plant-specific SSC fragilities)
- Staff availability

Planned Activities for CY 2014

- Construct and document initial SPRA model in first half of CY 2014
- Internally review SPRA model and perform self-assessment

Reactor, At-Power, Level 1, High Winds, External Flooding, and Other Hazards (1 of 2)

Current Status

- Developed four preliminary "high wind" event trees, one for high winds and three for tornados, and added them to the overall Level 1 PRA model – documentation is ongoing
- Included external flooding in "other hazards" evaluation
- Completed and documented "other hazards" evaluation
  - Preliminarily screened out all "other hazards," for example:
    - External flooding due to dam failure screened out due to elevation of the site relative to the Savannah River
    - External flooding due to local intense precipitation screened out due to sufficient available physical margin for both the design basis probable maximum precipitation (PMP) event and a beyond design basis PMP
    - Aircraft hazards screened out because the design basis meets the criteria in the 1975 SRP

Reactor, At-Power, Level 1, High Winds, External Flooding, and Other Hazards (2 of 2)

Major Challenges

- None currently identified

Planned Activities for CY 2014

- Finalize high wind models
- Complete documentation and perform internal reviews (including self-assessment)
- Prepare for, and support, industry-led peer review

Reactor, Low Power and Shutdown, Level 1, All Hazards (1 of 2)

Current Status

- Reviewed Vogtle reports of past refueling outages
- Defined low power and shutdown (LPSD) plant operating states for a representative refueling outage
- Performed initial identification of events to model and reviewed available initiating event frequency references
- Reviewed Vogtle procedures relevant to LPSD operations

Reactor, Low Power and Shutdown, Level 1, All Hazards (2 of 2)

Major Challenges

- Staff availability
- Applying practical scope limitations to the number of LPSD evolutions, plant operating states, and accident scenarios
- Analyzing internal fire and external hazards for unique LPSD operating conditions and plant configurations
- Applying HRA tools and methods to LPSD operations within existing resources

Planned Activities for CY 2014

- Refine plant operating states and accident scenarios to be modeled
- Develop model event trees and fault trees
- Determine appropriate initiating event frequencies
- Document model assumptions and bases

Reactor, At-Power, Level 2, Internal Events and Floods (1 of 2)

Current Status

- Incorporated containment systems and plant damage state logic into December 2013 stabilized Level 1 PRA model/code
- Quantified plant damage states and defined representative scenarios
- Developed preliminary containment event tree and release category framework
- Performing MELCOR analysis for representative scenarios to provide sequence timing, accident management diagnosis parameters, within-plant environmental conditions, fission product releases, etc.
- Performing supporting analyses (e.g., human reliability analysis, structural performance, equipment survivability)

Reactor, At-Power, Level 2, Internal Events and Floods (2 of 2)

Major Challenges

- Obtaining specific detailed plant characterization items (e.g., water intrusion into reactor cavity; auxiliary building performance)
- Computational challenges associated with Level 2 modeling, including integration with Level 1 model
- Human reliability analysis for onsite accident management; treatment of offsite resources

Planned Activities for CY 2014

- Completion of the internal event and flood Level 2 PRA
- Handoff of release categories and source terms to Level 3 PRA team
- Complete documentation and perform internal review (including self-assessment)
- Prepare for, and support, industry-led peer review

Reactor, At-Power, Level 3, Internal Events and Floods (1 of 2)

Current Status

- Completed review of prior Level 3 offsite consequence analyses
- Obtained all major input data needed for development of MACCS2 input decks
- Documenting technical basis for MACCS2 input parameters and datasets
- Performing MACCS2 development work in parallel with initial analyses

Reactor, At-Power, Level 3, Internal Events and Floods (2 of 2)

Major Challenges

- Definition of output measures (risk metrics)

Planned Activities for CY 2014

- Complete consequence analysis for reactor, at-power, internal events and floods, and identify and document parameter changes necessary to extend to other scope pieces
- Complete initial documentation of model and results

Spent Fuel Pool PRA (1 of 2)

Current Status

- Performed site characterization and limited walkdowns
  - Both SFPs are included in a single model, due to operational considerations
- Developed site operating phases to encompass major SFP configurations
- Identified hazards
- Performed numerous pre-fuel damage sequence timing calculations to prioritize probabilistic model build-out
- Developing initial Level 1 accident sequences

Spent Fuel Pool PRA (2 of 2)

Major Challenges

- Staff availability
- Scope (i.e., the multitude of configuration, decay heat, and hazard combinations)
- Detailed plant characterization issues (e.g., initial water temperature)

Planned Activities for CY 2014

- Structural performance characterization
- Probabilistic modeling for highest priority event/hazard combinations
- Development of detailed MELCOR model
- Development of human reliability analysis approach

Dry Cask Storage PRA (1 of 2)

Current Status

- Observed dry cask storage (DCS) loading operations
- Identified initiating events that could affect Vogtle DCS operations
- Met with Pacific National Northwest Laboratory to kickoff structural performance analysis of multipurpose canister, transfer cask, storage cask, and fuel assemblies during drop and tip-over scenarios
- Received most information related to Vogtle DCS activities

Dry Cask Storage PRA (2 of 2)

Major Challenges

- Development of peer review criteria

Planned Activities for CY 2014

- Complete DCS Level 1/2 PRA in second half of CY 2014
  - Initiating event analysis and screening
  - Data analysis and human reliability analysis
  - Multipurpose canister, transfer cask, storage cask, and fuel performance structural analysis
  - Estimate and quantify frequency of release and release fractions for the scenarios identified
- Prepare for, and support, industry-led peer review

Integrated Site Risk (1 of 2)

Current Status

- Developed Technical Analysis Approach Plan section
- Conducted SAPHIRE quantification experiments
- Identifying dependencies within and across risk sources
- Reviewing LERs to identify multi-unit trip events
- Addressing cross-unit CCF modeling and data
- Awaiting completion of single-source PRA models and their results

Integrated Site Risk (2 of 2)

Major Challenges

- Staff availability
- Applying practical scope and size limitations to the integrated risk model

Planned Activities for CY 2014

- Develop and quantify simplified logic models (anticipated order):
  - Reactor, at-power, Level 1, internal events and floods
  - Reactor, at-power, Level 1, high winds, external flooding, and other hazards
  - Reactor, at-power, Level 1, seismic events

ASME/ANS PRA Standard-Based Peer Reviews (1 of 2)

Current Status

- Initiated dialogue with PWR Owner's Group (PWROG)
- PWROG indicated willingness to support peer reviews of Level 3 PRA project
- Working with PWROG to determine scope and schedule for peer reviews to be performed in 2014

ASME/ANS PRA Standard-Based Peer Reviews (2 of 2)

Major Challenges

- Peer review of scope items with no relevant PRA standard
- Total number of peer reviews required

Planned Activities for CY 2014

- Finalize scope of peer reviews
  - Reactor PRA Level 1 for internal events and internal flood at-power conditions
  - Reactor PRA Level 2 for internal events and internal flood at-power conditions
  - Reactor PRA Level 1 for external high winds and other external hazards
  - Develop peer review criteria for spent fuel pool and dry cask storage
- Finalize schedule of industry-led peer reviews for CY 2014
- Prepare for, and support, industry-led peer reviews

Joint Plant Operating States

February 19, 2014

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Purpose and Assumptions

Purpose of the Integrated Site Risk Analysis is to estimate the total site risk and to identify the important contributors to total site risk.

- Create multi-source accident sequences by combining accident sequences from the single-source PRA models (reactor cores, spent fuel pool, and dry cask storage)
- To accomplish the above, a Joint Plant Operating State (POS) Matrix is being developed that will take into consideration all radiological sources from the site (see next slide)

Joint POS Matrix Assumptions:

- Consideration of site operating configuration by superimposing operating configurations defined within each single-source PRA model
- Form site radiological release states (RRS) by combining the RRS obtained from each single source PRA model
- Adjust and account for logically impossible combinations or combinations prohibited by Technical Specifications

Key Interface Considerations (1/4)

Reactor, Spent Fuel Pools (SFP) and Dry Cask Storage (DCS) Interfaces

- Reactor/SFP – physical boundary between containment and fuel handling building
- SFP/Dry Cask Storage (DCS) – scope of analysis delineated by interface between 10 CFR Parts 50 and 72 (e.g., cask loading belongs to DCS but cask drop effects on SFP structure belong to SFP)

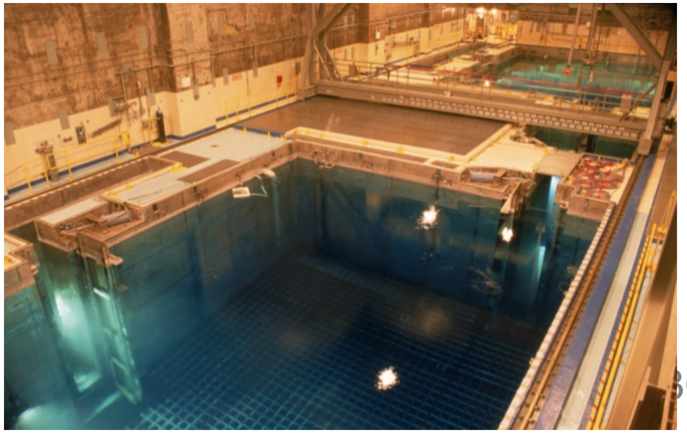
General Considerations

- Reactor at-power, reactor low-power/shutdown, spent fuel pool, and dry cask storage PRAs must be coordinated
- Have defined a representative ~ 18-month operating cycle for the site

Key Interface Considerations (2/4)

VEGP SFP Considerations

- The time since the last core offload has a significant impact on decay heat level, which in turn affects the boil-off duration and fuel behavior following uncovery.
- U1 and U2 SFPs both have high density racks, though the rack configurations are different.
  - Unit 2 SFP has higher fuel assembly capacity
- Both SFPs are contained within the Fuel Handling Building and share the same air space.
- Both SFPs are routinely hydraulically connected thru the cask pit.



Key Interface Considerations (3/4)

VEGP SFP Considerations (continued)

- SFP operating cycle phases are defined as nominal, outage entry, refueling, post-refueling and cask-loading
- Various plant activities result in changes in the number of assemblies that are in the SFP. This necessitates dividing the operating cycle so that calculations and logic modeling may be done using a single decay heat and assembly population for each phase

Key Interface Considerations (4/4)

VEGP DCS Considerations

- Approximately 6 casks would need to be loaded every 548 days to keep similar SFP fuel inventory (e.g., no expedited transfer).
- Each dry cask loading takes between 5 to 7 days from the first fuel movement (to be loaded in the cask) to the cask being placed at the Independent Spent Fuel Storage Installation.
- Dry cask loading times vary depending on the fuel decay heat and cask cooling requirements.
- The Integration Matrix assumes 40 days for DCS operations.
- DCS operating cycle phases are defined as cask loading and storage.

Individual Radiological Source POSs

- Reactor operating states
  - At-power
  - Low power and shutdown (14 separate states)
- SFP operating states
  - Nominal, outage entry, refueling, post-refueling
  - Nominal operating state includes five separate timeframes
- DCS operating states
  - Storage (nominal) or cask loading operations

Joint POS Matrix for all Radiological Sources

Index	Joint POS	Unit 1 Reactor		Unit 2 Reactor		Unit 1 SFP	Unit 2 SFP	DCS	Timeframe (days)	Fraction
1	S1AO	1	Low Power - Modes 2 and 3	0	At-Power - Mode 1	Outage entry (U1)		Storage	0-4	
2	S2AO	2	Cooldown w/ SGs - Modes 3 and 4)	0	At-Power - Mode 1	Outage entry (U1)		Storage		
3	S3AO	3	Cooldown w/ RHR - Mode 4)	0	At-Power - Mode 1	Outage entry (U1)		Storage		
4	S4AO	4	Cooldown w/ RHR - Mode 5)	0	At-Power - Mode 1	Outage entry (U1)		Storage		
5	S5AO	5	Mode 5 Vented	0	At-Power - Mode 1	Outage entry (U1)		Storage		
6	S6AO	6	Midloop (hot) - Modes 5 and 6	0	At-Power - Mode 1	Outage entry (U1)		Storage		
7	S7AO	7	Flood Up - Modes 5 and 6	0	At-Power - Mode 1	Outage entry (U1)		Storage		
8	SAR	8	Refueling - Mode 6	0	At-Power - Mode 1	Refueling (U1)		Storage	4-15	
9	S9AP	9	Draining - Mode 6	0	At-Power - Mode 1	Post-refueling (U1)		Storage	15-30	
10	S10AP	10	Midloop (cold) - Modes 5 and 6	0	At-Power - Mode 1	Post-refueling (U1)		Storage		
11	S11AP	11	Mode 5 Startup	0	At-Power - Mode 1	Post-refueling (U1)		Storage		
12	S12AP	12	Mode 4 Startup	0	At-Power - Mode 1	Post-refueling (U1)		Storage		
13	S13AP	13	Mode 3 Startup	0	At-Power - Mode 1	Post-refueling (U1)		Storage		
14	S14AP	14	Low Power / Startup	0	At-Power - Mode 1	Post-refueling (U1)		Storage		
15	AAN1	0	At-Power - Mode 1	0	At-Power - Mode 1	Nominal		Storage	30-80	
16	AAN2	0	At-Power - Mode 1	0	At-Power - Mode 1	Nominal		Storage	180-184	
17	AS1O	0	At-Power - Mode 1	1	Low Power - Modes 2 and 3	Outage entry (U2)		Storage	180-184	
18	AS2O	0	At-Power - Mode 1	2	Cooldown w/ SGs - Modes 3 and 4)	Outage entry (U2)		Storage		
19	AS3O	0	At-Power - Mode 1	3	Cooldown w/ RHR - Mode 4)	Outage entry (U2)		Storage		
20	AS4O	0	At-Power - Mode 1	4	Cooldown w/ RHR - Mode 5)	Outage entry (U2)		Storage		
21	AS5O	0	At-Power - Mode 1	5	Mode 5 Vented	Outage entry (U2)		Storage		
22	AS6O	0	At-Power - Mode 1	6	Midloop (hot) - Modes 5 and 6	Outage entry (U2)		Storage		
23	AS7O	0	At-Power - Mode 1	7	Flood Up - Modes 5 and 6	Outage entry (U2)		Storage		
24	ASR	0	At-Power - Mode 1	8	Refueling - Mode 6	Refueling (U2)		Storage	184-195	
25	AS9P	0	At-Power - Mode 1	9	Draining - Mode 6	Post-refueling (U2)		Storage	195-210	
26	AS10P	0	At-Power - Mode 1	10	Midloop (cold) - Modes 5 and 6	Post-refueling (U2)		Storage		
27	AS11P	0	At-Power - Mode 1	11	Mode 5 Startup	Post-refueling (U2)		Storage		
28	AS12P	0	At-Power - Mode 1	12	Mode 4 Startup	Post-refueling (U2)		Storage		
29	AS13P	0	At-Power - Mode 1	13	Mode 3 Startup	Post-refueling (U2)		Storage		
30	AS14P	0	At-Power - Mode 1	14	Low Power / Startup	Post-refueling (U2)		Storage		
31	AAN3	0	At-Power - Mode 1	0	At-Power - Mode 1	Nominal		Storage	210-260	
32	AAN4	0	At-Power - Mode 1	0	At-Power - Mode 1	Nominal		Storage	260-360	
33	AAC	0	At-Power - Mode 1	0	At-Power - Mode 1	Cask Loading			360-400	
34	AAN5	0	At-Power - Mode 1	0	At-Power - Mode 1	Nominal		Storage	400-548	
								Total	548	100%

Vogtle Units 1 & 2 Reactor Level 2 PRA – Methods & Status

February 19, 2014

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Level 2 PRA Presentation Overview

- Background
- Technical Elements:
  - Level 1/2 PRA Interface – Accident Sequence Grouping
  - Containment Capacity Analysis
  - Severe Accident Progression Analysis
  - Probabilistic Treatment of Event Progression
  - Radiological Source Term Analysis
  - Evaluation and Presentation of Results
  - Level 2/3 PRA Interface

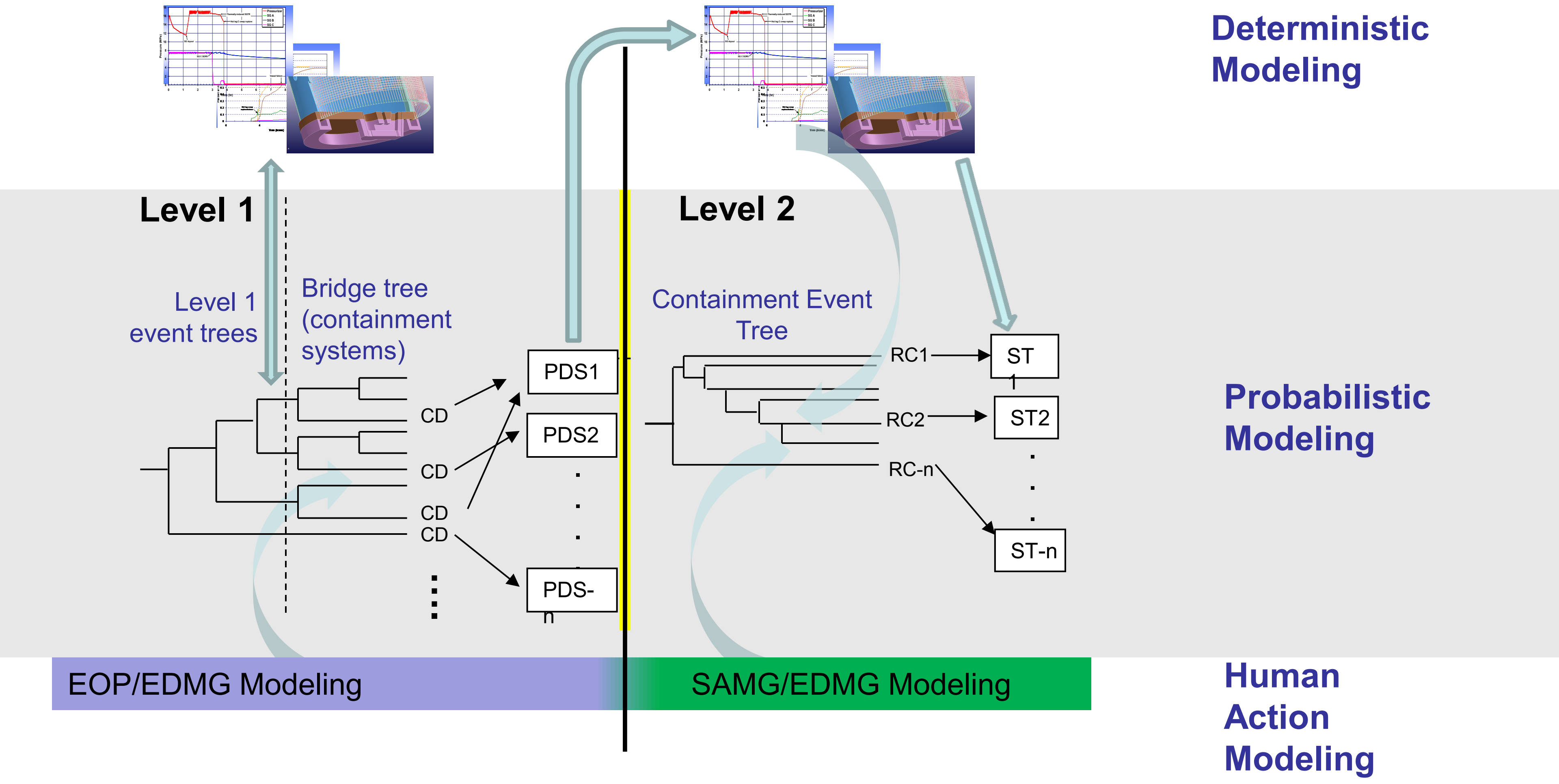
Why not use SNC's Level 2 model?

- Due to its lineage (LERF and SAMA), the model included modeling assumptions that, while found to be appropriate for those uses, limited its realism for the NRC's project (e.g., no treatment of fission product scrubbing via containment sprays)
- The full SNC Level 2 model was peer reviewed against the LE requirements of the ASME/ANS combined standard, which are by definition focused on those aspects of the model/documentation that are germane to LERF
- WCAP-16341-P (upon which the licensee's Level 2 model is based), has never been submitted to the NRC for information or for review
- Extensive work would still be needed to take ownership of the model
  - Conversion to SAPHIRE (partial migration was performed)
  - Extension to external hazards, low power & shutdown, and integrated risk
  - Level 1 internal events/floods migration took substantial work to understand all modeling assumptions and modify as necessary

Relationship between PDS bins and Level 2 sequences

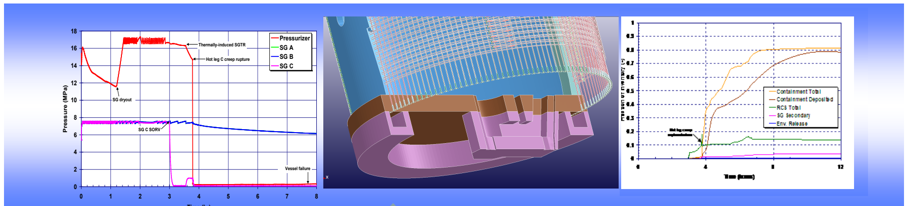
- For an integrated SAPHIRE Level 1/2 model, plant damage state (PDS) bins don’t explicitly affect the release category quantification
  - Level 1 cutsets + containment systems + CET = Level 2 cutsets
- They do provide the underlying basis for:
  - Narrative understanding of post core-damage response
  - Level 2 sequence timing issues
  - Phenomenological evaluations
  - Survivability and habitability
  - Human reliability analysis
  - Source terms
  - Starting points for some model uncertainty sensitivity analyses

Separated Level 1/2 Model - Cartoon

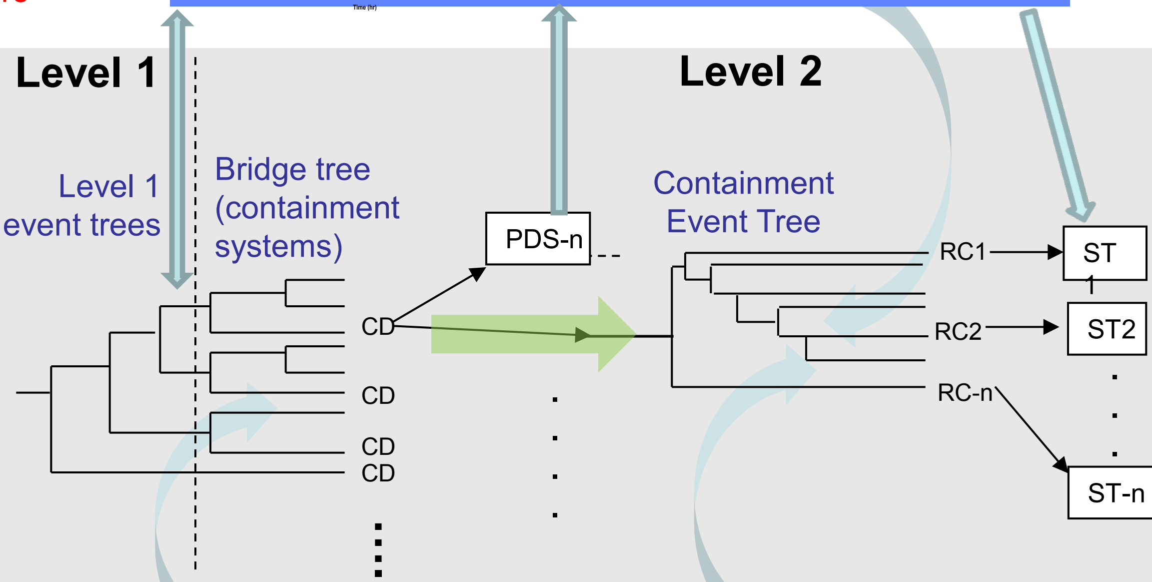


Coupled Level 1/2 Model - Cartoon

Dedicated Level 1 success criteria analysis; but Level 2 analysis also starts at time zero



Deterministic Modeling



PDS used to limit deterministic analysis, but not transfer of sequences/cutsets

Probabilistic Modeling

EOP/EDMG Modeling

SAMG/EDMG Modeling

Direct transfer of sequences/cutsets means HRA has Level 1 scenario attributes

Human Action Modeling

Level 1 / Level 2 Interface

Now, specific to the modeling we are doing for Vogtle…

- As is typical, work-arounds are sometimes needed to address ambiguities in the Level 1/2 interface, for example:
  - PDS binning logic related to RWST status (depletion)
  - Simplified hand calculation estimates for fail-to-run timings for loss of NSCW
  - Investigation of steamline flooding structural effects
- In some cases, changes were made to the Level 1 PRA to address Level 2 PRA team observations, for example:
  - Re-computation of ISLOCA frequency
  - Re-computation of manual TD-AFW operation HEP
- Other challenges in translating Level 1 cutsets to Level 2 sequences:
  - SBO battery depletion, TD-AFW operation, and RCP seal leakage variations
  - Assumptions about operator actions related to plant cooldown
  - Nuances on electrical maintenance combinations and exposure time assumptions
  - ISLOCA break size and locations, and operator actions to isolation break
  - Ambiguities regarding procedural actions not considered in the Level 1

Bridge tree (a.k.a., containment systems ET) logic

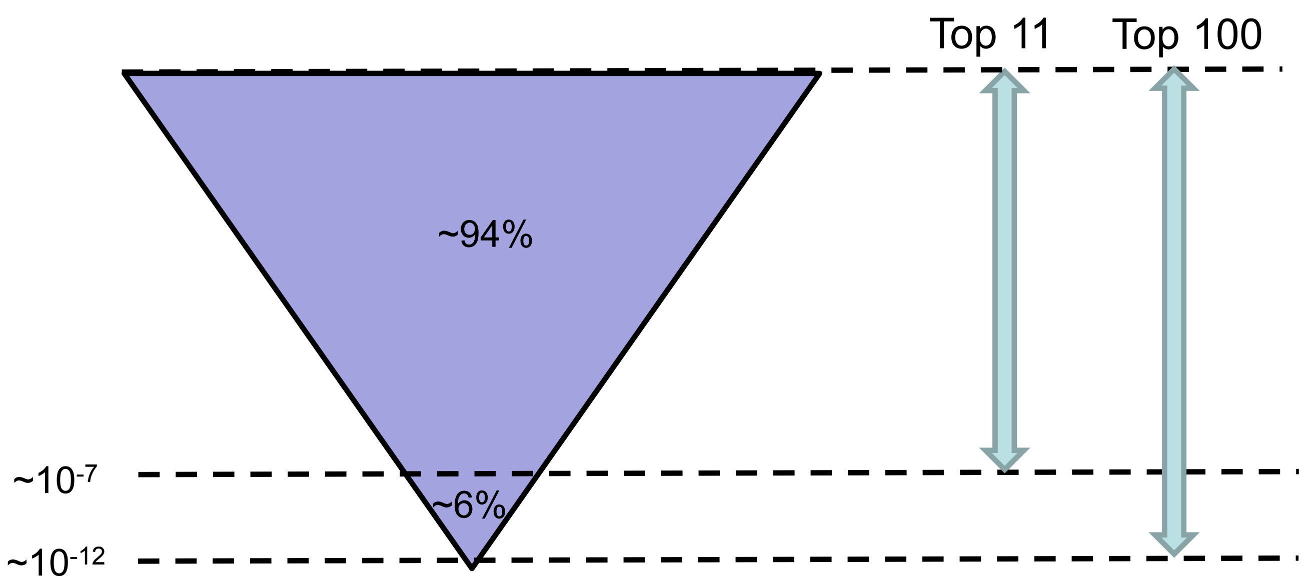
- Bridge tree:
  - Containment isolation (based primarily on SNC model)
    - Addresses active isolation failures > 2-inch equivalent based on licensee screening
    - Addresses liner tears and maintenance errors > ~1.2-inch equivalent
    - Independent investigation of transition failure size for pressure retention
  - Containment sprays (based on hybrid NRC/SNC logic model)
    - Significant development by NRC staff to address logic scope limitations
  - Containment cooling units (based primarily on SNC model)

PDS logic and quantification

- Along with bridge tree info, the binning categories are based on:
  - Accident Type
  - Steam generator cooling availability
  - Primary-side depressurization
  - RWST availability
  - ECCS availability
- Quantification based on Level 1 model "R01" (SVN version 127) with SAPHIRE 8.0.9.523, December 2013
  - Level 1 model has 122,000 Unit 1 internal events/floods CD cutsets
  - PDS frequency 17% higher than CDF due mostly to minimization within PDS rather than across all core damage cutsets
    - Non-minimal cutsets can be in different PDS than the associated minimal cutset

PDS quantification

- ~1100 logical combinations
  - ~100 PDS bins quantify to 1e-12/yr or greater
    - Top 11 comprise ~94% of PDS frequency



PDS – General observations

- PDS that contribute more than 1% of total PDS frequency have the following general traits:
  - SBO and transients
  - Primary-side depressurization not successful or not queried
  - ECCS and containment cooling/spray not available (due to electrical or NSCW failures)
  - Successful containment isolation
  - Do not include pipe ruptures (other than induced ruptures)

PDS – Other usual suspects

- All pipe ruptures combined are less than ~ 5% of total PDS frequency
  - Relatively evenly mixed between SLOCA, MLOCA, and LLOCA
  - ATWS contribution on the order of 0.1%
- SGTR and containment isolation failure each on the order of 0.1% of CDF
  - Carried forward anyway due to containment bypass

PDS at-a-glance

Ranked Order	Accident notional description	% of PDS
1	Loss of nuclear service cooling water leading to RCP seal failure and ECCS failure, without secondary-side cooldown	24%
2	Station blackout with extended manual operation of turbine-driven AFW	18%
3	Station blackout with turbine-drive AFW available until battery depletion (4 hrs)	17%
4	Dual-train electrical transient	13%
5	Loss of nuclear service cooling water leading to RCP seal failure and ECCS failure, with secondary-side cooldown	7%
6	Interfacing systems LOCA	5%
7	Station blackout with turbine-driven AFW fails-to-run	4%
8-10	Various transients	5% (combined)
11	Medium LOCA without high-pressure recirculation	<1%
…	…	…

Representative sequence selection

- Plant damage states are selected for deterministic evaluation because they:
  - Comprise a significant portion of CDF, and/or
  - Are of potentially high conditional consequence based on projection of release magnitude or timing, and/or
  - Illustrate or yield data or phenomenological insight in to particular issues of interest to the CET modeling
- Their detailed specification is based on scrutiny of the cutset contribution to the associated PDS
- On this basis, 8 basic representative sequences have been developed and are being analyzed using MELCOR

Representative sequences at-a-glance

Ranked Order	Accident notional description	% of PDS
1	Loss of nuclear service cooling water leading to RCP seal failure and ECCS failure	24%
2	Station blackout with extended manual operation of turbine-driven AFW	18%
3	*Station blackout with turbine-drive AFW available until battery depletion (4 hrs)**	17%
4	Dual-train electrical transient	13%
5	Loss of nuclear service cooling water leading to RCP seal failure and ECCS failure, with secondary-side cooldown	7%
6	Interfacing systems LOCA	5%
7	*Station blackout with turbine-driven AFW fails-to-run**	4%
8-10	Various transients *(PDS #10 only)*	5% (combined)
11	Medium LOCA without high-pressure recirculation	<1%
…	Steam generator tube rupture	…
	Station blackout with containment isolation failure	…

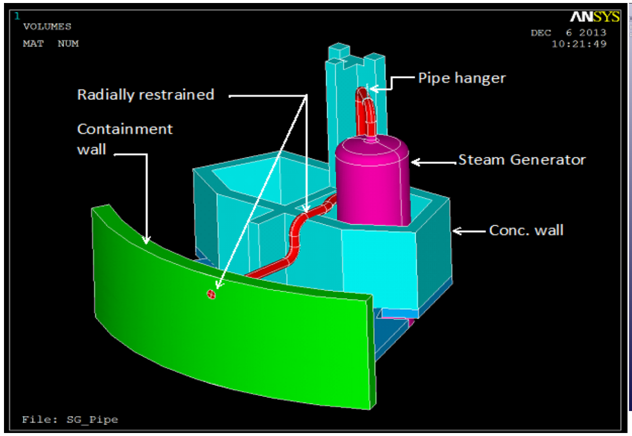
** As a variation (see next slide)*

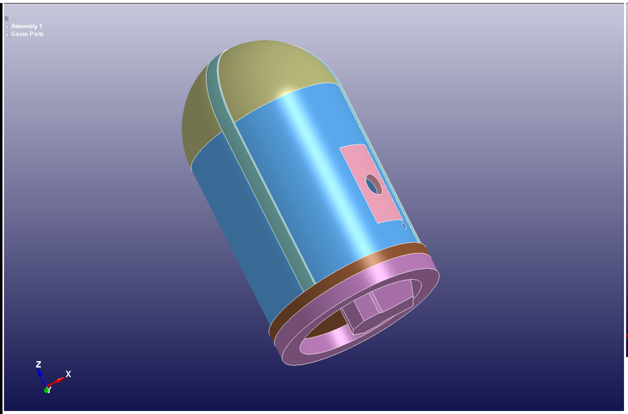
Representative sequence analysis

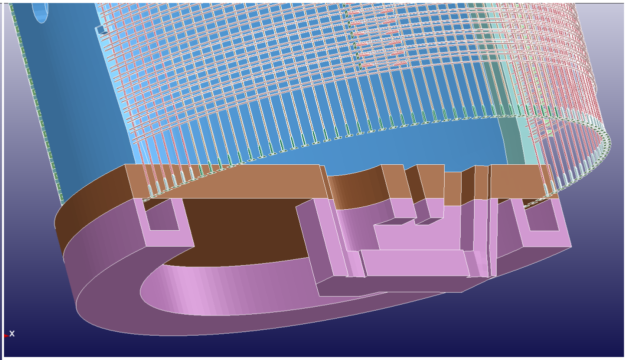
- The need for some variations on the representative sequences has been identified:
  - SBO variations related to AFW treatment, hydrogen combustion, and RCP seal leakage
  - Study of induced RCS failures (hot leg vs. SGTs vs. surge line [as well as the effect of in-core instrument tube failure])
  - ISLOCA break submergence, break location, and break size
  - Intrusion of containment spray water in to the reactor cavity
  - SG isolation assumptions during SGTR
  - Depending on initial calculation results:
    - Valve seizure treatment due to excessive cycling
    - Operator-induced cooldown and depressurization assumptions

Overview of structural work to date

- Reviewed failure characterizations from licensee's IPEEE analysis
- Performed additional analysis and characterization of basemat junction and hatch over-pressure failures
- Investigated steamline flooding dead loads





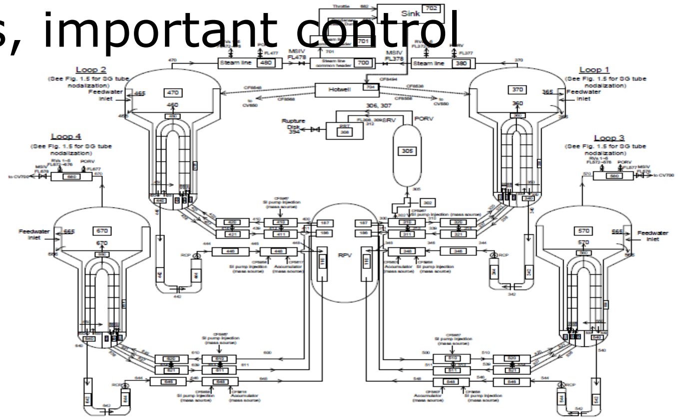


Fuel fission product characterization

- SCALE (v6.1.2) analysis (using updated ENDF/B-VII.1 nuclear data) used to provide
  - Decay heat as a function of time
  - Radionuclide inventories as a function of time
  - Radionuclide activities as a function of time
- Analysis used the TRITON and ORIGEN modules
- Investigated uncertainties associated with:
  - Core operational history assumptions
  - Assembly design assumptions
  - Burnable absorber modeling assumptions
  - Assumed axial power distribution
  - Hardware activation modeling
- Same tools used for SFP fuel characterization

MELCOR model development

- MELCOR 2.1 model developed for Unit 1 (Unit 2 is identical in the relevant respects)
- Based on FSAR, Tech Specs, licensee-provided information, models for similar plants, walkdowns, etc.
- Utilizes State-of-the-Art Reactor Consequence Analyses (SOARCA) best practices
- Detailed nodalization of the RPV, RCS and containment
- Models RPS, ECCS, containment systems, important control systems, simplified balance of plant
- Stylized modeling of adjacent structures to investigate important physical processes that may occur in these structures (e.g., in/out leakage from containment, fission product retention, combustion events)



MELCOR analysis

- Side studies to investigate:
  - Effects of various modeling assumptions
  - Instrument tube failure effects
  - Hydrogen combustion
  - C-SGTR modeling
  - Containment pressure and fission product retention as a function of leakage area
- Ongoing analysis of the aforementioned representative sequences and their variations

Instrument and equipment survivability

- Review of past approaches and methodologies, for example:
  - EPRI TR-103412 and TR-102371, NUREG/CR-5444, ALWR Chapter 19 approaches
- Focus on the instruments needed for SAMG navigation and equipment used for accident management
- Leverage results from MELCOR analyses and past studies
- Decompose each representative sequence (~10) by physical location (~15) and accident phase (~4) to arrive at location, time and scenario-specific 'load' trends
- Compare to the environmental qualification envelope, past testing characterizations, etc., of the impacted instruments / equipment to bin as:
  - Not likely to be challenged
  - Very likely to fail
  - Indeterminate (address via expert judgment or model uncertainty)
- Apply simplifying assumptions when cable routing information is not available

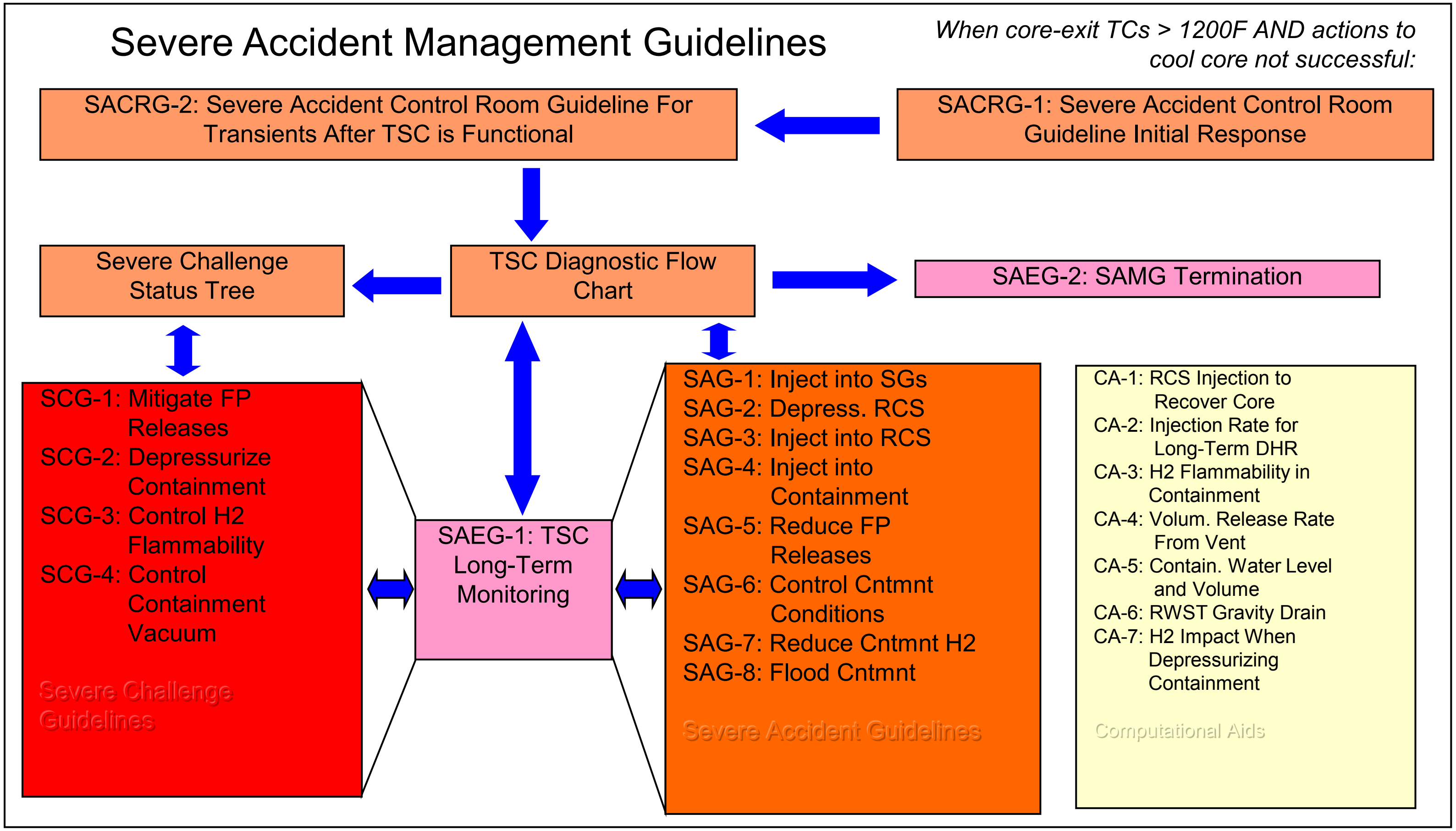
HRA Preparatory Work

- Developing Level 2 HRA basis and approach recommendations - Sandia National Laboratories
  - Screening and detailed analysis
  - Review of behavior models, decisionmaking, team coordination, etc.
- Reviewing fire HRA and other relevant activities where appropriate (e.g., useful concepts from the HRA SRM methodologies) to identify leveraging opportunities
- Performed walkdowns and discussions (during March and July 2013 site visits) related to the site's accident management infrastructure
- Critiqued a 2012 EP drill, which included limited use of the EDMGs and SAMGs (as a drill enhancement prompted by the 2011 NRC accident management inspection), to gain site-specific insights

HRA Preparatory Work – Example considerations

- Examples of complexities being evaluated:
  - Modeling of dependency between Level 1 and Level 2
  - Role of HP and security escorts in taking local actions
  - OSC, TSC, and control room communications and coordination
  - Decisionmaking biases for allocating resources toward repair versus bringing out-of-service equipment back online versus focusing on strategies using available equipment
  - Familiarity and competency with EDMGs and SAMGs

Westinghouse SAMG Structure



This is based on the 2012 SAMGs for Vogtle; this structure is being modified as part of ongoing PWR Owners' Group SAMG upgrade activities

Accident Management Action Identification Approach

- Treat EDMGs as subsidiary (support) strategies for accomplishing functions within the SAMGs – only justifiable after review and consideration of the plant-specific strategies and guidance
- Take advantage of the hierarchical nature of the Westinghouse SAMGs, and the prescriptive set-points for strategy entry
- Utilize representative scenario MELCOR calculations to assess priorities and habitability
  - MELCOR model has been set up to specifically output data streams for the parameters that govern SAMG navigation
- Generally include accident management action if:
  - It is the 1st or 2nd priority during the scenario, AND
  - It is ever the 1st priority OR it is the 2nd priority for at least 2 consecutive hours, AND
  - The area of the action is potentially inhabitable

Sample SAMG Scenario Crosswalk (For illustrative purposes only)

	dc power	I&C and equipment surviv. concerns	Habitability concerns	SCG-1	SCG-2	SCG-3	SCG-4	SAG-1	SAG-2	SAG-3	SAG-4	SAG-5	SAG-6	SAG-7	SAG-8
SAMG entrance @ 3.5 hours	yes							X	X	X	X		X		X
4 to 5 hours	no	see separate table that maps expected accident conditions for the various phases of the accident to physical plant areas to what environmental conditions are expected to be challenging	only inside containment	? - TBD				X	X	X	X	? - TBD	X		X
5 to 6 hours								X	X	X	X		X	X	X
6 to 7 hours						X		X	X		X		X	X	X
7 to 8 hours								X			X		X		X
8 to 9 hours								X			X		X	X	X
9 to 10 hours								X			X		X	X	X
10 to 11 hours								X			X		X	X	X
11 to 12 hours						X		X			X		X	X	X
12 to 13 hours						X		X			X		X	X	X
13 to 14 hours						X		X			X		X	X	X
14 to 15 hours						X		X			X		X	X	X
15 to 16 hours			Radiation levels in auxiliary, fuel handling, and control building may be a concern due to continued containment leakage			X		X			X		X	X	X
16 to 17 hours						X		X			X		X	X	X
17 to 18 hours						X		X			X		X	X	X
18 to 19 hours						X		X			X		X	X	X
19 to 20 hours						X		X			X		X	X	X
20 to 21 hours						X		X			X		X	X	X
21 to 22 hours						X		X			X		X	X	X
22 to 23 hours						X		X			X		X	X	X
23 to 24 hours						X		X			X		X	X	X

For illustrative purposes only

Preliminary screening HEP criteria

1.0 (100% chance action is NOT taken)	• If dc power (i.e., instrumentation) is unavailable during the period of diagnosis or execution
0.9 (90% chance action is NOT taken)	• It is never the highest priority during the scenario OR • More than 1 human failure event occurs upstream OR • The strategy is the #1 or #2 priority for less than 2 hours sequentially OR • An accident-altering event* occurs during the implementation period
0.1 (10% chance action is NOT taken)	• It is very similar to an EOP action in terms of the action's function AND • The same or similar action will also be prompted by the EDMGs AND • It is the highest priority for at least 3 consecutive hours (unbroken by an accident-altering event*) AND • During the above time period there is no habitability or survivability concern NOTE: The first two criteria would only be satisfied by injection in to the SGs or RCS depressurization via SG depressurization
0.5	• If not covered by one of the categories above

*vessel failure, containment failure, or a combustion event

Accident progression logic model

- A straw-man has been developed for the containment event tree, supporting decomposition event trees, and release categories
  - Decomposition event trees are a logical construct that replace supporting fault trees
  - The details of these will evolve as other ongoing work proceeds
- Quantification challenges:
  - Very large number of sequences, given integrated model
  - High failure probabilities
- The goal is to treat parameter and model uncertainty analogous to the Level 1 PRA approach, and to take advantage of using a coupled model
  - Propagation of parameter uncertainty
  - Identification and characterization of model uncertainty (40+ sources identified to date)
- Other aspects of the probabilistic treatment are still in the early stages

Remaining technical elements

- Investigating source term estimation and uncertainties
- Shaking down handoff of deterministic results to the Level 3 team
- Planning for industry-led peer review

QUESTIONS??

Level 3 PRA (Offsite Consequence Analysis) Status and Issues

February 19, 2014

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Outline

- Documentation Development
- Technical Element Status
- Consequence Reporting Considerations

Documentation Format

- Development of standard format and content based on review of prior studies
- Uses MACCS2 input parameters, organized according to TAAP technical elements, to structure qualitative discussion
- Individual volumes for each scope piece (e.g., reactor, at-power, internal events and floods)
- Each volume based on scope-piece-specific updates to initial volume

CONTENTS

Input Parameter Documentation

- Technical Discussion
  - MACCS2 conceptual model description based on MACCS model description documents (NUREG/CR-4691 Vol 2 and NUREG/CR-6613 Vol 1)
  - Discussion of technical bases for input parameters reflecting state of practice analysis
  - Technical bases drawn from site specific information and best practice recommendations documented in draft NUREG/CR-7009
- Tabular summary of input parameters
  - References to applicable discussion section for traceability
- Quality assurance discussion
  - Based on high-level and supporting requirements from draft Level 3 PRA standard
  - Include discussion of parameter and model uncertainties informed by SOARCA Peach Bottom Uncertainty Analysis

Technical Element Status

- Transition from the Radionuclide Release to Level 3 (RE)
  - MELMACCS development efforts for generation of composite sources for multisource releases
  - Coordination with Level 2 analyses for release category binning and representative source term development
- Meteorological Data (ME)
  - 1998-2002 meteorological data available from Vogtle early site permit (ESP) application
  - Extensive discussion of site meteorology from ESP environmental report and environmental impact statement
  - MACCS2 meteorological file to be reviewed by NRC staff meteorologists
- Atmospheric Transport and Dispersion (ATD)
  - Atmospheric modeling consistent with current best practice recommendations
  - Review of site-specific conditions to facilitate qualitative evaluation of model results

Technical Element Status (continued)

- Protective Action Parameters and Other Site Data (PA)
  - Based on work underway at Sandia National Laboratories (SNL)
  - Updated version of SECPOP available based on 2010 census data
  - Site demographic characteristics based on 2010 census data supplemented by information from site visits
  - Three standard evacuation models developed; detailed parameterization will be updated when source term data is available
  - Relocation, interdiction and decontamination models based on best practice default values
  - Leverage ongoing SNL work on updating decontamination plan data
- Economic Factors (EC)
  - Based on updated 2007 BEA and USDA databases in SECPOP and best practice default values for non-site-specific parameters

Technical Element Status (continued)

- Dosimetry (DO)
  - Dosimetry based on dose conversion factor files developed for SOARCA
  - Consistent with FGR-13 and recommendations by K. Eckermann
- Health Effects (HE)
  - Health effects models for acute and stochastic effects based on recommended best practices parameters
  - Acute early fatality parameters consistent with 1997 expert elicitation
  - Latent effects data consistent with BEIR V for consistency with dose conversion factor files
  - Latent health effects model to include dose-response models consistent with both linear no-threshold (LNT) and Health Physics Society (HPS) position statement

Consequence Reporting

- Reflects Quantification and Reporting (QT) and Risk Integration (RI) sections of TAAP
- Input parameter development based on consequence measures selected for reporting
- Consequence reporting considerations informed by review of
  - MACCS2 output capabilities
  - Consequence analysis applications
  - Past studies

MACCS2 Output Capabilities
Output Measures

- Concentration of individual radionuclides in air (Bq/m^3) and on ground surface (Bq/m^2)
- Dosimetric measures for individuals and populations by organ and for whole body
- Dose contributions to population dose by dose pathway, accident phase, and for individual cohorts.
- Collective and individual health effects resulting from accumulated doses
- Extent of land area and population affected by radionuclide deposition and/or protective measures
- Costs associated with protective measures

MACCS2 Output Capabilities
Output Format

- MACCS2 results computed on a radial spatial grid (e.g., 64 sectors x 26 radii = 1664 grid elements)
- Results computed for each weather trial (e.g., ~1000 weather trials to cover multiple meteorological bins defined by windspeed, stability class, and precipitation)
- Depending upon the selected measure, computational results can be:
  - Averaged over all weather trials or reported as a distribution across weather trials
  - Reported at a specified grid element
  - Integrated over a user defined radial region (e.g., 0-10 miles, 40-50 mile ring, etc.)
  - Normalized by the population in the user-defined region to yield an average individual risk in that region (e.g., latent cancer fatality risk within 10 miles)

Consequence Reporting
Applications

- Risk-informed decisionmaking (RG 1.174)
- Regulatory Analysis (NUREG/BR-0058 and NUREG/BR-0184)
- Backfit Analysis (NUREG-1409)
- Environmental Reviews (NUREG-1555)
  - Section 7.2: Severe Accidents
  - Section 7.3: Severe Accident Mitigation Alternatives

Applications
Summary of Output Measures

	Ind. Early Fatality Risk	Ind. Latent Fatality Risk	Collective Dose Risk	Offsite Property Damage Risk	Total Early Fatality Risk	Total Latent Fatality Risk	Land Contam. Risk
Risk-Informed Decisionmaking	X	X					
Backfit Analysis	X	X	X				
Regulatory Analysis	X	X	X	X			
Severe Accident Mitigation Alternatives			X	X			
Severe Accident Environmental Assessment	X	X	X	X	X	X	X

Consequence Reporting
Review of Past Studies

- CRAC/WASH-1400 (ca. 1975-1985)
  - WASH-1400 (*Reactor Safety Study*)
  - NUREG/CR-2239 (*Siting Study*)
  - NUREG/CR-2723 (*Strip Report*)

- MACCS/NUREG-1150 (ca. 1985-2000)
  - NUREG-1150 (*Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants*)
  - NUREG/CR-4551 Volumes 3-7 (*Plant-specific detailed reports supporting NUREG-1150*)
  - NUREG-5305 (*Integrated Risk Assessment for the LaSalle Unit 2 Nuclear Power Plant*)
  - NUREG/CR-6349 (*Cost-Benefit Considerations in Regulatory Analysis*)

- MACCS2/SOARCA (ca. 2000 – present)
  - NUREG-1935 (*State of the Art Reactor Consequence Analysis*)
  - NUREG/CR-7110 Volumes 1 and 2 (*Plant-specific detailed reports supporting SOARCA*)

Review of Past Studies
Summary of Output Measures

	Dosimetric		Health Effects				Social/Economic	
Report	Organ Dose	Collective Dose	Early Fatalities	Early Injuries	Latent Fatalities	Latent Injuries	Land Contam.	Economic Cost
NUREG-75/014 (WASH-1400)	IND*		TOT IND	TOT IND	TOT IND	TOT IND	TOT	TOT
NUREG/CR-2239	IND		TOT IND	TOT	TOT IND	TOT	TOT	
NUREG/CR-2723		TOT	TOT	TOT	TOT			TOT
NUREG-1150 NUREG/CR-4551 NUREG/CR-5305		TOT	TOT IND		TOT IND			TOT**
NUREG/CR-6349		TOT	TOT		TOT			TOT
NUREG-1935, NUREG/CR-7110			IND		IND			

TOT: Total health effects cases or cumulative amount; IND: Individual risk of health effect

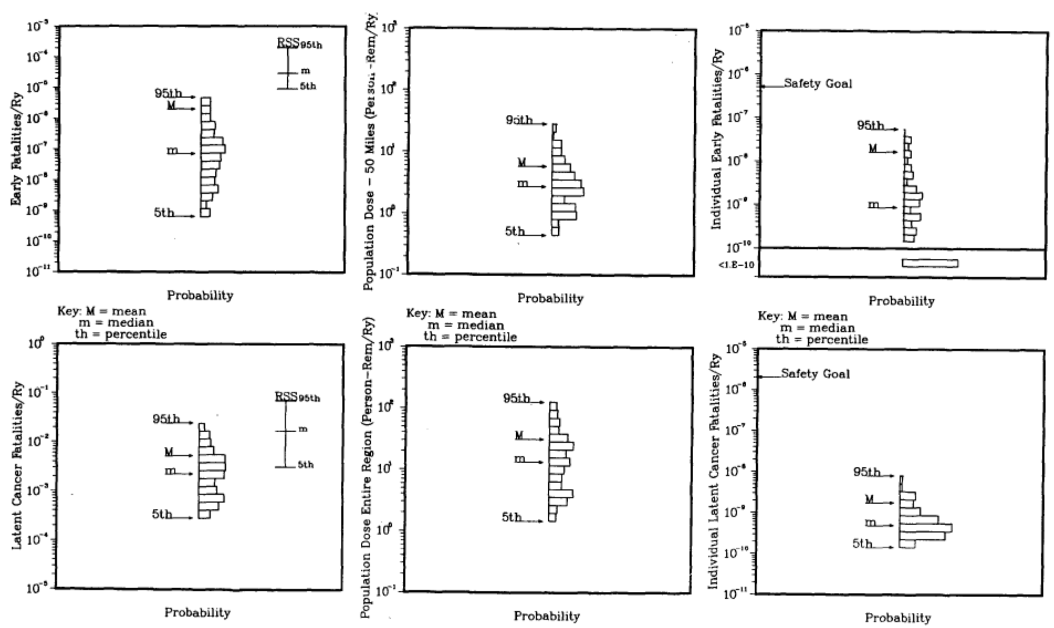
*Detailed organ dose results presented in explanatory sections in Appendix VI
** Property damage results presented in supplemental tables in appendices to NUREG/CR-4551

Historically Reported Metrics

NUREG-1150 Supporting Analyses

Table 4.3-1
Mean Consequence Results for Internal Initiators
(Population Doses in Sv)

Source Term	Early Fatal-ities	Total Lat. Cancer Fatalities	Pop. Dose Within 50 mi	Pop. Dose Entire Region	Individual Early Fat. Risk, 1 mi.	Individual Lat. Can. Fatality Fat. Risk 10 mi.
SUR-01-1	-----	-----	-----	-----	-----	-----
SUR-01-2	9.35E-5	9.31E+1	2.33E+3	5.73E+3	4.64E-6	6.52E-5
SUR-01-3	3.87E-2	3.90E+1	1.24E+3	2.24E+3	1.31E-3	1.42E-4
SUR-02-1	5.70E-4	2.43E+2	5.22E+3	1.46E+4	2.45E-5	8.38E-5
SUR-02-2	5.68E-1	7.67E+2	1.13E+4	4.42E+4	3.82E-3	1.48E-3
SUR-02-3	4.94E-2	2.72E+2	5.82E+3	1.61E+4	1.65E-3	2.28E-4
SUR-03-1	1.16E-2	6.89E+2	1.15E+4	4.19E+4	1.60E-4	1.12E-4
SUR-03-2	4.20E-1	1.59E+3	2.26E+4	9.60E+4	4.51E-3	1.54E-3
SUR-03-3	1.57E-1	7.94E+2	1.13E+4	4.78E+4	4.37E-3	3.62E-4
SUR-04-1	6.80E-4	1.04E+3	1.04E+4	6.13E+4	2.59E-5	1.17E-4
SUR-04-2	2.11E-4	9.37E+2	1.45E+4	5.55E+4	1.02E-5	2.86E-4
SUR-04-3	-----	-----	-----	-----	-----	-----
SUR-05-1	-----	-----	-----	-----	-----	-----
SUR-05-2	2.86E+0	3.61E+3	5.15E+4	1.92E+5	2.97E-2	3.99E-3
SUR-05-3	1.83E+0	2.56E+3	2.62E+4	1.58E+5	1.60E-2	8.91E-4
SUR-06-1	-----	-----	-----	-----	-----	-----
SUR-06-2	9.24E-2	2.42E+3	2.42E+4	1.44E+5	2.16E-3	7.47E-4
SUR-06-3	1.49E+0	2.19E+3	2.15E+4	1.32E+5	1.34E-2	9.67E-4
SUR-07-1	6.55E-2	2.38E+3	2.76E+4	1.42E+5	1.96E-4	1.13E-4
SUR-07-2	3.38E+0	2.83E+3	3.43E+4	1.67E+5	3.73E-2	2.72E-3
SUR-07-3	5.03E-1	1.40E+3	1.46E+4	8.30E+4	8.97E-3	5.96E-4
SUR-08-1	7.75E-3	2.20E+3	1.68E+4	1.31E+5	1.09E-4	1.32E-4
SUR-08-2	2.64E-2	2.27E+3	2.14E+4	1.34E+5	1.22E-3	3.72E-4
SUR-08-3	2.35E-1	1.44E+3	1.61E+4	8.43E+4	5.57E-3	5.11E-4
SUR-09-1	3.08E-3	1.66E+3	1.36E+4	9.83E+4	6.75E-5	1.21E-4
SUR-09-2	1.97E-3	1.35E+3	1.74E+4	7.97E+4	6.00E-5	3.06E-4
SUR-09-3	-----	-----	-----	-----	-----	-----



Historically Reported Metrics
NUREG/CR-6349

- *<u>Cost Benefit Considerations in Regulatory Analysis</u>*

- Tabulated values for
  - Early Fatalities
  - Latent Fatalities
  - Population dose
  - Offsite Economic Costs

- Tables for
  - each NUREG-1150 plant
  - 10, 50, 100, and 1000 miles

Table 4-16 Surry Consequences to 1000 Miles

Source Term	Mean Fre...	Early	Latent	Population	Offsite
SUR01-3	1.8				
SUR02-2	1.5				
SUR02-3	2.6				
SUR03-2	1.9				
SUR03-3	7.3				
SUR04-1	1.9				
SUR04-2	8.4				
SUR05-3	9.4				
SUR06-3	6.9				
SUR07-1	3.3				
SUR07-2	1.1				
SUR07-3	1.3				
SUR08-1	1.3				
SUR08-2	8.2				
SUR09-1	1.5				
SUR09-2	7.6				
SUR10-3	4.5				
SUR11-1	2.6				
SUR11-2	2.9				
SUR11-3	1.2				
SUR12-1	1.0				
SUR12-2	2.9				
SUR13-1	1.1				
SUR14-1	1.1				
SUR15-1	1.5				
SUR16-1	1.9				
SUR17-1	3.2				
SUR17-2	1.9				

Table 4-15 Surry Consequences to 100 Miles

Source Term	Mean Freque... (/yr)	Early	Latent	Population	Offsite
SUR01-3	1.80E				
SUR02-2	1.54E				
SUR02-3	2.65E				
SUR03-2	1.95E				
SUR03-3	7.30E				
SUR04-1	1.96E				
SUR04-2	8.40E				
SUR05-3	9.43E				
SUR06-3	6.94E				
SUR07-1	3.30E				
SUR07-2	1.13E				
SUR07-3	1.34E				
SUR08-1	1.37E				
SUR08-2	8.29E				
SUR09-1	1.53E				
SUR09-2	7.68E				
SUR10-3	4.54E				
SUR11-1	2.65E				
SUR11-2	2.95E				
SUR11-3	1.24E				
SUR12-1	1.01E				
SUR12-2	2.93E				
SUR13-1	1.18E				
SUR14-1	1.10E				
SUR15-1	1.50E				
SUR16-1	1.90E				
SUR17-1	3.20E				
SUR17-2	1.97E				

Table 4-14 Surry Consequences to 50 Miles

Source Term	Mean Freq...	Early	Latent	Population	Offsite
SUR01-3	1.80				
SUR02-2	1.54				
SUR02-3	2.65				
SUR03-2	1.95				
SUR03-3	7.30				
SUR04-1	1.96				
SUR04-2	8.40				
SUR05-3	9.43				
SUR06-3	6.94				
SUR07-1	3.30				
SUR07-2	1.13				
SUR07-3	1.34				
SUR08-1	1.37				
SUR08-2	8.29				
SUR09-1	1.53				
SUR09-2	7.68				
SUR10-3	4.54				
SUR11-1	2.65				
SUR11-2	2.95				
SUR11-3	1.24				
SUR12-1	1.01				
SUR12-2	2.93				
SUR13-1	1.18				
SUR14-1	1.10				
SUR15-1	1.50				
SUR16-1	1.90				
SUR17-1	3.20				
SUR17-2	1.97				

Table 4-13 Surry Consequences to 10 Miles

Source Term	Mean Frequency (/yr)	Early Fatalities	Latent Fatalities	Population Dose (Per-rem)	Offsite Costs ($)
SUR01-3	1.80E-07	6.41E-02	2.77E+01	4.97E+04	1.18E+07
SUR02-2	1.54E-08	2.21E-01	2.41E+02	2.99E+05	1.93E+08
SUR02-3	2.65E-07	7.73E-02	4.79E+01	1.00E+05	1.60E+08
SUR03-2	1.95E-08	2.41E-01	2.92E+02	4.29E+05	6.63E+08
SUR03-3	7.30E-07	2.29E-01	8.55E+01	1.97E+05	4.36E+08
SUR04-1	1.96E-07	8.44E-04	3.89E+01	9.08E+04	4.77E+08
SUR04-2	8.40E-08	1.40E-04	7.25E+01	1.72E+05	4.76E+08
SUR05-3	9.43E-08	2.66E+00	1.98E+02	5.01E+05	6.98E+08
SUR06-3	6.94E-08	1.89E+00	1.84E+02	4.26E+05	6.23E+08
SUR07-1	3.30E-08	5.01E-02	6.79E+01	1.31E+05	5.91E+08
SUR07-2	1.13E-07	2.59E+00	4.73E+02	6.47E+05	8.50E+08
SUR07-3	1.34E-07	7.18E-01	1.21E+02	2.73E+05	5.23E+08
SUR08-1	1.37E-07	8.94E-03	4.81E+01	1.08E+05	6.09E+08
SUR08-2	8.29E-08	8.32E-03	8.22E+01	1.93E+05	7.28E+08
SUR09-1	1.53E-07	3.52E-03	3.90E+01	8.89E+04	5.49E+08
SUR09-2	7.68E-08	2.05E-03	7.52E+01	1.76E+05	6.34E+08
SUR10-3	4.54E-08	1.52E+01	3.12E+02	8.28E+05	7.22E+08
SUR11-1	2.65E-08	3.30E-01	1.17E+02	2.21E+05	7.19E+08
SUR11-2	2.95E-08	1.31E-02	1.16E+02	2.17E+05	5.61E+08
SUR11-3	1.24E-07	5.61E+00	2.71E+02	6.29E+05	6.87E+08
SUR12-1	1.01E-07	1.37E-01	8.01E+01	1.66E+05	6.99E+08
SUR12-2	2.93E-08	1.10E-01	1.46E+02	3.10E+05	8.61E+08
SUR13-1	1.18E-07	3.92E-02	6.32E+01	1.40E+05	6.82E+08
SUR14-1	1.10E-07	1.73E-02	5.69E+01	1.28E+05	6.48E+08
SUR15-1	1.50E-05	0.00E+00	3.46E-03	3.39E+01	1.51E+03
SUR16-1	1.90E-05	0.00E+00	2.98E-02	2.40E+02	1.89E+04
SUR17-1	3.20E-06	0.00E+00	1.62E+01	3.95E+04	7.92E+07
SUR17-2	1.97E-07	3.87E-05	3.76E+01	9.04E+04	1.89E+08

Review of Past Studies
Observations

- A wide variety of output metrics have been reported in past studies
- Output metrics have been reported at a range of distances
- Level of detail of reported metrics dependent upon document hierarchy
- MACCS2 analyses produce conditional consequences for each representative source term/release category
- Results tabulated for use by risk integration team

Summary

- Consistent, structured document format and content facilitates traceability and transparency for both technical review and future use
- Consequence metrics analyzed in past studies have varied but have generally included both individual health impacts, societal health impacts, and measures of economic/property damage
- High level summary reports have generally been supplemented by supporting or supplemental reports with additional metrics and details

Selected References (1/2)

- WASH-1400 (*Reactor Safety Study*)
- NUREG/CR-2239 (*Siting Study*)
- NUREG/CR-2723 (*Strip Report*)
- NUREG-1150 (*Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants*)
- NUREG/CR-4551 Volume 2 Part 7 (*Quantification of Major Input Parameters supporting NUREG-1150, MACCS Input*)
- NUREG/CR-4551 Volumes 3-7 (*Plant-specific detailed reports supporting NUREG-1150*)
- NUREG-5305 (*Integrated Risk Assessment for the LaSalle Unit 2 Nuclear Power Plant*)
- NUREG/CR-6349 (*Cost-Benefit Considerations in Regulatory Analysis*)
- NUREG-1935 (*State of the Art Reactor Consequence Analysis*)
- NUREG/CR-7110 Volumes 1 and 2 (*Plant-specific detailed reports supporting SOARCA*)

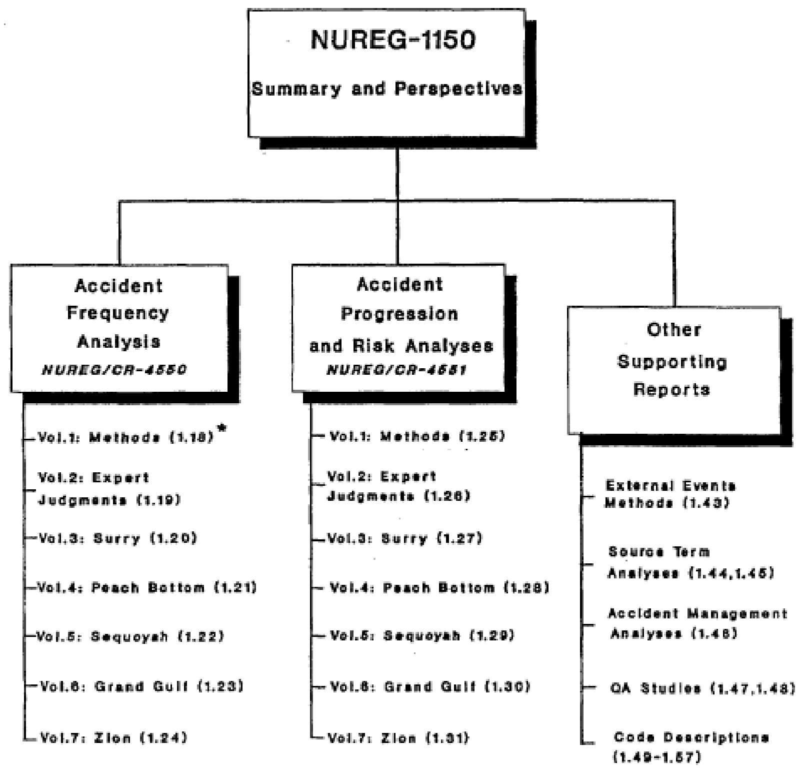
Selected References (2/2)

- NUREG/CR-4691 Volume 2 (*MACCS Model Description Document*)
- NUREG/CR-6613 Volume 1 (*MACCS2 Model Description Document*)
- NUREG/CR-7009 (*Best Practices from State of theArt Reactor Consequence Analyses Study*), unpublished draft
- Regulatory Guide 1.174 (*An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis*)
- NUREG/BR-0058 (*Regulatory Analysis Guidelines*)
- NUREG/BR-0184 (*Regulatory Analysis Handbook*)
- NUREG-1409 (*Backfitting Guidelines*)
- NUREG-1555 (*Environmental Standard Review Plan*)

BACKUP SLIDES

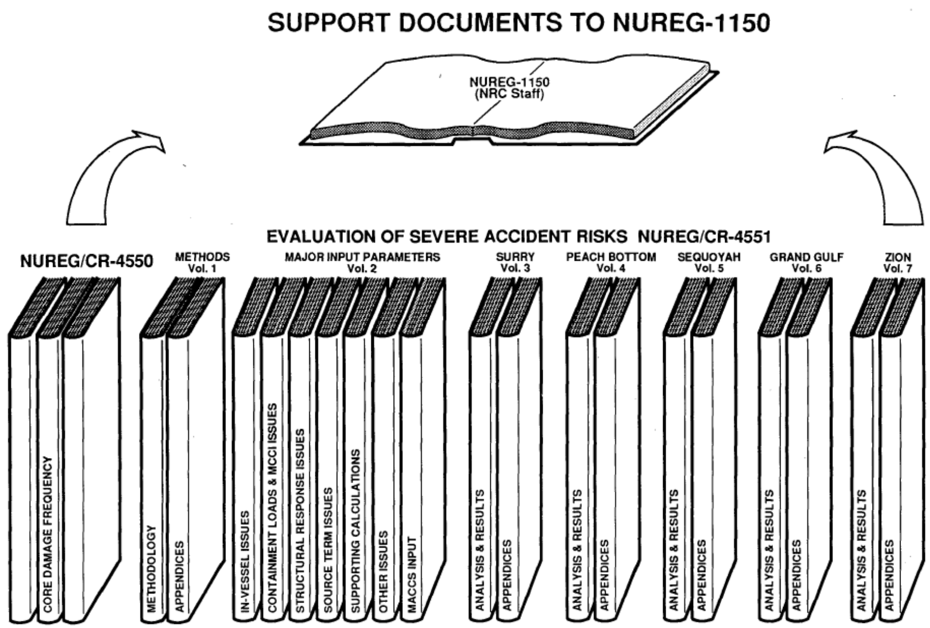
Historically Reported Metrics

NUREG-1150 Document Architecture



*See reference list at end of Chapter 1.

Figure 1.1 Reports supporting NUREG-1150.



Applications
Environmental Reviews of Severe Accidents

- Described in Section 7.2 (Severe Accidents) of NUREG-1555

Table 5-14. Mean Environmental Risks from an AP1000 Reactor Severe Accident at the Lee Nuclear Station Site

	Release Category Description (Accident Class)	Core Damage Frequency (per Ryr)	Environmental Risk: Population Dose (person-rem/Ryr)[a]	Fatalities (per Ryr): Early[b,f]	Fatalities (per Ryr): Latent[c]	Cost[d] ($/Ryr)	Farm Land Decontamination[e] (ha/Ryr)	Population Dose from Water Ingestion (person-rem/Ryr)[a]
IC	Intact containment	2.2×10^{-7}	1.2×10^{-3}	0.0	5.6×10^{-7}	0.97	1.1×10^{-5}	3.3×10^{-6}
BP	Containment bypass, fission products released directly to environment	1.1×10^{-8}	3.6×10^{-2}	5.5×10^{-10}	2.4×10^{-5}	118.00	9.1×10^{-4}	1.3×10^{-3}
CI	Containment isolation failure occurs prior to onset of core damage	1.3×10^{-9}	1.7×10^{-3}	0.0				
CFE	Early containment failure, after onset of core damage but before core relocation	7.5×10^{-9}	1.4×10^{-2}	0.0				
CFI	Intermediate containment failure, after core relocation but before 24 hr	1.9×10^{-10}	2.9×10^{-4}	0.0				
CFL	Late containment failure occurring after 24 hr	3.5×10^{-13}	7.9×10^{-7}	0.0				
Total		2.4×10^{-7}	5.3×10^{-2}	5.5 × 10				

(a) To convert person-rem to person-Sv, divide by 100.
(b) Early fatalities are fatalities related to high doses or dose rates that generally can be ex
(c) Latent fatalities are fatalities related to low doses or dose rates that can be expected to
(d) Cost risk includes costs associated with short-term relocation of people, decontaminati
associated with health effects (Jow et al. 1990).
(e) Land risk is an area where the average whole body dose rate for the 4-yr period followi
0.5 rem/yr by decontamination.
(f) The NRC staff examined the early fatalities for the Lee Nuclear Station site using both a
listed are for the four-plume segment model.

Table 5-15. Comparison of Environmental Risks for an AP1000 Reactor at the Lee Nuclear Station Site with Risks for Current-Generation Reactors at Five Sites Evaluated in NUREG-1150 and for the AP1000 Reactor at Four Sites

	Core Damage Frequency (per Ryr)	50-mi Population Dose Risk (person-rem/Ryr)[a]	Fatalities per Ryr: Early	Fatalities per Ryr: Latent	Average Individual Fatality Risk (per Ryr): Early	Average Individual Fatality Risk (per Ryr): Latent Cancer
Grand Gulf[b]	4.0×10^{-6}	5×10^{1}	8×10^{-9}	9×10^{-4}	3×10^{-11}	3×10^{-10}
Peach Bottom[b]	4.5×10^{-6}	$7 \times 10^{+2}$	2×10^{-8}	5×10^{-3}	5×10^{-11}	4×10^{-10}
Sequoyah[b]	5.7×10^{-5}	$1 \times 10^{+3}$	3×10^{-5}	1×10^{-2}	1×10^{-8}	1×10^{-8}
Surry[b]	4.0×10^{-5}	$5 \times 10^{+2}$	2×10^{-6}	5×10^{-3}	2×10^{-8}	2×10^{-9}
Zion[b]	3.4×10^{-4}	$5 \times 10^{+3}$	4×10^{-5}	2×10^{-2}	9×10^{-9}	1×10^{-8}
AP1000[c] Reactor at the Lee Nuclear Station site	2.4×10^{-7}	5.3×10^{-2}	5.5×10^{-10}	3.4×10^{-5}	0.0	3.0×10^{-11}
AP1000[d] Reactor at North Anna	2.4×10^{-7}	8.3×10^{-2}	1.2×10^{-10}	4.0×10^{-5}	2.6×10^{-13}	4.9×10^{-11}
AP1000[e] Reactor at Clinton	2.4×10^{-7}	2.2×10^{-2}	1.4×10^{-8}	1.2×10^{-5}	6.4×10^{-13}	5.5×10^{-11}
AP1000[f] Reactor at Grand Gulf	2.4×10^{-7}	1.4×10^{-2}	$< 1.0 \times 10^{-12}$	6.9×10^{-6}	$<1.0 \times 10^{-14}$	2.0×10^{-11}
AP1000[g] Reactor at the Vogtle Electric Generating Plant site	2.4×10^{-7}	2.8×10^{-2}	1.9×10^{-10}	1.9×10^{-5}	1.6×10^{-12}	1.1×10^{-11}

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Risks were calculated using the MACCS code and presented in NUREG-1150 (NRC 1990).
(c) Calculated with MACCS2 code using Lee Nuclear Station site-specific input.
(d) NUREG-1811 (NRC 2006a).
(e) NUREG-1815 (NRC 2006b).
(f) NUREG-1817 (NRC 2006c).
(g) NUREG-1872 (NRC 2008h).

Historically Reported Metrics
SOARCA (NUREG-1935)

- Output reporting issues discussed in
  - SECY-05-0233
  - SECY-08-0029

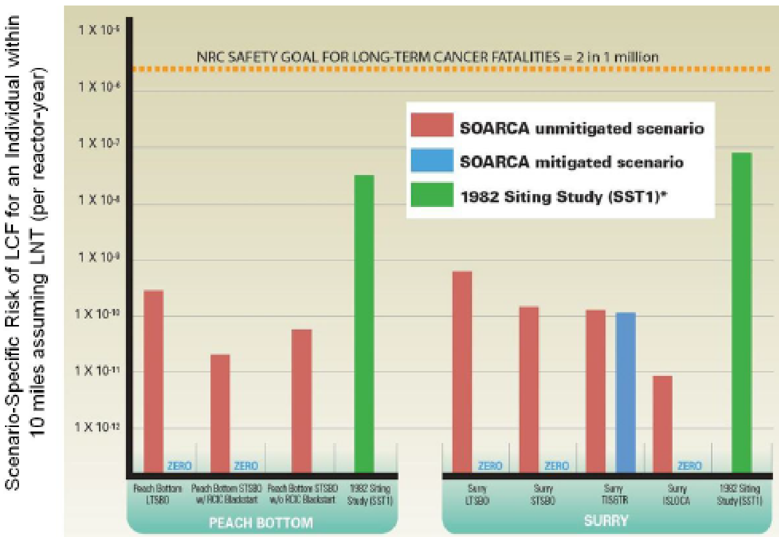


Figure ES-3 Comparison of average individual LCF risk results for SOARCA mitigated and unmitigated scenarios to the NRC Safety Goal and to extrapolations of the 1982 Siting Study SST1 (plotted on logarithmic scale)

Table 7 Surry Results for Scenarios Assuming LNT Dose-Response Model

Scenario	Core damage frequency [CDF] (per reactor-year)*	Mitigated		Unmitigated	
		Conditional scenario-specific probability of latent cancer fatality for an individual located within 10 miles	Scenario-specific risk [CDF x Conditional] of latent cancer fatality for an individual located within 10 miles (per reactor-year)	Conditional scenario-specific probability of latent cancer fatality for an individual located within 10 miles	Scenario-specific risk [CDF x Conditional] of latent cancer fatality for an individual located within 10 miles (per reactor-year)
Long-term SBO	2×10^{-5}	No Core Damage		5×10^{-5}	$\sim 7\times10^{-10}$ ****
Short-term SBO	2×10^{-6}	No Containment Failure **		9×10^{-5}	$\sim 1\times10^{-10}$ ****
Short-term SBO with TISGTR	4×10^{-7}	3×10^{-4} ***	$\sim 1\times10^{-10}$ ****	3×10^{-4}	$\sim 1\times10^{-10}$ ****
Interfacing systems LOCA	3×10^{-8}	No Core Damage		3×10^{-4}	$\sim 9\times10^{-12}$ ****

* The CDF assumes that 10 CFR 50.54(hh) equipment and procedures were not used.

** Accident progression calculations showed that source terms in the mitigated case are smaller than in the unmitigated case. Offsite consequence calculations were not run, since the containment fails at about 66 hours. A review of available resources and emergency plans shows that adequate mitigation measures could be brought onsite within 24 hours and connected and functioning within 48 hours. Therefore 66 hours would allow ample time for mitigation through measures transported from offsite.

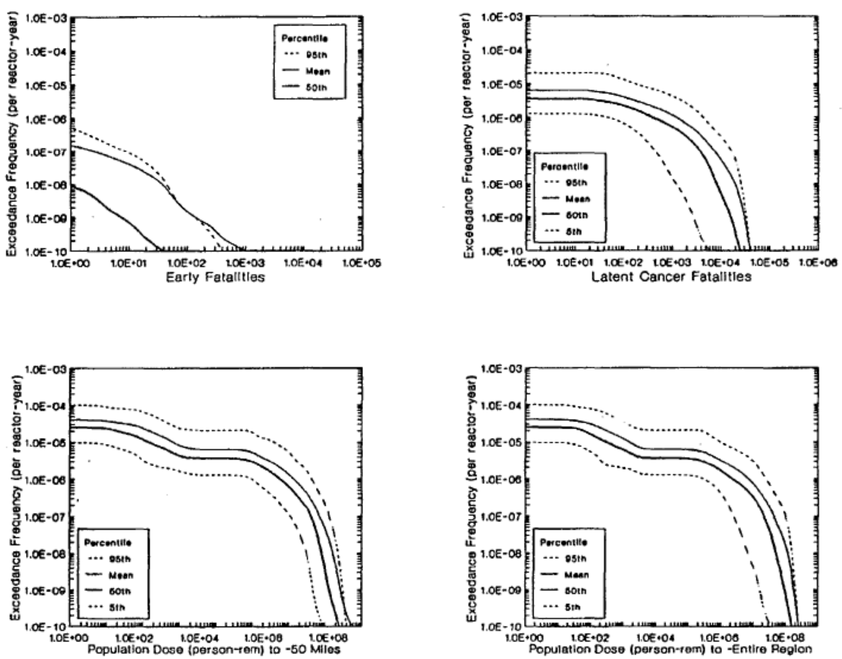
*** Containment failure is delayed by about 46 hours in the mitigated case relative to the unmitigated case. Rounding to one significant figure shows conditional LCF probabilities of 3×10^{-4} for both mitigated and unmitigated cases, however the original values were 2.8×10^{-4} for the mitigated case and 3.2×10^{-4} for the unmitigated case.

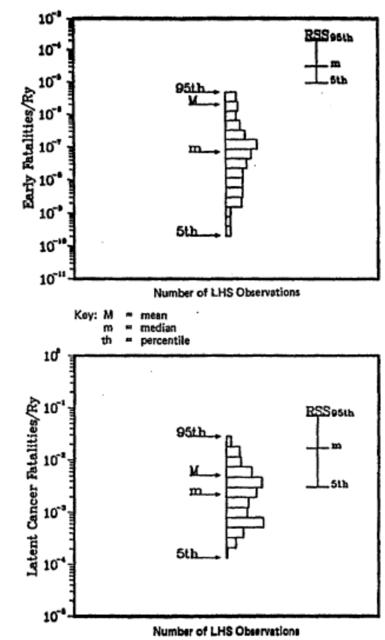
**** Estimated risks below 1×10^{-7} per reactor year should be viewed with caution because of the potential impact of events not studied in the analyses and the inherent uncertainty in very small calculated numbers.

Historically Reported Metrics
NUREG-1150

- CCDFs for:
  - Early Fatalities
  - Latent Fatalities
  - Population dose within 50 miles
  - Population dose in entire region

- Distributions for:
- Total Early and Latent Fatality Risk
- Individual Early and Latent Fatality Risk
- Population Dose Risk (50 mile and total region)





Note: As discussed in Reference 3.4, estimated risks at or below 1E–7 per reactor year should be viewed with caution because of the potential impact of events not studied in the risk analyses.

Figure 3.11 Early and latent cancer fatality risks at Surry (internal initiators).

Historically Reported Metrics

WASH-1400 Main Report

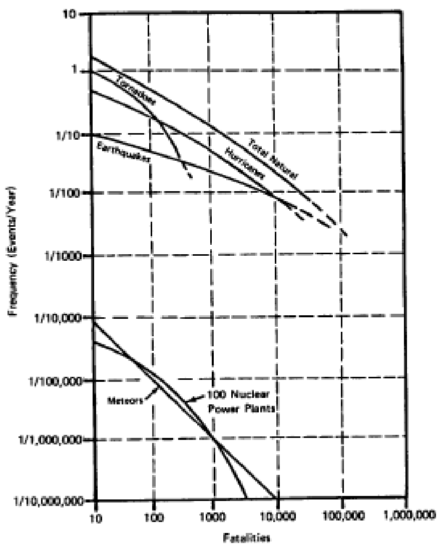


FIGURE 1-2 Frequency of Fatalities due to Natural Events

Notes: 1. For natural and man caused occurrences the uncertainty in probability of largest recorded consequence magnitude is estimated to be represented by factors of 1/20 and 5. Smaller magnitudes have less uncertainty.

2. Approximate uncertainties for nuclear events are estimated to be represented by factors of 1/4 and 4 on consequence magnitudes and by factors of 1/5 and 5 on probabilities.

FIGURE 1-3 Frequency of Property Damage due to Natural and Man-Caused Events

Notes: 1. Property damage due to auto accidents is not included because data are not available for low probability events. Auto accidents cause about $15 billion damage each year.

2. Approximate uncertainties for nuclear events are estimated to be represented by factors of 1/5 and 2 on consequence magnitudes and by factors of 1/5 and 5 on probabilities.

3. For natural and man caused occurrences the uncertainty in probability of largest recorded consequence magnitude is estimated to be represented by factors of 1/20 and 5. Smaller magnitudes have less uncertainty.

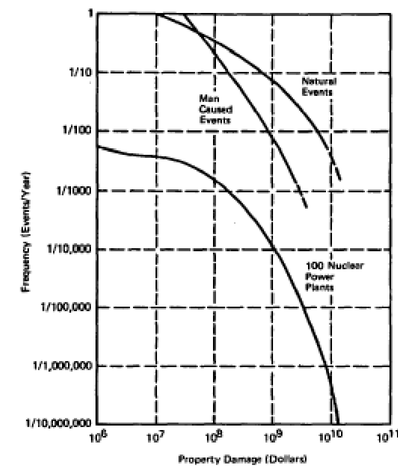


TABLE 5-6 APPROXIMATE AVERAGE SOCIETAL AND INDIVIDUAL RISK PROBABILITIES PER YEAR FROM POTENTIAL NUCLEAR PLANT ACCIDENTS(a)

Consequence	Societal	Individual
Early Fatalities(b)	3×10^{-3}	2×10^{-10}
Early Illness(b)	2×10^{-1}	1×10^{-8}
Latent Cancer Fatalities(c)	7×10^{-2}/yr	3×10^{-10}/yr
Thyroid Nodules(c)	7×10^{-1}/yr	3×10^{-9}/yr
Genetic Effects(d)	1×10^{-2}/yr	7×10^{-11}/yr
Property Damage ($)	2×10^{6}	——

(a) Based on 100 reactors at 68 current sites.

(b) The individual risk value is based on the 15 million people living in the general vicinity of the first 100 nuclear power plants.

(c) This value is the rate of occurrence per year for about a 30-year period following a potential accident. The individual rate is based on the total U.S. population.

(d) This value is the rate of occurrence per year for the first generation born after a potential accident; subsequent generations would experience effects at a lower rate. The individual rate is based on the total U.S. population.

Path Forward

February 19, 2014

Alan Kuritzky
Division of Risk Analysis
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(301-251-7587, Alan.Kuritzky@nrc.gov)

ID	Task Name	Milestone
1	**Rx, at-power, internal events and floods**	
2	Level 1	04/30/14
3	Level 2	08/31/14
4	Level 3	12/31/14
5	**Rx, at-power, internal and external hazards**	
6	Level 1	12/31/14
7	Level 2	03/31/15
8	Level 3	07/31/15
9	**Rx, LPSD, all hazards**	
10	Level 1	04/30/15
11	Level 2	08/31/15
12	Level 3	12/31/15
13	**Spent Fuel Pool**	
14	Level 1/2	01/31/15
15	Level 3	03/31/15
16	**Dry Cask Storage**	
17	Level 1/2	12/31/14
18	Level 3	02/28/15
19	**Integration**	
20	Preliminary approach development	06/30/13
21	Mulit-unit site risk with uncertainties	05/31/16
22	Full integrated site risk with uncertainties	10/31/16
23	**Insights and interpretation of results**	
24	Preliminary discussions, reviews, comments	05/31/16
25	Draft insights	10/31/16
26	Final insights	04/30/17
27	Final concurrence	07/31/17

Timeline: 2013 Q1 – 2018 Q1 (Q1 Q2 Q3 Q4 per year)

Project: Timeline_L3PRA_taskList
Date: Mon 02/03/14

Manual Milestone ◆ Manual Summary Rollup

Key Milestones – CY 2014

- Industry-led peer review of reactor, Level 1, internal event and flood PRA (Summer 2014)
- Completion of initial reactor, Level 1, seismic event PRA (Summer 2014)
- Industry-led peer review of reactor, Level 2, internal event and flood PRA (Fall 2014)
- Industry-led peer review of reactor, Level 1, high wind PRA (Fall 2014)
- Completion of reactor, Level 3, internal event and flood PRA (Fall/Winter 2014)
- Completion of dry cask storage, Level 1 and Level 2, PRA (Fall/Winter 2014)
- Meetings and briefings:
  - ACRS Full Committee meeting on project status and preliminary results (Spring/Summer 2014) (tentative)
  - Commissioner assistants briefing on project status and preliminary results (Fall 2014)
  - Public meeting on project status and preliminary results (Fall 2014)

Future Interactions

- Full Committee meeting in June 2014
- Additional Reliability and PRA Subcommittee meetings
  - Late summer 2014
    - Initial results of reactor, Level 1, high wind PRA
    - Possibly, initial results of reactor, Level 1, seismic PRA
    - Possibly, peer review for reactor, Level 1, internal event PRA
  - Late fall 2014
    - Peer review for reactor, Level 2, internal event PRA
    - Initial results of consequence analysis for reactor, internal events and floods
- Additional closed Subcommittee meetings for technical discussions?

U.S. NRC Level 3 PRA Project – Southern Nuclear Perspective

Owen M. Scott
Risk-Informed Engineering Department
Southern Nuclear Company
February 19, 2014

Outline

- SNC's initial perception of the benefits and how the project would proceed
  - Industry Benefits
  - SNC Benefits
- SNC's current thoughts on the how the project has progressed
- SNC's Experience – Positive Aspects
- SNC's Experience – Challenges
- Going Forward

SNC's initial perception of the benefits and how the project would proceed – **Industry Benefits**

- Development of a new multi-unit whole site risk model integrating risk from all modes and all hazards using state of knowledge methods and tools:
  - Establish an updated frame of reference (similar to impact of NUREG-1150)
  - Demonstrate how to build on existing models
  - New risk insights & Identify safety improvements
- Help advance the use of risk-informed decision making by highlighting the importance of realism and model freeze date
- Demonstrate that cooperation between utilities and NRC is more effective than confrontation in moving state of knowledge and state of practice forward

SNC's initial perception of the benefits and how the project would proceed – **SNC Benefits**

- Provide SNC new Vogtle models allowing us to better address additional hazards and operating modes to enhance our risk informed decision making process:
  - Low Power and Shutdown
  - Spent Fuel Pool
  - Dry Cask Storage
  - High Winds
  - Improved Level 2 model
- Additional review of the current Vogtle Internal Events and Fire PRA models by NRC PRA experts, resulting in continued improvement of Vogtle models

SNC's initial perception of the benefits and how the project would proceed – **SNC Benefits** (cont'd)

- Allow us to build positive relationships with the Staff
- Afford us additional opportunities to demonstrate the high level of knowledge and expertise of our in-house Risk Informed Engineering staff
- Maintain SNC reputation as an industry leader in risk assessment and application of risk insights in decision making
- Our cooperation and partnering with the Staff and open communication with the Level 3 PRA team in on-going activities

SNC's initial perception of the benefits and how the project would proceed – **SNC Benefits** (cont'd)

- Allow the Staff to see first-hand the high quality of the current Vogtle PRA models
  - Both the Internal Events and the Fire PRA models have undergone peer review against the ASME PRA Standards
  - All elements meet Capability Category 2 or better
  - Models are RG 1.200 compliant for use in Risk-Informed applications
  - Industry leading Seismic PRA under development for Vogtle 1&2
- Demonstrate SNC's full commitment to risk informed approach
- Opportunity to show the work that goes into maintaining models up to date that continue to meet the PRA Standards and state-of-the-art

SNC's Current Thoughts on How the Project Has Progressed

In a few isolated instances the Staff applied conservative methods reflecting individual preference rather than considering current methods considered acceptable practice by the broader PRA technical community in RG 1.200 peer reviews.

SNC's Current Thoughts on How the Project Has Progressed (continued)

- Example: Staff applied an incorrect interpretation of raw data in estimating human error probabilities (HEPs) resulting in over estimation of HEPs by a factor of 10 or more
  - Thus far, this HEP over estimation has limited impact on the overall Level 3 internal events risk results and insights.
  - However this overestimation is a major concern for SNC as the Level 3 project is moving to develop Fire and Seismic PRAs

SNC's Current Thoughts on How the Project Has Progressed (continued)

- The Level 3 project does not allow the Staff to fully appreciate the role of model updates/upgrades to address drivers for incorporating model changes:
  - Potential errors
  - State-of-knowledge/practice changes
- Example: Staff seems to be using contemporary information:
  - To declare that the technical adequacy of the older analysis methods may not be adequate to provide sufficient risk insights for our Risk-Informed applications
  - While not acknowledging that the model update/upgrade processes will result in appropriate changes being made

SNC's Current Thoughts on How the Project Has Progressed (continued)

- Vogtle model information was shared outside of Research and the Level 3 PRA project team
  - Disregard of original commitment to SNC
  - Recent Staff actions
  - May discourage future cooperation with the Staff
- SNC concerns with the Staff focus on meeting schedule with a very challenging budget and apparent willingness to use simplified models to reduce budget and schedule overruns
  - Fire PRA challenges to ensure realistic scenarios
  - Given the current conversations regarding the seismic hazard, Seismic PRA model is a major concern

SNC's Experience – Positive Aspects

- Communication and interaction with the Level 3 PRA team
- Opportunity to share Fire and Seismic information with the INL team developing an all hazards SPAR model for Vogtle
  - All Hazards SPAR model will be a valuable tool for SNC use as another source for risk insights
  - RIE staff has improved ability to use Saphire
- SNC has received positive feedback from the Staff and the Level 3 PRA team
- Retrieving information requested by NRC has identified areas we can improve the management of our documentation and infrastructure

SNC's Experience – Challenges

- Information acquisition was more burdensome than expected
  - SNC resources are limited
  - Formal process to protect proprietary information was difficult and time consuming
  - Too few information gathering/working visits to SNC to retrieve plant and model information

Going Forward

- If whole site all modes all hazards PRAs will be required in the future:
  - Should be incentives so that developing these models will be seen as cost effective for safety improvement
  - Large differences in uncertainties between internal events and external hazards should be properly characterized
    - Use of a single aggregate value may be unrealistic if results from the models for each hazard are not “ready” to be added together
    - Potential masking of safety improvements
    - Best risk insights are obtained by evaluating relative risks from each hazard to manage them properly
    - Value in identifying what is driving hazard-specific risk