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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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RELIABILITY AND PRA SUBCOMMITTEE

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OPEN SESSION

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TUESDAY

DECEMBER 13, 2016

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:32 a.m., John W. Stetkar, Chairman, presiding.

COMMITTEE MEMBERS:

JOHN W. STETKAR, Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member

WALTER L. KIRCHNER, Member

JOSE MARCH-LEUBA, Member

DANA A. POWERS, Member

JOY REMPE, Member

MATTHEW W. SUNSERI, Member

DESIGNATED FEDERAL OFFICIAL:

JOHN LAI

ALSO PRESENT:

ALI AZARM, IESS

ERICK BALL, ERI

KEVIN COYNE, RES

MARY DROUIN, RES

FELIX GONZALEZ, RES

DONALD HELTON, JR., RES

DAN HUDSON, RES

ROY KARIMI, ERI

ALAN KURITZKY, RES

MARVIN LEWIS, Public Participant*

BRIAN WAGNER, RES

*Present via telephone

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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'm John Stetkar, Chairman of the Subcommittee meeting.

ACRS Members in attendance are Ron Ballinger, Matt Sunseri, Dana Powers, Dennis Bley, Walt Kirchner and Joy Rempe. Dr. Mike Corradini will join us later in the afternoon, perhaps. John Lai of the ACRS Staff is the Designated Federal Official for this meeting.

The Subcommittee will hear the Staff's presentation on the progress of the Level 3 PRA Project, any integrated site risk approach in an open session of the meeting. The Staff will discuss the pilot study of integrated site risk, lower power shutdown, and dry cask storage risk assessment in a closed session of the meeting. A portion of this meeting will be closed in order to discuss and protect information designated as proprietary by U.S. NRC pursuant to 5 USC 552(b)(c)(4). I hope I got that right.

There will be a phone bridgeline during the open portion of the meeting, and we will switch to a different bridgeline to protect the discussion of proprietary information for the closed portion of the meeting.

To preclude interruption of the meeting the phone will be placed in listen-in mode during the presentations and Committee discussions. I'll open the public bridgeline at the end of the open session to see if there's any public comments on that session.

We 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 published in the Federal Register.

A transcript of the meeting is being kept and it 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. Participants should first identify themselves and speak with sufficient clarity and volume so that they may be readily heard. And I'll ask everybody to please check your little communications devices and turn them off.

We will now proceed with the meeting, and I call upon Kevin Coyne to begin. Kevin.

MR. COYNE: Okay. Good morning, and thank you, Chairman Stetkar. I'm Kevin Coyne. I'm the Acting Deputy Director of the Division of Risk Analysis in the Office of Research. Thank you again for this opportunity to brief the Subcommittee.

As a reminder, this project is being done per SRM-SECY-11-0098, which kicked off the Level 3 PRA project for the Vogtle site.

Just as a reminder of some of the objectives, we've stripped out some of the background material, but one of the key objectives of the project was to incorporate the last 20 years of experience and insights into a full complete Level 3 project to get a better understanding of risk at operating nuclear plants. A secondary objective, and maybe the key one in my mind is also knowledge management for the Staff, to have the

Staff develop PRA skills by actually doing the PRA. So although we had contractor support for the project, and you'll hear from one of our key contractors today, the Staff involvement in the project is really one of the key objectives.

Alan and I tried to count up the number of meetings. I think this is the 10th meeting that we've had on the project, and we've had about a half dozen fact finding meetings with Chairman Stetkar over the last five years. We've really enjoyed a high level of engagement with the ACRS. It's really benefitted the project. The consistency, quality, and completeness of the project has really been improved through these engagements, so they're very valuable for us.

Word on the schedule, I think we're in year five of our four-year project, and there's reasons for that, and Alan will go through some of them in his initial presentation. But it's been a very active last five years for the NRC, and so we've had diversion of some key Staff, and we've basically been assigning appropriate level of priority on this project, so we've kept it moving but we recognize some high priority issues have come up over the last five years; Fukushima response, waste confidence, and those types of things. But we're moving forward; we had a good production year in '16, we expect the same in '17, so the agenda today reflects some of the work that we're getting done.

With that, I think I will conclude the opening remarks and turn it over to Alan.

MR. KURITZKY: Thank you, Kevin. As Kevin mentioned, I'm Alan Kuritzky.

CHAIRMAN STETKAR: By the way, all of you are pretty familiar with this. Make sure the green light is on when you're speaking, and make sure it's off when you're not. It helps extraneous noise on the bridgeline.

MEMBER BLEY: You have one behind your computer.

CHAIRMAN STETKAR: And it's on.

MR. KURITZKY: Here we go.

CHAIRMAN STETKAR: And don't do a lot of that because it's really loud over there.

MR. KURITZKY: Okay. Again, Alan Kuritzky. I'm the Program Manager for the Level 3 PRA Project. I want to echo Kevin's sentiments that we appreciate the time and effort that the Subcommittee puts into this project. We've met with you very often, and it's been very valuable to us. I hope it's been interesting and useful to you, but it definitely has been useful to us.

I want to also mention that even though -- well, first of all, with me up here today also is Mary Drouin, who's the Principal Technical Advisor for the project, and Dan Hudson, who is going to talk to you a little bit later about integrated site risk effort, and Roy Karimi who is one of our contractors with Energy Research, Incorporated, who was supporting Dan on the integrated site risk work. And after the luncheon break we'll be shuffling some other people up here, so just to let you know who's going to be coming.

Going to the outline for today's session, Chairman Stetkar mentioned earlier on what's going to be covered. In the open session it will be my overview, then we'll have a discussion of the general approach for the Integrated Site PRA work that we've been doing.

I want to stress that even though we recognize that intersource dependencies are the primary drivers for multi-source risk or integrated site risk, what we're primarily going to be discussing is the nuts and bolts of how we're going to put that model together. How we're going to prioritize which types of dependencies to look at and how we're going to put the actual model together; the actual full hunt for various dependencies which is a major part of the work is not going to be the focus of the discussions we'll have today.

In the closed session we'll go over and discuss some of the applications we've been performing for that Integrated Site Risk approach, and then you'll hear about our Low Power Shutdown Level 1 PRA model that we've developed for internal events. And then, finally, our Dry Cask Storage PRA, which covers all PRA levels and all hazards.

Okay. So the project status, I'm talking to you today, Mary is going to be with me, but this is actually a huge group of people that have been performing this project. It spans many organizations both within and without the NRC in terms of contractors, and even industry organizations. I'll talk a little bit more about that at the end of the presentation when I do some acknowledgments, but I just want to stress that it's a very large team effort here.

MEMBER BLEY: Just given Kevin's

introduction, at the end are you going to show us a timeline of when you expect things to happen in the future, or do you have one?

MR. KURITZKY: I have actually a timeline, like a Microsoft Project timeline. It's not on here. It would require like 14 of those screens to put this timeline --

MEMBER BLEY: Perhaps simplified.

MR. KURITZKY: But we have a status, kind of like a bar chart about where we are, and then I'll talk about some of the more near term deliverables. But I can also --

MEMBER BLEY: But you'll get to that.

MR. KURITZKY: Yes.

MEMBER BLEY: So I'll wait.

MR. KURITZKY: And when we get to that, if you want to know more about long term schedules then just ask the questions.

MEMBER BLEY: Okay.

MR. KURITZKY: Then I can tell you.

Here is the list of the topics we're going to hit on in my presentation. It's not broken down equally. In other words, we have Level 1, Level 2, Level 3 separately broken out for the reactor at power, internal events, and floods but not for some of the other things like fires; and the reason being that we've done a lot of work in Level 1, Level 2, and Level 3 for internal events and floods, and so we have separate viewgraphs for each of those. Some of the other ones we focused primarily on Level 1 to date, so I haven't bothered to make separate viewgraphs for those.

Okay. So here's the first thing on project status. And what these bar charts represent there, they reflect the combined progress for both the model development and documentation, as well as the various review and update cycles that are involved with each area, and also their weighted combinations of the Level 1, 2, and 3 PRAs. So if you look at the charts you'll see that the reactor, at-power, internal event, flood, and the dry cask storage are the ones that are far along, because in both of those cases we've done a lot of work for the Level 1, Level 2, and Level 3 PRA models. For most of the other areas we've really just worked on the Level 1 to date, maybe a little bit of Level 2 work, so that's what makes those couple far ahead of the other ones.

And a gross look, you can see that

we're probably roughly 50 percent of the way done. You know, these are, of course, loose estimates, but about 50 percent of the way done with the project. I do anticipate between the end of this year and next year we're going to be making substantial headway.

One of the things that's kind of dragging this out has been the whole peer -- the review and update cycle which has really dragged for some of the earlier studies. I think we're going to have to streamline that for a number of reasons. One, just for schedule purposes, and I'll get to later in the presentation there's been changes in our strategy for reviews, and I'll discuss those reasons in a few minutes.

Going on to the internal event and floods, the Level 1 model. We have completed that initial model. It was peer reviewed by the PWR Owner's Group leading a PRA Standards Base Peer Review. It also received a substantial feedback from members of this Subcommittee, from the Subcommittee, and also in fact finding meetings with Mr. Stetkar. And that's led to a vastly improved model, but it also led to major changes in the model, so it was a very substantial effort to redo it. The document -- the model has been redone, the documentation is essentially complete. The only thing that we're still waiting to complete is there's one appendix with operator action dependencies that we're just resolving a couple of last comments, but that's going to be done probably within days or a week or two.

The internal flood report or the internal flood modeling, that's also been redone. That report is also nearing completion. There was a few areas that just need to be cleaned up there, but that as you're going to hear later from --

MEMBER BLEY: You got me curious on the last one you said. The human models where you're looking at dependencies, and the one we're going to look at today on dry cask, and they're on the human reliability analysis, you say the state of the art and thinking about dependencies is the old simple formula that was in the third manual and that applies to people doing essentially routine checking kinds of things.

I expect your overall dependency model looks at more complex issues. Is that same assumption that that's all you can do applying over there, or are you doing some new work in that --

MR. KURITZKY: For the internal events?

MEMBER BLEY: Yes.

MR. KURITZKY: For the internal events -- well, I will say that anything in the thing is all you can do. We're doing a state of practice study and there are various people have ideas, there's different ways of doing things, and it's been the state of practice. We have used a dependency approach that we feel is appropriate for the model, and it's -- yes, I think it's primarily THRP Based.

MEMBER BLEY: Okay.

MS. DROUIN: The dependency model, whether it's on the Level 1 across is all pretty much based on the good practices document. And if you go in there there's quite a bit of extensive discussion on --

MEMBER BLEY: Yes, there is. It isn't just the table out of THRP.

MS. DROUIN: That's right.

MEMBER BLEY: Okay.

MS. DROUIN: That's right.

MEMBER BLEY: That makes me happy. Thank you. I look forward to seeing what you've done there.

MR. KURITZKY: Okay. So, essentially, the internal event one is done except for a few loose ends. The internal flood, there's a couple of things that just need to revised and cleaned up in the report. Jeff Wood will be talking to you later about our Low Power Shutdown model. He's also in charge of internal flood, so he's got to get the Low Power Shutdown report done before he can go back and tie up the loose ends on the internal flood work. That's one of the things that we've been juggling of late. We have a lot of people on the project now double booked, and so that's one of the reasons that we are dragging some things out.

Also, as we've briefed the Subcommittee before, we completed an expert elicitation on interfacing system LOCA frequencies and break locations, and that work has been completed and has already been documented.

Going on to the Level 2 modeling for internal events and floods, but also we completed the initial model, had that peer reviewed. Again, a PWR Owner's Group led peer review, Standards Based Peer Review. We also got a lot of feedback from our Technical Advisory Group on that model, as well as feedback from the Subcommittee.

In revising that model we went and reran all the MELCOR calculations, also we had to run a few new ones. That's all been completed. We're now into the probabilistic modeling part; most of that has now been completed, also. What we're working on right now is cleaning up some of the uncertainty analysis work, and primarily documenting it. So that should be completed in the near future.

One thing we did come up with in doing the Level 2 requalification is because we link our Level 1 and Level 2 event trees together, we have a lot of accident sequences, and that's caused some hiccups with our PRA computer code, and so we're exploring various options for how to crunch that giant model. What we've been doing right now is quantifying in stages or phases, you know, a set of sequences and then combining the results afterwards. That may be the way we ultimately do it, but I don't want to say that's final right now, but just because it's too big right now just to run the whole thing at once. But it's not a showstopper, but it's -- we have to just work around that.

We hope to have that model and the

results ready to go to the Level 3 PRA Team hopefully in the next few weeks. The source terms have already been handed off to the Level 3 PRA Team, so right now it's just a question of finishing up the qualification and giving them the report.

MEMBER BLEY: I'm still looking at your bar chart.

MR. KURITZKY: Yes.

MEMBER BLEY: And the Level 2 and Level 3, is that all kind of embedded in the reactor, at-power, all hazards?

MR. KURITZKY: Yes. Each bar is kind of like a weighted average of the Level 1, 2, and 3.

MEMBER BLEY: Oh, okay.

MR. KURITZKY: All based on numbers that I made up using engineering judgment.

MEMBER BLEY: Okay.

MR. KURITZKY: Okay.

CHAIRMAN STETKAR: By the way, just for the record, we've been joined by ACRS Member, Dr. Jose March-Leuba. I just want to make sure you got your attendance on the attendance sheet here.

MEMBER MARCH-LEUBA: Yes, thank you very much.

MR. KURITZKY: Okay. Moving on to the Level 3 analysis, that part of the study also received a Standards Based Peer Review, and we're in the process of updating that model to reflect the peer review feedback, our TAG feedback, and other comments.

While much of the work is being done in parallel now to our Level 2 work because since the source term information has already been available to the Level 3 Team, they can do a lot of what they need to do to update their model in parallel with wrapping up the Level 2 study. There are some things that will just, obviously, have to wait until the Level 2 is complete, some of the final frequency numbers, et cetera. But, nonetheless, we hope to have that updated model completed sometime in the spring, in which case they will pass that off to our Risk Characterization Team, and that team essentially just takes the release category frequencies, combines it with the consequences and comes up with the risk metrics.

For internal fires, reactor, at-power internal fires we completed an initial model I think relatively early last year. But since that time -- and it was heavily leveraged on the licensee's peer reviewed Fire PRA model, but since that time the licensee redid their Fire PRA model because there was a number of issues particularly with electrical cabinet fire modeling. They gave us their new model, necessitating us to go ahead and redo our Fire PRA model. Now we have essentially redone that Fire PRA model. It was going through review. One thing we identified in the review was some issues with the Human Reliability Analysis, particularly with -- we had initially adopted the fire HEPs from the licensee's Fire PRA model, but then we realized there were some inconsistencies because we had requantified many of the HEPs from the internal -- the licensee's internal event model, and because of that we were coming up with some situations where we might have an HEP for a particular action in the fire model that was lower than the one we now had in our internal event model. So what we decided to do there is also since we couldn't really own and support some of the HEPs from the licensee's model, we decided to use the NUREG 1921 scoping approach to do the fire HRA initially, and that come up with a new set of values.

We already have some interim results

from that. There are certainly some of the scoping values that are driving, heavily driving the risk, so we're going to have to look back into those and see if we can get enough information to do a more detailed evaluation of them.

MEMBER BLEY: 1921, is it the fire HRA?

MR. KURITZKY: Yes, the scoping approach.

MEMBER BLEY: Oh, well it includes the scoping approach, but most everybody we've talked to who's tried using it has eventually given up on that and gone just on the analysis because they said it didn't work very well for them.

MR. KURITZKY: Right. Most people working with utilities who have access to all the information needed --

MEMBER BLEY: That's true.

MR. KURITZKY: -- to do what we do. Unfortunately, we don't have that information so we -- that's why I'm saying we're -- we've used it. It is definitely skewing our results badly, and we need to take at least -- the good thing is, it looks like there's a very small subset of actions that are really driving things, so those are the ones we need to do a more focused analysis on. I'm hoping that since it's a small set we might be able to get enough information from the licensee to be able to reevaluate those.

MEMBER BLEY: Well, I guess that's what you'd hope with the scoping analysis. Okay.

MR. KURITZKY: Yes.

CHAIRMAN STETKAR: And be aware of the boulders, and rocks, and pebble syndrome; that once you get rid of the big boulders, you're going to start seeing the rocks.

MR. KURITZKY: Right. But the rocks will not be nearly as alarming to us as -- the boulder sitting on the top of the hill is a lot more scary than the rock sitting up there. So yes, but we appreciate that.

Okay. So we hope to have the internal fire model and documentation completed in the next --probably sometime in January, I'm hoping optimistically, depending on how long it takes to wrap up those HRA issues. And then we'll be ready for what we previously called the peer review, now we call it the Technical Adequacy Review. And that brings me to the thing I mentioned earlier about peer reviews.

Up until now, we've been very fortunate

that the PWR Owner's Group has led and funded our Standards Based Peer Reviews. Unfortunately, going forward they're not in a position to fund those to the extent that they had in the past, so we're going to have to explore different options for doing some type of Technical Adequacy Review that is not necessarily going to be a full Standards Based Peer Review. And that's something we're still working out, so right now we just call them Technical Adequacy Reviews, and what that's going to involve we haven't quite decided yet.

CHAIRMAN STETKAR: Do you have any idea -- is it too premature to ask who might be doing those Technical Adequacy Reviews?

MR. KURITZKY: It is too -- because we don't even know what the nature -- how they're going to be done yet.

CHAIRMAN STETKAR: It's just something that's this big and will have this visibility, you're well aware should have a -- certainly an independent notion of that review in as much depth as you can afford.

MS. DROUIN: We are hoping that the PWR Owner's Group will be doing some of these. They're meeting right now to discuss this. Their budget was severely cut, so we're not going to be able --

CHAIRMAN STETKAR: No, I recognize that. It's just that -- and even having people in house or even in your contracting labs do it is just part of the same family looking at the stuff that the family does, and that's not necessarily a good thing.

MS. DROUIN: I know the PWR Owner's Group wants to do something, and so they -- as I said, they're in meetings literally this week.

CHAIRMAN STETKAR: Okay.

MS. DROUIN: And we hope to receive good news from them that they'll be able to do something.

MEMBER BLEY: But they've already done a number of reviews. They looked at the Level 1 --

MR. KURITZKY: The Level 1, internal event and flood. The Level 2 internal event and flood, Level 3 internal event and flood, and the Level 1 high wind and other hazards.

MEMBER BLEY: Okay.

MR. KURITZKY: And they also worked with us to come up with review criteria for the dry cask storage.

MEMBER BLEY: Okay. They haven't looked

at all at Level 2.

MR. KURITZKY: Level 2 for internal --

MEMBER BLEY: Oh, internal.

MR. KURITZKY: Level 2 and Level --

MEMBER BLEY: Level 2.

MR. KURITZKY: They had -- we had the draft standards for a pilot application --

MEMBER BLEY: Okay, thank you.

MR. KURITZKY: The next thing they were going to do for us was the Low Power Shutdown with the draft standard. Unfortunately, now we're in a new regime so I don't know exactly how that's going to play out. I think they seem --

CHAIRMAN STETKAR: But the Low Power Shutdown is next up on the --

MR. KURITZKY: Was supposed to be the next up.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: It's --

(Simultaneous speech)

MR. KURITZKY: They're all coming up around the same time, the fire, the seismic, they're all coming to fruition at the same time.

Okay. Seismic events, similar to the fire we have completed the initial seismic model earlier last year, but again later in the year a whole bunch of new plant-specific seismic hazard occurs, and plant-specific fragility information so we've gone and redone that model. We've completed the redo of that model and the documentation. The only thing that we still have to do is we're just finalizing some of the writeups for the new hazard and fragility information.

CHAIRMAN STETKAR: And I want -- really I was going to ask this earlier but I decided to wait. When you characterized the linking of the Level 1, 2, 3 models you said well, you know, the Level 3 people have things already set up, and all you need to do is take the frequencies from the -- the frequencies of the release categories from Level 2 and assign them to the right Level 3 conditions, and you're done there. Not so easy on seismic events, and that's done in flooding which probably is not a big issue at Vogtle, but seismic events; how are you looking at tailoring your Level 3 analyses to account for the seismic damage?

MR. KURITZKY: Okay. So let me just clarify. I may have misrepresented. We -- the idea was taking the release category frequencies combined with the consequences to get the measurements, that's the risk characterization test at the end.

For Level 3, what I mentioned was there's a lot of the work they can do right now because they have the source terms, but there are some things they can't do until they get the frequencies.

CHAIRMAN STETKAR: Right.

MR. KURITZKY: That's not to say that there's no work. The Level 3 Team is doing very specific work for each of these different things, and for seismic we'll have to consider impact on the evacuation models and EP based on impacts of seismic, et cetera.

CHAIRMAN STETKAR: Okay. But, I mean, in terms of the work that the Level 3 folks do, you're not going to have them do a continuous spectrum of possible damages out there in the infrastructure or the full range of the seismic hazard, are you? You know, in principle they could do that, or maybe not even for the -- I don't know how you're doing the seismic stuff because we haven't seen it, but the --- even the discrete seismic bins that you have, it may not be necessary.

MR. KURITZKY: Right. It's premature for

me to speak to that because --

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: -- we haven't started doing the Level -- even -- our Level 3, of course, I don't think is -- even at this point, I don't think he would be able to tell you much until we get to that stage.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: But, again, we're going to do -- like anything, we're going to do the minimum necessary to get a good answer, you know. We're not going to try to over do the problem if we don't have to.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: Okay. Again, so the seismic report for the Level 1 should be done I said late '16/early '17. At this point, late '16 is looking a little shaky since we're already into December, so let's say -- let's go with January on that one, but it should be done very soon.

For the reactor, at-power, high winds and other hazards, again these as we just mentioned were also subjected to a PWR Owner's Group led Standards Based Peer Review. We're in the process of addressing that feedback, as well as the feedback from our TAG.

One of the main comments from the -- I think both the Peer Review and the TAG was that they really didn't have a high wind walkdown performed. It really was using our seismic walkdown, and they made a few notes or observations related to wind. And so we have since gone back and had our primary commercial contractor, Energy Research, Incorporated, a subcontractor with Applied Research Associates, which is a very well known wind PRA outfit, and they went down and did a walkdown for us in November of 2015 at the Vogtle site. They also went and looked and took a look at our initial wind PRA report, and they gave us some recommendations on some further work that they thought, you know, might be warranted. Again, we did not have the full budget to do everything they would, obviously, like us to do and pay them to do, but we did agree to have them do some additional work for us. We've got all that back from them now this past October, and we need to just go ahead and incorporate that into our wind PRA so we can update that.

CHAIRMAN STETKAR: Are you actually going to quantify some wind PRA models?

MR. KURITZKY: Yes, we did. We have quantified that -- we have event trees and we've quantified wind PRA in the beginning.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: But it was a more simplified analysis. Now it's going to be a little more specific and a little higher --

CHAIRMAN STETKAR: Yes, but I mean you are going to have frequencies --

MR. KURITZKY: Yes.

CHAIRMAN STETKAR: -- and fragilities.

MR. KURITZKY: Yes, we have --

CHAIRMAN STETKAR: And all that kind of thing.

MR. KURITZKY: Yes, yes.

CHAIRMAN STETKAR: Good.

MEMBER REMPE: Remind me again on who's on the Technical Advisory Group. It's internal, right?

MR. KURITZKY: The Technical Advisory -- it's primarily internal. The Technical Advisory Group is essentially the Senior-Level advisors in PRA across the Agency, as well as in related areas like thermal hydraulics and EP, structural analysis. And then we also have two people from

Industry, Westinghouse and EPRI have both provided a senior staff member to participate on our TAG, so that's what makes them up.

MEMBER REMPE: Thanks.

MR. KURITZKY: Okay. The Low Power and Shutdown, that's something you're going to hear about in detail in the afternoon session, so I'm not going to take up too much time here. I just want to mention that we essentially have that model complete. And a common thing, some operator action dependencies is the only thing that we're still wrapping up there.

The thing there is we have a lead for human reliability analysis who's been tasked with a whole bunch of stuff all of a sudden at one time, and so she had to try and prioritize which things she's getting done, so that's kind of like a Critical Path item. But, anyway, so we're getting that wrapped up.

And as I mentioned, the recent work we've been focusing on has been the HRA. That's been one of the major -- and the Low Power Shutdown PRA, not surprising. That's one of the major issues that got addressed.

Also, because the scope of the Low

Power Shutdown PRA can be very vast and assuming you do not have unlimited time and resources, you need to have some kind of scheme for managing that scope. And so we came up with what we believe was an appropriate systematic approach to control that scope. We got feedback on that approach from our TAG, and that's been how we've directed our Low Power Shutdown effort. And we have -- like I said, we're going to have a report done, hopefully, very soon, and then it will be available for -- whatever that Technical Adequacy Review will be going forward.

We also had -- we reinitiated work on Low Power Shutdown for Level 2. We actually did some work in Level 2 for Low Power Shutdown earlier on. We've put together some work on the -- did some work on the bridge tree and the plant damage states. Also we've put together and shook down some MELCOR models, but we kind of put that on the shelf temporarily because we needed to wait for the Level 1 effort to be further along. Now that it's coming to closure, we've jump started the Level 2 again. The Level 2 Team is now interfacing with the Level 1 Team to get that work going again.

One of the main things that they are

focusing on is what HRA approach to use. We have an HRA approach that we use for the Level 2 analysis for at-power, internal events and floods, which could serve as kind of a starting point for this, but we also have an HRA approach that we use for Low Power and Shutdown Level 1, which could be a starting point. So whether we try to do our Level 2 Low Power Shutdown HRA approach, kind of base in our at-power Level 2 approach, or our Level 1 Low Power Shutdown approach, or some combination thereof remains to be decided.

Also, because we determined that focusing the scope was such an important item for Low Power Shutdown PRA, we felt that this project and Low Power Shutdown PRA, in general, would benefit if we put together an expert elicitation to kind of rank order what were the important aspects to be included in a Low Power Shutdown PRA in terms of plant outage types, plant operating states, you know, hazards to consider, various influencing factors like equipment maintenance and thermal hydraulic, or containment and RCS boundary conditions, et cetera. So we have now started an expert elicitation using the Phenomena Identification and Ranking Technique to come up with that kind of rank ordered list so that theoretically a future PRA Team that's going to do a Low Power Shutdown PRA, they could start at the top of the list and work their way down until they've used up their resources, and they will have hopefully addressed the most important things as determined by this set of experts.

CHAIRMAN STETKAR: Alan, we're going to have a lot more discussions on the Low Power and Shutdown PRA this afternoon, so I don't want to go into details about that. But just, you know, my first thought regarding the HRA for Level 1 and Level 2, because human performance is so important during Low Power and Shutdown, and there's so much -- so many human actions in those Low Power and Shutdown Level 1 models, it strikes me that there could be an incentive for having -- using the same methodology all the way through Level 2, because changing methodologies just at that artificial, you know, line in the sand, if you will, could cause problems. I don't know, you know, what you're planning to do, and I'm not necessarily endorsing the method that you've used for the Level 1, but just whatever method is used, because the human performance tends to be so important in Low Power and Shutdown, it strikes me that it would be useful, anyway, to use the same methodology all the way through, if it's feasible. And if it's not, you --

MR. KURITZKY: Right.

CHAIRMAN STETKAR: -- need to be really careful about that break point.

MR. KURITZKY: Right. So I'm very sensitive to that concern, but the issue is that it's not really arbitrary break from Level 1 to Level 2. I don't know how exactly it plays out in the Low Power Shutdown, and we're still looking at that.

CHAIRMAN STETKAR: It is in some sense because, for example, if one of the actions early I would assume in Level 2 model is operators reclosing the containment hatch, if it's open. Now, that actually occurs in the midst of things that are going on in the Level 1 models, like when stuff starts to boil. And that's why I say it's an artificial -- just saying well, the action to close the hatch is in the Level 2 model, and the actions taken while boiling is imminent or progressing as in a Level 1 model doesn't necessarily catch the notion that it's sort of a group of people responding within a continuous timeline. That's my notion of this artificial break of, you know, which bin do you throw those operator actions in.

MR. KURITZKY: Right, and I agree. That's a good example of something that --

CHAIRMAN STETKAR: Yes, because that, for example, isn't in the Level 1 model.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: You know, those types of things.

MR. KURITZKY: Right. Now, and this is why I'm saying, I'm not sure how it will play out for Low Power Shutdown. For internal event -- for at-power, it was a bigger concern because the SAMG, the Severe Accident Management Guidelines, et cetera, it's a whole different paradigm than the operator procedure based --

CHAIRMAN STETKAR: Yes, I could twist my mind in internal events, at-power to somehow rationalize that break; although, on the record I'm not twisting my mind that way, but I think it's a lot easier to think of that in the context of that model. But Low Power and Shutdown seems to be a bit different.

Dr. Powers, you've been shut off twice

now, and I'm --

(Simultaneous speech)

CHAIRMAN STETKAR: -- ceding the floor to you quickly.

MEMBER POWERS: It seems to me that I would make a transition or would not be surprised that somebody would make a transition in their treatment of HRA between Level 1 and Level 2, simply because errors of commission become far more likely and consequential once you go into the Level 2 regime. Is that not correct? Am I thinking poorly here?

CHAIRMAN STETKAR: I don't know, actually. I don't like to make those value judgments about the relative importance of omission or commission in that sense on Level 1 versus Level 2. I'm more concerned --

MEMBER POWERS: It seems to me that you get into a regime that's unpracticed here where --

CHAIRMAN STETKAR: It may be --

MEMBER POWERS: -- remarkable phenomenological events occur that are at best poorly predicted with existing technologies.

CHAIRMAN STETKAR: It may be -- and I think you're right, that you may -- you want to make sure that whatever methodology you select is capable of addressing those concerns. And whether those concerns are more important in, you know, the Level 2 chunk of the model than the Level 1 of the model kind of depends on scenarios and stuff.

MEMBER POWERS: Presumably, you could have an HRA model that's perfectly capable for low phases to handle errors of commission, but I got the impression that there was a certain element of expediency here to quote the speaker, don't overwork the problem, just get a good answer, which I'm not sure everybody would fall all over themselves on that, but I think I understand the sentiment.

CHAIRMAN STETKAR: I'm a bit more concerned about the types of conditions that I mentioned earlier where you have actions that are evaluated in the so-called Level 2 PRA models --

MEMBER POWERS: Oh, I understand your --

CHAIRMAN STETKAR: -- that are being taken in the midst of things that are going on --

MEMBER POWERS: Yes, you're saying you're binning it one and in the other.

CHAIRMAN STETKAR: Right.

MEMBER POWERS: And then somehow you change, but I think a good answer should be the same for actions that simply fall from bin to bin, but in general in Level 2 PRA land, I think you're tracing into areas that -- where proceduralization is more qualitative than it is during Level 1 PRA. I mean, it just --

CHAIRMAN STETKAR: That's certainly true, I mean, as Alan mentioned.

(Simultaneous speech)

MEMBER POWERS: That I might -- especially under Low Power Shutdown conditions, if I went into -- transitioned into an accident where I was likely to get core damage, that the potential impact of errors of commission would be much more consequential. It just seems to me. I don't know, but I would not leap up and be shocked if a more sophisticated approach to HRA were adopted.

CHAIRMAN STETKAR: Don.

MR. HELTON: Don Helton, Office of Research. I was just going to clarify that -- so you brought up the issue of containment closure, and that is certainly an action that falls in the modeling of the bridge tree, which can be called the Level 2, but it's occurring prior to core damage. That's something that we're specifically addressing by having quantified initially by the Level 1 HRA method and then extending it to the various -- the suite of different situations that are of interest to the Level 2. So, in effect, from an HRA perspective we're treating that as a Level 1 HRA issue.

Specifically, what Alan is referring to in his slide is are actions that are being taken following core damage using the extensive damage mitigation guidelines as opposed to the procedures -- the different set of procedures that are in play prior to core damage.

So all of that said, we agree with much of what you're saying, and then these are the sorts of things we're trying to factor in and consider the pros and cons in selecting a method.

CHAIRMAN STETKAR: Are you going to be around this afternoon?

MR. HELTON: I will be for the Low Power -- through the Low Power Shutdown.

CHAIRMAN STETKAR: All right, good. Thanks. We can talk a little bit more in detail then in closed session. Thank you.

MR. KURITZKY: Okay. Again, this

feedback is very timely, because we are in the process of trying to come up with a method, so all this feedback is very useful. And as you saw, many of the people that are going to be involved in that decision are either here or listening in, so it's good feedback. Thank you.

CHAIRMAN STETKAR: All right.

MR. KURITZKY: Okay. Moving on to the Spent Fuel Pool. That's one that -- an area that we haven't made a lot of progress on, but we have made some. This is a situation where we have essentially double booked our own Staff in a sense that the person to lead this is in charge of many other activities both in this project and outside the project, but we have gotten some things done over the last couple of years.

We did define operating states, and we've been interfacing with the parts of the study that are most relevant for the Spent Fuel Pool; that is the dry cask storage, and the Low Power Shutdown modeling. We also have done some work in developing a MELCOR model for the Spent Fuel Pool, and developed and been shaking it down. And we have put together some event trees for seismic events which we believe to be one of the more dominant contributors to Spent Fuel Pool risk for all the different seismic bins, and operating states for the Spent Fuel Pool. But the reality is, is that we just haven't been making enough progress here, so we have decided to shuffle things up a little bit. We're putting a new -- we put a new Task Lead onto this part of the work to kind of break that bottleneck, and we're also going to farm more of the work to our contractor just to get the whole thing moving forward a little bit more quickly.

Dry Cask Storage PRA; again, this is one that you'll be hearing a lot more details about in the afternoon session, so I'm not going to belabor it, just to mention that we have completed our Level 1, 2, and 3 PRA for all hazards for the Dry Cask Storage. But as part of the review of that work, we made a decision that we wanted to revise the consequence analysis. The initial model used the consequence analysis from NUREG -- largely used the consequence analysis from NUREG 1864, which was the NRC's previous Dry Cask Storage PRA, but that work was not done -- it was done for a different site, and so we decided it was worth the time and effort to do a little more rigorous look into the consequence analysis for Vogtle itself. So we're in the process of redoing that; that should be done momentarily. You're going to actually hear -- I think most of that stuff has been completed, and you're going to hear some of that in the presentation this afternoon. We just need to tie up some loose ends and get the documentation cleaned up.

MEMBER BALLINGER: Are you going to factor in -- I think there's an EPRI project now to do consequence analysis for Dry Cask Storage, which I think the report is supposed to be issued sometime in 2017, I guess. Is that going to be factored in in any way?

MR. KURITZKY: I don't know whether or not we had that information in time to do any work with it. I think not. I think that time-wise it's just something we have not considered. When we discuss this in the closed session you can bring it up, because then the people who have been doing the work will be able to respond to you.

MEMBER BALLINGER: Thank you.

MR. KURITZKY: But I think time-wise that's not lining up. We hope to have this thing ready for -- whenever that next step Technical Adequacy Review is going to be, that should again be ready by the beginning of next year.

CHAIRMAN STETKAR: Beginning of next year being like 2018, or 15 days from now?

MR. KURITZKY: Like I said, I think the analysis has been done. You're going to hear about it this afternoon. It's just tying up the documentation and doing a few more -- have that part internally reviewed again before we go out for external review.

Okay. Integrated Site PRA; again, something you'll hear about this -- in fact, you'll hear about the approach right after my presentation right now, and then you'll hear about the pilot studies in the afternoon session since they involve some proprietary information.

But, again, I just want to reemphasize that we recognize that this was the driving force here for Integrated Site Risk, or multi-source Risk. So that's, obviously, a key focus of the work. But what we're talking about now is even once you have identified those dependencies, you need to put the model together. And so what we're actually going to discuss, primarily, is our approach for putting the whole model together and coming up with the Integrated Site results.

And, also, because there's almost a limitless source of potential intersource dependencies, you have to have some type of prioritization on what you're looking at to get more bang for your buck, so to speak. So you don't want to spend a lot of time and effort looking at various potential dependencies that aren't really going to make a big difference in the risk picture. And so we have an approach that we have come up that we think will help us be much more efficient and focusing our effort, and that will also get described in the next presentation.

MEMBER BLEY: You haven't given us any reading information on this.

MR. KURITZKY: No, all we have is the present -- we don't have any documentation on this yet. Just the slides that you're going to get is -- all we've internally has been the Team giving us presentations, and you're getting essentially the same presentation.

MEMBER BLEY: Okay.

MR. KURITZKY: You'll know as much about it as I will by the end of --

MEMBER BLEY: I've been in a couple of meetings in the last few weeks outside of here.

There's an awful lot of interest in this idea.

MR. KURITZKY: Yes.

MEMBER BLEY: And people are going to be watching very closely for this when it comes out.

MR. KURITZKY: Right. Okay. And now Mary is going to talk to you a little bit about some of the documentation that we are going to produce, or have been producing for this project.

MS. DROUIN: Okay. You know, documentation -- sorry. As important as the technical work is, you know, how you judge the adequacy of the technical work is on the documentation, and how well we do that.

The documentation is a huge challenge on this project just because of the shear size of it. And when you break it down, we essentially have six types of documentation. There will be the published NUREG which will be publicly available, and I'm going to get more into detail what that NUREG is going to look like. We're using to a certain extent NUREG-1150 as our guideline of what to include in that NUREG report.

Technical reports, those are more akin to like the NUREG/CR-4550s. These have all the details, but another key part of the working files, and we've put a lot of effort into these working files because this, in my mind, is what's providing you the traceability of the work. We went into a lot of effort to make sure that the Staff -- you know, that they're documenting the normal assumptions you make in the course of your work. When you're having discussions and decisions that you make, these are the things that, you know, really in a lot of sense can drive the results, and you don't get those documented very well. And you have to go back to the actual offer. Well, we're trying to create a program where, you know, five years down the road the documentation will hold on its own, and you don't need the people there if you wanted to go back and truly understand, you know, how this model was built and everything.

MEMBER BLEY: That's really important if you can do that. I'm remembering there was an NRC project a few years ago in PRA where because the area -- and Alan mentioned that you're having to maybe make some modifications in the computer code. By the time the project was finished there had been so many modifications in that computer code that by the end you couldn't run the work that had been done in the early year or two and get the same answers. Things had been changed, and I hope part of this documentation is maybe retaining versions of the code that you used to do the analysis, even though it's being changed in the future.

MR. KURITZKY: And let me just -- Dr. Bley mentioned, just on top of that. So one of the things we do for all of our technical reports where we produce results is we document the version of the code and the version of the model, because we have many, many versions of both, more of the model than the code, but still many, so we want to have that code and model version so that we can, in fact --

MEMBER BLEY: And you've actually got those archived, because they disappear.

(Simultaneous speech)

MR. KURITZKY: The concern is going to be years going forward will they still be archived. It's on a server that the lab maintains for us. I don't know what the long-term prognosis for that is, but at least for the time being we have them all archived and documented.

MEMBER BLEY: Budgets are tight but right now storage is almost free, so you think of other ways to back it up.

MEMBER REMPE: When you say the "lab," which lab is it?

MR. KURITZKY: Idaho.

MEMBER REMPE: Okay. So experience has indicated when NRC budgets dry up, the archival information at a National Laboratory will disappear, so you might want to consider having it somehow or other transferred back to NRC.

MR. KURITZKY: Yes. We haven't decided yet exactly how we're going to deal with the long-term storage. It's something we've already -- Kevin and I have already started discussing, and so we haven't come up with an actual answer. But it's on our radar, because we want to have some way to preserve that and have access to it after the project is completed.

MEMBER KIRCHNER: How are you dealing with the QA of the codes? You just mentioned the codes are evolving. Do you go back and then rerun earlier studies and results, and do you get conversions?

MS. DROUIN: We do some level of benchmarking, but probably not to the level of detail that you perhaps are desiring.

MR. KURITZKY: Kevin, you want to speak

to that?

MR. COYNE: Yes, so SAPHIRE is the name of the computer code we use for the PRA modeling. It's developed and maintained under our formal QA Program that meets NUREG/BR-0167, which is our software QA requirement. And we've got a stack of QA documentation a couple of feet high that -- both the QA Plan and the supporting documentation, and it falls under INL's normal lab processes for software development and control.

So the other thing we've done with this project is we haven't had a philosophy of developing a breakaway version of SAPHIRE just for the purposes of the Vogtle Level 3. We're using the main production version of SAPHIRE that we used to support SPAR models in the ROP. It's the same version that is running the model.

Now, there's some time issues that, you know, we may have the capability that supports the Level 3 project that doesn't exist in the, you know, production released the code but eventually we merge those back, so our goal is to have a single version of SAPHIRE used for all NRC applications. And that will make it easier for us to maintain the accessibility of the Vogtle model going forward.

We had a Lesson Learned with the NUREG -- I'm drawing a blank. The previous PRA study.

MS. DROUIN: 1150.

MR. COYNE: 1150. I kept thinking of 2150 and I knew that wasn't right. NUREG-1150, where they did find the archived PRA models on paper taped in a closet in Idaho National Lab, and so --

MEMBER REMPE: You were lucky.

MR. COYNE: Well, we were lucky we found it, but we had no means to run it, so that's one of the things that we've been considering longer term, is that because knowledge management is such a big part of the project, we want to be able to keep this code at least being able to run under the current release of SAPHIRE going forward. As Alan said, we're still kind of working out what the best way to do that would be, but that is our end goal, is to make the model runable with future versions of SAPHIRE. But, Dr. Bley, you bring up a good point, and that's why we've done this archiving, that the Low Power Shutdown may have been version 237 which, you know, there'll be another version in the future. So the availability of those earlier versions may be something that we have to give some more thought of how we maintain that.

MEMBER BLEY: Okay, thank you.

MS. DROUIN: So, I think that we given you a presentation in the past on our QA Plan, and our QA plan goes into quite a bit of detail on documentation and the templates that we've created that, you know, the whole team follows. And documenting, hopefully, every little thought; I mean, it's not quite, you know, that extensive but, you know, we really have tried to do a good job on documentation. And I can tell you the documentation we're doing on this job far exceeds the documentation we did on 1150. It far exceeds it, so we have made, you know, substantial strides in that area.

CHAIRMAN STETKAR: And kind of playing on your theme of every little thought; you can't document every little thought.

MS. DROUIN: No.

CHAIRMAN STETKAR: I have --

(Simultaneous speech)

CHAIRMAN STETKAR: No, but I brought this up in the past. I've personally been frustrated when I've picked up Risk Assessments done by others, and I've been probably more frustrated when I've picked up Risk Assessments done by myself years later looking at them and asking myself well, my heavens, why didn't they look at X? And in many cases, analysts are fairly good, fairly good, not always very good at saying today I made the decision to do X because. They're not as good at saying today I made an active decision not to do Y because. And that's really, really important in terms of the legacy of the PRA because it's awfully useful to future analysts to know that at least today I thought about it, and had a reason why I didn't do something. That means that I, in the future, don't need to go back and recreate everything to figure out whether it was just an oversight or, you know, something like that. That's really important in terms of this sort of growing the ability of people within the Agency to do these types of analyses, and to understand sort of the progression of them in the future. So I hope you're trying to encourage analysts to --

MS. DROUIN: We certainly are encouraging them --

CHAIRMAN STETKAR: When they're making those active decisions. Now, if they don't think about something, they don't think about something. So, basically, if I see silence, I assume it was, you know, an oversight, or they didn't think about it. But if there's an active decision made, that I'm not going to model this because, then that's important.

MS. DROUIN: They certainly have been encouraged to do that.

CHAIRMAN STETKAR: Okay.

MS. DROUIN: And when you do go into our QA Plan on the template and the instructions, you know -- and we've given the analysts a lot of flexibility, because we don't want to get, you know, so black and white and prescriptive. So, you know, there is, you know, guidance and, you know -- there is guidance for that. And, hopefully, we have captured more of that than not.

CHAIRMAN STETKAR: You certainly don't want to make it a fill in the box type process.

MS. DROUIN: Right. And we've tried --

CHAIRMAN STETKAR: Because that --

MS. DROUIN: -- you know, not to do that.

CHAIRMAN STETKAR: That is, actually, useless.

MS. DROUIN: Yes.

CHAIRMAN STETKAR: so, okay. All right.

MR. KURITZKY: Also, let me, if I could, Mary, just to step into that just one minute. So as Mary said, we have tried to encourage that. And no one is going to document every little thing. You're doing work; you can't document every thought. And we don't make any claims that we're anywhere close to that, but we have tried to push that envelope much further than it has typically been done in the past. We have the meeting templates that Mary had mentioned that she designed for us that -- to capture the decisions, and we do have quite a few of those filled out, and so we do have things, the basis for why we did something, or why we didn't decide to look at something. And we have an issue tracking list that we maintain for the project, which is now at well over 300 items that identifies issues when they come up, and then as -- their proposed resolution, and then when it is resolved, how we resolved it. And a lot of times you'll see in there things that we decide to pursue or not to pursue, and the reason why. So we're not going to claim anywhere near 100 percent completeness, but I think we're doing a lot more in that regard than may have been --

CHAIRMAN STETKAR: That's good. You're never going to get 100 percent, and it's silly to strive for that. But it's just a matter of kind of instilling that notion among people that if they do make an active decision and they think it's important, you know, write it down.

MS. DROUIN: You know, as Alan said, we have the assumptions. You know, we ask them to document decisions they make, you know, in meetings and stuff like that. We've provided extensive guidance on documenting the assumptions they make just in the course of doing the analysis. So, you know, once again, you know, we really have tried to go, you know, that extra mile in capturing that kind of information which is normally, you know, not captured in analyses. And then it's hard to reproduce and understand how the model was created, so we really have tried -- we've put a lot of thought into that. It would have been really nice if we could have done, you know, an interactive thing, but that was way beyond us.

There's also an incredible amount of information from Vogtle that we have that's just within, you know, the Team for use. It's not publicly available information; a lot of reference sources. And then the last set of documentation they're all the different project reviews, and extensive reviews, because each team member does a self-assessment of their work, and we have a TAG review. The goal was, hopefully, to have peer reviews on everything but, you know, because of the budget of the PWR Owner's Group, so we're looking at that to do these adequacy reviews. And there are reports from all of these that are documented.

CHAIRMAN STETKAR: I hate to bring this up but I'm forced to. How are you handling that bridge between the Vogtle proprietary stuff and what is available in the rest of the project documentation? I'll give you an example, perhaps a silly example.

I have a Vogtle pump that puts out X.YY gpm flow. Is that a proprietary set of information, or is that non-proprietary because that X.YY gpm of flow might appear in some thermal hydraulic analysis?

MS. DROUIN: Let me get to the next slide and try and answer that as part of what --

CHAIRMAN STETKAR: Okay.

MS. DROUIN: -- well, it's probably in

two slides from now. But in the next one, you know, on the NUREG -- and this is what's going to be publicly available. So, you know, we want enough information so that, you know, you can understand the technical approach, you know what the major assumptions are, you have a fundamental understanding of the design and operation of the plant, the results, you know, the insights and perspectives. And then these last two, you know, the potential uses and the future work; the future work one is continually growing because, you know, as we get closer we're not able to do as much as we want, so we're documenting this stuff as future work. We are going to try and insert hyperlinks where we can.

Now this, I think, next point gets to your point that you raised, Dr. Stetkar, that, you know, the level of detail that we can put in this report, you know, recognizing, you know, the concern from Southern Nuclear, the proprietary, you know, that's the challenge that we are facing. So, you know -- and then just the shear size of this program, you know, the fact that it's not just a Level 1, 2, 3 for a reactor, you know, it's all operating states, all hazards, reactor, spent fuel pool, so how do we capture all of this, you know, in a document, just the shear amount of information? And to organize it in a manner that's understandable and you're not overwhelming the reader, because there's many different ways that you could organize this information. You could go through and say I'm going to do all the Level 1 by itself, or I'm going to do all one hazard by itself. So, hopefully, the way we've organized it, you know, I don't know if it -- hopefully, it makes the most sense and the easiest for the reader to comprehend.

We are also -- we've already started having dialogues with publications because I'm sure you all have seen from other programs, publications is a challenge. So we're trying to work with them right away so that when we actually go to publications it'll be smooth. You know, we're contemplating or we're pursuing the idea of maybe we publish different volumes at different times, and it's not all one at the end, but these are all things that will happen. Go ahead.

MEMBER BLEY: For me, this is a good overview of the public report. Are you having some kind of parallel internal report that ties -- for

NRC Staff next year or the year after, ties you back to the proprietary information, or is it just in a big catalogue?

MS. DROUIN: We have guidance for the next level of reports, the technical reports, and there are references -- I mean, everything has to be referenced.

MEMBER BLEY: Okay. Back to the -- if it's proprietary back to the --

MS. DROUIN: Yes, yes.

MEMBER BLEY: Okay, so you can track --

MS. DROUIN: So, in the technical reports you will see the proprietary information. Okay, so if we go to the next slide.

Okay. Here is how right now we've sort of organized the public report. So right now we're contemplating, you know, having three parts and it may be in three separate volumes. Depending on how much it turns out, it may end up being five volumes, so nothing here has been pre-decided, but pretty much the organization. So in the first part we're looking at doing an introduction, you know, and a summary of the approach, and a plant description. So, you know, the introduction standard stuff you see, you know, background, objective, scope, all that kind of stuff.

Then when we get to the summary of the approach, the way we've tried to do this is that -- and a lot of this is actually written, is that, you know, kind of an overall approach. But when you look at, you know, your different parts of your PRA, your technical elements at a generic letter -- you know, you have to do a systems analysis, you have to do HRA, you've got to do data analysis, so we've taken all these technical elements and written a high-level generic approach to how you do each one of those. And then as we go into the reactor risk model we'll say okay, for HRA here's how we did it for this part of the model. So we won't keep repeating, so we have the generic elements written up front in 2.2, and then how we applied them to the different parts of the model, you know, are then in 2.3, 2.4, 2.5, and 2.6.

The summary of the plant description; I'm really pushing the envelope here, and anything that I can find on the internet, it's going -- you know, so I'm sort of doing a double check to see what I can find there. And then, you know, we're going to allow, of course, Southern Nuclear to take a look at this, but hopefully they will not have a problem with the level of detail that we've put in terms of summarizing the plant description.

Then Part 2 is getting into the results, and we just organized it by, you know, the reactor, the spent fuel pool, dry cask, the site risk results, and then it's broken down into Level 1, Level 2. So here's how we've divvied up the pie there.

And then the third part is trying to get into, okay, given some insights, you know, what are the overall, you know, perspective, you know, your dominant accident sequences, your significant contributors, et cetera. And then we would go and give the perspective for each piece of the PRA model, you know, the reactor, the spent fuel pool, the dry cask storage, you know, and the site risk results.

Then we thought it was important to kind of step back and say, okay, what have we learned from this study, you know, and compare it to the -- we've gone all the way back to LARS 1400, you know, starting with the Reactor Safety Study, looking at NUREG-1150, you know, what insights we got out of IPE and what's been updated since then. And then looking at --

MEMBER POWERS: I can certainly see why you might want to go back to 1150, and even the IPE and, of course, we can't comment without failing to mention the superb, and excellent, and wonderful IPE summary study conducted by someone who will remain anonymous, but I can't see what the utility is going back to RSS.

MS. DROUIN: You know, it may turn out that when we looked at that we may delete it, but I don't know. But I didn't want to pre-throw it away. You know, maybe --

MEMBER POWERS: Well --

MS. DROUIN: -- just from a historical point to show what we've learned, you know, since that -- since 1975.

MEMBER POWERS: It seems to me that what you've learned from 1150 forward is far more germane. I mean, I absolutely endorse taking from the IPE summary document forward, and certainly if you could produce something of equivalent impact to your IPE summary document, that would be superb.

MEMBER BLEY: I wouldn't completely agree. I mean, LARS 1400 was such a major step forward. Some of the things that were looked at in detail there have never been looked at again because of what was found looking there. For example, a lot of the stuff on containment isolation, I mean, that was a massive piece of work in their study and nobody's ever approached it at that level again. For me, it's worth a look and pulling out salient things from back then.

MS. DROUIN: Yes, as I've said, you know, as we start going down into this how much -- you know, it's -- you know, we haven't even started this part of the report yet; no more than thinking this should be in the report. And, you know, we may revisit this as we start writing it, but that's our intent, was to go and look all the way back to LARS 1400.

MEMBER BLEY: But it is 40 years ago.

MEMBER POWERS: One can't omit the overall perspective item called "Significant Uncertainties." It catches attention, especially when you plunge into Level 2 land, because there are substantial uncertainties there. And I wonder what that encompasses; in particular, does it encompass things that are inherent to your core degradation modeling that dictate the accident progression?

And I think, for instance, the -- I

believe the accident analysis model you're using is MELCOR, and in it is a predilection especially for consequential accident sequences such as station blackout to put an enormous heat load on the piping system so that you get a creep rupture which, unfortunately, is something that no hint of it occurred during the TMI accident. So it must represent some sort of uncertainty in that core degradation modeling.

Similarly, the code has a predilection to seal the loop seals and enter into a counter-current natural convection that minimizes the heat load on the piping system, and reduces the probability of consequential steam generator tube rupture.

Do those kinds of significant uncertainties get exposed in this study?

MS. DROUIN: You certainly are when we're looking at the uncertainties -- you know, we certainly are looking at the phenomenological uncertainties, so those are included. And as you can see, you know, that was one of the key things that we have.

We also -- that's -- if I skip back over to the approach, you know, one of the technical elements is, you know, the uncertainty analysis. So we're starting to grapple with that, and what those -- how we're going to go about and identify those uncertainties, and how we're going to get our perspectives in terms of how significant they are, what their potential impacts are.

MEMBER POWERS: One of the things that's being done with phenomenological codes now that I think has a potential to be revealing is this walk through activity that was conducted between the MAAP code and the MELCOR code for Fukushima. That's not so pertinent for Vogtle, but now they're doing their walk through for -- between the AZTEC and the MELCOR code. Are you looking at those results?

The problem I see is -- problem inherent obstacle to develop codes is that once you become a code developer, I can say from experience, you put your heart and soul into it, and you have a tendency to believe it's true. And you don't step back -- in fact, it's quite impossible for the individual developer to step back and say what are my assumptions and major uncertainties here, because if he could identify those things he would have done something about it in the code. And so I think a lot of the phenomenological uncertainties maybe of most importance can't be identified by the code developer himself.

MS. DROUIN: That may --

MR. KURITZKY: Excuse me. Don Helton is here. He can talk to --

CHAIRMAN STETKAR: We need to be a little bit aware of time because we don't want to get too backed up at the end of the day, unless you folks want to stay until 7 or 8 tonight. I'm just telegraphing that.

MR. KURITZKY: Yes, and I wanted to mention that we have three very long presentations coming up.

CHAIRMAN STETKAR: We, indeed, do.

MR. KURITZKY: So Don will give you a brief response.

MR. HELTON: Don Helton, Office of Nuclear Regulatory Research.

So the points are well taken. Obviously, when we're trying to characterize the phenomenological uncertainty, we're both looking at that from the perspective of running some study analyses and MELCOR to see the different outcomes depending on different boundary conditions, or input conditions to that particular code.

And then we are trying to take a step back for instance on CSGTR to leverage the work that's been done over the last 15 years by the NRC and industry on the CSGTR issue, and also specifically looking at things like the MAAP/MELCOR crosswalk that was done for Fukushima and what that tells us about the core degradation phenomenon, hydrogen production when using a different set of models. So it certainly will not be the end all/be all of phenomenological uncertainty assessment, but we are trying to look across that cadre of information sources.

MEMBER POWERS: I think you -- I don't know that I want to pursue that in any greater depth. I will point out, you run sensitivity studies until your eyes fall out, you will not ever reveal embedded inherent assumptions.

MEMBER BLEY: I want to slip in two comments. And I apologize I have to leave for a little while for something else.

The first one is looking back at your Volume 1, and dry cask storage jumped off the chart for me down there in summary of plant description. When I look at the plant description there, it's all in a big proprietary section. Have you thought about how you're going to untangle the description stuff as proprietary from that which is not?

MS. DROUIN: There is quite a bit of information that's not proprietary on the dry cask storage.

MEMBER BLEY: Okay. You just can't tell it from the version I've got because the whole thing is labeled proprietary, but that's okay.

MS. DROUIN: Yes.

MEMBER BLEY: Just so you've thought about it.

The other is, I want to jump ahead for a second because I won't be here to talk about it. When I look back at your project status slide, there are a fair number of things between 15 and 30 percent complete, and then I look at your path forward slides with all but one item finishing in early 2017, it seems optimistic. And with that, I'll see you a little later.

MR. KURITZKY: Okay, so just to respond to that. What you're seeing in the path forward are the near-term deliverables.

MEMBER BLEY: Ahh.

MR. KURITZKY: So that's not -- there are many more things -- there are essentially 20

PRA models associated with this whole project, and so you're seeing the first maybe --

MEMBER BLEY: That makes sense. Thank you. That's what I was worried about.

MS. DROUIN: Okay. You know, just to wrap up. I won't go through all of those but, you know, we are going to have a whole chapter in there, you know, how to use this document as a resource document. We plan to have some appendices here, some initial thoughts, you know, I mean, to have a glossary. We think that's an important thing, you know, describe the project organization. We're going to have a slimmer down version of our QA plan, we'll put in there. And the results of the independent -- whether or not we pursue that has not been decided at this point, but that's it for the documentation.

MR. KURITZKY: Okay. Thank you, Mary.

Okay, so just to wrap this up. We want to get back on schedule.

The path forward here really is just a summary of the things I already mentioned in the previous viewgraphs. This just shows the same deliverables I was mentioning earlier, the milestones that will get wrapped up in the early part of next year. We're going to have the seismic, internal fire models be ready for whatever level of next stage review they're going to undergo; will be ready in early 2017. That's also true for our dry cask storage PRA which covers all PRA levels and all hazards. And it's also true for our Low Power Shutdown Level 1 model for internal events. All these things will be ready for the next stage technical adequacy review in early 2017.

We also will be completing the revised Level 2 model for internal events, internal flood. Just like we completed the one for Level 1, we'll have completed the one for Level 2 in early 2017, and the one for Level 3 in the spring of 2017, as it will show here. And then also, the at-power Level 1 modeling for high wind and other hazards, that will also be revised and ready for -- that one has already been through the external review, so that one will be finalized in early 2017.

So, again, this is just for those -- this is just the near term milestones. There's many other aspects of the study which we haven't yet addressed, or aren't close to completion.

And I just want to mention one last thing, that the schedule challenges -- we've been plagued with schedule challenges all along. Kevin mentioned a number of them in the beginning. Some of them continue to plague us. The diversion of key Staff has always been a big one, and rightfully so. Again, there are many high priority projects the Agency has had to respond to, and these people are needed to deal with those other projects, so that's clear.

Right now we've gotten to the point because of varying delays at different rates in different parts of the project, we've gotten some comping where we have internal now conflicts, where the person was in charge of multiple things but they are well laid out apart initially, now have gotten compressed, and now the same person has to do multiple things at once, and so that's why we're juggling a little bit with some of the assignments, and also getting stuck behind a few areas.

Contractor staff availability is also something that has still been getting us. Quite honestly, there is still hangover effects of the sequester from 2013. One of our primary labs had to let some people go and they haven't really come back up to full speed in our area, and so we're still feeling some pains from that.

The peer reviews is another thing, as I mentioned before, since the PWR Owner's Group is now going to have to scale back some of their support in terms of what we're going to use to replace that going forward, or how we're going to make use of them going forward, that's something that still needs to be resolved, but it's clearly going to have some impact on the schedule.

And the last thing I want to mention on this is, as much we're trying to maintain the schedule -- and Kevin said, I think before, that we're trying to look for ways to try and get the schedule moving a little efficiently or quickly, but we have taken time in different cases to explore some technical issues that we felt were really necessary to address to really improve the quality of the study. Some examples are the interfacing system, LOCA frequency, and break location that we discussed earlier that we had the expert elicitation for. Another one is what we refer to as the safe and stable issue, cases where you have 24 hours after the initial event you may not have core damage, but the plant isn't stable, and you will probably end up getting core damage sometime after that without further mitigative actions. And so we've done a re-look at that issue, and it required us to make some major modifications to our event trees and fault tree modeling to address that.

And another one is the impact on system success criteria, and accident sequence timing based on what types of boundary conditions or assumptions you make in doing the thermal hydraulic analyses. As Dr. Powers mentioned, we use the MELCOR code, and depending on what assumptions and boundary conditions you use you can come up with some different results. A good example is in the LOCA break size categories. You know, depending on where in that spectrum of size breaks you pick to do your calculations, particularly as you get close to the boundaries, you can get some very different results. And so we spent some time looking at that and comparing results to, for instance, what the MAAP calculations showed from the Southern's runs, or from other work that we've done in related projects, so that's another area where we took the time to try and drill down a little bit more deeply just to improve the quality of the study.

Okay. I mentioned earlier on that this has been a very broad team effort, so I just want to close by giving a shout-out to some of the support we've received. Southern Nuclear, first and foremost, has just been tremendous in their support for this project. They have not only hosted us at many, many, many site visits, but also provided us, as Mary mentioned before, a tremendous amount of information for the study.

The PWR Owner's Group, as I mentioned, have been leading and supporting, and funding a lot of the peer reviews, the Standards Based Peer Reviews that have occurred to the project to date. Westinghouse and EPRI, in response to Dr. Rempe's question, have been -- they've supplied senior members for our TAG.

In terms of the NRC itself, not only have all three technical divisions of the NRC been -- of the Office of Research have been heavily involved in this project, but we also have gotten support from across the Agency, almost all the technical offices in the Agency have provided support either by front line workers through rotations or being part of review panels, or just being available to answer questions, and that includes people from the Regions and the Technology Transfer Center, our Training Center, also.

National Laboratories, we've dealt with four different National Laboratories. Idaho National Lab has been our primary contractor. They maintain the SAPHIRE model for us, and they are in charge of our actual -- the PRA model for this project.

Sandia National Labs has supported us both in HRA area, as well as in our fire -- exploration of the fire PRA, and also now becoming heavily involved in our spent fuel pool work.

Pacific Northwest National Labs has led our two expert elicitations, and they also have been heavily involved, as you're going to hear later, in the structural analysis work for our dry cask storage PRA.

And Brookhaven National Lab is now getting involved in working with us for external reviews, independent reviews of the whole study, so a lot of support from the labs and commercial contractors.

Energy Research, Incorporated has been our primary commercial support, and they've been involved in almost all aspects, all areas of the study. You're going to -- I think everything you're going to hear about this afternoon has been supported by someone in ERI. And through their subcontracts we've gotten Applied Research Associates, who is -- like I said, did this high wind walkdown for us and reviewed our wind PRA. And IESS has also -- under ERI has supported us in a number of areas. Most recently they've been involved heavily in our Low Power Shutdown PRA, and you're going to -- Ali Azarm will be here to talk to that also, I think, later.

So, again, a very broad team effort, a lot of folks across the Agency and across other organizations outside the Agency have been really supporting this project, and tremendous thanks to all of them. And that's all I have.

CHAIRMAN STETKAR: Anything more on this? Member comments, questions? If not, let's switch gears. We're behind schedule here, but that's to be expected.

(Off microphone comments)

CHAIRMAN STETKAR: Turn your microphone on so you're clearly on the record there.

Dan, please.

MR. HUDSON: Thank you. All right, I'll do my best to make up some ground during this open session presentation. So good morning, everyone.

I'm Dan Hudson. I'm a Reliability Risk Engineer in the Office of Nuclear Regulatory Research Division of Risk Analysis. It's a pleasure to be here this morning. The last time -- are you having difficulty hearing me?

Okay. So, it's a pleasure to be here this morning. The last time I spoke before this group was a bit more than five years ago. At the time, I was the Project Manager for the Level 3 PRA Scoping Study that preceded this project. Now I'm working as the Technical Lead for two major tasks for the Vogtle project. The first is the Integrated Site PRA Task that I'm going to be talking more about in the open and closed sessions today. The second major task that I'm the Technical Lead for is the Risk Characterization Task, which you heard Alan mention before. And that's where we're combining the outputs from the Level 1 and Level 2 Logic Models with the outputs from the Conditional Offsite Radiological Consequences Models to develop qualitative and quantitative characterizations of risk.

Before I dive into the details of the presentation, it's important to acknowledge, as Alan mentioned, that while I'm going to be doing much of the talking today, the work that I'm going to be describing has been supported throughout by our contracting team at ERI, including Roy Karimi, who's sitting beside me.

Some caveats that I want to put out up front. I had the opportunity to talk about this part of the project a couple of weeks ago with our Technical Advisory Group, and had some important Lessons Learned from that interaction which I've benefitted from.

The first thing I need to do is be clear about where we are in this part of the project, and what our expectations are for engaging with the ACRS right now. Dr. Bley mentioned that there's intense interest in this area across the international PRA community, so people are going to be looking at this project.

I'm not here to tell you this morning that we have solved the Integrated Site Risk problem. We're talking about an approach that we developed that we think is practical, that's going to generate some new risk insights that supports one of the major objectives of this Level 3 PRA project. I'm going to talk about some small-scale studies that will be done to evaluate the technical feasibility of this approach.

Alan mentioned that there's going to be a lot of interest on the topic of Intersource Dependencies that we think are going to be dominant contributors to Integrated Site Risk, but we're not going to talk a lot about that today. I expect that there's going to be opportunities for future engagement with our Technical Advisory Group and the ACRS on that subject.

Another Lesson Learned from my engagement with the TAG. In this open session we're talking about the general approach, and we're going to talk more about the pilot applications in the closed session. But for the benefit of the members of the public who are able to follow along during the open session, I developed a simplified hypothetical example that walks individuals through the general approach. We learned through our engagement with the TAG that talking about the general approach benefits from having some concrete examples that you can point to, and so there's a set of supplementary slides that we could go to at any point during this session, as Members desire, but they're intended to be a standalone set of slides that a member of the public can step through when they get their hands on the slides and the transcripts for the meeting.

All right. With all those caveats, I'll start by talking about what is Integrated Site Risk? What are we trying to do at this part of the project? Overall, we're trying to assess the risk to the public of a broad spectrum of postulated accidents involving the Vogtle site. That includes the accidents that involve the individual onsite radiological sources, the reactors, the spent fuel pools, the dry cask storage facility.

That's an important part, but because we are going to have the insights from the single source PRA models, the focus of this task is really on evaluating the contributions risk from accident scenarios that involve different combinations of more than one onsite radiological source. And here, like in other parts of the project, we're assessing the risk from a broad spectrum of accident scenarios that include those initiated by internal and external hazards, except deliberate malevolent acts which are excluded from the scope of the study from the beginning, and also accident scenarios that are initiated during at-power, low power, or shutdown plant operating states. And as Level 3 PRA study, we're quantifying the frequency of nuclear fuel damage accidents, accidental radiological releases, and offsite radiological consequences.

I'd like to talk a bit about our motivation for developing this approach that we're talking about. First, through our experience conducting some small-scale trials early on in the project, we learned that trying to logically combine the accident sequences from the single source PRA models is not going to be feasible using our existing analytical tools. So we did some trials involving the SAPHIRE code where we logically combined loss of offsite power accident scenario from Unit 1 and Unit 2 and solving that model took several hours. So we know that we need to develop an approach that's going to be -- that's going to allow us to use our existing tools to develop a solution for this part of the project.

CHAIRMAN STETKAR: Dan, just because something takes several hours given -- on a computer which I can push a button and go home and have dinner, and sleep, and come back, and check on it, doesn't strike me as an impediment to doing this, because you may not -- yes, we've all done that, so there must --

MEMBER POWERS: Every time the code blows up on me when I'm --

CHAIRMAN STETKAR: Blowing up the code is a different thing, you know. The inability of the code to solve the model is something else, but simply a long run time on a project like this -- you might only have to do it once to gain a lot of insights. So my question is, is it simply run time on a code or is it the fact that you can't solve the model?

MR. HUDSON: I think it's more than that. I mean, these trials that we're talking about, we're talking about, you know, a single two-unit accident sequence. And Alan mentioned earlier some of the issues that we're having with the Level 2 -- quantifying the Level 2 model where we have the integration between the Level 1 and Level 2 models. And we're running into problems now with just a single source PRA model, when you consider the number of accident sequences that are involved.

MR. KURITZKY: And also, Dan, let me further say that we're also talking -- that previous thing with Level 2 for just the reactor, a single source unit, and that was also just for internal events and floods. When we throw in fire and seismic, and the high winds, and then try to put all the things together, let alone at-power and low power shutdown, it's just not going to be practical.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: And it goes beyond just the quantification scheme itself. I mean, you can't just throw the model -- you still have to do a lot of work to get the dependencies represented, too.

CHAIRMAN STETKAR: No, no, no. I understand the problem is very, very difficult. I just -- my eyes glaze over on these big projects when somebody says well, it took several hours to run the computer code. Well, you know, fine. We've all suffered through times when it's taken days, and days, and days to finally run computer codes. And, you know, that -- as long as the computers can solve it, let it go do it.

But, anyway, let's hear the approach here. I just don't want to use computer run time as an excuse for trying to get clever about things.

MR. HUDSON: I understand. Thank you.

A second Lesson Learned is that trying to use a purely deductive approach, some people call it a top down approach, where you try to identify up front the multi-source accident scenarios that are going to be important and all of the different intersource dependencies that apply to different combinations of accidents involving multiple radiological sources on the site, that makes the problem -- the problem gets out of control very quickly; extremely massive and we're concerned that, you know, we do have, you know, schedule and resource constraints on this project. We're concerned that trying to do that could end up focusing resources on factors that may not ultimately be important in the end to Integrated Site Risk. So that motivated our approach to developing a focused approach using single source PRA models that will allow us to make some informed approximations and obtain useful risk insights in the end.

There are a couple of key assumptions or hypotheses that underlie the approach that we developed. The first, you've heard it a few times this morning, is that the intersource dependencies are likely going to be the dominant contributors to Integrated Site Risk. We, therefore, anticipate that the majority of our effort and resources will be focused on the systematic identification, characterization, and accounting for these dependencies. So, again, I expect that we'll come back and have further discussions on that topic as the project progresses.

The other key assumption is that the risk insights from the single source PRA models can be used to prioritize our efforts. A related assumption is that factors that are not important to the single source PRA models are generally not going to be significant to Integrated Site Risk, even when you do account for potential intersource dependencies for these insignificant factors.

CHAIRMAN STETKAR: I listen to this, and I don't want to slow us down too much, but one of the things we've learned from the old Level 1, Level 2, Level 3 PRA is that the things that are important in Level 1 PRA space often are not so important in Level 2 and Level 3. So, for example, Interfacing System LOCAs, steam generator tube ruptures, they kind of show up to core damage frequency, but not so much. They're really important for Level 2, Level 3 releases.

Is there a danger of focusing on what we know about a single unit event and trying to use that as the basis for this winnowing approach akin to that process where there may be very, very low frequency things that are really, really important to the risk for multi units that we don't -- we're not particularly sensitive to when we look at a single unit? I don't know. You know, I have my own opinions, but I --

MR. KURITZKY: Let me just --

CHAIRMAN STETKAR: I'm just -- because we've not seen this before.

MR. KURITZKY: Right, right.

CHAIRMAN STETKAR: This is kind of realtime reaction.

MR. KURITZKY: And that's a real concern, but I what I want to stress is that right now while Dan is going to walk through our approach for Level 1 and Level 2, the pilot approach he'll discuss, of course, in detail in the closed session. And so you're right; to try and base it on just the Level 1 results, or even just the Level 2 results isn't necessarily going to give you the risk -- you have a chance of losing some of the risk, major risk contributors. But we will be doing it for the -- we'll have single source Level 3 models for all -- in all the different sources, so it will be those results as we get to that stage that will be driving it. So the point is not that we're using Level 1 to tell us what's important in Level 3, or --

CHAIRMAN STETKAR: No, no, no, no. You're missing the point. I was using the analogy of Level 1, 2, and 3, that if you focus only on Level 1 you might miss stuff for Level 3. I'm saying focusing only on single source, are you going to miss things for multi-unit effects because you're focusing only on that single unit?

MR. KURITZKY: Right. And so --

CHAIRMAN STETKAR: And saying well, this is not important to single units, so I'll place a lower priority on it.

MR. KURITZKY: Right. And I think, Dan -- you know, the hypothesis or assumption that Dan is providing is that we feel if something is not an important contributor to the single source, there is not a high likelihood that it's going to contribute to -- now, there could be something --

CHAIRMAN STETKAR: That's my danger.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: That's exactly --

MR. KURITZKY: And there's no guarantee.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: There's no guarantee, but we haven't been able to postulate things that might --

CHAIRMAN STETKAR: Okay. We'll see how the -- you know --

MS. DROUIN: I think one of the big things here that when you do start looking at your dependencies, and I think that when you're looking at your results from your reactor that aren't important and will they play a role in the overall site risk, I think that will come out when you start looking at the dependencies, because how can those results affect your spent fuel or your dry cask? So I don't think that they're going to be -- they aren't going to be disregarded. I think what Dan is saying is that we are looking at that, and our guess at this point is that once we take the dependencies into consideration, they probably will not be important.

MR. COYNE: Alan, if I could also add. This is Kevin Coyne from the Research Staff.

I think a key factor here is what's significant in the single source models, and Dan's going to talk about that in a minute, but the objective here is to try to trim the single source models so that we can combine them together to try to get -- to run them through SAPHIRE and get the risk results. So to clarify Dan's earlier point, the model running a couple of hours is of no concern to us. I think the current version runs overnight or even more. It's we're hitting limitations in the SAPHIRE code, and any code would hit the same limitations, the number of cut sets, and the amount of memory you need to run the models, so we absolutely have to get these single source contributions trimmed down. And so really the trick here, and where we really appreciate feedback is what is significant in the single source model relative to the Integrated Site Risk portion, because we have to get the single source models down and then combine them. So, like I said, Dan has some screening criteria that he's worked out, but that's an area that feedback would really be appreciated to make sure that we're capturing 80, 90, or even more percent of the answer. I think there's always going to be something that gets left out, but we want to get the majority of the insights from that.

MR. HUDSON: Yes. Thank you, Kevin. And coupling the review of the risk insights from the single source PRA models with the dependencies that we'll be talking about, I think that is going to be a critical aspect of this that can help bridge that gap, or give us some confidence that we're not missing something important. And we'll talk some more about that as we step through the approach.

I won't spend too much time on this overview slide. It's meant to provide a high-level summary of the approach that we can refer back to, as needed. I'm going to be talking about each step in more detail as we step through this in this open session presentation.

MEMBER KIRCHNER: Does this philosophical approach essentially assume in some way physical separation of each of these sources, or put some bounds on that? It's a leading question, because I'm thinking ahead to a new reactor design.

MR. HUDSON: Yes. I think we'll address your question as we start talking about the dependencies. We're not making any explicit assumptions up front about the degree of separation between the units on the site. That's going to be an aspect that is evaluated.

So, the first step of the process is to

specify the scope of the multi-source PRA model. And to do that, you have to address four different PRA scope elements; the radiological sources, so which sources are going to be included in the model. For the Vogtle site we have operating reactor Units 1 and 2, the operating reactor spent fuel pools for Unit 1 and 2, and the dry cask storage facility. You also have to specify the plant operating states for each of the sources that we're talking about, so you can think about the at-power and low power shutdown operating states. You specify the initiating event hazard groups, and we'll be looking at internal hazards, including internal events, floods and fires, and the external hazards, as well. And then, finally, you specify the PRA end state of interest for the multi-source PRA model, and you can specify that you're looking at the frequency of nuclear fuel damage accidents, or radiological release categories, or the offsite radiological consequences.

The figure on Slide 29 is meant to illustrate the different inputs to the Integrated Site PRA Task for the Vogtle Project and the relationships between them. And I put a note on there, you know, where we have a bullet that specifies all plant operating states, all hazards, all sources, what we mean by that are those that have been selected for inclusion within the scope of each individual PRA model, and the overall project, as well. Next slide, please.

Step 2 involves reviewing the results from the single source PRA models that are providing input to the multi-source PRA model. And by this, we're going to be taking a look at for each end state that we're interested in, the significant cut sets. And here we rely on the Level 1 large early release frequency PRA standard for nuclear power plant applications for our definition of what is considered a significant cut set. And those are cut sets for which the combined contribution of the set contributes greater than or equal to 95 percent to total end state frequency, or an individual cut set that contributes greater than or equal to 1 percent to total end state frequency.

Now, the number of cut sets that you're going to be looking at for a particular end state depends on a number of factors, including the truncation threshold that you're using quantifying the model, but here in particular it depends on the end state risk profile. So end states that have a concentrated risk profile will have a limited number of significant cut sets to evaluate, and that actually makes the problem a bit easier for us; if you have a few cut sets that are the dominant contributors to end state frequency.

When you have end states that have a diffuse risk profile it makes the problem more challenging, and will require us to make some decisions that balance our desire for completeness with our schedule and resource constraints to get the project done.

The set of significant cut sets are then coupled with importance measure results to identify other events that could be of interest that may not be identified by just taking a look at the dominant cut sets. Here we're using the Fussell-Vesley Importance Measure, which is the fractional contribution to total end state frequency of cut sets that include the event of interest with the criterion that Fussell-Vesley measure is greater than .005. And then we're also using the Risk Achievement Worth Importance Measure, which is the factor by which total end state frequency would increase if the event of interest is assumed to occur with 100 percent probability. And here the criterion is that the raw importance measure value is greater than 2. Again, these criteria were pulled from the Level 1 LERF PRA Standard.

Step 3 is really a critical step for this approach, and that's where we attempt to systematically identify the intersource dependencies that will be important. And here, this is really coupled with the work that is done in Step 2. So the existence of a potential intersource dependency is what determines whether a significant cut set that was found in the single source PRA model results would contain a basic event that could have a potential intersource dependency that would, therefore, make that cut set one that we would include in the multi-source PRA model.

CHAIRMAN STETKAR: Dan, to go back, and we'll discuss more of this in the closed session, but go back to my kind of previous theme.

Suppose in my documentation I wrote down I, today, John Stetkar, decided not to model Initiating Event X, because I don't think it's important in my single source PRA. Therefore, that was done. And, indeed, that are no cut sets in my single source PRA from Initiating Event X because I didn't think it was important. And yet, lo and behold, Initiating Event X might be important for coupled risk. Now come -- in the closed session I'll give you a couple of examples of those.

MR. HUDSON: Okay.

CHAIRMAN STETKAR: How can any evaluation of my single source cut sets identify the fact that I missed X? It can't.

MR. HUDSON: Well -- yes.

CHAIRMAN STETKAR: It cannot. There are no cut sets there.

MR. KURITZKY: Okay. Dan, if I may.

MR. HUDSON: Yes.

MR. KURITZKY: Okay. So in that situation clearly, once it's ruled out from the single source model we're not going to catch it.

CHAIRMAN STETKAR: Right. So my whole point is why are you focusing a lot of effort looking at that single source model? Why are you doing all of this one and two steps? Why don't you look at intersource dependencies? What can affect both of those reactor units, as the first thing?

MR. KURITZKY: Right.

CHAIRMAN STETKAR: And the primary

thing.

MR. KURITZKY: As Dan mentioned previously, if we were to go right jump into looking at all the intersource dependencies, you could quickly get into a big quagmire, and it wouldn't necessarily be --

CHAIRMAN STETKAR: How many cut sets do you have from your Level 1, 2, 3 internal events at-power model, if you're looking at those cut sets and examining them?

MR. HUDSON: Well, the internal events model that we worked with for our pilot study that we're talking about, it's on the order of tens of thousands --

CHAIRMAN STETKAR: Yes. Loss of offsite power is an internal initiating event last I checked.

MR. HUDSON: Right.

CHAIRMAN STETKAR: Four different causes for loss of offsite power, grid, weather, switch yard, and plant-centered. So I'm just -- what I'm asking you is this focus on looking at cut sets from a single source and somehow using that as -- it's presented as Steps 1, 2, and 3 here --

MR. KURITZKY: Well, it's --

CHAIRMAN STETKAR: -- strikes me as not a top down approach. It strikes me as a very bottom up kind of mechanistic approach to looking for things.

MR. HUDSON: Right.

MR. KURITZKY: Okay. So to get to your point, even though there are many cut sets, what our pilot studies applications are going to demonstrate hopefully is that using the approach that we have, we feel we can efficiently go through that and come up with the insights to help us identify the important dependencies to model. Okay? And that's the whole premise of why we're doing this approach.

CHAIRMAN STETKAR: We'll see. I'm just trying to challenge you here in terms of your -- as I said, we haven't seen this before.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: So this is the first exposure to it. Are approaching -- the question is, are you approaching the problem with the correct emphasis on things?

MR. KURITZKY: Right, and that's hopefully the --

CHAIRMAN STETKAR: In this slide, Number

3, Intersource Dependencies, but not looking at cut sets seems to be the way to approach it.

MR. KURITZKY: Right, and that -- and Dan's presentation is going to go into explain --

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: -- why we feel that our approach is appropriate.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: But, again, as Dan stated, it's not the end all and be all, and we're open to other ideas.

But to get back to the issue that you raised about something being screened out in the internal event model, or single source model, and then we don't know if it could be potentially important to the multi-risk model. No guarantee, but the thinking there is that if something is not important to the single source model, which means it's orders of magnitude below other things that are important, okay?

CHAIRMAN STETKAR: I'm sorry. Orders of magnitude means you quantified it and you know that. I'm saying I today decided not to model it at all because I didn't think it was important to my single source model.

MR. KURITZKY: Right, and --

CHAIRMAN STETKAR: I didn't model. It's not there.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: It's zero.

MR. KURITZKY: Right, and the basis for making that decision theoretically would be that you have information or good reason --

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: -- to say that it's not a major contributor, which means it's orders of magnitude lower than the stuff you have modeled.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: And if that's the case, a multi-source release is not going to be orders of magnitude higher than a single source release, so it should theoretically not be important to multi-source release.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: And that's our justification for why we feel that wouldn't be a limitation of our approach.

CHAIRMAN STETKAR: Okay.

MR. HUDSON: I think your point is well taken, and I think an issue here is the order in which these steps are presented. When you talk about looking at the cut sets from a single source PRA model, it screams of a very bottom up approach, as you said, but we're coupling that with a look for the intersource dependencies that is more of a top down kind of approach. So it's a hybrid approach that leverages the advantages of both approaches to developing the model. And if you -- let's go ahead and step through, and I think --

CHAIRMAN STETKAR: I made my point. We've got to get --

MR. HUDSON: Yes. Okay, so -- but this framework that we're going to be talking about on the next slide, we relied on a review of the literature taking a look at past multi-source PRAs that have been done, such as the Seabrook study that was done in the '80s, and some other research that has been done taking a look at operational experience. You know, some work was done by one of our Staff members, Suzanne Dennis, former Suzanne Strayer, for her Master's thesis work under Professor Mohammad Modarres at the University of Maryland. They took a look at the dependencies that were involved with various events associated with licensee event reports. So the categorization scheme that we've developed is going to be used during our single source PRA model results review, is driven by what we've learned from multi-unit events and previous multi-source PRA models.

This table is intended to define the five major categories of dependencies that we consider to be important to developing a multi-source PRA model. We define them and provided some examples to clarify them. So under the category of Initiating Events, and I think this is getting at your question that you just raised. How do you identify an initiator that is not included in the single source PRA model?

So here we have two major groups of initiators under that category. The common-cause initiators that can simultaneously challenge multiple sources on the site, and the consequential initiators that arise from events that occur in another unit that is co-located with multiple sources.

An example of the common-cause initiator is the loss of the shared electrical grid, as you highlighted, or loss of ultimate heat sink. A consequential initiator is a transient that occurs in one reactor unit, ends up causing a loss of offsite power to the other units on the site.

The next category of dependencies are the shared structures, systems, and components. This was asked about earlier. These are the SSCs that can support multiple sources on the site under various conditions, and here an illustrative example are electrical power sources that can swing between different sources on the site.

The third category are common-cause failure events. These are dependent failures of structures, systems, or components across multiple radiological sources due to a shared cause that are not otherwise explicitly included in the model. An example here are the failure of similar components that are installed in each unit due to a shared defect.

The fourth category are the phenomenological dependencies, and these can arise from exposure of multiple SSCs to shared phenomenological or environmental conditions. Here an example is the failure of components in multiple sources to shared environmental conditions; for example, high temperature levels, high moisture levels, or radiation levels that end up exceeding the capacity of the equipment.

And then the final category of the dependencies are the human or organizational dependencies. These are those dependencies between operator actions associated with multiple sources that can arise from many different causes, including shared organizational factors. So here an example could be, you know, shared training procedures or command and control structure that causes recovery actions in response to an accident in one unit to be dependent upon those that are taken in response to an accident involving another unit.

After we've performed this review of the single source PRA model results coupled with our dependency categorization scheme, we construct our multi-source PRA model using top level end gates that combine our end states of interest for the selected radiological sources. From there we use mid-level ore gates that combine the cut sets with intersource dependencies that were selected for inclusion in the model. And then, finally, you have these bottom level end gates that combine the basic events for each of the cut sets that were selected for inclusion in the model.

The next step after you've constructed

your model is to model the intersource dependencies. And here I use the term "model" rather loosely. What we really mean here is we developed a set of rules for identifying multi-source cut sets that include dependencies of interest, and we implement a procedure that accounts for the impact of those dependencies on the conditional probability, so we're not trying to actually model the dependencies themselves so much as we're trying to model the impact on conditional probabilities.

And the approach that we use here depends on the particular event of interest. So you can imagine there are site level events that are in each of the single source PRA models that represent the same event across all radiological sources, so it's important here that the same event applies to all of the modeled radiological sources to insure the proper structure and quantification amenable cut sets are the multi-source end states of interest.

For other dependent events we use a different approach. We start off using a screening analysis where we assume that there is a complete dependence across the sources of interest for the model-dependent events, so we set the conditional probability of the dependent event and the co-located sources to one given that the related dependent event occurs in another source. And from there we take a look at the results that emerge, and for those dependencies that we find to be significant, we iterate on that and attempt to refine the conditional probability estimate. In doing so you can imagine that you may end up seeing other dependencies rise to the top, and so again this is going to have to be an iterative process.

Then the last step is quantifying the model, so you select your multi-source end states of interest, specify a cut set probability truncation level, and I mention that here because we're going to talk about it more in the closed session when we take a look at the pilot studies and what we've learned. But it's important that you have the right probability truncation level; otherwise, you're going to up screening out a bunch of important sequences.

When I say that -- again, the next step in this process is getting into the details of the SAPHIRE code that we use, but this is where you have to implement the rules that I just mentioned to account for the dependencies when you're solving the model. And then, finally, we take a look at our results of interest for the multi-source cut sets and the importance measures.

We're going to talk more about the pilot applications in the closed session, but for the benefit of the members of the general public who are listening in, I want to just briefly highlight what we did with them.

We conducted a couple of pilot studies to evaluate the technical feasibility of implementing this approach using our existing analytical tools. And an important objective here was to identify any potential barriers to implementing this approach. We've recognized that the identification and characterization of intersource dependencies is important. That would be true of any approach that we used, so we know that that's a part of the problem that is going to have to be addressed. Right now, we're concerned about the technical feasibility of this approach.

For these two pilot studies we first took a look at the reactor at-power internal events Level 1 PRA for Unit 1 and Unit 2, and then the second pilot study took a look at reactor at-power internal events and floods Level 2 PRA. And I'll mention this now but we used different versions of the model, so the Level 1 PRA model that we used for the first pilot study was circa April 2016 when the study was done, or no, it would have been February 2016; whereas, the version that we used for the Level 2 pilot application, because we don't have a current completed Level 2 PRA model, we used a Fall 2014 version for the study.

MR. KURITZKY: Just to clarify --

CHAIRMAN STETKAR: It's okay. This is a work in progress, so that's fine.

MR. HUDSON: So, our key finding from these pilot studies is that for the scoping elements that we included in the pilot studies, the technology that we have available to us with some work-arounds that we'll talk about during the closed session can be used to develop a focused Integrated Site PRA model that relies on the risk insights from the single source models.

And there's a big note at the bottom, we're trying to drive this point home. These were small-scale focused pilot studies that we did not attempt to do a systematic comprehensive identification of the intersource dependencies. And that concludes the open session presentation, unless we have some specific questions that we'd like to address.

CHAIRMAN STETKAR: Any Member questions on this topic? If not, there's a couple of things that I need to do before we take a break.

First of all, if there's anyone in the room who would like to make a comment, please come up to the mic and do so. Seeing no stampede to the microphone, I'll ask if there's anyone on the bridgeline, member of the public who would like to make a comment, please identify yourself and do so.

MR. LEWIS: Marvin Lewis, member of the public.

CHAIRMAN STETKAR: Hello, Marvin.

(Off microphone comment)

CHAIRMAN STETKAR: Do you have a comment?

MR. LEWIS: Yes, please.

CHAIRMAN STETKAR: Speak up.

MR. LEWIS: All right. Well, first of all, you're going into closed session. You're going into closed session on paperwork, not on anything that you're going to buy on the open market. And I'm just thinking that, you know, here the public who are from the Level 3 consequence --

CHAIRMAN STETKAR: Marvin.

MR. LEWIS: -- study are the ones that are being excluded. I'm not saying that's wrong. I'm saying you can get the feeling that --

CHAIRMAN STETKAR: Marvin --

(Simultaneous speech)

MR. LEWIS: -- that over the years I've seen the NRC avoid, let's call it avoid, I don't know if that's the correct legal term, but like Three Mile Island Alert wanted some more security on the approach to Three Mile Island. They even went to I guess the ASLB with it, yes, ASLB, and their comments were not in the record, and they couldn't get their own comments that were pointed into the record. I don't know if this is a good way to do PRA work or any work.

I, myself, have -- after I got the Three Mile Island Number One Restart Hearing, I talked the licensee into putting an opening, a filter, an opening on the Three Mile Island Number One before restart. And, you know, I never see that sort of question come up when you're looking at anything. Hey, how can we do it better? How can we -- maybe we do need an opening on the filter vent on some of these things.

Well, obviously, it isn't happening. It isn't going to happen for eight years. But, luckily, now you've decided to do that. That's a good idea. Thank you.

The point I'm making is you have such power to look at things or ignore things, and I feel your power is being used preferentially and improperly. Thank you.

CHAIRMAN STETKAR: Thank you. And by the way, I wasn't trying to interrupt you earlier. When you -- in the early part of your comments you were breaking up a little bit, so I -- but we -- I think we got everything; certainly, after the first minute or so we have everything on the record. So when I was trying to break in, I wasn't trying to stop you at all, it's just that you were breaking up on our end.

For the record, I have to say that we're going into closed session because we have to do that legally. There is plant proprietary information that will be presented in that closed session that cannot be made public, so we can't make those -- we can't make the closed session of this meeting open to the public. It's -- as much as

I would like to, we can't. We're kind of legally bound that way.

Are there any other members of the public on the line who would like to make a comment? Hearing none, to close out the public session what I'd like to do, as we usually do in these Subcommittee meetings, I'd like to go around the table and see if any of the Subcommittee Members have any final comments or questions related to the open session material. Ron, I'll start with you?

MEMBER BALLINGER: No.

CHAIRMAN STETKAR: Matt?

MEMBER SUNSERI: No comments. Thanks.

CHAIRMAN STETKAR: Dana? That was no. Walt?

MEMBER KIRCHNER: Nothing. Thank you.

CHAIRMAN STETKAR: Jose?

MEMBER MARCH-LEUBA: No, I have no comment.

CHAIRMAN STETKAR: And Joy?

MEMBER REMPE: I have no comments, but I just wanted to thank the Staff for their presentations and their efforts.

CHAIRMAN STETKAR: Great, and with that

we will close the open session. We will recess until 10 minutes to 11, and we'll come back in session in closed session.

(Whereupon, the proceedings went off the record at 10:35 a.m.)

Full-Scope Site Level 3 PRA

Advisory Committee on Reactor Safeguards
Reliability and PRA Subcommittee

December 13, 2016
(Open Session)

Alan Kuritzky
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Outline

- Open Session
  - Project status overview
  - Integrated Site PRA (general approach)
- Closed Session
  - Integrated Site PRA (pilot applications)
  - Low Power and Shutdown Level 1 PRA for Internal Events
  - Dry Cask Storage PRA

Level 3 PRA Project Status Overview

Advisory Committee on Reactor Safeguards
Reliability and PRA Subcommittee

December 13, 2016
(Open Session)

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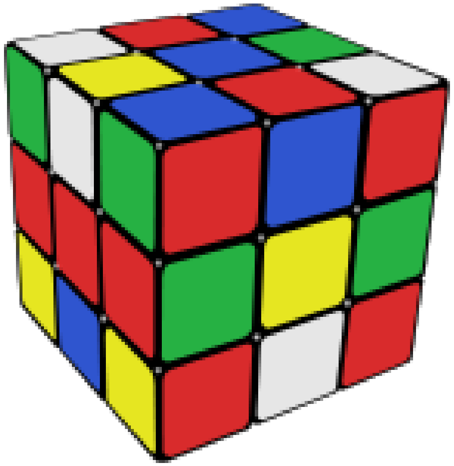
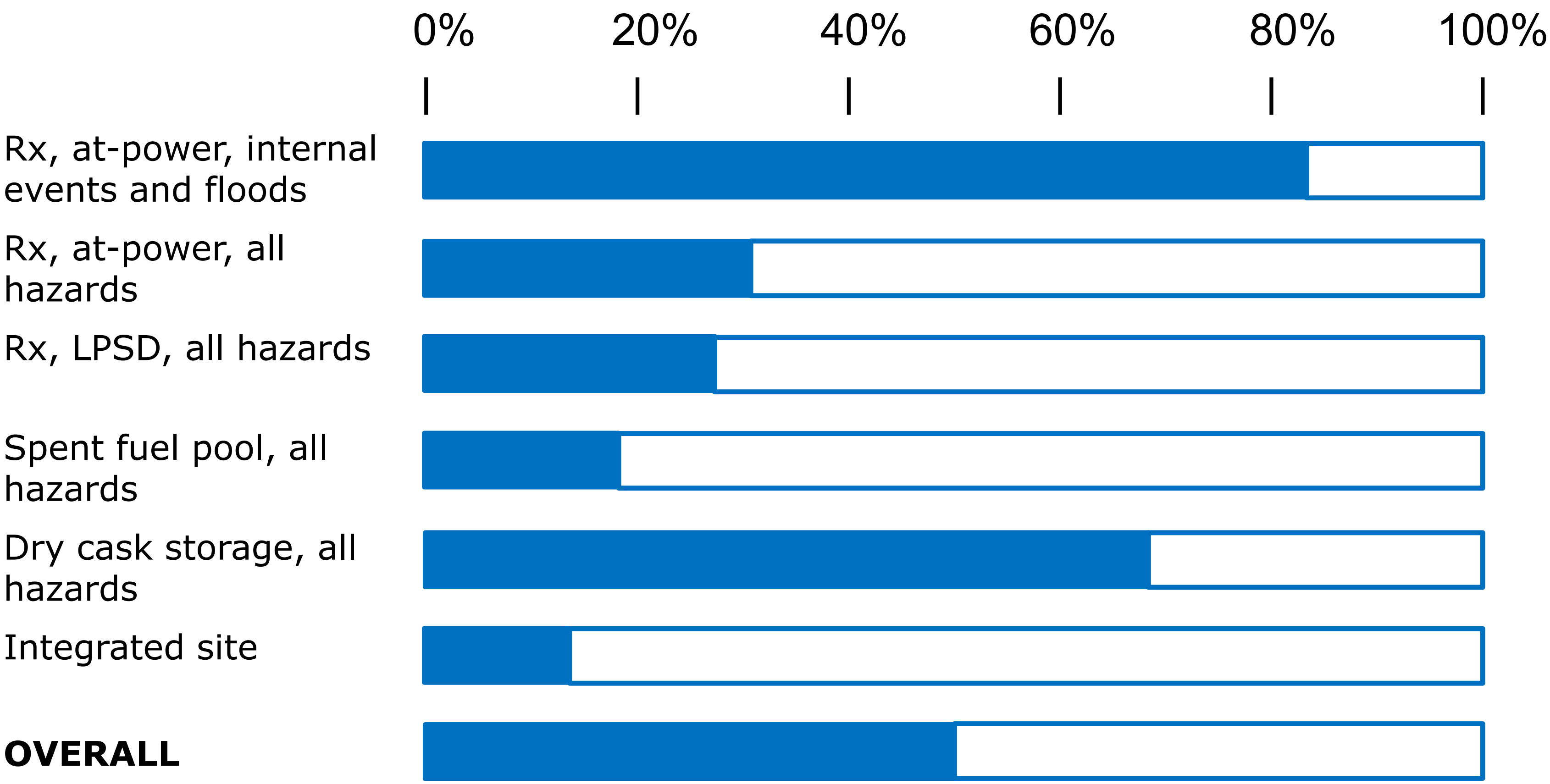
Outline of Presentation

- Reactor, at-power, internal events and floods, Level 1
- Reactor, at-power, internal events and floods, Level 2
- Reactor, at-power, internal events and floods, Level 3
- Reactor, at-power, internal fires
- Reactor, at-power, seismic events
- Reactor, at-power, high winds and other hazards
- Reactor, low power and shutdown
- Spent fuel pool
- Dry cask storage
- Integrated site
- Documentation
- Path Forward



Project Status

Combined status of model development, project reviews, and project documentation



Reactor, At-Power, Internal Events and Floods, Level 1

- Completed ASME/ANS PRA standard-based peer review, led by PWR Owners Group
- Completed substantive update to address peer review and other comments
  - Internal event report essentially complete
  - Internal flood report nearing completion
- Completed expert elicitation for interfacing systems LOCA

Reactor, At-Power, Internal Events and Floods, Level 2

- Completed ASME/ANS PRA standard-based peer review, led by PWROG
- Revising model and documentation to address peer review, TAG, and other comments
  - Re-performed all MELCOR calculations and performed some new ones
  - Updating probabilistic model to reflect revised Level 1 PRA and feedback on initial Level 2 model
  - Quantification has become problematic due to sheer size of model (i.e., number of sequences)
- Complete model and handoff results to the Level 3 PRA team by late 2016/early 2017

Reactor, At-Power, Internal Events and Floods, Level 3

- Completed ASME/ANS PRA standard-based peer review, led by PWROG
- Updating model to reflect revised source terms and address peer review, TAG, and other comments
- Complete model and handoff results to the risk characterization team in Spring 2017

Reactor, At-Power, Internal Fires

- Completed initial revision of Level 1 fire PRA model and documentation based on new input from SNC
- Revising HEPs using NUREG-1921 scoping approach for fire HRA
  - Addressing internal consistency of HEPs for internal events and internal fires
  - More detailed HRA will be performed for selected HFEs, as needed
- Anticipate Level 1 model and documentation ready for technical adequacy review by early 2017

Reactor, At-Power, Seismic Events

- Completed initial revision of Level 1 seismic PRA model based on new input from SNC
- Finalizing seismic PRA report
  - Updating discussion of plant-specific seismic hazard and fragility analysis
- Anticipate Level 1 model and documentation ready for technical adequacy review by late 2016/early 2017

Reactor, At-Power, High Winds and Other Hazards

- Completed ASME/ANS PRA standard-based peer review, led by PWROG
- Currently addressing peer review and TAG comments
- Applied Research Associates high wind walkdown performed in November 2015; follow-on analyses received in October 2016
- Anticipate completion of revised models/analyses and documentation by early 2017

Reactor, Low Power and Shutdown

- Initial LPSD Level 1 PRA model for internal events is essentially complete
  - Systematic approach used to manage scope (feedback received from the TAG)
  - Recent work has focused heavily on HRA
- Model and documentation should be ready for technical adequacy review in early 2017
- Work initiated on LPSD Level 2 PRA
  - Interactions with Level 1 LPSD team
  - Discussions on HRA approach
  - Initiated work on bridge tree and PDSs
  - Developed initial MELCOR model
- Currently establishing a Phenomena Identification and Ranking Technique (PIRT) expert elicitation to identify ranked list of focus areas for LPSD PRA

Spent Fuel Pool PRA

- Many tasks are underway, but progress has been limited
- Focus so far has been primarily on:
  - Defining operating states
  - Interfaces with other analyses (i.e., dry cask storage and LPSD)
  - Thermal-hydraulic model development
  - Accident sequence modeling for large seismic events
- Reshuffling task lead and increasing contractor support to rebalance work load and accelerate progress

Dry Cask Storage PRA

- Completed initial Level 1/2/3 model and documentation for all hazards
- Revising consequence analysis to be Vogtle-specific
- Anticipate model and documentation ready for technical adequacy review by early 2017

Integrated Site PRA

- Inter-source dependencies are expected to be dominant contributors to integrated site risk
- Developed an approach for an integrated site PRA model using single-source PRA model results and risk insights to prioritize the systematic identification and modeling of inter-source dependencies
- Completed pilot applications of the approach for:
  - Reactor Units 1 & 2, at-power, internal events, Level 1 PRA
  - Reactor Units 1 & 2, at-power, internal events and floods, Level 2 PRA

Documentation – Six Types

1. NUREG report which contains publicly available information
2. Technical reports which are not publicly available
3. Working files (including both staff and contractor files) which are not publicly available and generally not available outside of project team
4. Vogtle plant information not available outside of project team
5. Reference sources
6. Project reviews (e.g., self-assessments and peer review reports)

NUREG-xxxx, “An Assessment of Site Risk for the Vogtle Electric Generating Plant, Units 1 and 2”

- Contains sufficient information to understand:
  - The technical approach
  - Major assumptions
  - Design and operation of the plant
  - Major results
  - Major insights and perspectives
  - Potential uses
  - Potential future work
- Hyper-links where practical
- Major challenges
  - The level of detail of information in the report recognizing SNC concern regarding propriety information
  - The significant amount of information – what to and not to include – so as not to overwhelm the reader but remain informative
  - How to represent the information in an efficient and understandable manner for a “four dimensional” PRA model that addresses multiple sources, multiple hazards, multiple operating states, and all three PRA levels
- Working with publications; for example
  - Publish individual volumes as they are completed?

TABLE OF CONTENTS

NUREG-xxxx, “An Assessment of Site Risk for the Vogtle Electric Generating Plant, Units 1 and 2”

Part 1 (Volume 1)
Introduction and Summary of Approach and Plant Description

*Approach addresses the different hazards and operating states

Part 2 (Volume 2)
Summary of Results

*Results are presented for the different hazards and operating states

Appendices (Volume 4)

Part 3 (Volume 3)
Perspectives and Uses

*Same subset of perspectives as listed for Section 8

Path Forward (1 of 2)

- Continue work in all technical areas of the study
  - Reactor, at-power, Level 1, seismic event PRA ready for technical adequacy review (late 2016/early 2017)
  - Reactor, at-power, Level 1, internal fire PRA ready for technical adequacy review (early 2017)
  - Dry cask storage, Level 1, 2, and 3 PRA ready for technical adequacy review (early 2017)
  - Reactor, LPSD, Level 1, internal event PRA ready for technical adequacy review (early 2017)
  - Complete updated reactor, at-power, Level 2, internal event and flood PRA (early 2017)

Path Forward (2 of 2)

- Continue work in all technical areas of the study (continued)
  - Complete updated reactor, at-power, Level 1, high wind PRA and other hazards analyses (early 2017)
  - Complete updated reactor, at-power, Level 3, internal event and flood PRA (Spring 2017)
- Schedule challenges
  - Diversion of key staff
  - Contractor staff availability
  - Peer reviews
  - Resolution of key technical issues

Acknowledgements

- SNC
- PWR Owners Group
- Westinghouse
- EPRI
- NSIR, NRO, NRR, NMSS, Regions, TTC
- National Laboratories (INL, SNL, PNNL, BNL)
- Commercial Contractors (ERI, ARA, IESS)

Acronyms and Definitions

ANS	American Nuclear Society
ARA	Applied Research Associates
ASME	American Society of Mechanical Engineers
BNL	Brookhaven National Laboratory
EPRI	Electric Power Research Institute
ERI	Energy Research, Inc.
HEP	Human error probability
HFE	Human failure event
HRA	Human reliability analysis
IESS	Innovative Engineering & Safety Solutions, LLC
INL	Idaho National Laboratory
LOCA	Loss of coolant accident
LPSD	Low power and shutdown
PDS	Plant damage state
PIRT	Phenomena Identification and Ranking Technique
PNNL	Pacific Northwest National Laboratory
PRA	Probabilistic risk assessment
PWROG	PWR Owners Group
SNC	Southern Nuclear Operating Company
SNL	Sandia National Laboratories
TAG	Technical Advisory Group

Level 3 PRA Project
Integrated Site PRA: General Approach

Advisory Committee on Reactor Safeguards
Reliability and PRA Subcommittee

December 13, 2016
(Open Session)

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Integrated Site PRA Problem Definition

- Focuses on accident scenarios involving different combinations of more than one major on-site radiological source (i.e., reactors, spent fuel pools, dry cask storage facility).
- Assesses risks attributable to a broad spectrum of postulated accident scenarios.
  - Accident scenarios initiated by internal and external hazards, except deliberate malevolent acts.
  - Accident scenarios initiated during at-power, low-power, or shutdown plant operating states.
- Level 3 PRA considers:
  - Frequency of nuclear fuel damage accidents.
  - Frequency of accidental radiological releases.
  - Frequency of offsite radiological consequences.

Motivation for Approach

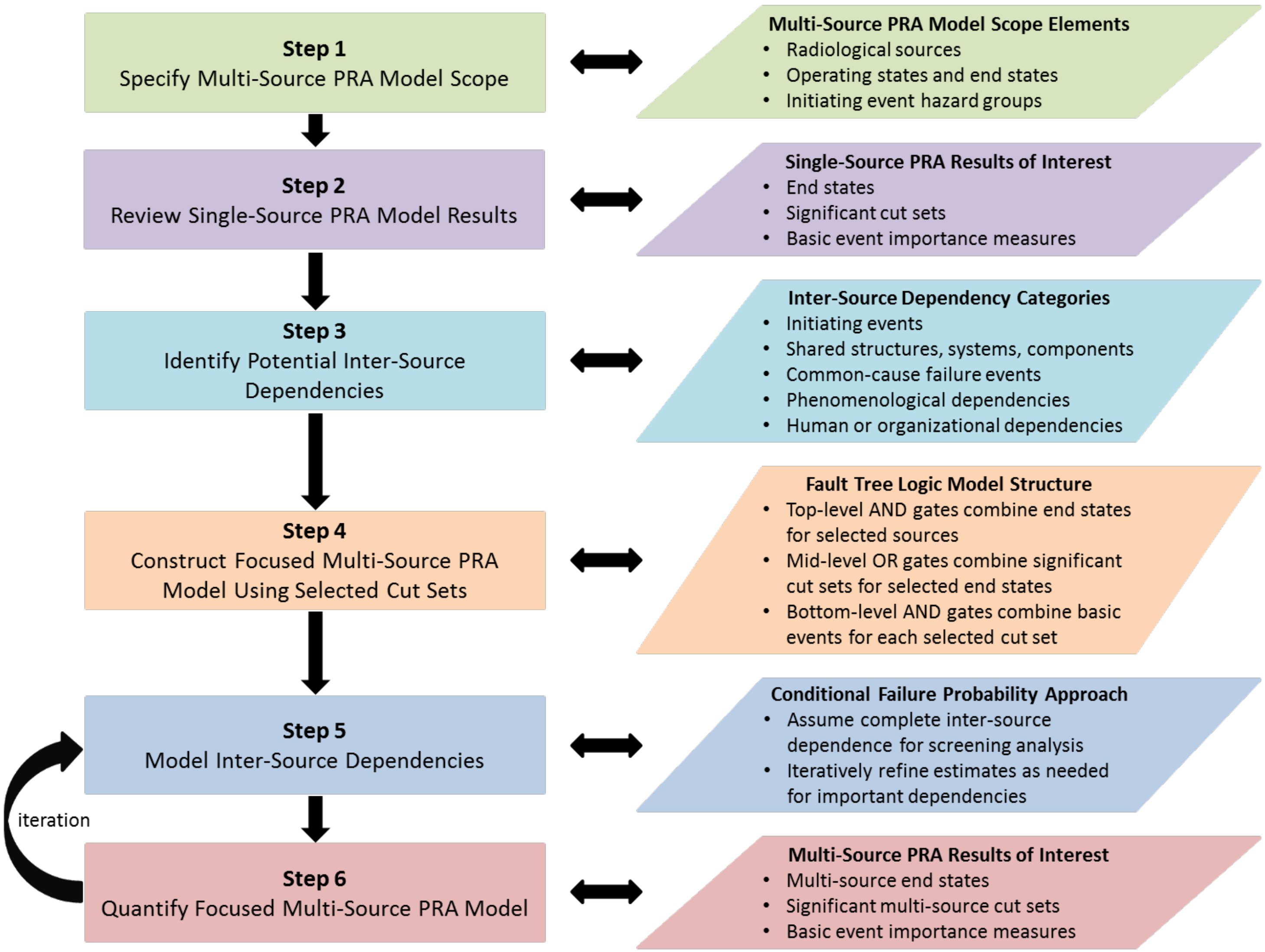
- Logically combining accident sequences from single-source PRA models is not feasible using existing analytical tools.
- Purely deductive approaches can make problem intractable and focus resources on factors that may not be important.
- We therefore need a focused approach that makes informed approximations to obtain useful insights.

Philosophy of Approach

- Inter-source dependencies will likely be dominant contributors to integrated site risk.
  - Majority of effort will thus be focused on systematically identifying and accounting for these dependencies.

- Risk insights from single-source PRA models can be used to prioritize efforts.
  - Factors not significant to single-source risk are generally not likely to be significant to integrated site risk, even when considering inter-source dependencies.

Overview of Approach

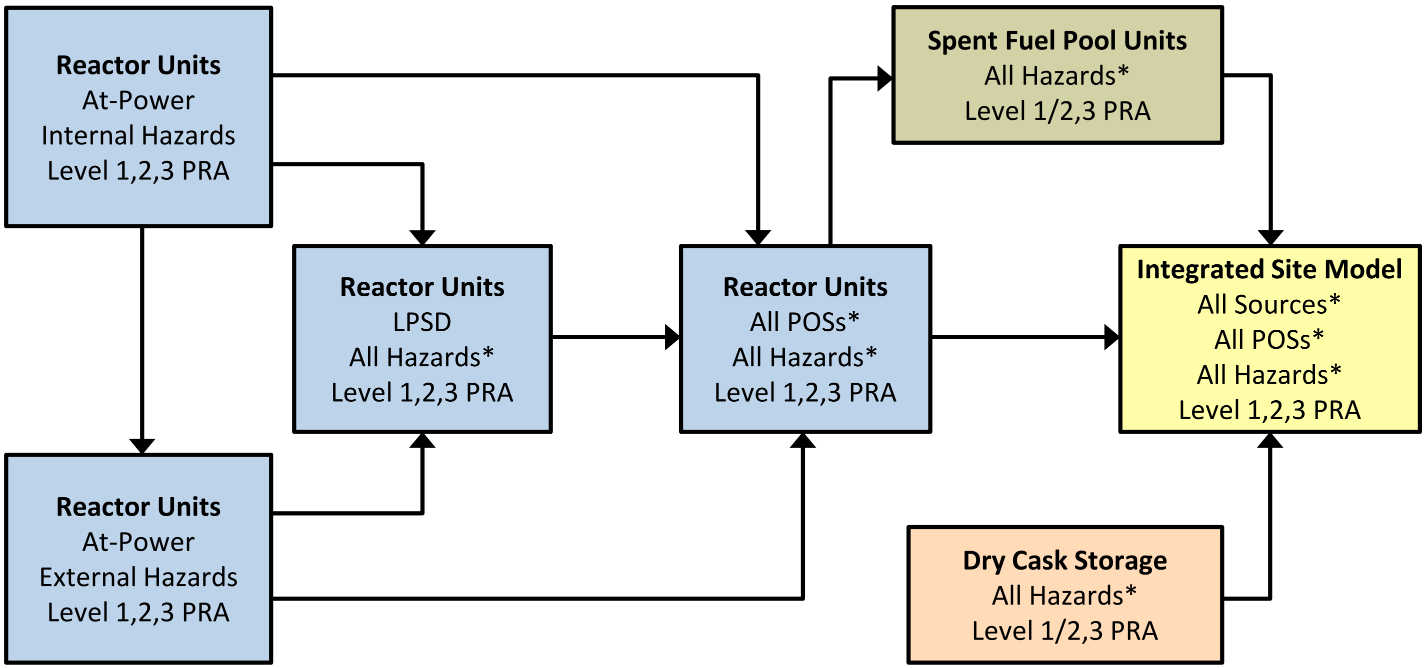


1. Specify Multi-Source PRA Model Scope

PRA Scope Element	Scoping Options
Radiological Sources	Operating Reactor Units (Unit 1 & Unit 2)
	Operating Reactor Spent Fuel Pools (Unit 1 & Unit 2)
	Dry Cask Storage Facility
Plant Operating States (POSs)	At-Power
	Low-Power and Shutdown (LPSD)
Initiating Event Hazard Groups	Internal Hazards (Internal Events, Floods, and Fires)
	External Hazards
PRA End States	Level 1: Nuclear Fuel Damage
	Level 2: Radiological Release Categories
	Level 3: Offsite Radiological Consequences

1. Specify Multi-Source PRA Model Scope

Integrated Site PRA Inputs and Interrelationships



Acronyms

LPSD:	Low-Power and Shutdown
POS:	Plant Operating State
PRA:	Probabilistic Risk Assessment

* **NOTE:** The term "all" in this context means all factors (sources, POSs, or hazards) selected for inclusion in the scope of the project and individual PRAs that provide input to the integrated site PRA task. It does not mean that all possible factors are included within the scope of each PRA.

2. Review Single-Source PRA Results

- End state significant cut sets
  - Combined contribution ≥ 95% OR individual contribution ≥ 1% to total end state frequency.*
  - Number depends on end state risk profile.
    - End states with a concentrated risk profile have a limited number of significant cut sets to evaluate.
    - End states with a diffuse risk profile may require balancing completeness with schedule and resource constraints.
- End state significant basic events
  - Fussell-Vesely (F-V) > 0.005.*
    - Fractional contribution to total end state frequency of cut sets that include event of interest.
  - Risk Achievement Worth (RAW) > 2.*
    - Factor by which total end state frequency increases if event of interest is assumed to occur with 100% probability.

* **NOTE:** These criteria are consistent with definitions specified in the ASME/ANS *Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications*.

3. Identify Inter-Source Dependencies

- Existence of a potential inter-source dependency determines whether a significant cut set or cut set containing a significant basic event is selected for inclusion in the multi-source PRA model.
  - Dependencies of interest are scenario-related causal links between basic events.
- Literature review on multi-source PRAs and operational experience involving multi-source events led to identification of five broad dependency categories.
- Categorization scheme is coupled with review of single-source PRA model results to identify cut sets that will be included in the multi-source PRA model.

3. Identify Inter-Source Dependencies

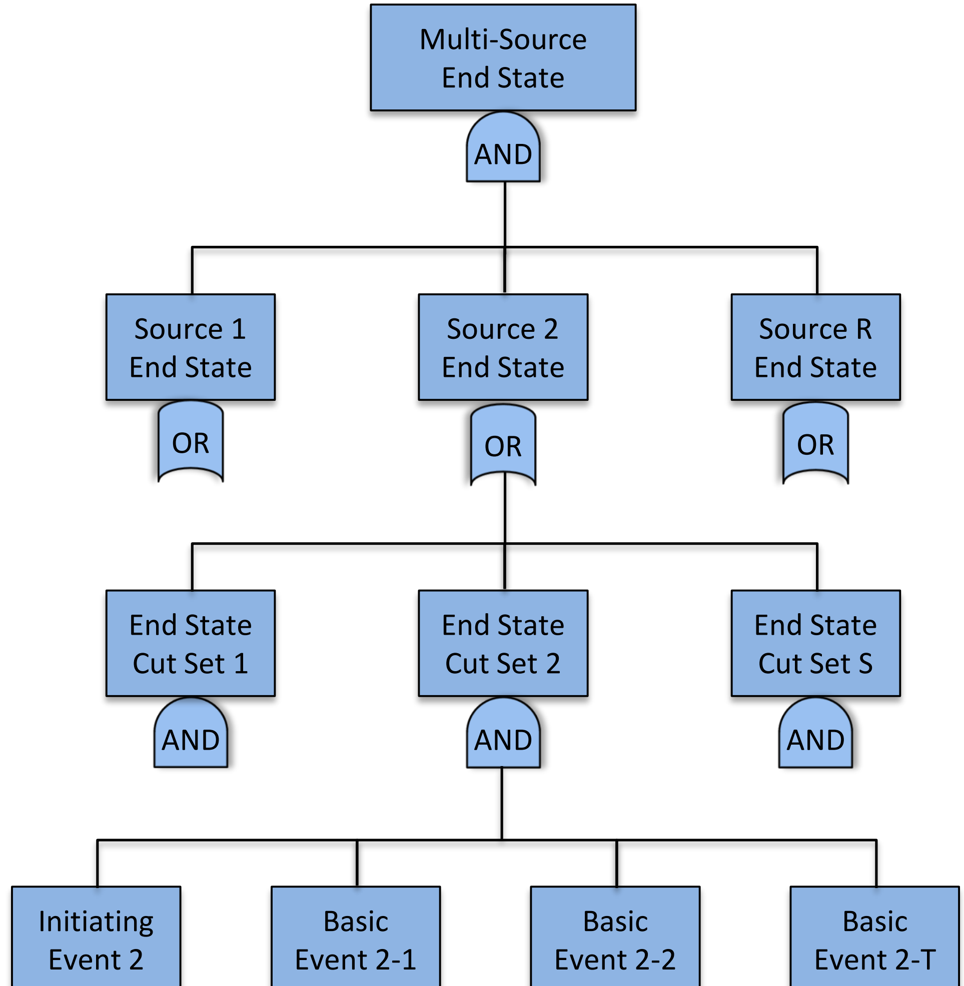
Category	Definition	Example(s)
Initiating events		
• Common-cause initiators	Initiators that simultaneously challenge multiple radiological sources.	Loss of shared electrical grid or ultimate heat sink.
• Consequential initiators	Initiators that arise from events involving another radiological source.	Transient in one reactor unit causes loss of offsite power to another unit.
Shared SSCs	SSCs that support multiple radiological sources under various conditions.	Electrical power sources that can swing between radiological sources.
CCF Events	Dependent failures of SSCs across multiple radiological sources due to a shared cause that are not otherwise explicitly modeled.	Failure of similar components installed in each unit due to a shared defect.
Phenomenological Dependencies	Arise from exposure of multiple SSCs to shared phenomenological or environmental conditions.	Failure of components in multiple radiological sources due to shared environmental conditions (e.g. temperature, moisture, or radiation levels) that exceed capacity.
Human or Organizational Dependencies	Dependencies between operator actions associated with multiple radiological sources that can arise from multiple causes, including shared organizational factors.	Shared training, procedures, or command and control structure cause recovery actions taken in response to an accident affecting one radiological source to be dependent upon those taken in response to an accident affecting another radiological source.

4. Construct Multi-Source PRA Model

- Top-level AND gates combine end states for selected radiological sources.

- Mid-level OR gates combine cut sets with inter-source dependencies.

- Bottom-level AND gates combine basic events for selected cut sets.



5. Model Inter-Source Dependencies

- Approach depends on event of interest.
- Site-level events in each single-source PRA model that represent same event across all radiological sources.
  - Ensure same event applies to all modeled radiological sources to ensure proper structure and quantification of minimal cut sets for multi-source end states of interest.
- Other dependent events:
  - Screening analysis
    - Assume complete inter-source dependence for modeled dependent events (i.e., conditional probability of dependent event in co-located sources is 1.0 given event occurrence in one source).
  - Iteration
    - Iteratively refine conditional probability estimates for dependent events that are significant contributors to multi-source end state frequency.

6. Quantify Focused Multi-Source PRA Model

- Select multi-source end states of interest.
- Specify cut set probability truncation.
- Account for modeled inter-source dependencies.
- Results of interest:
  - Significant multi-source cut sets.
  - Significant basic event importance measures.

Pilot Applications

- Purposes*
  - Evaluate technical feasibility of implementing the focused approach using existing analytical tools.
  - Identify potential barriers to implementation.
- Scope
  - Reactor, At-Power, Internal Events, Level 1 PRA
  - Reactor, At-Power, Internal Events and Floods, Level 2 PRA
- Key finding
  - For scoping options addressed in the pilot applications, available technology with workarounds can be used to efficiently develop a focused Integrated Site PRA model based on risk insights from single-source models.

* **NOTE:** No attempt was made to comprehensively identify, characterize, and model inter-source dependencies for each of the pilot applications. Since the main purpose of the pilot applications was to evaluate the technical feasibility of implementing the focused approach using existing analytical tools, only a limited set of inter-source dependencies was identified, characterized, and modeled as part of the pilot applications.

Acronyms and Definitions

ASME	American Society of Mechanical Engineers
ANS	American Nuclear Society
CCF	Common-Cause Failure
CD	Core Damage
EPS	Emergency Power System
F-V	Fussell-Vesely
LOOP	Loss Of Offsite Power
LPSD	Low-Power and Shutdown
POS	Plant Operating State
PRA	Probabilistic Risk Assessment
RAW	Risk Achievement Worth
SAPHIRE	Systems Analysis Programs for Hands-on Integrated Reliability Evaluations
SSC	Structure, System, Component

Supplementary Information

A Simplified Hypothetical Example for Illustrating Application of the Integrated Site PRA Approach

Introduction

- Purpose
  - To illustrate application of the general Integrated Site PRA approach using a relatively simple hypothetical example.
- Simplifying Assumptions
  - A hypothetical site of interest includes only two identical operating reactor units (Unit 1 & Unit 2).
  - A loss of offsite power (LOOP) is the only initiating event that can result in reactor core damage.
  - Each unit includes two Emergency Power System (EPS) trains (Train A and Train B). Each individual train is capable of providing electrical power to critical safety systems needed to prevent reactor core damage.

Simplified Hypothetical Example

1. Specify Multi-Source PRA Model Scope

- Radiological sources
  - Operating reactor units (Unit 1 & Unit 2)
- Plant operating states
  - At-power
- Initiating event hazard groups
  - Internal events
  - Simplified LOOP scenario for illustrative purposes
- PRA end states
  - Reactor core damage

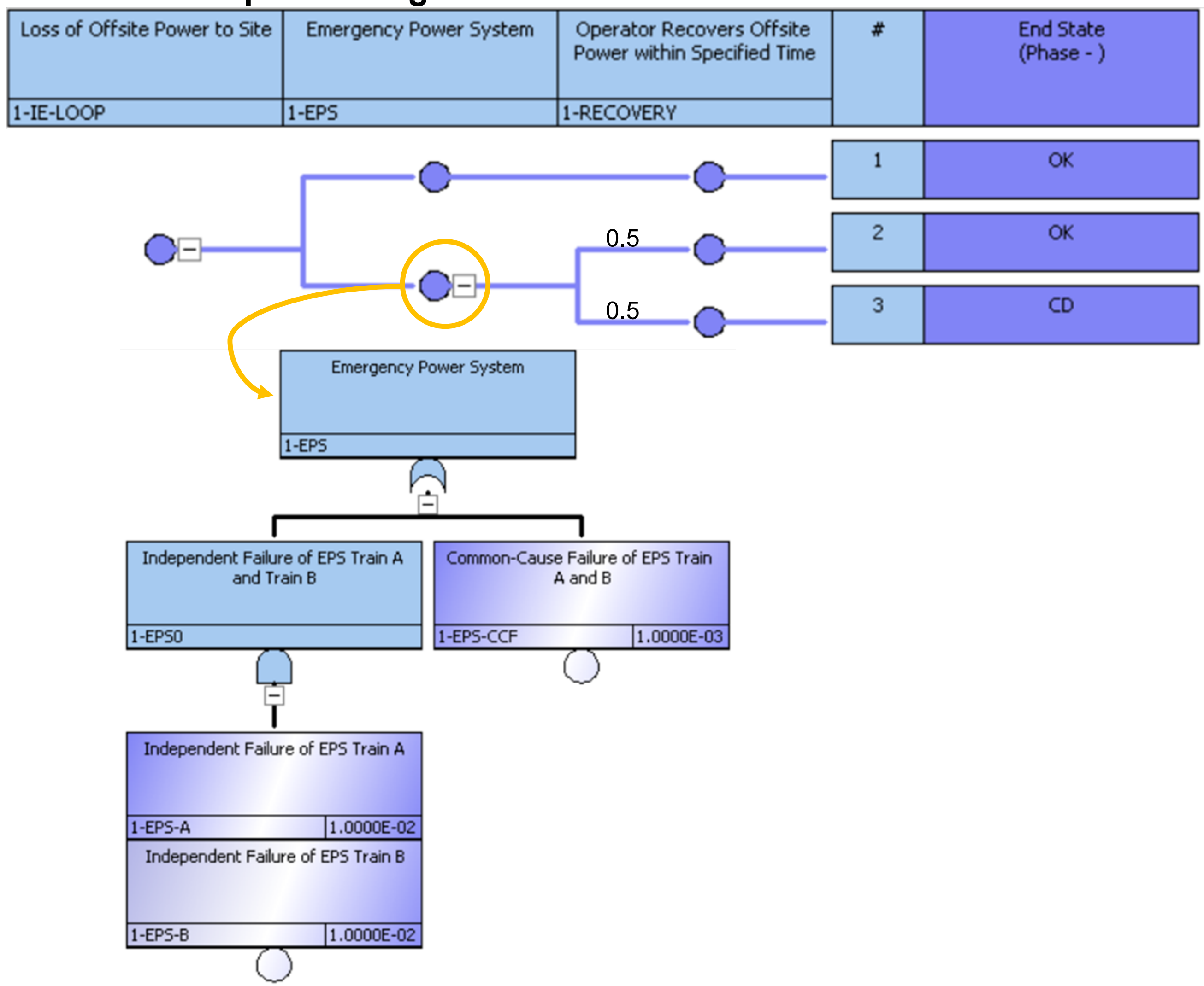
Simplified Hypothetical Example

2. Review Single-Source PRA Results

Simplified Single-Source PRA Model

LOOP Event Tree

Linked EPS Fault Tree



Simplified Hypothetical Example

2. Review Single-Source PRA Results

End State Significant Cut Sets

Cut Set No.	Prob/Freq	Total %	Cut Set Event	Event Description
	6.E-06	100		Reactor Core Damage
1	5.E-06	91	Loss of Offsite Power Core Damage Sequence	
	1.E-02		1-IE-LOOP	Loss of Offsite Power to Site
	1.E-03		1-EPS-CCF	Common-Cause Failure of EPS Train A and B
	5.E-01		1-RECOVERY	Operator Recovers Offsite Power within Specified Time
2	5.E-07	9	Loss of Offsite Power Core Damage Sequence	
	1.E-02		1-IE-LOOP	Loss of Offsite Power to Site
	1.E-02		EPS-A	Independent Failure of EPS Train A
	1.E-02		EPS-B	Independent Failure of EPS Train B
	5.E-01		1-RECOVERY	Operator Recovers Offsite Power within Specified Time

End State Significant Basic Events

Event	Event Description	Prob/Freq	F-V	RAW
1-IE-LOOP	Loss of Offsite Power to Site	1.E-02	1.E+00	1.E+02
1-RECOVERY	Operator Recovers Offsite Power within Specified Time	5.E-01	1.E+00	2.E+00
1-EPS-CCF	Common-Cause Failure of EPS Train A and B	1.E-03	9.E-01	9.E+02
1-EPS-A	Independent Failure of EPS Train A	1.E-02	9.E-02	1.E+01
1-EPS-B	Independent Failure of EPS Train B	1.E-02	9.E-02	1.E+01

NOTE: Fussell-Vesely (F-V) and Risk Achievement Worth (RAW) importance measure results highlighted in green indicate those that satisfy one or both of the following criteria used to identify significant basic events:

- F-V > 0.005
- RAW > 2

Simplified Hypothetical Example

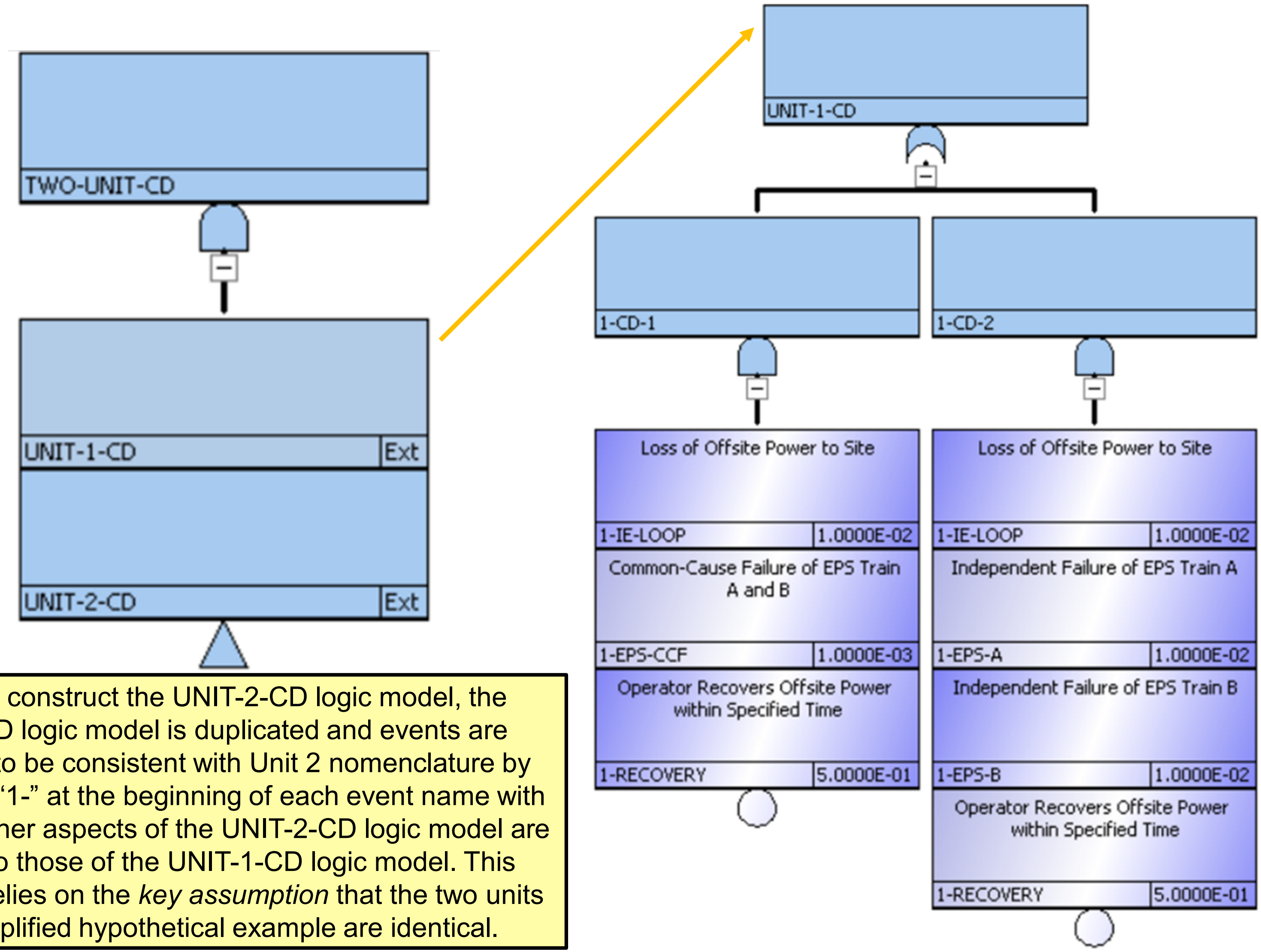
3. Identify Inter-Source Dependencies

- Initiating events
  - LOOP impacts both Unit 1 and Unit 2.
- Shared structures, systems, components (SSCs)
  - Assumed to not apply to this simplified hypothetical example.
- Common-cause failure (CCF) events
  - EPS Train A and Train B fail due to shared cause in both Unit 1 and Unit 2.
- Phenomenological dependencies
  - Assumed to not apply to this simplified hypothetical example.
- Human or organizational dependencies
  - Operator recovery of offsite power within specified time impacts both Unit 1 and Unit 2.

IMPORTANT CAVEAT: Consistent with its intended purpose, this simplified hypothetical example does not address all potential inter-source dependencies that would need to be considered in performing an Integrated Site PRA for a commercial nuclear power plant site.

Simplified Hypothetical Example

4. Construct Multi-Source PRA Model



NOTE: To construct the UNIT-2-CD logic model, the UNIT-1-CD logic model is duplicated and events are renamed to be consistent with Unit 2 nomenclature by replacing “1-” at the beginning of each event name with “2-.” All other aspects of the UNIT-2-CD logic model are identical to those of the UNIT-1-CD logic model. This process relies on the *key assumption* that the two units in this simplified hypothetical example are identical.

Simplified Hypothetical Example

5. Model Inter-Source Dependencies

- Treatment of site-level events: Needed to ensure proper structure and quantification of minimal cut sets.
  - *LOOP initiating event:* If Unit 1 and Unit 2 LOOP initiating events jointly occur in same cut set, remove Unit 2 LOOP.
  - *Operator recovery of offsite power:* If Unit 1 and Unit 2 recovery actions jointly occur in same cut set, remove Unit 2 recovery action.
- Treatment of inter-source CCF events
  - CCF of EPS Train A and B: If Unit 1 and Unit 2 CCF of EPS Train A and B jointly occur in same cut set, replace Unit 2 CCF event with a factor that represents the conditional probability of the CCF event occurring in Unit 2, given that the CCF event occurred in Unit 1.

Simplified Hypothetical Example

6. Quantify Focused Multi-Source PRA Model

Case 1: Independent Case (Truncation = 1E-16)

	Prob/Freq	Total %	Cut Set
	3.E-11	100	
1	3.E-11	83	1-IE-LOOP,1-EPS-CCF,1-RECOVERY,2-IE-LOOP,2-EPS-CCF,2-RECOVERY
2	3.E-12	8	1-IE-LOOP,1-EPS-CCF,1-RECOVERY,2-IE-LOOP,2-EPS-A,2-EPS-B,2-RECOVERY
3	3.E-12	8	1-IE-LOOP,1-EPS-A,1-EPS-B,1-RECOVERY,2-IE-LOOP,2-EPS-CCF,2-RECOVERY
4	3.E-13	1	1-IE-LOOP,1-EPS-A,1-EPS-B,1-RECOVERY,2-IE-LOOP,2-EPS-A,2-EPS-B,2-RECOVERY

NOTE 1: Case 1 assumes Unit 1 and Unit 2 are completely independent to provide a reference point for comparison with Case 2, which assumes complete inter-source dependence. While multiplying two LOOP initiating event frequencies is mathematically incorrect, this practice provides a conservative estimate of the frequency of Unit 1 and Unit 2 *independently* experiencing a LOOP within the specified mission time, given that Unit 1 or Unit 2 experienced a LOOP.

Case 2: Complete Dependence Case (Truncation = 1E-16)

Cut Set No.	Prob/Freq	Total %	Cut Set
	5.E-06	100	
1	5.E-06	100	1-IE-LOOP,1-EPS-CCF,1-RECOVERY,EPS-FACTOR
2	5.E-10	< 0.01	1-IE-LOOP,1-EPS-A,1-EPS-B,2-EPS-CCF,1-RECOVERY
3	5.E-10	< 0.01	1-IE-LOOP,1-EPS-CCF,2-EPS-A,2-EPS-B,1-RECOVERY
4	5.E-11	< 0.01	1-IE-LOOP,1-EPS-A,1-EPS-B,2-EPS-A,2-EPS-B,1-RECOVERY

NOTE 2: Assuming complete dependence has two main impacts on the two-unit core damage results:

- The frequency of two-unit core damage events increases by several orders of magnitude.
- Results are completely dominated by a LOOP scenario in which CCF of EPS Train A and Train B occurs in both units, with the assumption that CCF of EPS Train A and Train B in either unit implies CCF of both trains in both units.

Simplified Hypothetical Example

6. Quantify Focused Multi-Source PRA Model

Case 2: Importance Measure Results

Event	Event Description	Prob/Freq	F-V	RAW
1-IE-LOOP	Loss of Offsite Power to Site	1.E-02	1.E+00	1.E+02
1-RECOVERY	Operator Recovers Offsite Power within Specified Time	5.E-01	1.E+00	2.E+00
1-EPS-CCF	Common-Cause Failure of EPS Train A and B	1.E-03	1.E+00	1.E+03
EPS-FACTOR	Probability of EPS Train A & B in Unit 2 Failing Given CCF Failure of EPS Train A & B in Unit 1	1.E+00	1.E+00	1.E+00
1-EPS-A	Independent Failure of EPS Train A	1.E-02	1.E-04	1.E+00
1-EPS-B	Independent Failure of EPS Train B	1.E-02	1.E-04	1.E+00
2-EPS-A	Independent Failure of EPS Train A	1.E-02	1.E-04	1.E+00
2-EPS-B	Independent Failure of EPS Train B	1.E-02	1.E-04	1.E+00
2-EPS-CCF	Common-Cause Failure of EPS Train A and B	1.E-03	1.E-04	1.E+00

NOTE: The factor that represents the conditional probability of a CCF of EPS Train A and Train B occurring in Unit 2, given that this CCF event occurred in Unit 1 (EPS-FACTOR) appears as a significant basic event with a F-V importance measure value of 1 (F-V > 0.005). This is based on the *key assumption* of complete inter-source dependence, which is consistent with the screening analysis step outlined in the general Integrated Site PRA approach. In practice, this step would be followed by subsequent analyses in which the conditional probability estimate that EPS-FACTOR represents would be iteratively refined until reasonable estimates are obtained for inter-source dependency factors that are determined to be significant contributors to multi-source end state frequency, recognizing that the set of significant inter-source dependency factors can change as conditional probability estimates are iteratively refined.