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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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RELIABILITY AND PRA SUBCOMMITTEE

LEVEL 3 PRA TECHNICAL ANALYSIS

(Open Session)+ + + + +

MONDAY

JULY 22, 2013

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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 8:30 a.m., John W. Stetkar, Chairman, presiding.

COMMITTEE MEMBERS:

JOHN W. STETKAR, Subcommittee Chairman

DENNIS C. BLEY, Member

MICHAEL L. CORRADINI, Member

JOY REMPE, Member

STEPHEN P. SCHULTZ, Member

NRC STAFF PRESENT:

JOHN LAI, Designated Federal Official

SUSAN COOPER, RES

RICHARD CORREIA, RES

KEVIN COYNE, RES

MARY DROUIN, RES

DON HELTON, RES

CHRIS HUNTER, RES

ALAN KURITZKY, RES

MARTY STUTZKE, RES

MAGGIE TOBIN, RES

ALSO PRESENT:

JOHN SCHROEDER, INL

*Present via telephone

C-O-N-T-E-N-T-S

P R O C E E D I N G S

8:30 a.m.

CHAIRMAN STETKAR: (presiding) The meeting will now come to order.

This is a meeting of the Reliability and PRA Subcommittee. I am John Stetkar, Chairman of the Subcommittee meeting.

ACRS members in attendance are Dennis Bley, Mike Corradini, and Joy Rempe.

John Lai of the ACRS staff is the Designated Federal Official for the meeting.

The Subcommittee will hear the staff's discussion of the Level 3 PRA Technical Analysis Approach Plan with Integrated Site Risk and other topics.

And just for the record, we have been joined by Steve Schultz.

There will be a phone bridge. To preclude interruption of the meeting, the phone will be placed in listen-in mode during the presentations and Committee discussions.

Parts of this meeting may be closed in order to discuss and protect information designated as proprietary by the NRC, pursuant to 5 USC 552b(C)(4).

We have received no written comments or requests for time to make oral statements from members

of the public regarding today's meeting.

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

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

A transcript of the meeting is being kept and will be made available as stated in The Federal Register notice. Therefore, we request the 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 they may be readily heard.

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

MEMBER REMPE: Excuse me, Mr. Chairman. I need to first acknowledge that I do have some organizational conflicts of interest with certain aspects of this work that will be discussed this morning. So, I will have to limit my participation in certain portions of this meeting.

CHAIRMAN STETKAR: Okay. Thank you.

Rich?

MR. CORREIA: Good morning, and thank you for the opportunity to brief the Reliability and PRA Subcommittee on the Vogtle Level 3 Project. This is the third meeting that we have had with the Subcommittee to cover the Level 3 Project Technical Analysis Approach Plan, or the TAAP. Previous meetings were in December of last year and May of this year.

Today's focus is on the integrated site risk portion of the TAAP. This is the final TAAP section we intend to brief and a very important and unique aspect of the project.

In response to a previous ACRS request, we are also providing an overview of plans for the Human Reliability Analysis, or HRA. This is still a work-in-progress that we are converging toward a technical approach for some of the more difficult aspects of the study, such as HRA for Level 2.

We have also reached an important project milestone in that we are transitioning from project infrastructure development and planning towards a much stronger focus on technical work. As such, we are also going to provide a preliminary overview of the Level 1 Internal Events at Power PRA during the second half of the meeting.

Now I will turn to Alan Kuritzky.

MR. KURITZKY: Thank you, Rich.

I'm Alan Kuritzky, Program Manager for the Level 3 PRA Project. I want to echo Richard's sentiments. We are appreciative of the opportunity to discuss this project with the Subcommittee.

Today with me are Mary Drouin, the Principal Technical Advisor for the project. Also, we are going to be hearing from Marty Stutzke and Maggie Tobin on integrated site risk aspects, as Rich mentioned, followed by a discussion of our thoughts on the approach for HRA from Susan Cooper.

And then, in the closed session of the meeting, John Schroeder from Idaho National Lab will discuss our taking of the model from the licensee and giving it over to SAPHIRE.

And then, Chris Hunter of the staff will discuss the NRC's taking ownership of that model and the work that we have done to delve into the model and dig into the details, as well as providing some of our initial Level 1 Internal Events At Power results.

So, with that, let me turn it over to Marty.

MR. STUTZKE: Good morning.

I'm Marty Stutzke, the Senior Technical Advisor for PRA Technologies in the Office of Research. I'm also the Task Leader for the Integrated Site Risk

Assessment portion of the program.

Seated next to me is Maggie Tobin who is assisting me. She's actually doing the work, and I set her up and write TAAPs and things like that.

But today we want to talk about -- let's go to slide 4, please.

CHAIRMAN STETKAR: Marty, are you going to need input from anyone on the bridge line.

MR. STUTZKE: Not for our part.

CHAIRMAN STETKAR: Okay. I am going to get it muted from our end here because it tends to pop and crackle.

MR. STUTZKE: I understand.

So, we will talk about the actual TAAP itself, the Technical Analysis Approach, and why it evolved into the approach that it currently did like this.

Maggie, then, will brief you on the current status of work like this.

And finally, we will revisit the notion of risk metrics that the project will be computing.

So, when we normally build SPAR-like models, we are into a linked fault tree mindset process, and that poses a number of challenges when one tries to develop a large model to do the integrated site risk like this because what it implies is we would have to link various

single-source PRA models together in some coherent, reasonable fashion in order to produce the results.

When we say single source, what we mean is a source of radiological hazards. So, it could be either of the reactors onsite, either of the spent-fuel pools onsite, and, of course, the dry cask storage locations themselves. And so, we are talking about forming combinations. Maybe two reactors or a reactor and its spent-fuel pool or a reactor and the opposite spent-fuel pool, all of these combinations are possible like this.

We have been wrestling with this challenge for quite some time now. When one gets into the linked fault tree type of approach, you generate a model that is so large it is hard to understand whether the model is correct or not, let alone be able to solve for results like this.

So, based on our White Paper that our consultants did for us, we have been reviewing the model in some detail. Maggie has been doing almost gate-by-gate type of review to try to understand what is in the model. We have done some experiments inside of SAPHIRE to try to understand solution time, simple quantification techniques of just linking sequences together from one reactor to another like that. She will speak to that later.

I think another important thing to realize is we have an overall project schedule, but it is the coordination or the timing of the individual piece parts. Right now, what we have is the reactor model for both units. It's a Level 1 and it is the at-power model. So, none of the shutdown states are there. I haven't seen the Level 2 model yet. It is being developed like this. And certainly nothing on the spent-fuel pool.

CHAIRMAN STETKAR: Marty, do you have fires in the Level 1 model?

MR. STUTZKE: Not yet.

CHAIRMAN STETKAR: Okay.

MR. STUTZKE: It's only internal hazards so far. So, it's internal floods and the usual laundry list of internal initiating events.

MEMBER BLEY: Now your starting point was the existing SPAR model or the plant's PRA?

MR. STUTZKE: It's the plant's PRA converted to SAPHIRE. So, there has been some learning curve as well.

MEMBER CORRADINI: You guys are like talking to each other and you understand. So, take one step back and tell me short. So, I take the plant's PRA and I convert it to SAPHIRE. What does that mean?

MR. STUTZKE: The existing licensee's model

is built in the CAFTA software.

MEMBER CORRADINI: Who?

MR. STUTZKE: CAFTA.

MEMBER CORRADINI: So, a different software package?

MR. STUTZKE: It's a different software package. So, in principle, one converts one to the other, and it kind of works easily. It is like converting --

MEMBER CORRADINI: This is like running TRAC and RELAP1? One doesn't simply run TRAC. One has to go and take all the input and put it into RELAP and redo it?

MR. STUTZKE: No, I don't think it's that hard. It's more like a word processing for event tree logic.

MEMBER CORRADINI: Okay.

MR. KURITZKY: Let me just interrupt one second, Dr. Corradini.

Actually, John Schroeder, when he talks in the next section, is going to specifically get to how we switched over.

MEMBER CORRADINI: Okay. Right. I just wanted to make sure I understood what you were getting at. Thank you.

MR. STUTZKE: Yes, but it is not of the irk

where we would take the actual SPAR model that we know and love and then augment it, expand it out to add more detail or things like.

MEMBER CORRADINI: You just simply translate it?

MR. STUTZKE: We just simply take the licensee's model over.

MEMBER CORRADINI: Okay. Thank you.

MR. STUTZKE: And it implies some learning as you get in there because you build it and you find things. And there's always this tendency among PRA analysts to say it must be wrong because that isn't how I did it or I would have done it like that. So, a great deal of a learning process like that.

MEMBER CORRADINI: Can I ask another question?

MR. STUTZKE: Yes.

MEMBER CORRADINI: So, I'm going to still use the TRAC/RELAP analogy. Usually, there is a background document that discusses all your assumptions in making the base model. Is there always a background QA document? Because at least when you do it for thermohydraulics, NRC requires the licensees to do it. So, I'm sure that NRC requires their own people to do it. There is a data book that says I am modeling the

real system like this, and here are the assumptions I got to get to the models.

MR. STUTZKE: Oh, absolutely. I mean, Southern Nuclear has been very cooperative. We have all of the system notebooks, all of the individual descriptions with these parts.

MEMBER CORRADINI: Okay.

MR. STUTZKE: We have their results. Part of this effort is to benchmark when we put it in the SAPHIRE. Chris Hunter will speak to that --

MEMBER CORRADINI: Okay. Thank you.

MR. STUTZKE: -- as well as John will like that.

But it became abundantly clear to try to link single-source models together wasn't going to be too successful for us. There are a large number of sequences. Maggie has got the actual number, but we are talking about thousands of sequences for just one reactor at power. So, a couple of thousand times a couple of thousand generates more work than I think is reasonable to get done in this time.

So, the idea is to be iterative and highly strategic and constantly maintain the focus on what we think is risk-significant in a multi-source environment like that.

MEMBER BLEY: Will Maggie be telling us about, when you do this, how you look at the things that are common across these models?

MR. STUTZKE: We will talk in some detail about how we are trying to identify what appears to be common like this.

MEMBER BLEY: Okay. And carry that through? Okay.

MR. STUTZKE: Right.

MEMBER SCHULTZ: Marty, I can hold the question, if it's appropriate, until later. But you mentioned you run across things that you might have modeled differently or you might question the model as you go from one model to the other. And that's ordinary.

But what do you do when you find something like that? Is it earmarked for discussion?

MR. STUTZKE: Oh, absolutely. It is tracked under our Quality Assurance Program. I mean there are a couple of things in there. One is, if we find something we think is technically wrong, then we elevate it that way and go back and fix the single-source model like that.

You know, the thing I am referring to is we found an example of logic that is in the tree that is apparently turned off that has to do with

cross-connecting diesels from one unit to another. And when you find it in the gate structure, you wonder why is it there if it is turned off, things like that.

MEMBER SCHULTZ: Thank you.

MR. STUTZKE: So, some issues like that.

What it is involving, then, is going to be some highly-iterative effort as we try to build this model piece by piece to pick up what we think is important. We will talk in a few more slides about how we are identifying what's important.

A heavy burden on the project team, so large numbers of meetings. I have to keep track of what other people are doing like this and benchmarking, benchmarking partial solutions, making certain that the model works at each part.

MEMBER CORRADINI: So, is this the first time this has been done or has it been done before historically, and there are ways you can check out what you're doing versus what people have done in other sites?

MR. STUTZKE: Well, it has been done historically. I mean, a notable example is Seabrook was a multi-unit PRA, or at least there were multi-unit aspects done at Seabrook back in the eighties by Pickard, Lowe, and Garrick --

MEMBER CORRADINI: Yes, I figured it was

that three-letter group.

MR. STUTZKE: -- like that. A lot of the nuts-and-bolts details of how they actually quantified and produced their answer are not available to us. At least we haven't been able to find it at any level, although we are maintaining good contact with people like Carl Fleming who was one of the lead developers of that.

MEMBER CORRADINI: Okay. Okay. And in your eyes, that's a good example? That's the only example --

MR. STUTZKE: Well, you know, I pointed out early, our mindset here between SPAR is a linked fault tree. So, put everything together and solve this massive fault tree equation. And the PLG approach is always the support state. So, it's a large event tree type of approach like this. And so, there are modeling differences into how things are picked up like that.

Okay. So, slide 6, I think. We are developing insights from the individual single-source models to try to focus attention like this. For example, we know from our experience that in PWRs reactor pump seal LOCAs to tend to be important risk contributors like this. And so, we have spent some time looking at this.

We have also looked at loss of offsite power sequences, trying to understand how the plant behaves.

Realize, though, very few cross-connects between the two units, between the two reactors are the same.

Obviously, at the switchyard, but it is not an interlaced sort of electrical system where one unit is driving the other units, half of the units' buses like this. Service water is split out or the equivalent of service water. Nuclear service's cooling water system tends to be independent like this.

So, we are focusing on that, trying to understand what are the dominant risk contributors for the single-source at-power reactor PRA that we have linked this, and trying to understand the dependencies that could come into other units like that.

At the same time, that's informing us on the development of criteria or assumptions to focus-in on the model. And the notion is that we can screen some of the possible configurations and sequences out at a high level without even having to develop them or develop them a great deal.

MEMBER BLEY: Marty, in this early look, are you looking at Level 2, especially Level 3 considerations that can compound this problem?

MR. STUTZKE: That's the intent, but we have just scratched the surface now with the Level 1.

CHAIRMAN STETKAR: I want to follow up on

that a little bit because, as I read through this section of the plan, there was a lot of emphasis placed on examination of, I will call it a hierarchical examination, which Dennis alluded to, that we'll look at Level 1, then we'll look at Level 2, then we'll look at Level 3.

And within each of those three areas, there was emphasis on we'll look at the dominant contributors. Our experience is that the contributors way down at the bottom, the things that you don't look at are the things that are important to look at.

We raised this, for example, in the SOARCA project. Seismically-induced loss of DC power will not show up in your Level 1 PRA model when you eventually put the seismic stuff in that Level 1. It won't show up. It could very well be a very, very significant contribute to the integrated Level 1-2. I'm quite sure how it affects Level 3, but it is probably pretty bad seismic events. So, it will probably affect evacuation planning. And if there is any amount of correlation in the seismic fragilities for the DC power system between the two units, it could be even relatively more important.

How does this hierarchical look in focusing on the dominant contributors, as you characterize them, to the results in separately Level 1, Level 2, Level

3 going to capture that, the need that you really need to look at that, perhaps? I don't know.

MR. STUTZKE: Yes, the idea is to look at it from multiple perspectives. So, in other words, we're not fixated on frequency of sequence per se. That's one of the criterias to get rid of things.

CHAIRMAN STETKAR: It says multi-source sequence frequency.

MR. STUTZKE: Right.

CHAIRMAN STETKAR: And there was emphasis in the paper on this.

MR. STUTZKE: But there's also emphasis on the risk because we don't want to have, what I'll call, the SOARCA dilemma where you fixate on the frequency at the exclusion of what the risk consequences like that.

CHAIRMAN STETKAR: Okay. I'm glad to hear that because --

MR. STUTZKE: Part of the problem now is, I mean, you see the emphasis on frequency. And part of it is reflecting, I guess, my own bias, being a Level 1 PRA type of person like that.

Also, we don't have the risk results for the single source yet. So, you look at what you've got to look at.

CHAIRMAN STETKAR: That's right, but there

is a danger. I mean, you do have a budget and a schedule. There is a danger that, once you get those Level 3 integrated results from a single source -- let's call it a reactor source -- with internal and external events, that you might learn things that cause you to go back and substantially rethink how you're going to stitch everything together. It is perhaps a lot of waste of effort.

MR. STUTZKE: Well, it's a learning process.

(Laughter.)

Yes, hence, the nature on highly-iterative like that. I guess the other way to look at is we are not at this point screening anything. It's more we're prioritizing by different types of criteria. So, we can rank-order by sequence frequency. When we get the risk results, we can rank-order by the risk or we can rank-order by the consequence, and based on the totality of that information, decide what we are going to do.

Another example is screening on the likelihood of the site configuration. When we talk about a site configuration, what we mean is, say, Unit 1 reactor is operating at power, its spent-fuel pool with some anomal configuration. Meanwhile, Unit 2 is shut down. It might be in refueling, in moving fuel and things like this. Its reactor, in fact, might be at mid-LOOP

operation.

So, you look at the likelihood of that type of occurrence, and it is like .1 percent of the total operating time. And yet, we all know that mid-LOOP can be an important risk driver.

So, how to screen, or is it even appropriate to screen out, some of these not-rather-frequent site configurations, yes or no? Screen them out would save us a great deal of time, but you might miss the risk insight from a mid-LOOP operation.

CHAIRMAN STETKAR: Absolutely.

MR. STUTZKE: So, these are the sorts of tradeoffs. The belief is that, if we prioritize by several different ways and, then, decide together.

The other part that doesn't come across per se -- and I guess it has come out in discussions with the TAG. That's our Technical Advisory Group. It's chaired by Nathan Siu. The notion is that, as we prioritize and, then, pick what sequences we want to evolve, we are going to run it through the TAG to see their insights, you know, suggestions, and things like that. So, it is not just going to be me picking sequences and say that's the one.

MEMBER CORRADINI: So, once again, you guys are talking to each other. So, let me make sure I'm

clear.

So, here's where it is that you screen out based on frequency something that seems a low-probability event. Therefore, you say, even though it could be incredibly high consequences --

MR. STUTZKE: Or some other thing like that.

MEMBER CORRADINI: So, can I go back then? So, leads me to my question when I asked historically how you attacked this. And I don't still understand it, and you said somebody will explain it to me eventually.

But if you have an integrated fault tree approach versus an event tree approach, again, an analogy between finite different and finite element for modeling a system, they both give you the same answer if you work hard enough. But is the front-end work the way you are doing it much higher than where you essentially sketch out a set of event trees and do kind of a quick Phase 1 look at things to decide where things sit? Do you know what I'm asking?

MR. STUTZKE: I think I know what you mean. The secret is, when you do it at an event tree level, you need to ensure the events headings themselves are independent like this. In fault tree analysis you will pick that up because the dependencies are lurking in the basic events in there, presumably.

MEMBER CORRADINI: All right.

MEMBER REMPE: Maybe it's understood by others, but I didn't see it in the information I looked at, but are you doing uncertainties or just point estimates here?

MR. STUTZKE: We will be doing some uncertainties.

MEMBER REMPE: But you're not so far?

MR. STUTZKE: Not yet.

MEMBER REMPE: Okay.

MR. STUTZKE: No, we haven't even quantified anything yet like that.

MEMBER REMPE: Okay.

CHAIRMAN STETKAR: Marty, just one last thing. You may want to look at the plan itself because, as I said, as I read through it, there was a lot of emphasis on this notion of we're going to look at the dominant contributors; we're going to look at the top contributors. We're going to consider frequency.

And there is an example in 17.3 that tries to elaborate on this frequency notion. It uses loss of offsite power and says, well, if we have a LOCA scenario that is going to core damage on Unit 1 at a frequency of 10 to the minus 7, the probability of consequential loss of offsite power is 5 times 10 to the minus 3.

So, lo and behold, we've got something that's 5 times 10 to the minus 10. So, who cares about it? Loss of offsite power affects both units, or at least several of the contributors affect both units.

So, there's an example where just blind use of frequency will screen out a common coupling between the two sources and, in fact, four sources because both the spent-fuel pools and the reactors.

MR. STUTZKE: Right.

CHAIRMAN STETKAR: So, those kind of little nuggets in there is what got me kind of worrying about this.

MR. STUTZKE: Right. You know, it's interesting, whenever you screen based on either frequency or you could screen on risk, and, of course, you have a variety of risk metrics, early fatality risk, you know, the latent cancers and some things like that. But, normally, you want to screen so you are neglecting a low percentage of the total risk, but we don't know what the total risk is a priori.

So, the screening criteria, you know, quantitative, that I have been considering like this are at a very low level, you know, like 10 to the minus 10, which basically means you're not going to screen anything. And hence, the notion to prioritize and say,

well, I'll start what I think is the most important until I run out of time and money, some sort of conversions.

You know, other things to think about, a more complete response. We have thought about Level 3 in the context of what is MACCS2 really capable of doing for us like this? It can handle what I'll call multipuffs. So, you can have a release, and sometime period later you have a second release and that has its own set of source terms. And, of course, meteorological conditions were sampled at the time and things like this.

And we have thought about, does that mean that the consequence is simply the sum of the individual consequences if release that? Probably not.

CHAIRMAN STETKAR: Certainly nots if the releases occur close in time under similar weather conditions. So, you can't just --

MR. STUTZKE: Well, and they could be higher or they could be lower because, you know, you've already got the general emergency declared. The evacuation has started like this when the second release comes. So, from certain risk metrics, it might be a "no, never mind at all." From other metrics, you know, for population dose risk or something, it could have a notable impact.

But the only way to get it is to start doing MACCS2 runs where I've got multiple releases. And our

Level 3 Analyst, Keith Compton, has actually been doing some sample results, or at least he told me he would be.

CHAIRMAN STETKAR: I think some of these -- and again, it's not the Subcommittee's or ACRS's role to give you insights on management projects. But I think some of this discussion anyway is why we were trying to emphasize doing what we were calling a horizontal pass through the PRA. In other words, get all the way out through Level 3 risk metrics for the Unit 1 reactor or whichever one you are picking.

MR. STUTZKE: Yes. Absolutely.

CHAIRMAN STETKAR: First, because you will learn a lot from that, and then, build more vertical.

MR. KURITZKY: And that is the approach we are taking.

CHAIRMAN STETKAR: Yes. Okay. Sure.

MR. STUTZKE: Yes, we want breadth over depth that we can.

CHAIRMAN STETKAR: Okay.

MR. STUTZKE: And I am just waiting to see the Level 2 and the Level 3 results for the single reactor because I think that will be very informative like this.

MEMBER SCHULTZ: But, Marty, what you're saying is that, looking forward to Level 3, there is

thought in the project about what MACCS should need to do in terms of its modeling capability to handle the two or four sources that could be modeled.

MR. STUTZKE: Right.

MEMBER SCHULTZ: And (knocking on table as "knock, knock, knock"), so you're approaching it from both ends in terms of the evaluation?

MR. STUTZKE: Right. As far as we know, we think MACCS2 has the capability that we need. There are some issues with the maximum time that it allows releases to begin, you know, a seven-day period. So, if you get a release that is staggered by two or three days, you begin to wonder, can you simulate as far as you would like to simulate like that. But, you know, you use the tool that you have available.

CHAIRMAN STETKAR: Well, and again, this has been always -- I was waiting for Alan to step in, but I will say it -- this is a state-of-the-practice, not a research project PRA. So, you're not going to be doing any MACCS development work, at least under this project.

MR. STUTZKE: I didn't want to fall back on that excuse.

(Laughter.)

CHAIRMAN STETKAR: Oh, I'm sorry.

MR. KURITZKY: I mean, there's going to be some finetuning of a few things, of course, like the time delay, the release timing. But, right, we are not doing whole-scale changes.

MR. STUTZKE: All right.

CHAIRMAN STETKAR: Okay.

MR. STUTZKE: Okay. Again, identifying/prioritizing by initiating event, by sequences, damage states, release states like this. Trying to identify dependencies within and across the risk sources. Maggie will describe briefly our dependency metrics approach, what we have been doing like this.

One of the things that I found very helpful, when you think about modeling multi-source sequences, is that initiators can be divided up into two types, what I will call single-source initiators -- for example, a LOCA in one unit. And it may get into the other unit. It may propagate into the other unit through some sort of dependency like a shared system or a fire. It could be spatial interaction. There could be cross-unit common-cause failures of the diesels, things like this.

But the point is, for single-source initiators, you have to model them in all the sources. Each source is a contributor to the total risk equation

like this.

In contrast, you get common-cause initiators, like a big earthquake, and everything gets shaken at the same time. It will trip all at the same time, something like that. So, we will talk -- a little bit later I have got some cartoon event trees to show you why the modeling approach needs to be different for them. But I find that to be a very important concept to understanding the modeling technique.

Okay. So, roughly on slide 8, we intend to develop a simplified model, based on our dependency analysis, our prioritization schemes like this; quantify that model in stages to determine what we can safely set aside or what we need to retain like this.

Okay. Slides 9, 10, and 11 are the actual figures out of the TAAP that show the flow through the project like this. I won't go into any great detail about how it all works. I will point out, well, a couple of things.

One is we have some initial steps that are common to the Level 1, 2, and 3. Task 1 is identifying risk insights. We have a format to try to capture those things, as well as the development of criteria and assumptions to let us simplify. So, that is Task 1 and 2 in here.

Also, I will point out a little idiosyncracy I have received numerous comments on. And that is, the Level 1 portions of the TAAP, all the tasks are labeled 1-something, not to be confused with Task 1, which is the risk insights. The logic there is Task 1-something, it is a Level insight. A 2-something, it is a Level 2. So, it makes in its own way. It is not a typo like that.

You will see the numerous feedback loops like this. Basically, what it says is choose some sequences, some multi-source sequences, work on them a while, quantify it, loop back, and pick up some more like this. You will see it on Level 1 and, then, 2 and 3 like that.

But I would like to jump now to slide 12 to try to --

MEMBER CORRADINI: Before you do any jumping --

MR. STUTZKE: Yes.

MEMBER CORRADINI: I know you guys like these things, but these confuse the hell out of me. So, you guys are primarily working in the green box these days? Where are you working now? Are all the boxes -- I don't understand.

MR. STUTZKE: Okay. We are in, now on slide

9, we are in the two gray boxes, Tasks 1 and 2 --

MEMBER CORRADINI: Oh.

MR. STUTZKE: -- identifying the risk insights, and part of Task 1-1 and 1-2. 1-1 is prioritizing by initiating an event and accident combinations from fuel damage like that. We have a start of a --

MEMBER REMPE: So, are you doing some quantification then?

MR. STUTZKE: Not right now.

MEMBER CORRADINI: They are just identifying things.

MR. STUTZKE: Well, we are taking the results of the single-source quantification, but it is not finalized yet.

MR. KURITZKY: Right. We have done case --

MEMBER REMPE: And the SPAR case --

MR. KURITZKY: Not the SPAR, but our internal Level 1 at-power internal events model we have quantified, okay, from the integrated side. Risk, we have not done any quantification, but we have done quantification for the Level 1 at-power internal events model, including internal floods.

MR. STUTZKE: Yes. So, the quick answer is the gray box and the green box. But it is a matter of strategy. It is attack on all fronts right now.

But I would like to jump down, looking at the clock a little bit, and talk more about modeling common-cause initiators versus single-source initiators like this. In the common-cause initiator, one of the things you notice is you don't have this notion of what I will call subsequent initiating events. In other words, all units see the initiator simultaneously like that.

So, we can, then, think conceptually about taking sequences, for example, from the Unit 1 reactor and combining them from the Unit 1 spent-fuel pool, seeing what results like this, apply our screening and scoping strategies. Then, add on perhaps the Unit 2 reactor.

These are ideas on a conceptual -- I mean, it makes sense from some perspective, because the Unit 1 reactor and spent-fuel pool have common systems. There are some shared systems like electric power, to try to combine them first. We might also decide to use the Unit 1 reactor directly with the Unit 2 reactor to pick up those types of dependencies, and then, add the spent-fuel pool like that.

What I want to point out is on slide 13, for example, the single-source initiating model, is you will see that third event tree heading. And it says, "No initiator in the Unit 1 spent-fuel pool." A single-source initiator doesn't automatically generate

an initiating event for all the other sources on site. Okay? If they did, we would call them common-cause initiators.

Now one of the ones that I used to think of, and I still think a lot of the team does, is loss of grid. Obviously, that is a multi-source initiator. Actually, according to the data we have available, a loss of grid only has an 80-percent probability of affecting the other unit. It is not 100 percent. So, a loss of grid is a single-source initiator, according to that definition like that.

CHAIRMAN STETKAR: Marty, but there is an 80-percent probability.

MR. STUTZKE: But there is an 80-percent probability.

CHAIRMAN STETKAR: Now I will let you finish this thought.

MR. STUTZKE: Well, what it means I have to model loss of grid that got Unit 1 propagating into Unit 2 with an 80-percent probability, plus another contribution of a Unit 2 loss of grid that propagates into Unit 1. So, it is the sum that needs to be considered in that sort of thing.

And what this event tree structure is trying to show you is a very explicit consideration of how does

the other source get into trouble. What is its initiating event? And you find, for things like loss of grid or something like that, perhaps a loss of service water, there is a direct cause in there like that.

Sometimes it is not so obvious. The emergency management guidelines at the site talk about, if one unit is in a severe accident configuration sort of thing, think about what you want to do with the other unit. And it might require shutdown of that other unit. Okay? Well, that is a demand on that second unit. It looks like a general transient, a reactor trip. But that might not be quite so simple because some of the systems that it needs have already been used under the Unit 1. For example, diesel generator common-cause failure might span across multiple units like this.

The other thing, when you think about sequence modeling, is when we talk about multi-source risk assessment, most people will automatically think, "I want an accident scenario where both sources are damaged." Okay. So, a release from Unit 1 or damage in Unit 1 and damage in Unit 2, and that is what we are talking about.

You have to realize that those are what I call cascading sequences. I had to invent some titles, a vocabulary, in order to be able to think about it.

But there are also what are propagating sequences where, for example, Unit 1 has a loss of offsite power. It survives because of perhaps aux feedwater like this, but Unit 2 now goes down because of some diesel common-cause failure that got the entire site. And maybe its aux feedwater pump didn't survive. So, now the transient propagates from one unit into the other like this. And I think we need to be able to chase those, to be able to account for them in the pre-structure like this.

So, it is not just a matter, when I first was drawing these trees, to say, well, any success sequence I can ignore. It is not true.

MEMBER BLEY: You are making it almost sound like it would be easier just to combine the whole mess and live with the long runtimes.

(Laughter.)

It is getting very complicated.

MR. STUTZKE: That's possible. Yes.

MEMBER BLEY: Yes.

CHAIRMAN STETKAR: Is it simply a long runtime?

MEMBER BLEY: Or do you overwhelm the --

CHAIRMAN STETKAR: Do you have to set your numerical truncation when it is so high that you only

survive 10 to the minus 2 upsets?

(Laughter.)

MR. STUTZKE: You know, it is the whole play. You know, to speed up the runtime, you can jack up the truncation frequency, so you can force a solution. Maggie will talk about that in some detail.

CHAIRMAN STETKAR: Okay.

MR. STUTZKE: But the answer is, when we raised it up and it ground and ground for hours, and we got no cut sets.

MR. KURITZKY: And then, also remember, it is not just a question of jamming together the two at-power Level 1 reactor models. You also have to, then, combine low-power and shutdown models in one reactor and the at-power at the other one, all various combinations, go into spent-fuel pools.

CHAIRMAN STETKAR: Yes.

MR. KURITZKY: A dry cask can probably be done more independently, but still runtimes, computer things, the software code will be able to handle such things. And there's a lot of logistical things there.

MEMBER CORRADINI: So, I have a question. You guys are, again, back into talking to each other.

Just go back down again. So, I am still back with comparisons. When I went back to Seabrook,

you said to me that they use event trees, not fault trees, but I see you're using event trees. So, does the completeness issue pop up here or is this, again, a practical way to unwrap things enough so you can think it through?

MR. STUTZKE: I think it is the latter. The modeling approach at Seabrook tends to have relatively-large event trees. I mean, they have fault trees, too.

MEMBER CORRADINI: So, then, my next question would be, when you took Vogtle, you were given -- I can't remember what you said it was -- some other software package that, yes, CAFTA, that one --

MR. STUTZKE: Right.

MEMBER CORRADINI: -- that did the calculation, but it was per unit.

MR. STUTZKE: That's right.

MEMBER CORRADINI: So, why not simply take that, check its QA, and use it with these event trees to do this?

MR. STUTZKE: Because we don't have access to that software package.

MEMBER CORRADINI: Aha. So, you now have the input model, but you don't have that software?

MR. STUTZKE: Uh-uh.

MR. KURITZKY: Well, actually, we do have access to that software.

MEMBER CORRADINI: I am sorry to seem so lazy. I am just looking for a way that saves you all the trouble of remodeling it with a different software package. Because it seems to me the --

MEMBER BLEY: I think they have already done it, though, Mike.

MR. STUTZKE: Yes, it's done.

MEMBER CORRADINI: Oh, okay.

MR. KURITZKY: And there's a number of reasons why we did that. First of all, as you can tell by this discussion, we're going well beyond an internal events at-power Level 1 model.

MEMBER CORRADINI: I understood that.

MR. KURITZKY: And to do that, we are going to have to make -- our codes are going to have to handle a lot more than that --

MEMBER CORRADINI: For a unit?

MR. KURITZKY: Well, for a unit if integrates high risk.

MEMBER CORRADINI: Okay, okay.

MR. KURITZKY: One units going to Level 1, Level 2, et cetera. So, we want to be really able to adjust the code to handle whatever we need to stick in

there. And so, for that reason --

MEMBER CORRADINI: I understood that.

MR. KURITZKY: You control over the CAFTA code.

CHAIRMAN STETKAR: And part of this, Alan carefully said "we," meaning the staff and contractors, but basically the staff.

MEMBER CORRADINI: That's fine.

CHAIRMAN STETKAR: So, they are going to have to use the software that they are most familiar with also.

MEMBER CORRADINI: No, that's fine. Now I understand.

Going back, your point is the reason you are doing it this way, besides it being a nightmare to do a lot of calculations between the units, is that this allows you to think through logically how the two things talk to each other or don't talk to each other?

MR. STUTZKE: That's the idea.

MEMBER CORRADINI: Okay. So, it really is very similar to what you said? Is it similar to what they did in Seabrook? I'm still back to the historical comparison. I am very curious about that.

MR. STUTZKE: It's similar --

MEMBER CORRADINI: Okay.

MR. STUTZKE: -- to how that was done.

MEMBER CORRADINI: Right.

MR. STUTZKE: But, you know, the concern is building a logic model so large you can't interpret the result, even when it quantifies.

MEMBER BLEY: Just an aside, Mike, back when WASH-1400 was done, their first attempt, all they had were fault trees. And they built a fault tree with the top event being core damage. And I remember them talking about it. It kind of started here on the ceiling and it went down over all the walls. And when you would come in and say, "I'm worried about this small LOCA," it took them about a half-hour to find where it was in this thing. And the event trees came about as a way to structure that model, so you could understand the whole model.

MEMBER CORRADINI: Okay. Thank you.

MS. DROUIN: And also remember the Seabrook model is only giving us insights with regard to integrating two units. You know, they did not integrate two spent-fuel pools, dry cask storage. So, at this end, it is a lot more complicated in that regard.

MEMBER CORRADINI: Okay. Thank you.

MEMBER SCHULTZ: Different modeling and different software package again, an earlier time.

MEMBER CORRADINI: Understood.

MR. STUTZKE: Okay. I'm going to let Maggie explain what work we have actually achieved to date.

MS. TOBIN: In addition to providing the TAAP, we have done some work on dependency matrices for the reactor PRA model, which I will talk about no the next slide. But we haven't done anything for the spent-fuel pool, just the reactor.

We have also conducted a SAPHIRE experiment to assess quantification capability, which is what you guys were asking about earlier. Basically, what I did was I linked two sequences from each one, one from each unit, to see how long it took, and all those sorts of things. So, it was just one sequence on each side, as a smoke test. I needed to use a very low truncation, and it took hours, which basically just showed that brute force, at least on computers, you know, a standard computer wouldn't work.

We are also working on developing a table of single-source sequences for the reactor at-power internal hazards, basically, for the model we have now. I will talk about this table more in a few slides.

But, basically, it gives insights into what causes the problems, and it will allow for sorting by frequency, by risk, by whatever, you know, whatever sorts

of things we decide to put in it. And I will start at maybe the most likely and work down or, you know, play with it and see what happens.

CHAIRMAN STETKAR: Just, again, Maggie, I am going to keep saying that. Don't get trapped into spending 90 percent of your time and effort studying the largest contributors to core damage from a single source and, then, try to do everything else in the remaining 10 percent of your time and budget.

MS. TOBIN: Right. I understand.

CHAIRMAN STETKAR: It is better to start at the bottom, look at the stuff that is not important, and understand why it isn't, because, then, the stuff that is important becomes a lot more apparent, and you more efficiently discover the things that, indeed, do couple stuff together. So, just be careful.

MS. TOBIN: Okay. Thank you.

MR. KURITZKY: But clarify, when you say, "Start at the bottom and look at the things that are unimportant," that is a nice phrase, but in practical implementation what are you actually saying there?

CHAIRMAN STETKAR: You don't look at the top-frequency cut sets. You look at very low-frequency cut sets. You look at things that were truncated out numerically and see if you lose any important combinations

of functions that might affect either multi-sources or Level 1 and Level 2 together.

MR. KURITZKY: But I guess maybe --

CHAIRMAN STETKAR: I mean, it involves an engineering understanding of the model in the context of the quantified results, rather than just simply looking at cut sets and say, "Okay, I understand this one, and that might have an effect. So, I'll put it in this box." "I understand this one, and that probably doesn't. So, I'll put it in this other box."

MR. KURITZKY: I definitely understand the idea of having the engineering understanding to determine what might be important, particularly when we go over different boundaries like Level 1 to Level 2 or single-unit to multi-unit. But Marty was talking about how we would look at things from different perspectives, and that one was one perspective.

But to say to look at the cut sets, I mean, we all cut sets, as you go in value, are going to go like this.

CHAIRMAN STETKAR: Sure.

MR. KURITZKY: So, to say to look at the cut sets that are screened out, instead of looking at 100, you're looking at 100,000 or 10 million.

CHAIRMAN STETKAR: Yes.

MR. KURITZKY: So, that's not practical, obviously. So, I understand the engineering aspects.

CHAIRMAN STETKAR: It's not practical if you consider each of those cut sets as a world unto itself. There are patterns among those cut sets that you very quickly recognize.

MR. KURITZKY: Right.

CHAIRMAN STETKAR: The geometric progression doesn't come about --

MR. KURITZKY: Right, but the number of patterns also increases substantially as you work your way down that list.

CHAIRMAN STETKAR: Sure, it does. Yes.

MR. KURITZKY: I understand the concept. I just don't know whether from a practical implementation what that actually would refer. I agree that the qualitative engineering analysis and perspective is important, but I'm not sure --

CHAIRMAN STETKAR: It is just a warning, you know, collectively that Marty said you are going to look at all of the stuff. If you spend 90 percent of your time just looking at the most important contributors to a single-unit core damage frequency, you are, then, going to become trapped.

MEMBER BLEY: You almost know a priori that

whatever is done with respect to the single reactor for core damage is not going to be what is dominant for the release scenario, as in the health effects in Level 3. So, it is not worth spending much time on that if you are interested in the Level 3 results. That is what he is saying.

MR. KURITZKY: Right, but one thing that our intuition or engineering knowledge tells us that we know will kind of -- like the big seismic event has both Level 1 and Level 2 and 3 implications, has both single-unit and multi-unit implications.

MEMBER BLEY: The blackout. There are some things hidden.

MR. KURITZKY: So, there are some things that we kind of know even a priori are probably going to be big contributors. It is getting that next level and what's the best way to dig up that next level of insights. And so, that is just the thing that I am not sure. I mean, clearly, we want to do it from different perspectives, but I just wasn't sure, when you mentioned going to the lower level, practically what that meant.

You know, I understand taking the engineering look at it and saying don't just go by the dominant cut sets. You've got also look at these things that are going to cross the boundaries and could be important

for the big picture, if not for the small picture. I just didn't know whether there was any specific thing you had in mind when you were talking about --

CHAIRMAN STETKAR: No, there isn't because I understand plant.

MEMBER CORRADINI: It is almost like, I mean, I think what John is saying, it is almost like you have to do a sanity check once you start seeing things and saying, well, gee, if that one didn't appear, where is that one? Oh, it is way down here. Well, it should be --

CHAIRMAN STETKAR: That is exactly what I am saying.

MR. KURITZKY: Right, that is the engineering knowledge, right.

CHAIRMAN STETKAR: Again, it is not our role for managing a project. It is just I have seen people spend, practical experience, spend a lot of time and effort concluding that all of which they spent their time on was not very, very important. And then, suddenly deciding that in the remaining 10 percent of my time I need to assemble something from the things that I haven't looked at or thought about yet.

MR. KURITZKY: Okay. Okay. Thank you.

CHAIRMAN STETKAR: Uh-hum.

MS. TOBIN: In order to gain some insights

on source dependencies, we are working on creating a dependency matrix that shows which systems can be cross-linked between all of the major radiological sources.

Just a couple of examples of these is the cross-connect between the diesels that Marty mentioned. It is modeled, but turned off. It is something we are looking at.

MEMBER BLEY: When you say a dependency matrix, are you looking at systems versus systems or are you looking at functions versus systems or even a three-dimensional function versus support systems versus --

MR. STUTZKE: Right now, we are at systems versus systems level.

MEMBER BLEY: I haven't tried to do what you are trying to do in a long time, and there it was just for a plant with two reactors. But I am just thinking off the top of my head that extending that dependency matrix to include some key functionality that you know will affect Level 3 risk might let you pick up things --

MR. STUTZKE: Right.

MEMBER BLEY: -- along the lines that Alan was talking about a few minutes ago.

MR. STUTZKE: Well, you know, one of the

other things, when we think about this, and it goes ack to some of the SAPHIRE stuff, is not having a good handle on the types of operator dependencies floating around makes you want to put all those human error probabilities to one, just so you generate this enormous cut set that is full of human errors, you know, multiple human errors that we all understand --

CHAIRMAN STETKAR: Is SAPHIRE snorkly if you put something at one?

MR. STUTZKE: You betcha. You betcha.

CHAIRMAN STETKAR: Put it at .9.

(Laughter.)

No.

MR. STUTZKE: The solution speeds down when you try to solve it, and then, you end up with a pile of stuff to go through like that.

MS. TOBIN: Okay. Another example is just the two spent-fuel pools are usually connected hydraulically, and they have a large airspace together which is spatial dependence.

MEMBER BLEY: When you say "usually," that is by time? Much of the year they are connected --

MS. TOBIN: Usually by time, correct. And it goes down when you drain, you know, when you have an accident of some sort, you drain down twice as fast

once you uncouple in that unit.

Some insights from the single-source PRA. We are working on creating a sequence table in order to get -- which is what we have been talking about this whole time, is a sequence table. And these are the sorts of information that we think is important that we can sort by for each sequence to determine, to work on how they tie together and things.

So, we have sequence source, which is obvious just which source is being challenged; the operating state; the initiator, like loss of offsite power, general transient sequence, point estimates, logic or cut set count, the logic. So, like success of reactor protection system, failure of aux feedwater, whatever.

Common-cause initiator, single-source initiator, which Marty talked about earlier, multiple operator actions, and CCF potential across sources. So, like a failure of all four diesels or a failure of all motor-driven aux feed pumps, things like that.

And with all this information, we are trying to tie it all together to be able to understand the model well enough to pull out the independent pieces that don't have potential to go to the other unit or to the spent-fuel pool or things like that.

CHAIRMAN STETKAR: Maggie, just out of

curiosity, you have used the word "sequence" here often. Is a sequence a cut set?

MS. TOBIN: No, a sequence is not a cut set.

CHAIRMAN STETKAR: Thank you.

MS. TOBIN: A sequence --

CHAIRMAN STETKAR: That is enough.

(Laughter.)

MS. TOBIN: Okay.

CHAIRMAN STETKAR: Thank you.

MEMBER BLEY: But, right now, what you are looking at is a Level 1 risk at one unit?

MS. TOBIN: That is correct, yes.

MR. KURITZKY: Actually, CBF is at-power.

CHAIRMAN STETKAR: Internal events only.

MEMBER BLEY: At-power, internal events only.

MS. TOBIN: Yes.

MR. STUTZKE: And we are waiting for the other models.

MS. TOBIN: Yes.

MEMBER BLEY: So, given our previous discussion, this is maybe little more than exercise at coming up with the best way to look at things until you get something that goes beyond a Level 1 result?

MS. TOBIN: Absolutely.

CHAIRMAN STETKAR: You are going to have to do this again, though, once you get the sequences integrated out through Level 2, right --

MR. KURITZKY: Yes.

CHAIRMAN STETKAR: -- release categories or whatever you are going to call them.

MEMBER BLEY: Your Level 1 results just go to core damage or no core damage? They don't have any fine structure about how they will affect the Level 2 analysis?

MR. KURITZKY: No, it is not damage to --

MEMBER BLEY: No planned states of any kind?

CHAIRMAN STETKAR: There's no containment. The containment system is nothing. It is just --

MR. KURITZKY: No. I mean, we have some containment system that we are doing separately, but --

CHAIRMAN STETKAR: Yes, but, I mean, so far, it is just straight what we consider Level 1?

MR. KURITZKY: Right.

MEMBER BLEY: I guess just back to what john said, I know you have got to do this to work out the structure for how you are going to look at these things. But I would urge you not to try to do this perfectly because you really need to do this when you have the results that are going to matter to you at hand.

MR. STUTZKE: You don't have to worry about us doing this perfectly.

(Laughter.)

MR. KURITZKY: The reality is also a lot of this work is additive. So, they can do some of it now. It is not like lost work because they are not doing analysis. I mean, they are gathering information and helping to formulate thoughts.

MEMBER BLEY: Let me ask a question about, and it wasn't clear to me, you said "logic". Now, when you are doing logic, if you some how organize the cut sets by some of these things you know are likely to be important in Level 2 or in Level 3, that might be very helpful. I don't know if that is what you are doing, but the things that do take out all power, the things that would affect containment systems.

MR. STUTZKE: Well, the important thing is normally, when we label sequences, we write a list of everything that failed, right?

MEMBER BLEY: Right.

MR. STUTZKE: I want to identify what is known to succeed in that as well.

MEMBER BLEY: Okay.

MR. STUTZKE: And that is what we mean by logic as well.

MEMBER BLEY: Oh, okay.

MR. STUTZKE: Because, you know, the way that event trees are drawn, some questions in the event tree aren't even asked. You don't know whether it succeeded or it failed. And I am trying to get my arms around, well, how is that?

MEMBER BLEY: Okay.

MS. DROUIN: One of the things in building all of this, even though the picture shows that it is done Level 1, Level 2, Level 3, is that we do understand that you have got to look at this thing from Level 1 all the way through Level 3. And when you look at the way the tasks were set up with Task 1 and Task 2, and it is really hard to show some of this stuff three-dimensionally. So, we were forced to show it two-dimensionally. But that whole Level 1-Level 2 task is meant to cut across all three levels.

Now, ideally, if we had the single-source models from Level 1, Level 2, Level 3, we could look at it that way. But, in waiting for that, you know, we are starting with the Level 1 and, as Marty said, this is going to be incredibly iterative.

MEMBER BLEY: Yes. No, the only thing I was trying to think of there was, if you could throw your cut sets into some category bins, sort of like a

preliminary definition of plant states, that you know would have some effect later, you could be doing some of that --

MR. KURITZKY: Right.

MEMBER BLEY: -- looking at things that you are pretty sure will affect Level 2, Level 3, at this stage, before you even have those results.

MS. DROUIN: And we will. We just haven't gotten to that point yet. But, in formulating all the insights initially, you know, as work is done on these Level 1, that will expand and grow. But, in trying to understand all the criteria and assumptions to scope and bound the problem, that is being looked at across all three levels.

MR. STUTZKE: Risk metrics. This table shows we're pretty confident that we will compute this list of risk metrics on this table because of the categories here, whether they are part of the safety goal/quantitative health objective, clearly, we want to pick those up. We wanted to pick up everything that was previously recorded in NUREG-1150, so that we could make some comparisons.

We are interested in risk metrics that drive our regulatory analysis for things like backfit or rulemaking. So, that would explain why we are going

to pick up the offsite economic cost risk like that.

In addition, slide 18, we are thinking of other candidate risk metrics, and I fall into the ilk of, gee, that would be interesting to go compute because nobody has ever computed it before, and it might give us some broader perspective on risk. So, injury risk, cancer incident risk, things like that.

When this table was put together, we were very interested in measures of land contamination risk. You know, usually, that is the area that has been contaminated at a certain level or the amount of area that would be condemned or interdicted, something like that. So, we may still look at things like that.

MEMBER BLEY: Some of the earlier studies did the first three on that.

MR. STUTZKE: Uh-hum. So, you know, I think it would be good because realizing this project, I won't say it is a replacement for 1150, but it could be a reference for the staff into the future. And it would be nice to compute them while we are computing things, things like that.

Some of the problematic things are defining risk surrogates in a multi-source environment. For reactors, we all understand what core damage frequency is or large early-release frequency like that. What

is the analogy in a multi-source? So, would we define something like a fuel-damage frequency for spent-fuel pool? And one could extend that over to dry cask, but now the interpretation is different because those aren't surrogates for the QHOs necessarily like this.

Then, when one defines something like fuel damage frequency, would it be the frequency that more than one source is involved or would it be the frequency that exactly three sources are involved? There are different ways to define these metrics and to compute them. So, we need to sort through that.

You know, the whole notion of an early release, as in large early release, well, one of the releases could be early in a multi-source sequence, and the other one not early like this. And so, even the definition of what these metrics, these surrogates could be is a little problematic.

CHAIRMAN STETKAR: That is interesting, but, again, those are just intermediate constructs --

MR. STUTZKE: Right.

CHAIRMAN STETKAR: -- that people have traditionally used because they haven't done the Level 3 risk assessment. I mean, aren't we as an agency anyway interested in public health and safety, interested in the final answer, those other metrics that we use --

MR. STUTZKE: Yes.

CHAIRMAN STETKAR: -- you know, offsite health effects and things like that? So, that struggling with naming additional new artificial, you know, intermediate constructs doesn't strike me as something that's all that useful.

MR. STUTZKE: It may not be.

CHAIRMAN STETKAR: I mean, you know, core damage frequency --

MR. STUTZKE: Yes.

CHAIRMAN STETKAR: -- is useful, for example, for the reactor oversight process because it is something that you can kind of get your hands around and understand that hardware and humans kind of affect that. And maybe even large early release because, you know, things that affect containment isolation or containment systems are things that I can deal with in the reactor oversight process.

But, for this exercise, it is not at all clear why struggling with what you have just discussed means an awful lot. The reason I bring it up is it might detract from the real emphasis of the study.

MR. STUTZKE: There have been some efforts to define the site core damage frequency internationally.

MEMBER BLEY: The what? I'm sorry?

MR. STUTZKE: Site core damage frequency.

MEMBER BLEY: Oh.

MR. STUTZKE: In some of the work IEEA has done IAEA has done, I have reviewed it, and, of course, I asked the same questions: what do you mean by this? Why bother?

CHAIRMAN STETKAR: And you probably got really coherent answers.

(Laughter.)

MEMBER CORRADINI: Your response, I am curious about that because I have seen some work that Carl Fleming has done in that regard. So, can you go a little bit further. So, you're saying, why bother? Since you guys again are nodding at each other --

MR. STUTZKE: Well, it is what John was saying. I mean, the important thing is what is the risk. And when you look at things like core damage frequency, at least here in the staff, we use that as a surrogate for risk.

MEMBER CORRADINI: Okay. So you are saying that --

MR. STUTZKE: But you don't know that it is a surrogate for multi-source, source risk at this time.

MEMBER CORRADINI: Thank you.

MS. DROUIN: And people forget that we have these surrogates we had done Level 3 PRAs. So, you cannot come up with the surrogate unless you have done the full Level 3 to show that it can actually be an acceptable surrogate.

So, people have this idea, well, I can come up with this surrogate and never do the Level 3. That is not true because it is based on our knowledge of doing Level 3 PRAs.

MEMBER CORRADINI: Okay. Thank you.

MR. STUTZKE: I would also point out in 1150 LERF doesn't appear. It hadn't even been defined when 1150 --

MEMBER CORRADINI: I still don't completely understand it, but that's okay.

MR. STUTZKE: Okay. So, some challenges and considerations. We have talked before a little bit about we are looking into the capability of MACCS2. Beyond that, you know, questions of we are going to use linear no-threshold models or we are going to look at various threshold models like SOARCA did. And if so, which ones? Because the more different models you look at, the more computational burden you are imposing.

MEMBER BLEY: Where do you stand right now on that?

MR. STUTZKE: I like LNT personally.

MEMBER BLEY: Whether you like it or not, I think you need to at least do that one.

MR. STUTZKE: Yes.

MEMBER BLEY: It is interesting to see the others, but --

MR. STUTZKE: There are issues of distance truncation. You know, 1150, they also reported things like population dose, and they called it the entire region. And what they used was the default in MACCS2. I think it is a 500-mile radius around the site, and you go, okay, large numbers of people with micro-doses of radiation, is that meaningful to even have that? Oh, SOARCA went out to 100 miles. So, we might think about that.

I had mentioned briefly before about duration, truncations, you know, the code only models out to seven days following release. We have actually informally spoken to Sandia, "Well, could we extend that? What would it mean in the codes?" We are not limited by that type of capability.

MEMBER SCHULTZ: So, if you use LNT, then you do need to consider what you are going to do about distance truncation and duration truncation.

MR. STUTZKE: That's right. They are all

related somehow. But, to be honest, I mean, this list hasn't changed since the last time I was in front of the Committee. We haven't had a great deal of thinking about conclusions on what we want to do here.

MEMBER SCHULTZ: I'm not sure that when you get there you can't use one or two additional models to LNT and draw some meaningful conclusions pretty rapidly.

MR. STUTZKE: Right.

CHAIRMAN STETKAR: Yes. It seemed like the SOARCA folks, I didn't hear them saying that that was a tremendous burden on them.

MR. STUTZKE: Yes, but they only did one sequence.

CHAIRMAN STETKAR: They only did one sequence; that's true. Yes, that's true.

MR. STUTZKE: I have hundreds of thousands to get through, and I would like to know that I was right before you guys tell me, "You know, you should have done this." And as you said, now I am starting over again.

That's what we have for you today.

CHAIRMAN STETKAR: There were some rather interesting things that came out of the SOARCA uncertainty analysis --

MR. STUTZKE: Yes.

CHAIRMAN STETKAR: -- you know, that I'm sure you're well aware of that argue for looking at some distance, certainly not out to 500 miles.

MEMBER CORRADINI: But I take your bullets to mean that you might use some threshold model instead of distance.

CHAIRMAN STETKAR: That's entirely possible.

MR. STUTZKE: Questions?

CHAIRMAN STETKAR: Anything else for the staff on this before we change gears and talk about human reliability?

(No response.)

MR. STUTZKE: Okay.

CHAIRMAN STETKAR: Well, thank you. That was relatively painless --

MR. STUTZKE: Thank you.

CHAIRMAN STETKAR: -- at least for us.

(Laughter.)

MR. KURITZKY: Okay. Susan Cooper will now give you some of our current thoughts and thinking on how we are going to approach human reliability analysis for this project, particularly beyond the Level 1 internal events.

MS. COOPER: Thank you, Alan.

Good morning.

Susan Cooper, the Office of Research.

Yes, I will be talking about beyond Level 1. However, I am going to talk about Level 1 some as well because we have been spending quite a bit of time on that. As has been mentioned a few times, we are just getting to the point of getting all of those results quantified.

So, next slide, starting our discussion of HRA for Level 1, and that's at-power internal events. You have already seen the technical analysis approach plan, which includes what we intend to do for HRA. And I have included on this slide just a few excerpts of things that were our intention going into doing the transformation of the licensee's PRA to what we were going to use. And I just draw your attention to a few things.

We had hoped for the HRA, as for all the tasks, that spot-check reviews of the HRA documentation and the peer reviews and limited rework, qualitative and quantitative analysis, was going to be sufficient for the Level 1 for NRC's purposes. But, going on to the next couple of bullets, our initial reviews led us to do more work than what we had originally intended. And that included both the Vogtle documentation and

its peer reviews.

And that led us to asking certain questions about how methods were applied, and so on and so forth. And we are currently addressing that with the licensee.

Next slide, please.

CHAIRMAN STETKAR: Are we going to hear a little more about that when you go into closed session? I mean, I don't want to ask details, obviously.

MR. KURITZKY: We are going to hear a little bit more about it.

CHAIRMAN STETKAR: Okay.

MR. KURITZKY: We are not going to hear a lot more because we are still working things out with Southern Nuclear.

CHAIRMAN STETKAR: Okay. Okay. Thank you.

MS. COOPER: So, this slide is intended to give you a flavor for what the additional work involved, including more detailed reviews of both pre-initiator and post-initiator HFEs and their associated human error probabilities. As a result, we did some not only review, but I am calling it recasting of timing analysis.

And what that simply means is that we did not, at least at this point in time, use any of our own, for example, thermohydraulic resources to do recalculations for timing analysis. We used the existing

timing information and revised it to be used in a way that we felt was appropriate for our particular study.

In making decisions about doing the rework, we did a lot of not only reviews, but we did some comparison with results of SPAR models; of course, our own experience as to what we would expect.

Sorry?

MEMBER BLEY: Your previous thing just brought something to mind. I guess it is more for Alan.

Are you using, essentially, the thermohydraulic calculations that the utility had done to support your analysis? Are you going to have to do more? Have you looked at those? Have you reviewed them? Where do you stand on all that?

MR. KURITZKY: Okay. We actually have; we have looked over a lot of the analysis that the licensee did using MAAP. We have a MELCOR deck that we developed for the Vogtle plant for our use. And we actually have gone through and recalculated a number of different of the success criteria. We have modified some of the success criteria based on the fact that we have done our own calculations, and there are some areas --

MEMBER BLEY: Are we going to hear about that sometime today or at the next? Or we have another meeting scheduled --

MR. KURITZKY: I think in the afternoon session, I mean not the afternoon, the second session you will hear a little bit about it.

MEMBER BLEY: Okay.

MR. KURITZKY: As you know, we're going all day. Yes, we have some, I think, information on that.

CHAIRMAN STETKAR: But those MELCOR models are going to extend all the way out through --

MR. KURITZKY: Yes. So, we are going to use those for severe accidents, yes.

CHAIRMAN STETKAR: Severe accidents.

MEMBER BLEY: Have there been any significant changes in success criteria, anything that would affect the HRA work? And are you aware of --

MR. KURITZKY: I think right now it has mostly just been system success criteria, not so much the HRA.

MEMBER BLEY: Okay.

MR. KURITZKY: I think we did hear some, when Don Helton talked to you in May, in December about the Level 2 PRA, we talked about we had a MELCOR deck. And I mentioned in May -- now I think we are on Revision 3 of it, and it is being used for the Level 2 analysis as well as the success criteria.

MEMBER BLEY: Okay. Sorry, Susan.

MS. COOPER: No, that's fine. And Alan and

other task leaders have been making certain that task leaders, such as the HRA, are involved in any kind of meetings where were are discussing some kind of modeling change or assumptions. So, we have had significant discussions about those things. It is at least apparent to me from some of the discussions we have had, whether they be face-to-face or emails, that everyone is looking out for everyone else and finding things and sharing things. Anyway, so far, so good.

As a result of the reviews of the Level 1 model, one of the things that we did, using the licensee's timing information, was to identify some time-critical operator actions and their associated human failure events. And we did some recalculation of those.

The EPRI HRA Calculator was the tool that was used by the licensee. When we did our recalculations, we used that same tool. At the same time, there were other events that were risk-important, not necessarily risk-critical, that we identified using -- oh, I'm sorry, John.

CHAIRMAN STETKAR: Everybody always refers to the EPRI HRA Calculator as if it is something that is well-defined and unique. Last time I checked, it is a toolkit that you could use a variety of different methods to quantify human error probabilities. So, which

methodology was used, and will you continue to use that methodology?

MS. COOPER: A little bit of the discussion --

MR. KURITZKY: But, Susan, a lot of that is going to be discussed in the afternoon also.

CHAIRMAN STETKAR: Okay.

MS. COOPER: Okay. So, you don't want me to talk --

CHAIRMAN STETKAR: That's fine. Fine.

MR. KURITZKY: You can talk at a high level on this.

CHAIRMAN STETKAR: No, that's fine. I will ask later. Let's wait.

MS. COOPER: Sorry.

CHAIRMAN STETKAR: No, that's okay. It is good. Don't worry. I just wanted to bring out the point that just saying, "I used the EPRI HRA Calculator" means I think I could have used one of at least three different methods.

MR. KURITZKY: It's your area. You might --

MS. COOPER: Okay. I can answer at least that question. Usually, the approach used by the licensee was to use the EPRI approach, which is defined. And that is to use THERP for execution, the execution portion

of a human failure event. And then, there is another portion that is addressed. You know, the cognitive is addressed by other methods.

CHAIRMAN STETKAR: Okay.

MS. COOPER: And that is as far as I can go right now.

CHAIRMAN STETKAR: Thanks.

MS. COOPER: We can talk about the rest of it later.

CHAIRMAN STETKAR: Thank you. Thanks.

MS. COOPER: But, anyway, so those are the tools that we used.

I'm sorry.

MEMBER SCHULTZ: Your understanding and what you are describing here, it sounds as if you are becoming familiar with what the licensee has done in their modeling. And then, you have done some cross-checking, but also you are getting into recalculation and --

MS. COOPER: That's correct.

MEMBER SCHULTZ: This is for what purpose? As an application to the modeling that we have heard about previously? There is a different connection between the HFE modeling for the NRC's models versus what the licensee has done? I am trying to understand what the --

MS. COOPER: So, I am not sure how far I can get with the answers to this question.

MEMBER SCHULTZ: Later?

MR. KURITZKY: The idea is we had some questions on what the licensee had terms of their application of some of the methods in the HRA.

MEMBER SCHULTZ: Sure.

MR. KURITZKY: So, we got some information from the licensee. We are still working with them to resolve exactly why they did certain things --

MEMBER SCHULTZ: Okay.

MR. KURITZKY: -- because things aren't totally clear with us. And that is why we are not at liberty to really discuss that yet because it is kind of an ongoing discussion with the licensee.

But, in the meantime, for the Level 1 at-power internal events model, our model of it, not the licensee's but our model --

MEMBER SCHULTZ: Right.

MR. KURITZKY: -- we decided to apply methods in a slightly different fashion --

MEMBER SCHULTZ: Okay.

MR. KURITZKY: -- than they have. And so, that led us to recalculate a number of HFEs. And we will go into a little more detail on that in the next

part of the meeting, but basically that is what --

MEMBER SCHULTZ: So, regardless of the findings, in order to apply it in the way that you feel is appropriate for your modeling, that's what we are talking about with regard to recalculation and reworking?

MR. KURITZKY: Right.

MS. COOPER: That is correct.

MEMBER SCHULTZ: Okay. Thank you.

MS. COOPER: That is correct. And the driving forces were defining human failure events that seemed to be time-critical or otherwise were risk-important. We looked at those in more depth insofar as they were treated with the HRA methods that were selected and how that was done. And in certain cases, we did things differently from the licensee.

MEMBER SCHULTZ: Right. And you found some -- okay. And this is based upon the comment that you found some differences --

MS. COOPER: That's right.

MEMBER SCHULTZ: -- that you felt appropriate to discuss and address?

MS. COOPER: That's correct.

But, then, moving to the second-to-last slide, we also did some rework of the dependency analysis. And when it comes to that, I mean, we have inputs, we

have provided inputs to the Level 1 PRA folks on uncertainty analysis also. That also will be different.

And the review of all that work is not quite complete. So, that is in progress right now. But we have provided the results on to the Level 1 PRA for them to adjust human error probabilities, and so on and so forth, independency analysis.

MS. DROUIN: One of the things you will hear more about this afternoon, not this afternoon, later on this morning from Chris, you know, when you go in and you are leveraging a PRA that has already been built, there is a lot of advantage of that in terms of efficiency and time-saving. But it also presents a challenge because we have to take ownership of that model. We have to be able to defend it, and we can't go back and say, "Oh, well, Southern Nuclear, why was that in the model that way?" In taking ownership of this model, it has just proven to be a lot more challenging than we thought it would be.

MS. COOPER: Thank you, Mary.

So, on to slide 22, I want to talk a little bit about the self-assessment of the NRC's Level 1 HRA. This was based on our analysis, our model, were it differs from the licensee's. So, it is based on that.

There is a software tool that was used by

all of the tasks, the PRA tasks, and we used that, and did the same process. But there was still a substantial amount of information, I think as Mary alluded, that came from Vogtle's PRA, their HRA documentation, their peer review. We are still relying on some of that for our self-assessment as well as --

MEMBER BLEY: But do you have to go beyond that and talk to them to really understand what they have done? Or is there documentation --

MS. COOPER: We have had some interaction with them, and we will probably have some more. The documentation for HRA is a little bit distributed. There is an HRA section, but there is also quite a lot in the event tree section.

But the answer is, yes, we have to go a little bit farther. As I think both Alan and Mary have alluded, the transfer of ownership for us was a little bit more involved than simply just reading the reports and looking at the calculation files and stuff like that.

And then, just one note, that we haven't done a self-assessment on the internal flooding portion of the Level 1 PRA. We have not done that yet. There has been some activity on HRA support for that PRA. But we have not done the self-assessment for that part.

CHAIRMAN STETKAR: Susan, just out of

curiosity -- and if this is too detailed, tell me that we will get to it later this morning -- they are developing, Southern Nuclear is developing the internal fire analyses, is that correct?

MR. KURITZKY: Southern Nuclear has, they have already peer-reviewed internal fire PRA.

CHAIRMAN STETKAR: Okay. Have you looked at the HRA yet for that?

MS. COOPER: No. No is the short answer.

MEMBER SCHULTZ: For clarity, Susan, in your first bullet, this recasting of the timing analysis, what does that recasting mean in that phrase? Is it that you have done some changes or you are using the same approach in a different model.

MS. COOPER: Well, the timing analysis that was done by Vogtle, certainly they defined a system window from T0 to when some kind of either core damage or some other damage has occurred. We haven't changed that.

And then, there are other things like when cues will come in that are important for operator actions. That is there. And then, there are certain timing like manipulation times that they might have derived or massaged using job performance measures, that sort of thing. None of that have we changed.

But there are some interim times that are

important, especially for exercising some of the quantification tools that you need to derive. So, the base information was provided. We used that to derive some of the timing inputs that were needed for the methods.

MEMBER SCHULTZ: Okay.

MS. COOPER: And they weren't originally calculated.

CHAIRMAN STETKAR: A couple of other kind of higher-level questions. Vogtle does not have a low-power shutdown model. So, the staff will be developing that model, is that correct?

MR. KURITZKY: Yes.

CHAIRMAN STETKAR: Okay. Completely?

MR. KURITZKY: Yes. Well, we have -- Southern Nuclear actually commissioned an outfit to do a low-power shutdown PRA for them several years back. But, it ended up, since there was no standard in place at the time, they decided to table that effort. But they were able to provide us some of the initial work they did on some of the definitions of plant operating states and initiating events.

CHAIRMAN STETKAR: In terms of fleshing out the details, and particularly the HRA, that's --

MR. KURITZKY: Right. That is all on us.

CHAIRMAN STETKAR: You are going to own that?

MR. KURITZKY: All the work essentially will be done.

CHAIRMAN STETKAR: One last big chunk. The seismic model, is the staff going to develop the HRA for the seismic? Okay.

MS. COOPER: That is correct.

CHAIRMAN STETKAR: From scratch? Okay.

MEMBER BLEY: Will you have access to Vogtle operation staff when you do that?

MS. COOPER: I have made one trip to visit the plant, spent three days there. The licensee staff there were very generous with their time, a lot of good information, very forthcoming.

My focus -- and I am actually talking about that in a couple of slides here -- was mostly on Level 2 integrated risk issues, a little bit on Level 1. And also, there was some small portion that was related to internal floods. So, that was the focus of those three days.

I haven't been told yet when I can go back. I have been asking because I know I need more information.

So, I would like to. We will see how the schedule and budget, the travel budget, and so forth, works out. That certainly would be my impression in a perfect world.

MEMBER BLEY: Is the utility amenable?

MR. KURITZKY: The utility has been very cooperative every time we have asked to --

MEMBER BLEY: You are doing new analysis coming up, and that seems it would be very helpful to have --

MR. KURITZKY: Right. And whenever Susan is ready to go down for, say, seismic or other aspects, we will schedule it because we have the budget.

MEMBER BLEY: Okay.

MR. KURITZKY: And she will be going down to talk to them.

MEMBER BLEY: That is good to know, though. Thanks.

MS. COOPER: As far as I know, the next possible trip is actually going to be related to cask handling, you know, dry cask storage. I think it is --

MR. KURITZKY: October or November?

MS. COOPER: Yes, something like that.

MR. KURITZKY: December?

MS. COOPER: There is a trip related to that coming up.

Anyway, next slide, slide 23, please.

Okay. Now we are going to start talking about Level 2, our approach to Level 2. As an overall

statement as to how we are going to address Level 2, when we are moving from Level 1 to Level 2, we are going to try to maintain internal consistencies on our human error probabilities that we assign by the reviews, sanity checks, and so forth. We are going to try, as best we can, to maintain a continuous narrative of the failure path for risk-important scenarios, and certainly recognize that there are going to be differences in how we model Level 2 HRA because of certain influencing factors, which we will talk a little bit about some more.

One thing that I think is particularly crucial, and I put it out here as a bullet, is that the plant's information is very important. I am going to mention in a minute that I have done some expansions on the TAAP specifically for Level 2, which is kind of more process-oriented. And I have also written a few things down. I have had a lot of conversations with people, but I have written some things down.

I see James Chang and Jin Ying are here. We have a joint paper in the upcoming PSA 2013 that captures some of the thinking that has been going on with respect to how Level 2 will be addressed. But, really, that is going to be very much filtered and focused on the plant information, especially with respect to the Severe Accident Management Guidelines and their

implementation of it.

And that probably at least in part has to do with the fact that SAMGs are a voluntary effort on the part of industry. So, there isn't a lot of consistency or standardization with respect to how the individual plants have implemented these guidelines.

So, I note here that I made a visit to the plant last month and found some very interesting information. I am still in the process of digesting that raw information and with others. But, to my mind, that is going to rather substantially change my picture going in, which was based on sort of looking at the procedures at the desk, looking at the inspection findings from 2011, where across the country all the plants, SAMGs, and programs for implementing SAMGs were reviewed. That gives you kind of a broad picture of things, but getting there and seeing how they actually use them and talking to people how they are using them gives a slightly different picture.

MEMBER BLEY: I hate to do this, but when we did PRAs like the one you are doing, you have to set some freeze point in time for doing your analysis. If this were to finish on the schedule we have seen in the past, that --

MR. KURITZKY: You are going to see a new

one later, but --

MEMBER BLEY: -- this would all just be great, and we would see the freeze point. I suspect when we see the one later, and then, when we see the one a year from now, what is going to happen is this project is going to crisscross with the rulemaking on --

MR. KURITZKY: The flex equipment and --

MEMBER BLEY: Well, and on integrating the procedures --

MR. KURITZKY: The procedures, yes.

MEMBER BLEY: -- at NRC, and not being strictly voluntary. Have you planned for what you are going to do at that point? I mean, I think you have got to freeze it, do your analysis, but, by the time you are done, you are probably going to get attacked because it is not the way it is anymore.

MR. KURITZKY: Well, by the time it is done, we are going to get attacked because the study doesn't represent the exact as-operated, as-designed plant, as-built plant at that time --

MEMBER BLEY: This could be a big deal, though.

MR. KURITZKY: I think we discussed these in the May meeting. I can't remember.

MEMBER BLEY: Yes, I think so.

MR. KURITZKY: To have criteria for determining what things we are going to include in the model, because there are a number of major things. We mentioned previously RCP seals design.

MEMBER BLEY: Uh-hum.

MR. KURITZKY: They are going to be changed out. The flex equipment might be in place by that time. The idea of the integrated procedures might be in place, depending on when it is done.

So, there are a number of these things. Generally, the default is not to include these things unless we meet all these specific criteria, which they have to be pretty darn certain they are going in. And there has to be training and procedures. Obviously, the procedures are a little bit different, but training and procedures such that there is high confidence that they can implement, that these will be input, and they can be --

MEMBER BLEY: And I think most of those things that we talked about the last time, you are probably going to be able to make pretty good decisions on those. I think this is one that you ought to have just maybe something in your report that says, you know, it might be important to go back and revisit this after the rulemaking is complete and implement it sometime in the

future. This won't be clear until your are essentially done, and then, it is going to be a deal.

So, I think just flagging this one is something that might need to get revisited after the rule is in place and actually implemented in the plants, and leave it at that for now.

MR. KURITZKY: Yes. Again, some of these things, most things we are not going to be putting in the base-case model. Some of them we will do sensitivity studies on, depending on how easy it is. Some things aren't going to be so easy for, at minimal, for doing a sensitivity --

MEMBER BLEY: Even if it is in place, it won't have been implemented.

MR. KURITZKY: Right. I think that will not be in our base-case model.

MS. COOPER: Yes, that having been said, to the extent that I am able to fit it in with all the other things I am doing, I have been trying to keep in touch with the folks that are involved in the rulemaking.

MEMBER BLEY: Uh-hum.

MS. COOPER: So, I have from time-to-time heard what kind of thinking is going on insofar as what might be included in that rulemaking, insofar as what might be required in the future. And that certainly

did play a role in the kinds of questions and things I was looking for when I went to the plant site.

MEMBER BLEY: That's good.

MS. COOPER: So, I have some sense of where they fall and how I want to treat it. I don't know exactly in what timeframe or when we might discuss that or if we would discuss that, or if you are interested in the next session, we could certainly talk about that. But, in any case, that certainly was an influence for me insofar as what I was looking for when I went to the plant.

MEMBER BLEY: Okay. I think that is good.

MS. COOPER: All right. Next slide.

So, I mentioned that it is in draft form; you don't have it yet. I have to talk with Alan insofar as when this is going to be a formal part of the TAAP. But I have put together an expansion of the TAAP for HRA, specifically for Level 2. And I have got some comments on it. I haven't incorporated them yet. But it is very process-oriented, but it does address some of the issues.

I don't imagine, based on how I understand the TAAP to be, that it is ever going to be able to incorporate some of the insights and filtering that I would have gotten from the plant. That is going to have to be documented in a different way in a different place probably. Or maybe there is some filtering.

But, in any case, the expansion addresses all the process steps in the HRA that were identified in the original TAAP, but focuses on how Level 2 will be different for HRA than traditionally-performed.

Next slide, 25, please.

So, it is just some examples, you know, to have some discussion about the qualitative analysis, how it is going to have to focus on a different set of procedures. Certainly, the Severe Accident Management Guidelines, the SAMGs, but also the EDMGs. In fact, if the Technical Support Center is going to be the focus for where decisionmaking takes place, and the fact that more actions may need to be taken outside of the control room, and the fact that cues for action may not be available or useful to the decisionmaking process --

MEMBER BLEY: Have you had a chance to go through the procedures, both the SAMGs and the EDMGs yet?

MS. COOPER: I have taken some pass through the procedures. I am certainly going to do it again, now that I have been to the plant and have some notion as to how they are using them. So, I don't see that activity as over.

MEMBER REMPE: Has it been established that the Technical Support Center is where the decisions will

be made?

MS. COOPER: Yes.

MEMBER REMPE: Is that standard --

MS. COOPER: Yes.

MEMBER REMPE: -- across all plants, even though that some of them may not be operators?

MEMBER BLEY: This is for Vogtle.

MS. COOPER: This is for Vogtle.

MEMBER REMPE: This is Vogtle; I know --

MS. COOPER: Yes.

MEMBER REMPE: -- but for Vogtle that's true?

MS. COOPER: Right.

MEMBER REMPE: Is that true in other places?

MS. COOPER: I don't know exactly how it is implemented everywhere. I do know that, from the three-day training course that was arranged at the NRC by Westinghouse staff, that their intention is that it be implemented such that the Technical Support Center be where decisions are made.

MEMBER REMPE: Even though they are not plant operators, the operators will deal with the --

MS. COOPER: That is a plant-specific thing.

MEMBER REMPE: And that's what Vogtle will do, though? They have made that decision?

MS. COOPER: I don't know that I can say

that right now. Can I say that?

MEMBER CORRADINI: Maybe we just should wait until we are in --

MS. COOPER: Yes.

CHAIRMAN STETKAR: Susan?

MS. COOPER: Yes?

CHAIRMAN STETKAR: The last couple of slides we have talked about Level 2 PRA, and you have emphasized SAMGs and EDMGs, which are obviously a transition in terms of thinking about human performance. As I understand it, the current Level 1 models take it out to core damage. It doesn't take it out to containment failure.

How are you handling that extension through actions that are -- let me say "scenarios" rather than actions -- in the current Level 1 model that include EOP guidance, for example, for things like containment isolation, containment cooling, containment -- you know, fission product removal, if they have guidance in their EOPs for that, basically, containment protection functions that aren't necessarily part of this SAMG stuff? It is still within the EOPs, but have yet to be modeled in the existing Level 1 PRA. That is part of this scenario extension process.

MS. COOPER: Yes. Yes. One of the

challenges for HRA is going to be crediting the use of procedure bits that are in various places --

CHAIRMAN STETKAR: Okay.

MS. COOPER: -- and how that credit can be established or not.

CHAIRMAN STETKAR: Yes.

MS. COOPER: So, that is certainly going to be one of the important tasks for HRA.

CHAIRMAN STETKAR: Okay.

MS. COOPER: And it is going to be highly-informed by the plant --

CHAIRMAN STETKAR: Okay.

MS. COOPER: -- to the best that I can do that.

At this point in time, the visit that I made was not focusing-in on any particular scenario because we don't even have --

CHAIRMAN STETKAR: Sure.

MS. COOPER: -- the results for Level 1 yet. It is kind of a little bit broader. But, to the extent that I could make some guesses about things that would be important, I asked some specific questions there and did some things there. But my hope is that, when I do have some things to worry about very specifically, that I can go and ask some questions.

MEMBER BLEY: We haven't delved into methods in any detail. But I guess credit is a word that to me smacks of deterministic analysis, and then, a PRA accounting for an influence probabilistically somehow seems more in the spirit of things. I would just toss that on the table here.

MS. COOPER: Well, yes, I guess the reason why I use that word is maybe because I just spent the last week teaching fire HRA. But the notion of feasibility is definitely going to be one that is going to be carried, to my mind, into this analysis where there has been specific criteria that we establish for fire. And something like that, I imagine being used for all of the rest of the PRA jobs that I have to do, where certainly training and procedural links and cues and all those kinds of things are important factors in deciding whether or not you can even put this in the model or put in the model with any number less than one.

So, some notion like that is going to play a role, I think, throughout the bar or the criteria may change somewhat, depending on whether we are talking about fires or we are talking about operator actions in the field for Level 2, and so forth, because the timing is going to change, but that doesn't necessarily mean that, just because you have a lot of time, that suddenly

your chances of success are going to be a lot greater if it is after core damage.

So, there is going to have to be some adjustments to what those criteria are, but that is sort of what I mean by credit or even in a qualitative analysis the story that you build to say this is how they would actually arrive at using, as John's example, this piece out of an EOP, when they are actually in the SAMGs. Exactly how you build that story, what the basis is, that is sort of what I meant by credit, maybe more broadly than you intended.

MEMBER BLEY: Thank you.

MS. COOPER: Sure.

Another thing that there is some discussion on in this draft expansion of the HRA TAAP for the purposes of Level 2 is that the definition of human failure events or failure events in general don't map well to our traditional way of defining success and failure. And that certainly plays a role in how you look at operator actions or human actions, or whatever it is that is being represented in Level 2.

After core damage, it is just kind of different degrees of different things really. So, I think that is going to play a role and may actually result in some of our sorting-out of things as not necessarily

being binary, not just success and failure, but maybe either this choice or this choice or this choice, that kind of thing. But we will see what can be accommodated by the larger PRA. That is definitely going to be, is an ongoing discussion.

Don Helton, who is here, is a Level 2 PRA lead. We have been having this discussion, been having it with Marty also. And the context of integrated risk as certainly any complication in Level 2 is going to be a complication for him.

With respect to quantification and quantification tools, I don't say anything specific about yet what we are going to do. My choices, when I make them, are definitely going to be highly dependent on plant information and how that can be factored in and crediting different things.

I do have some discussion about how I expect execution of actions, especially if they are outside the control room, where I think we can borrow from recent work that has been done in the fire HRA area, where we did do some fairly extensive work on making certain that performance-shaping factors that are environmental hazards, or whatever, and timing issues, and then, the whole notion of feasibility are all going to have to be part of looking at whether an action that's done in

the field can actually have some reason to believe that it is successful.

The decisionmaking, on the other hand, is a very different thing. And I have already mentioned that I had a particular mindset before going to the plant, based on their procedures and a more general notion of how SAMGs are implemented. That is going to be adjusted now where that is actually documentable. It will probably be not a public document, but that will certainly influence my choices.

Next slide, 26. This might be a little bit out of order, but it is relating to Marty's discussion.

And these are just some examples of things, questions that we are asking, I'm asking, and have asked, and we continue to ask, to address how HRA modeling, and so forth, is going to affect how we represent integrated site risk, really questions about how priorities are established.

In other words, if you have got multiple things going on now, two reactors having issues, or a spent-fuel pool, or whatever, how do you establish priorities between those different sources? How the actions track, that might be easy enough if you are only dealing with one reactor. But, if you have got two thins going on, how does that work? Who is keeping track of

all the things, you know, orchestrating response. How many decisionmakers do you need, then, and how they are coordinated.

You know, those are just some of the examples of things that we are talking about. And then, there are going to be some very specific things with respect to the Vogtle plant site and how they are organized, starting with the fact of the configuration, the control room, and so on and so forth. And I have some initial answers on this, but we will keep looking for more information.

Just a little bit more about the visit that I made to the plant last month. I had two general goals. One was to do some confirmation of information from Level 1. That was fairly limited. Most of what I was focused on was trying to collect some initial information to support the Level 2 HRA and some aspects of the integrated risk model.

And then, I just provide a list of some of the things that I did on the rest of this slide and the next one. I did look at a crew performing a simulator exercise. I walked down some plant locations that were especially recommended to me by the Level 2 lead that were associated with EDMG strategies for station blackout.

I spent some time in one of the control rooms.

Spent some time in the Technical Support Center, getting a tour of that, and talking to people about that.

Next slide, please, Alan.

I also did a lot of interviewing, simulator trainers, lots of licensed operators who had roles related to training, to give me some history of the plant and drills that have been done for training.

And also, last August, Vogtle did an emergency planning drill where they actually used their SAMGs. So, I got a lot of feedback from a variety of people on how that went.

MEMBER BLEY: Was anybody from staff down to observe that one? Or did you get anything from the --

MS. COOPER: Just the resident.

MEMBER BLEY: The resident? Okay.

MS. COOPER: I did talk to the resident quite a lot about that and others. I talked to a field operator they called system operators on their training on EDMGs and, also, learned some things about their combined training with licensed operators, what they call mini E-drills, and staffing issues and other things.

I talked with the SAMG developer, an EDMG developer, and a variety of the players in SAMGs, implementers, including an emergency director and people who play the role of evaluator in the SAMG structure.

I already mentioned the resident inspector. So, I talked to a lot of people, got a lot of notes, and I have typed them up and circulated them within the staff, and talked to a few people about that. But we will need to do some more to coalesce our ideas from that.

MEMBER SCHULTZ: Susan, in the course of your work, will you have an opportunity to observe in the Technical Support Center a full-scale emergency exercise? Based on what you are trying to do, I think you would find that valuable.

MS. COOPER: I agree. It was one of the things that we talked about. I need to make a list of things that I want to get that we talked about and I need to get. They do them every two years. So, in principle, the next one is not going to be until 2014.

MEMBER SCHULTZ: Right.

MS. COOPER: I am not sure how that is going to match up with our schedule. But, you're absolutely right, that would be very helpful.

MEMBER SCHULTZ: Even if it is confirmatory, I think it would be useful.

MS. COOPER: I agree. Now, that having been said, this drill last August was the first time they used the SAMGs --

MEMBER SCHULTZ: Right.

MS. COOPER: -- as part of the drill. I mean, part of what I did some time ago, when I was preparing for the job of HRA lead in this particular project, was I looked at the 2011 inspections of SAMGs across the U.S. at plants. If you look at that, it is relatively rare that a plant has done that. You know, my rough recollection is it is something on the order of one or two plants per region, at least when that inspection had been done, that will have done that.

MEMBER SCHULTZ: But it will become more frequent.

MS. COOPER: I think there are a number of people that would think that is a good idea. Actually, I would -- well, maybe I can't say that now. Anyway, yes, I'll just leave it there.

Anyway, next slide.

MEMBER SCHULTZ: Thank you.

MR. KURITZKY: Wasn't that your last slide?

MS. DROUIN: It must be your last slide.

MS. COOPER: Oh, it is. Okay. All right. Great. Well, that's it then.

MEMBER REMPE: Well, then, before you take off, on slide 26 you had a lot of questions.

MS. COOPER: Yes.

MEMBER REMPE: And you said you had some

answers. Can you elaborate on some of the ones that you do have answers for? Like are they operators? Are they trained in the occurrences of multiple accidents?

MS. COOPER: We can't answer that right now.

MEMBER SCHULTZ: But they are going to wait until --

MR. KURITZKY: Yes, if you want specifics pertaining to Vogtle, then we will have to discuss that --

MEMBER REMPE: In the closed session? So, I looked ahead at the closed session slides and I didn't see any slides on that topic.

MR. KURITZKY: No, it's not.

MEMBER REMPE: So, we will just have a bunch of questions?

MR. KURITZKY: Right. You can bring it back up then.

MS. COOPER: Okay. Thanks.

CHAIRMAN STETKAR: Anything else?

MS. COOPER: That's it.

CHAIRMAN STETKAR: Okay.

MS. COOPER: This is a backup slide.

CHAIRMAN STETKAR: Oh, okay. I didn't read the slide, but it said "backup slide".

(Laughter.)

MS. COOPER: Yes, yes. I think a lot of

people missed that. Yes, it is a backup slide.

CHAIRMAN STETKAR: Any other questions for Susan?

(No response.)

If not, thank you. You got through a lot of stuff, covered what we asked for.

MS. COOPER: I am almost on time.

CHAIRMAN STETKAR: And you are only five minutes over schedule. So, that's good.

With that, we will take a break. When we return, we will come back in closed session to hear more details about the Vogtle models. I will be generous. We will return at 10:40.

(Whereupon, at 10:23 a.m., the meeting went off the record for a break and returned at 10:39 a.m. in Closed Session.)

(Returned from Closed Session –Approximately 12:09pm)

CHAIRMAN STETKAR: What I would like to do first is see if there are any comments from anyone in the room. Anyone?

(No response.)

Everyone is being appropriately silent.

We have opened up the bridge line. I don't know if there is anyone out there. If there is, first of all, could you just say something, please, to make

sure we confirm that the bridge line is open? Anyone?

(No response.)

Since there is no one there, I don't need to ask for comments.

If there is nothing else, thank you very, very much, and we are adjourned.

(Whereupon, at 12:10 p.m., the proceedings in the above-entitled matter were adjourned.)

Full-Scope Site Level 3 PRA

Advisory Committee on Reactor Safeguards
Reliability and PRA Subcommittee

July 22, 2013
(Open Session)

Alan Kuritzky
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Outline

- Open Session
  - Integrated site risk
  - Human reliability analysis
- Closed Session
  - Level 1, at-power, internal events model conversion
  - Acceptance review and initial results
  - Path forward

Site Level 3 PRA Project
Integrated Site Risk Assessment (ISRA)
(TAAP Section 17)

July 22, 2013

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Agenda

- Integrated Site Risk Assessment (ISRA) Technical Analysis Approach
- Current Status of Work
- Risk Metrics

ISRA Technical Approach

- The single-source PRA models will not be directly integrated (linked together) to form the multi-source PRA models; rather, they provide the "raw material" used to develop the simplified ISRA PRA models.
- A highly iterative effort
- Important to maintain functional and logical consistency:
  - Frequent and substantive Task Leader meetings
  - One-on-one meetings with other Task Leaders
  - Documentation of modeling issues as specified in Section 18 (Quality Assurance), and prompt resolution of these issues
  - Comparison of results to the single-source PRA results as the ISRA is progressively developed

ISRA Technical Approach Involves

- Developing insights from individual single source models to focus attention on risk-significant multi-source accidents; e.g.,
  - RCP seal LOCAs (loss of coolant accidents) tend to be risk significant in PWR PRA models, often involving a loss-of-offsite power. Because loss-of-offsite power sequences can often affect both units at once, these sequences may be a driving risk factor for dual-unit core damage.
- Developing criteria and assumptions to help simplify ISRA model; e.g.,
  - Screening on the likelihood of the specific site configuration, the partial multi-source sequence frequency, or the partial multi-source sequence risk.

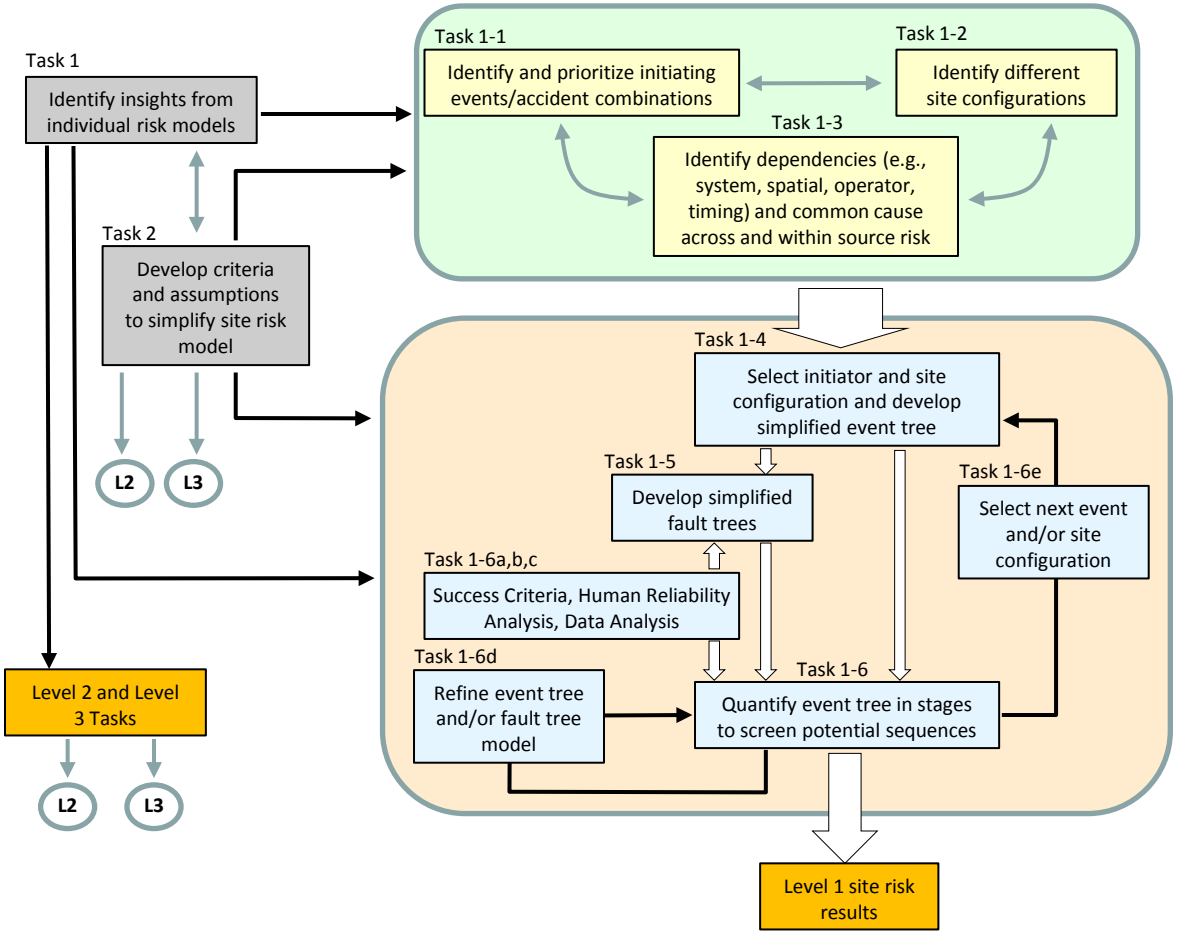
ISRA Technical Approach Involves (cont'd)

- Identifying and prioritizing; e.g.,
  - Initiating events and accident sequences
  - Plant damage states
  - Radiological release states
- Identifying dependencies within and across risk sources; e.g.,
  - Single-source initiators may cause multi-unit accidents due to cross-unit dependencies such as shared support systems, spatial interactions (e.g., flood propagation pathways), common-cause failures, or operator actions
  - Common-cause initiators that simultaneously challenge all of the units at a multi-unit site (e.g., earthquakes, external floods, severe weather)

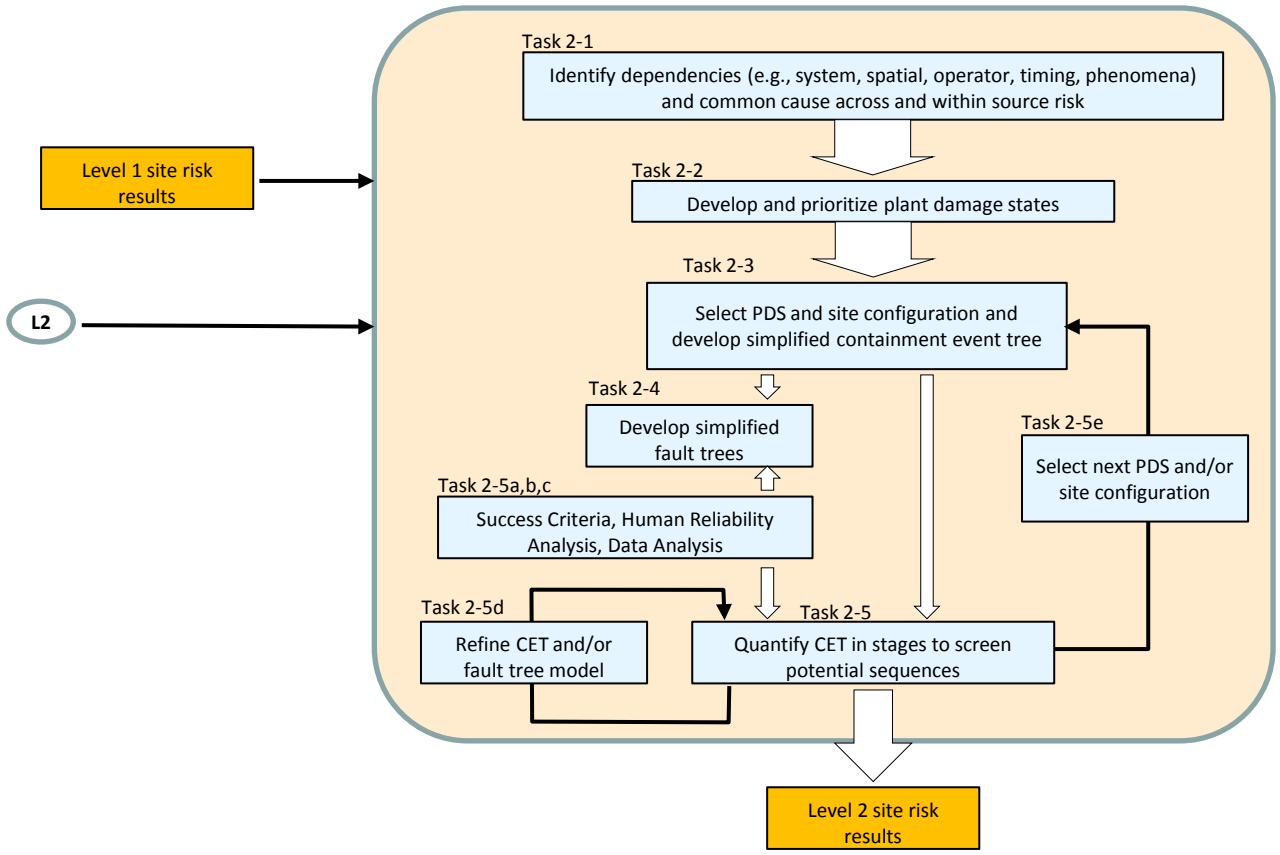
ISRA Technical Approach Involves (cont'd)

- Developing simplified model based on prioritization and dependency analysis
- Quantifying model in stages to determine if screening criteria are met
  - Use screening criteria developed in earlier task
  - Revise and refine the simplified model

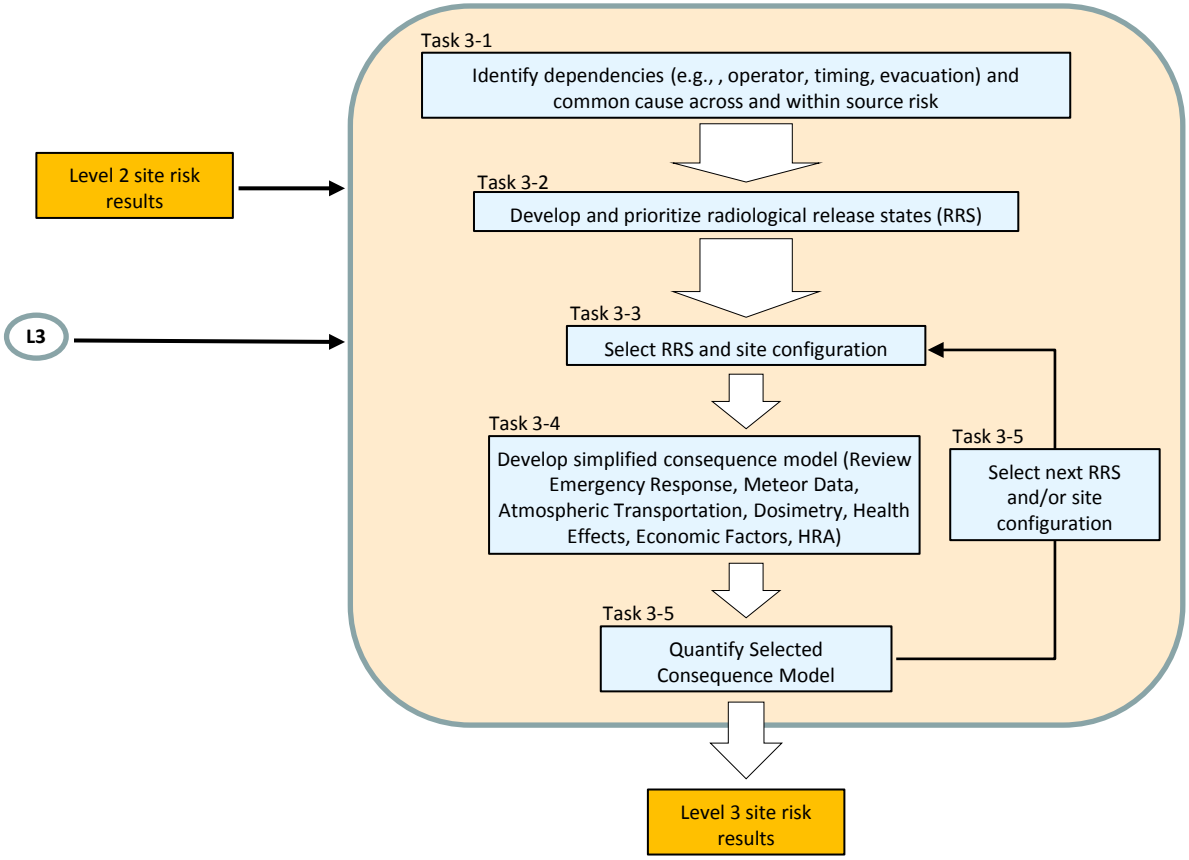
Integrated Site Risk Analysis Flowchart (Level 1)



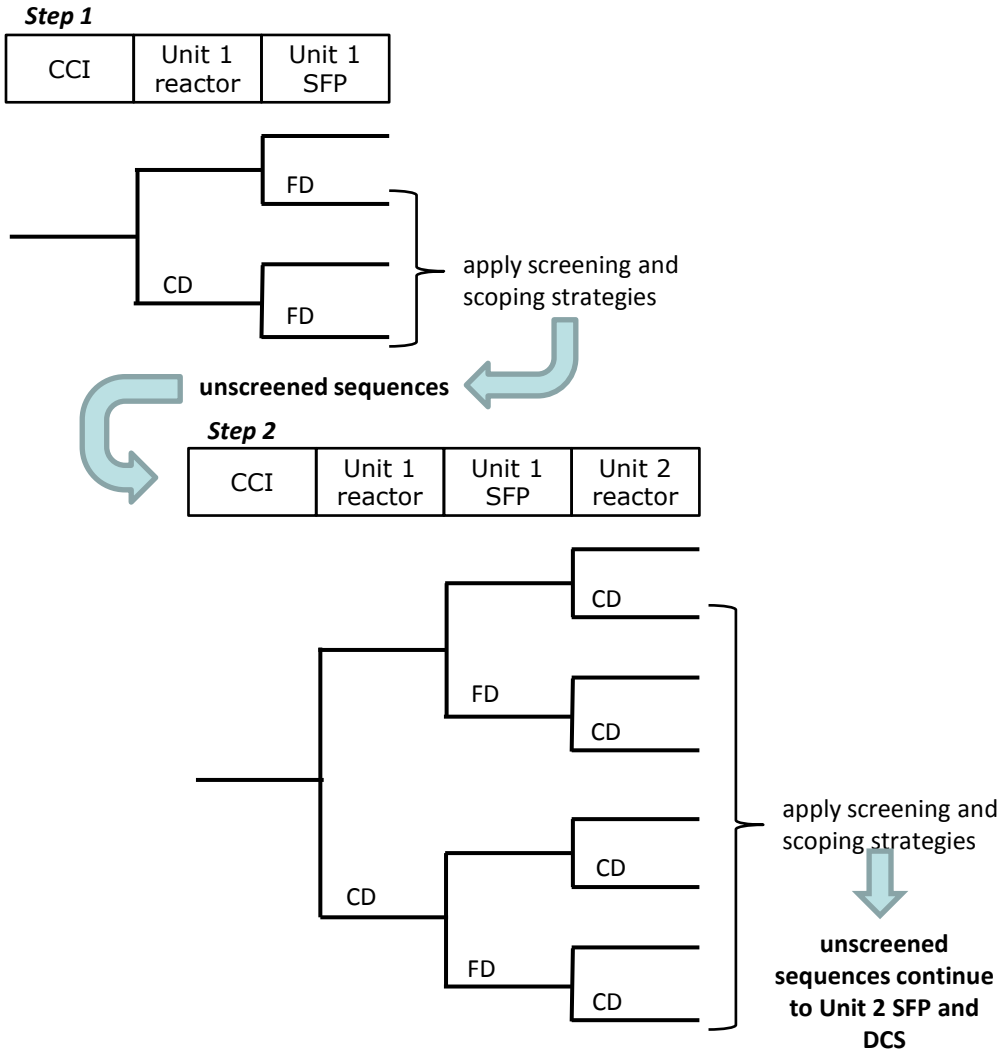
Integrated Site Risk Analysis Flowchart (Level 2)



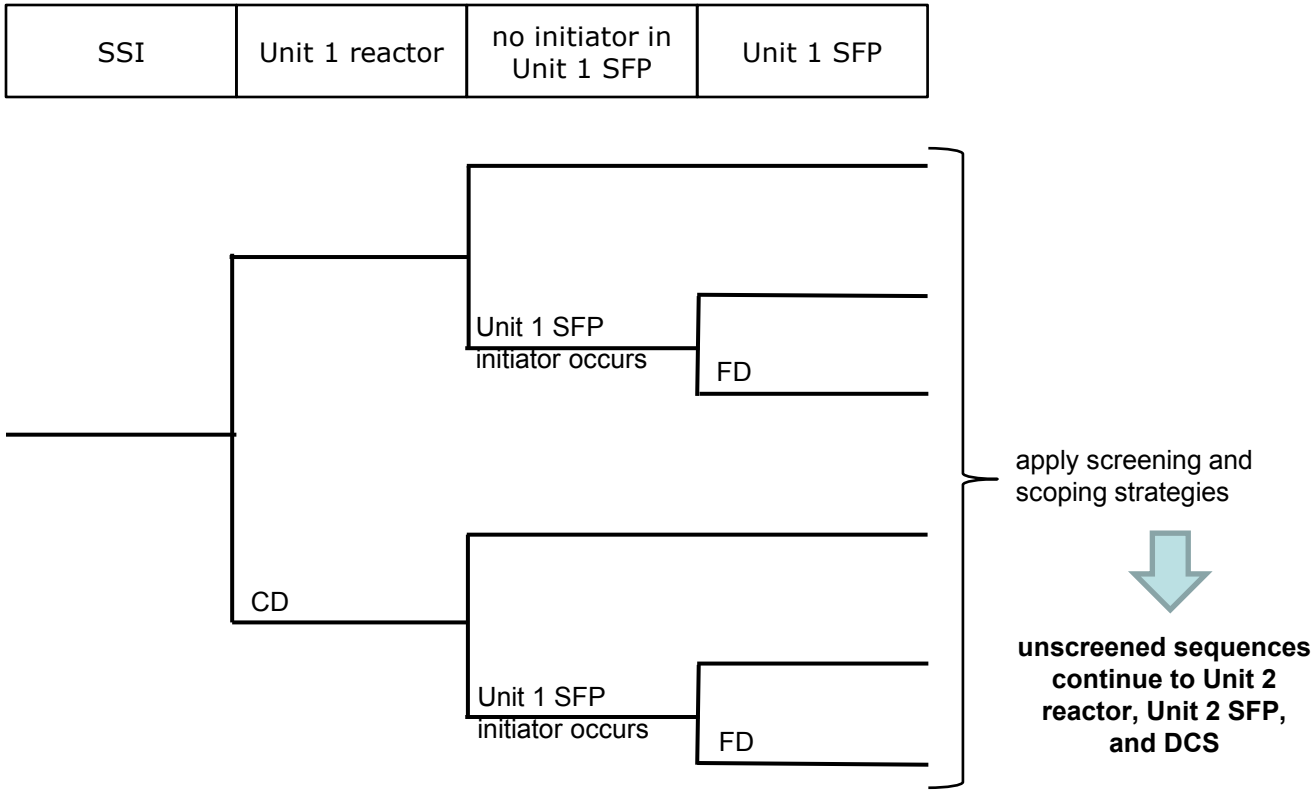
Integrated Site Risk Analysis Flowchart (Level 3)



Common-Cause Initiator Modeling



Single-Source Initiator Modeling



Work Performed to Date

- Completed dependency matrices for reactor PRA model
- Conducted SAPHIRE experiment to assess quantification capability
- Developing table of single-source sequences for the reactor, at-power, internal hazards

Insights on Source Dependencies

- A dependency matrix is being created that shows what systems can be cross-linked between the five major radiological sources (i.e., the two reactors, two spent fuel pools and the dry cask storage).
- Some examples of these dependencies are:
  - A potential cross-connection between the diesel generators of the two units
    - This cross connection is modeled, but turned off by default.
  - The two SFPs are usually connected hydraulically and with a large common air space.

Example of Insights from Single-Source PRA

- A table of sequences is being created that lists the following information for each sequence:
  - Sequence Source
  - Source Operating State
  - Initiator
  - Sequence Point Estimate
  - Cut Set Count
  - Logic
  - Common Cause Initiator or Single Source Initiator
  - Multiple Operator Actions
  - CCF potential across sources

- With all of this information, can begin to understand how the different sources at the site affect each other, and begin to pull out the independent pieces of the model

Candidate Risk Metrics

	QHO	Reported in NUREG-1150	Regulatory Analysis
Total early fatality risk		X	
Total latent cancer fatality risk		X	
Individual early fatality risk (0-1 miles)	X	X	
Individual latent cancer fatality risk (0-10 miles)	X	X	
Population dose risk (person-rem/y)		X	X
Offsite economic cost risk			X

Candidate Risk Metrics (cont'd)

- Other potential risk metrics
  - Cancer incident risk
  - Early injury risk
  - Land contamination risk
  - Multi-source risk surrogates
  - Others?
- Challenges and considerations
  - Use of LNT and/or threshold models
  - Distance truncation
  - Duration truncations
  - Others?

Human Reliability Analysis

July 22, 2013

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HRA Approach for At-Power, Internal Events Level 1 PRA

- Original plan (as described in TAAP):
  - Uses utility's analysis and results for NRC's HRA, to extent consistent with NRC's needs
  - Involves spot-check reviews of Vogtle's HRA documentation and calculation files
  - Involves reviews of Vogtle's peer review results for HRA
  - Assumes limited re-work of Vogtle's qualitative and quantitative HRA for NRC's purposes
- Initial reviews of Vogtle's documentation and peer review led to more work than originally planned
- Review findings identified questions regarding, for example, how methods were applied, basis for selection of methods
  - Currently addressing with SNC

HRA Approach for At-Power, Internal Events Level 1 PRA (cont'd)

- Additional work has included:
  - More detailed review of pre-initiator HFEs and associated human error probabilities
  - Verification of appropriate post-initiator HFEs (comparing PRA basic event files with other HRA documentation)
  - Review and simple re-casting of Vogtle's timing analysis
  - Limited comparisons with SPAR model HFEs and associated HEPs
  - Identification of time-critical operator actions (and associated HFEs)
  - Identification of risk important HFEs (using importance measures)
  - Review of Vogtle's inputs and analysis using EPRI HRA Calculator for time-critical and/or risk important HFEs
  - Re-calculation of HEPs for time-critical and/or risk important HFEs
  - Re-work of HRA dependency analysis and uncertainty analysis
  - Internal reviews of all re-analysis (still on-going)

HRA Self-Assessment for At-Power, Internal Events Level 1 PRA

- HRA self-assessment was based on:
  - NRC's HRA, for example,
    - NRC's re-casting of Vogtle's timing analysis
    - NRC's re-calculations of HEPs for several HEPs
    - Vogtle's HRA for remaining HFEs
  - Use of same software tool and process used for self-assessment of other PRA elements
  - Vogtle's HRA documentation
  - Vogtle's PRA peer review
- HRA self-assessment for internal flooding – not yet completed
  - No post-flood HFEs modeled in Vogtle's converted internal flooding scenarios

HRA Approach for Level 2 PRA

- Overall:
  - Maintain internal consistency of HEPs through reviews, sanity checks, and so forth
  - Especially for risk-important scenarios, maintain a continuous "narrative" of the path to failure
  - Recognize important differences between Level 1 and Level 2 with respect to influencing factors
- Vogtle-specific information is crucial, e.g.,
  - Collection and review of plant information (e.g., SAMGs, emergency drill critiques)
  - Plant site visit (June 18 – 20)
  - Discussion and interpretation of plant information (in collaboration with other L3PRA leads)

HRA Approach for Level 2 PRA (cont'd)

- For the HRA Technical Analysis Approach Plan (TAAP):
  - Original process steps still apply
- To assist in communicating the differences between HRA for Level 2 and more traditional HRA:
  - Expansion of TAAP specifically for HRA supporting Level 2 PRA has been drafted
  - Expansion addresses each process step in the HRA TAAP (e.g., definition and interpretation of HRA/PRA issue, qualitative analysis, quantification), focusing on how HRA for Level 2 will be different from how it is traditionally performed

HRA Approach for Level 2 PRA (cont'd)

- Examples of discussion in expanded HRA TAAP:
  - Differing from Level 1 HRA, qualitative analysis will need to focus on SAMGs and EDMGs, the TSC and field operators, availability and usefulness of cues
  - HFEs in Level 2 do not map well to our traditional definitions of success and failure
  - In quantification, the execution of actions may be addressed using existing methods with some expansion to address relevant PSFs (especially, environmental factors); many differences between Level 1 and Level 2 with respect to decision-making which will require a correspondingly different approach

HRA Approach for Integrated Site Risk

- For multiple source accident, issues being identified needing resolution; for example:
  - How are priorities established?
  - Is the accident tracked? How is the accident followed in trying to understand what has occurred and why, and how to arrest the accident?
  - Who is orchestrating the team response to the accident? Who is making the ultimate decisions and how are they communicated?
  - How many decision makers are there? Is there one for each source (e.g., Unit 1 versus Unit 2 versus spent fuel pool versus dry cask storage)? How is it coordinated?
  - What is the protocol if challenged with multiple accidents? That is, both reactors, and spent fuel pool and dry cask storage? How are multiple accidents handled? Will there be a priority, for example, attempt to save one unit and not the other?
  - Are decisions made in light of what may occur, how is this determined?
  - Are the operators trained on the occurrence of multiple accidents? What does the training involve?
- Some initial answers were obtained from Vogtle plant site visit

Summary of Vogtle Plant Site Visit

- Overall goals:
  - Gain general confirmation of operator behavior for at-power, internal events Level 1
  - Gather initial information relevant to HRA in support of Level 2 PRA and integrated risk model
- Walk-downs and activities observed:
  - Simulator exercise
  - Several recommended plant locations and equipment associated with EDMGs, especially related to SBO events
  - Main control room
  - Technical Support Center (TSC)

Summary of Vogtle Plant Site Visit (cont'd)

- Interviews (some staff with multiple roles):
  - Simulator trainers
  - Various SROs, especially on topics related to:
    - Training (specific types of scenarios and procedures)
    - Plant history and drills on "challenging scenarios"
    - Back-up strategies for electrical connections
    - August 2012 Emergency Planning drill (where SAMGs were implemented)
  - System operator, especially on topics related to:
    - EDMG training
    - Combined training with licensed operators (i.e., "mini E-drills")
    - Staffing
  - SAMG developer
  - EMDG developer
  - SAMG "players":
    - Emergency director
    - SAMG Evaluator/Operations
  - NRC resident inspector

Backup Slide: HRA TAAP: Key Assumptions & Limitations

- Procedures & other formal guidance that support operator actions addressed in the PRA exist & are currently being used & trained upon
- Action locations, equipment, control panels and so forth exist, are currently being used & trained upon
- Licensee's PRA(s) will form the basis for the NRC analysis, provided that it:
  - Is adequate for needs of NRC's Level 3 HRA/PRA effort with respect to scope & objectives
  - Meets the ASME/ANS PRA Standard requirements
  - Has a peer review
  - Requires no adjustment to success criteria or timing information relevant to HRA
  - Addresses key & relevant performance influencing factors
  - Has used HRA methods & approaches suitable for the application
  - Has included an HRA that was performed using HRA methods & approaches as they are intended to be used
  - Requires little or no re-work of HRA qualitative or quantitative analysis for post-initiator HFEs
  - Requires no re-work for pre-initiator HFEs