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

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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SUBCOMMITTEE ON REGULATORY POLICY AND PRACTICES

+ + + + +

MONDAY

JUNE 21, 2010

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CLOSED SESSION

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ROCKVILLE, MARYLAND

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The Subcommittee convened at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., Dr. William J. Shack, Chair, presiding.

SUBCOMMITTEE MEMBERS PRESENT:

WILLIAM J. SHACK, Chair

SAID ABDEL-KHALIK

J. SAM ARMIJO

DENNIS C. BLEY

MICHAEL CORRADINI

MICHAEL T. RYAN

JOHN W. STETKAR

CONSULTANTS TO THE SUBCOMMITTEE PRESENT:

THOMAS S. KRESS

NRC STAFF PRESENT:

HOSSEIN P. NOURBAKHSH. Designated Federal Official

JIMI YEROKUN

CHARLES TINKLER

RANDY SULLIVAN

MARTY STUTZKE

JON AKE

ROBERT PRATO

JASON SCHAPEROW

JOCELYN MITCHELL

JENNIFER UHLE

ALSO PRESENT:

RANDALL GAUNTT

T-A-B-L-E O-F C-O-N-T-E-N-T-S

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

8.28 a.m.

CHAIRMAN SHACK: The meeting will now come to order.

This is a meeting of the ACRS Subcommittee on Regulatory Policies and Practices. I am Bill Shack, Chairman of this meeting.

Members in attendance are Sam Armijo, Said Abdel-Khalik, Dennis Bley, John Stetkar, Mike Ryan. Mike Corradini will be joining us a little bit later, hopefully, if there aren't any thunderstorms in the mideast.

Our consultant Tom Kress is also attending today.

The purpose of the meeting is discuss the draft NUREG-1935 State of the Art Reactor Consequences Analysis Project as well as the draft peer review report, peer review of the SOARCA project.

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

Dr. Hossein Nourbakhsh is the Designated Federal Official for this meeting.

All portions of today's meeting will be

closed to prevent disclosure of information, the premature disclosure of which would be likely to significantly frustrate implementation of a proposed Agency action pursuant to 5 USC 552b(c)(9)(B).

A transcript of the meeting is being kept. It is requested that speakers first identify themselves, use one of the microphones and speak with sufficient clarity and volume so they can be readily heard.

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

One thing I did notice on the agenda is that there's no discussion of the uncertainty analysis that I know you're planning on talking about. And somewhere in today's presentation I wish somebody could at least go over the proposed methodology. I think that would be of great interest to the Committee if that could somehow be worked into someone's presentation.

We'll now proceed with the meeting. And I call upon Mr. Jimi Yerokun of the Office of Nuclear Regulatory Research to begin.

MR. YEROKUN: Thank you very much.

My name is Jimi Yerokun. I'm a Branch

Chief in the Office of Nuclear Regulatory Research. That branch has the leadership for the Agency for this SOARCA project.

We're here today, as has been pointed out, to present the results of the pilot project is -- is now the results for the pilot project for SOARCA. We've completed analysis for BWR and a PWR as pilot for the project. And the goal for today is to be able to go through all those results with you at this meeting.

There's a couple of things that I wanted to point out before we get going.

I want it to be known that SOARCA is the joint Agency effort across the multiple offices in the NRC. Presenting to you today you have staffs from the Office of Research you have staffs from NSIR as well as NRO. NRR is also a part of the membership for this effort. So this effort is across the Agency, although it's led by the Office of Research.

In addition, we have support from the Sandia National Labs. They're supporting with the analysis for this effort, the pilot routine for this project. And we have a rep present today from the Lab, Randy Gauntt sitting in the back in there. He's here to provide moral and technical support as we need.

We also, we've shared the results of SOARCA with external peer reviewers. And one of those reviewers is here today observing this meeting. Jeff Gabor is in the back in there with Randy.

And also, we invite our SRAs, of course they just will drop in and observe as we go on with this meeting.

We've been here about five times since 2006. I think a couple of full Committee meetings and maybe three or so Subcommittees. We also had a meeting with the previous ACNW. So you know we've had a lot of interactions with ACRS on this project.

Since we've met again we've shared the results with external peer reviewers. We are still working on some of the comments from the peer reviewers.

We have also shared the results with Beach Bottom and Surry with the intent of looking at the results for factual accuracy only. The system is the information we use for their Site 1 to verify the factual accuracy of this information. So we shared it with those plants solely for that purpose. We did not solicit any comments from them on the process, conclusions, anything else apart from the facts of what we use for the science. We have the feedback from Peach Bottom and Surry on those facts and we're still working those into the document as well.

So you will hear some discussions today that will involve some of the comments we have from the peer review as we're still dealing with and you might hear some comments that involve some of the feedback we had from Peach Bottom and Surry, the plants that we used for this assessment that we're still dealing with.

And again, you know the plan is, of course, to give you a synopsis of the project, the objectives, overall conclusions and results. Charles Tinkler from the Office of Research will do that, to which we'll do down in the various phases of the project as we get into sequence selection, mitigating measures, you know in logical order. And I would think that's probably the best way to give it to you, and hopefully we'll have a meaningful interaction all day today.

With that, I would then step aside and let Charles Tinkler start it off.

Thank you.

MR. TINKLER: I hate this. I'm at this point where my eyesight is such that when I have to look down here and look out there, it takes at least another 15 seconds to re-orient and I haven't quite figured out how to solve that problem.

CHAIRMAN SHACK: You could always have a second career as an umpire.

MR. TINKLER: I'd like to get to the point where I need the same glasses or glasses for both, but I'm not sure if I want to wish for that yet.

Anyway, I'm Charles Tinkler from the Office of Research.

Actually, I point to the fact that on Jimi's slide he listed all the offices of the NRC that have contributed to this, and it's been good in that respect. It's been equally good that the various divisions within the Office of Research have worked cooperatively and have coordinated on this. It's really been a good thing. I can't say all the interactions have been as smooth as we might have hoped, but that's only natural since we're doing a lot of new things here. But the coordination between Division of Systems Analysis, Division of Risk Analysis and the Division of Engineering has really been quite good. We've really been fortunate in that. Folks in DRA have tolerated us in their pursuant of deterministic best estimate analysis and we tried to develop a better understanding of their concerns about probabilistic outcomes.

The folks from DE have provided really strong technical support in the area of containment failure modes. We took a fresh look at containment failure modes and the way they were treated in the past in NUREG 50.

So, I wanted to make a pitch for that. That kind of coordination doesn't always happen. And one of the benefits of having one of these multi-disciplinary projects is it kind of forces everybody to coordinate and get up to speed where everyone else is. And so it's a good thing.

The background, the roots if you will of the SOARCA project trace back to the security studies done in the 2002/2004 time frame where the NRC, they took an assessment of the potential vulnerabilities arising from terrorist attacks on nuclear power plants. The focus of that study was if such vulnerabilities were revealed by the assessment, then the Commission was really interested in not just knowing how bad things could be but what are practical mitigation measures that might be implemented to either avert core damage or reduce the effects. That was really an important element of it, and that plays into where we ended up going on SOARCA.

About a third or maybe less of the way through the security assessment it became reasonably apparent that in the security assessments that a number of the threats from commercial aircraft actually resembled in a functional sense the kinds of scenarios we deal with in severe accident analysis that are dealt with in probabilistic risk analysis. And they were quite similar to what we call typical and important severe accident scenarios, or what you might say are the usual suspects when anyone goes into a PRA for a light water reactor.

And we saw that early on when we were doing detailed calculations using MELCOR in the security assessment that these releases were dramatically smaller than in some of the legacy or historical documents like the 1982 Siting Study. And the Commission at that time was concerned about a number of these legacy documents and studies that seemed to indicate that the consequences of some of the severe accidents were extraordinarily large, particularly with respect to early fatalities, but also with respect to latent cancers. Now part of it was the way in which earlier studies, like the Siting Study recorded in the media, rarely quoted mean values. Typically they quoted 99th percentile values from the 1982 study. And that typically represented the uncertainty associated with weather.

But nonetheless, the security studies fairly clearly demonstrated that for a number of these important sequences, scenarios the consequences would be considerably smaller and that the earlier studies were quite conservative, and excessively so in some regards to the point that those numbers weren't really useful and didn't represent what we thought was likely to happen.

Again, we did those calculations in the security using our most advanced with a focus on being realistic. Our most advanced modeling with a focus on realism. We used the MELCOR code. I presume everyone here has head about the MELCOR code countless times. But it does represent the embodiment of everything we've learned in severe accident research that's been going on for the last 20/30 years.

A lot of work has gone into getting this code to the point that it represents a state-of-the-art and in some cases, we might claim that we're pushing the state-of-the-art a little bit.

The security assessment relied heavily on the MACCS code. While the MACCS code may not represent state-of-the-art plume modeling, it is a widely used, extensively used model for consequence and risk assessment in PRA. It's used throughout this country, and I believe in other countries. It has a great deal of flexibility. It's one of the strengths. It's reasonably well understand. And I think we've concluded that it is quite suitable for these kinds of calculations.

In the beginning of the project, which was late 2005, we had a more ambitious program. We were going to kind of do a replacement for the 1982 study. We were going to look at every site. And our source terms were going to be generated based on the eight classes of reactors; Westinghouse Large Dry, Sub-atmospheric, Ice Condenser, CE, B&W, Mark 1, Mark II, Mark III. And using PRA insights, we were going to develop more or less generic source terms and apply them to all 70 some sites; almost a one-for-one replacement for that '82 study.

We were still going to do, more likely, what we think were the risk important scenarios. And we were going to do realistic analysis. We were going to include all the improvements that have taken place since that '82 study and other studies, including NUREG-1150. We were going to use realistic EP; that was going to be a site-specific consideration. Early on, we had considered that we would look at different ways of treating latent health effects, latent cancer fatalities, whether we would use just LNT or non-LNT models including the modeling implied by the Health Physics Society position paper; five rem a year and ten rem lifetime as a truncation level below which we would not estimate risk.

In the beginning, we thought well what if we uncover a scenario that posed significant risk. Well, like the security we figure we'll look for practical additional mitigation measures. We sent this out to a lot of folks for the review. The Commission chewed on this for several months.

I neglected to mention that even in the very beginning it was obvious that we would need an uncertainty analysis. If we claimed to do best estimate, someone's going to naturally ask you well what about the uncertainty. So we had from the very beginning conceived that we would need an uncertainty analysis to address those kinds of issues. It's a separate but very closely related study.

The original program was, as I said, presented to the Commission. We had public meetings to get feedback. We had some early ACRS contacts on this.

And we at that point began to think about perhaps an independent peer review.

Some of the early feedback and reviews, the Commission early on sensed that the original program was a little too ambitious. I don't know if it was matter that they thought we'd never finish or they just thought we would perhaps be better off focusing on two or three or so plants. They made it clear that they thought us technical folks were doing a spectacularly bad job of risk communication and we needed to improve. And I'm probably as guilty, if not more, than anyone on that score. But the Commission made it clear they had a real strong interest in doing a better job of communicating what a ten to the minus seven event means and what risk means, and all that kind of context.

The Commission thought that we would be better suited by focusing on current mitigation capabilities, including those that had recently been implemented as far as a security assessment. As I said, originally we were going to look at perhaps additional mitigation measures. And they said well you just concern yourself with what's out there now. And in hindsight, that was a good thing.

CONSULTANT KRESS: Well do you think after the two pilot plants you'll ever return to the original scope?

MR. TINKLER: We're going to talk about that a little bit. But I think we're still in the process of formulating where we go. Okay?

We're clearly going to do an uncertainty analysis; that's beyond dispute. But whether or not we do two more pilot plants or we do eight; one representative from each of the eight classes that still has not been resolved.

In October we're scheduled to provide the report, its conclusions to the Commission and make a recommendation at that point. So we'll go through lots of gyrations between now and October on that matter.

Early on, the ACRS raised --

CHAIRMAN SHACK: Charlie, just on this point again, you keep coming back to the uncertainty analysis and your best estimate. And if there's an uncertainty analysis, I'd do it on the best estimate or the deterministic calculation; that's one sort of thing. There's also the uncertainty analysis with the way I've chosen to attack this problem; the accident progressions that I've always picked the most likely scenario rather than an alternate scenario I've truncated this.

How much of the uncertainty is really an uncertainty analysis of the deterministic calculation and how much is an uncertainty of what I'm missing because of the way I went about this analysis?

MR. TINKLER: I think we will address both uncertainties. Okay? To the extent that some of the uncertainties stems from the path that the event took, either as a result of equipment or other things, we will address some of those. Some of it will be the more traditional severe accident phenomenological uncertainty. But as an example, what we have seen and where the peer reviewers have identified. Frankly, the peer reviewers seized on some of those things and said well, gees, you haven't done an uncertainty analysis, so how do we know it's any good? How about doing some sensitivities?

So, the absence of an uncertainty analysis has driven us, in part, to address peer review concerns by doing sensitivity calculations. We think they are instructive and revealing, and address a number of them. But if you think some of these paths, which are different paths for a scenario, if you think some of them is more stochastic than epistemic and more system oriented as opposed to phenomenologically oriented, it is our plan to address some of those as part of the uncertainty analysis.

This notion of if a SRV sticks open in a BWR transient, when does it stick open and what causes it to stick open? Our best estimate calculation for Peach Bottom long-term, short-term station blackout is that after hundreds of cycles and some of them at extraordinarily high temperature, that that SRV is not going to reseat. It's going to stick open. The valve spring weakens, all kinds of things going on, very high temperature, hundreds and hundreds of cycles. You know, there's uncertainty about that. That's not what we would typically call phenomenological uncertainty, okay? But it is an uncertainty that influences that calculation.

So, while we haven't mapped all those out, I think it's safe to say that we would consider some of those kinds of elements in our uncertainty study.

CONSULTANT KRESS: Do you plan on drawing heavily on NUREG-1150 for your phenomenological uncertainties? Just to select those or --

MR. TINKLER: No. No. Not really. We think NUREG-1150 phenomenologically from a modeling point of view is too dated in that respect.

CONSULTANT KRESS: Okay.

MR. TINKLER: We will base it on what we understand uncertainties to be from things like Phebus, ARTIST, recent, recent; all the 20 years that we've done since NUREG-1150 plus all the other calculations that we've done. We'll look at things in separate projects, okay?

The application of MELCOR in everything from the revised source term to a high burnup fuel; all these kinds of things are a sense of core-melt progression uncertainty, are a sense of uncertainty in some of the containment phenomena.

CONSULTANT KRESS: So, you've got a new set of expert opinions?

MR. TINKLER: No. We're not going to forget what we've learned from NUREG-1150.

CONSULTANT KRESS: Yes, of course.

MR. TINKLER: But we are going to kind of take a fresh look at that.

Now we did this a little bit when we looked at MELCOR analysis to support risk-informing 10 CFR 50.44, the hydrogen void. We did MELCOR calculations to look at primarily the issues of core-melt progressions. How did it change the prediction of hydrogen generated in a severe accident? Did you generate more hydrogen, less hydrogen, faster and slower? So we looked at a lot of those issues.

We developed distributions for our core-melt progression modeling parameters; zinc oxide breakout, temperatures, core collapse temperatures. So we went through this process a couple of years ago to look at the minutiae of core-melt progression modeling. And we think we learned from that. Things came up in SOARCA that we can see have the potential to influence, and I say the BWR SRV, but there are others. But this uncertainty started just like MELCOR, you know look at the calculation in MACCS, too.

Well, you know, we got all excited about heat transfer and fluid flow and thermal dynamics; when you look at uncertainty in cancer risk factors and a few other things, well maybe we're not so important as we think we are. That's not a prejudgment, okay. It's just a recognition that this is a big integrated calculation and there are lots of parts.

So right now, frankly, we're haggling over well how many variables are you going to adjust and how many are you going to want to adjust. And we got the structural guys, maybe they'll want to adjust them in the containment failure model. We're going to look at the sensitivity and a certain number of variables in MELCOR. The MACCS people, they think a different set of parameters. Well, how many parameters do you want to vary in this uncertainty analysis? You want to vary 500? Well, we'll give up and surrender if it's 500 because we can't do it.

MEMBER STETKAR: Charlie, you talk about doing uncertainty analysis in piece parts. And uncertainty and risk is, indeed, the cumulative effect of our entire uncertainty throughout the integrate scenario. So looking at variations in very, very structure piece parts of little models that you can vary parameters values is not really doing an uncertainty analysis through the integrate risk assessment.

Do you plan to do an integrated, quantitative assessment of the risk results from the SOARCA study end-to-end from initiating event frequency through plant models, through phenomenological events in the containment event tree out through emergency planning and response? Yes or no.

MR. TINKLER: Well, I don't --

MEMBER STETKAR: You know, yes or no. Just a short answer.

MR. TINKLER: Okay. Okay.
MEMBER STETKAR: Just a short answer.
MR. TINKLER: If I can clarify after I say yes or no.
MEMBER STETKAR: Sure.
MR. TINKLER: No.
MEMBER STETKAR: Okay. Thanks. Now you can clarify.
MR. TINKLER: But I could be wrong about this.
MEMBER STETKAR: Okay.
MR. TINKLER: Right now we weren't going to tackle frequency. We weren't going to tackle scenario frequency.
MEMBER STETKAR: But the current results are driven by seismic events, aren't they?
MR. TINKLER: Yes. Understood. Understood. Okay. And we have from about 2007 said, you know SOARCA reveals that you need to do seismic PRA. We haven't been shy about that. We've been saying that in RIC meetings from the get-go. As soon as we got done our scenario selection, it slaps you in the face that everything is a seismic initiator. And the Subcommittee and Committee said well, gee, why don't you do a better job on seismic? And we

acknowledge that. But to the extent there are fire and floor initiators that kind of look like seismic, we think some of these insights also apply. But the point I wanted to make was most of the uncertainty that I spoke of is in elements where the event has begun, where the scenario has begun. You know, how does it progress? The very portion of it, the SPAR calculation if you will or the seismic frequency assessment we were not intending to tackle that. We would prefer to leave that to a future activity that looks at a full scope Level 3 PRA. We want to bore down on the modelings not only on uncertainty associated with that closer examination of accident progression through a start and consequences. We think that's where the most benefits would be revealed.

MEMBER STETKAR: Okay. I think you'll need to be extremely careful when you do whatever you do to be sure to clearly document what you're not doing so that you don't necessarily over-sell, if you will, the extent or the integrated nature of whatever uncertainty evaluations you do.

MR. TINKLER: Sure. Sure. And with respect to the model uncertainty versus parameter uncertainty, what I described more or less was the parameter uncertainty stuff, not a model uncertainty stuff. You know, we're not going to generate another MELCOR. Now could we address that with something like a MAAP calculation? Well, yes, that could be done but we're not the best people to do that.

MEMBER STETKAR: Even within standard propagation of parametric uncertainties there are parts that might not be included.

MR. TINKLER: Yes. Yes. But like I said, the details of some of this are still to be resolved. Whether or not we could actually look at the variations in the model in MELCOR, I think that's feasible in a few areas. It's not feasible across the board. To the extent that some key sub-elements of modeling could be attacked differently, that's a possibility.

MEMBER STETKAR: I'll come to your rescue here a bit. If you're worried a lot about the modeling uncertainty, that certainly is a strong concern in some areas in terms of modeling uncertainty. On the other hand, if you're taking a snapshot, as you are, and saying that this is the current state-of-the-art assessment of our ability to quantify risk, not many people are a practical manner currently do very well in terms of addressing model uncertainty.

I mean, they do do pretty well or you can do pretty well, at least in quantifying parametric uncertainty. So by at least not doing a complete job in that area, it is not a state-of-the-art assessment.

MEMBER BLEY: Rather than a tutorial, I just want to ask you when will there be a plan of how you're going to do the uncertainty analysis? And I sure hope there's going to be a plan before you take off on this thing. And I really hope you share the plan with us before you get all your results done.

MR. TINKLER: I agree. Well, I'm not a good predictor of these things because I would have thought we would have been well on our way by now. But these are comments we got from the peer reviewer, you know we would really like to see this thing. And I understand the Committee would.

I suppose that we'll probably be scheduling future meetings with the Committee to talk about this sort of thing. We're still working out some basic approaches and how many variables we're going to sample, and what kind of distributions, what the distributions will look like.

MEMBER BLEY: Are you thinking of anything like a PERT to help prioritize these things that you're doing some clear way to show why you've picked what you've picked instead of other things and why you think the things you haven't picked aren't too important?

MR. TINKLER: Well, we have basically gone through that sort of within the broader team of Sandia folks and NRC folks and other folks. And then we were going to submit to people for review.

I don't want to speak out of turn, but at one time we talked about going back to the peer reviewers when we had a list of parameters and distributions when we could say concretely this is what we're going to do. And we would go back to the peer reviewers and say "What do you guys think?" And I presume that we would do the same thing with the Committee.

MR. YEROKUN: If I may chime in. I mean, it's very clear that some of you have great interest from the Committee on the uncertainty analysis with regards to what interest was expressed by the peer reviewers. And I think our study pointed out this is something that is still being formed. And the fact that it needs to be shared with the peer reviewers, I think it's getting rather clear that we need to mix and how we interact with the ACRS on that as we move along as well.

We've shifted attention in the past couple of months on what are the drives in the project. It's not uncertainty analysis. Things are still being formed on that.

CHAIRMAN SHACK: And again, it depends on what your objective is. You know, if we're still coming back to this it's somehow a realistic assessment of the risk to the public, that's a different kind of uncertainty analysis that's much more akin to John's statement than it is an understanding of the uncertainties in our ability to model severe accidents. So, you kind of --

MR. TINKLER: Yes. I would say it's a little in between. It's going to be a statement of the uncertainty or the sequences that we've chosen. It's not going to be a statement of the uncertainty of total risk. I mean, the Committee's already going to tell me I haven't captured total risk. So, I don't want to argue on that grounds because that's an unwinnable argument. But for the sequences that we have selected, for the initiating event scenario frequency that we have determined we're going to propagate the remaining uncertainty and look at how it changes the estimate of risk for those important scenarios with that frequency.

I'll give you another example of something that right now it's just beyond the scope because we'd have to undertake a whole different kind of test.

The events we have we've assessed with and without mitigation. We think mitigation is reasonable; we think it's likely. We have not done a detailed HRA. That's been a source of discussion and contention, and all kinds of things. I couldn't possibly claim to have a full picture of the scenario frequency unless I had resolved that. But when we first went down that road it looked to be a very large effort and, frankly, one in which we thought maybe we wouldn't get as much out of it. We wouldn't be able to see any many new insights if we went down that road that we would by doing this kind of work. We think, again, that important insights are revealed by doing the kind of work we did in SOARCA. Other insights in other areas clearly would be available in doing additional kind of work. But we think these insights are of particular importance because we think this is an area where, frankly, PRA hasn't folded in all this kind of stuff yet.

Now we're in the process as a result of coordinating and working with our folks in DRA, the insights from SOARCA are finding their ways into their future PRA activities. That's all a good thing and we think something that needed to be done.

You know, HRA on the B.6.b measures and other stuff, that's perhaps a topic for another day.

CONSULTANT KRESS: I'm confused, Charlie. I think this is a consequence analysis and people may have questioned risk. Are you going to convert it into some sort of risk metric?

MR. TINKLER: Well see that last bullet on this slide. In effect what we're doing is assessing the risk for specific scenarios. It's not a total risk. But we can calculate individual risk, conditional individual risk. We have scenario frequencies they can be translated into a risk-specific -- I mean a scenario --

CONSULTANT KRESS: It'd be a lot easier to do an uncertainty on the consequences than it is on the risk.

MR. TINKLER: Well, but that's only a part of -- we could. But frankly, a comment we got early on is if we released a report that strictly has consequences without any context or frequency, we're back in the same risk communication problem. We say, okay, there's X number of latent cancer fatalities.

Well, what does that mean? What's the frequency of event? And so decoupling consequences from frequency was an issue that was identified in some of the early comments of the project.

And as a result of other considerations down the road our Senior Steering Committee composed of managers at the NRC actually thought we would be better off portraying the consequences in a risk context. Not to be confused with total risk for the scenarios that we have selected, let's put some frequency context on those numbers. And the way to do that is to portray it as a scenario-specific risk.

CONSULTANT KRESS: What would you do with such numbers?

MR. TINKLER: Well, we think if they're the important scenarios, you learn something from that.

CONSULTANT KRESS: You know whether to go back and try to mitigate them, is that --

MR. TINKLER: Well if your SPAR model, your basic external events model says this is a big part of the pie and you have a number that you think you could lower by some means, you could use it for that. Alternatively, if you think you have a big part of the pie and your number if really below the safety goal, well maybe the safety goal should be tightened. If we're a thousand times less than the safety goal, and that's the trend, maybe the safety goal is a little too slack.

That's Charlie talking, okay? But other people have said that. I didn't dream that up. Well, I dreamed it up, but other people have said it when that's easy to make a safety goal. And the Commission has already stated its expectation that new plants would be safer. People have done PRAs, they've done IPEs. The industry has voluntarily made improvements to their plant which have driven down the internal events frequencies. So what are we left with? Earthquakes because the internal event frequency has been driven down, down, down, down. Okay.

I think there's a possibility that if someone says "Well, look, we don't have LERF on any of these sequences, and we barely have any latent cancer fatality risk." Well, maybe we should look at land contamination.

CONSULTANT KRESS: Are you going to?

MR. TINKLER: We're not. We're not. But if at the conclusion of --

CONSULTANT KRESS: That's the reason to do that. I mean, that would be the easiest thing to do.

MR. TINKLER: Well, that requires -- we talked about that with the Commission and they said hold off on that for the time being.

CONSULTANT KRESS: I see.

MR. TINKLER: Okay. But if you had no LERF, I'm generalizing here --

CONSULTANT KRESS: Yes.

MR. TINKLER: If you had no LERF and the latent cancer fatality risk is very low, maybe you should worry about just the issues of land interdiction, land contamination.

CONSULTANT KRESS: Well, I think those are the things the general public would be interested in: What are the total number of deaths, the land --

MR. TINKLER: Sure. Sure. And we got a constant reminder of it right now in the news.

CONSULTANT KRESS: I see.

MR. TINKLER: Contamination.

CONSULTANT KRESS: You're right.

MR. TINKLER: It won't be hard for people to put that together.

CONSULTANT KRESS: But you've been told not to do that part of it?

MR. TINKLER: Well, they just said, you know for the time being let's focus on the things that we have historically focused on. And as Jocelyn could point out to you that land contamination is tied up with our sense of interdiction and rehabilitation and all that other stuff.

CONSULTANT KRESS: Yes, but so is all the other stuff.

MR. TINKLER: Yes. So if you think they don't know how to clean up oil, how do you think we know about cleaning up land contamination from a nuclear event over big areas I don't know what kind of boom you're going to get for that, but any event, those are just --

CHAIRMAN SHACK: Subversive.

CONSULTANT KRESS: But MACCS will just kick that number out for you.

MR. TINKLER: Well if it knew how to -- oh, absolutely. Yes.

CONSULTANT KRESS: Yes.

MR. TINKLER: On land contamination. Yes. And frankly, we have reported those kinds of numbers in other forums.

CONSULTANT KRESS: It seems like it would be an easy extension to get.

MR. TINKLER: Yes, it is. Very easy. We looked at it as some of the security assessments at the request of the Commission.

CONSULTANT KRESS: Yes.

CHAIRMAN SHACK: Well you have to do that for the Environmental Impact Statements for license renewal and such.

MR. TINKLER: Yes. Well, I just don't want to get too far ahead, but there are some reasons for this thing in looking at scenario-specific risk. I know we're not going to be able to meet an ASME standard on completeness. You guys got some really tight numbers. That was pretty impressive if you believe it. But we think, like I said, if we talk to a big part of the pie, that's a good thing. And we think we have.

I'm way behind.

CONSULTANT KRESS: Before you leave, that first bullet under ACRS, have you ever articulated the real criteria for your truncation of frequency? Why you chose the particular value? Is there some sort of defendable reason that you have?

MR. TINKLER: We have tried to. We're going to talk about this. And I'm going to go over every one of these things there as issue a little later.

CONSULTANT KRESS: Okay. Fine.

MR. TINKLER: Actually in about two more viewgraphs.

Anyway, having gotten all of this feedback we then refined, adjusted, revised our objective. A fairly concise statement of it is to develop a body of knowledge on the realistic outcomes of severe reactor accidents. Not all, but selected severe reactor accidents.

The supporting corresponding objectives were to develop plant improvements that hadn't been addressed in earlier assessments either consequence assessments and probabilistic risk assessment.

It was our intent to incorporate state-of-the-art modeling. We think we have. Like I say, in some cases we think we've actually pushed the state-of-the-art a little bit.

It was the Commission's interest that we evaluate specifically the benefits of some of those mitigation measures that they mandated during the security assessments. It's quite understandable because there was some sense that if you went out and got portable power supplies and diesel-driven pumps to advert core damage during a terrorist attack, that diesel-drive pump because it's not ac-dependent could also be used in a SBO. Portable power supplies, well you could really use those in an SBO. So it was pretty self-evident in some respects.

Again, they wanted this so we would be able to communicate to different kinds of folks about risk of nuclear safety and within an emphasis on effective risk communication.

Last but not least, they wanted to update this quantification. Now the update of the quantification is not going to be as clean as it was before. We now are presenting what results with our risk context, with our frequency context. The 1982 Study was absolute numbers. So that does become a little more impaired by the way we moved on the SOARCA project. But we still think there are ways in which to make that comparison.

The approach. Again, I've said most of this stuff so I don't think I need to go over it with the possible exception that early on we decided that we weren't just going to look CDF. Well, we would use CDF as a basic screening criteria, but that we would drop to a lower frequency for bypass events because the potential for higher consequences. We understand that risk is not just a function of CDF, it's a function of all the other things that go into these calculations.

Well, there's some obvious advantages from having SBOs be your dominant contributor. You don't need to worry an assessment of the availability of containment systems because containment systems are lost just like ECCS is lost. They have the same power dependencies. So it makes it a little cleaner, it's kind of fortuitous in that respect. But that's, frankly, why SBO shows up as an important contributor in a lot of PRA. It's hard to get lots and lots of independent failures.

MEMBER STETKAR: Charlie, have you thought about upgraded plants and new plant designs where indeed SBO is just part of the broad spectrum of risk contributors? For example, it is a ten percent contributor as are nine other equal ten percent contributors that are not SBO?

You're right, it's easier to model with SBO.

MR. TINKLER: Right. Right.

MEMBER STETKAR: It's not so easy to model with other things.

MR. TINKLER: If I had one of those kinds of designs and I was analyzing them, I'd have to pay a lot more attention to the aggregation of lots of little things. And that's where those points, they're fundamental truisms of PRA in a generic sense, they would really be a problem. Part of it, you know we argue that the goodness of our criteria are in part because of the fleet of plants we're looking at and their designs. And we've learned a lot from looking at them over the last 20 years. We can use this simplified, more or less, screening criteria and screening approach for the operating fleet.

If I have designs where SBO is ten percent and something else is ten percent, and something else is ten percent, I'd have to adopt a different approach.

MEMBER STETKAR: Have you thought much about the implications of that going forward for the new plant designs where you might be faced with that type of situation? In other words, is the relevance of this study strictly limited to our existing operating fleet with its design characteristics and its perceived dominant contributors to core damage frequency or is it more generically applicable going forward?

MR. TINKLER: I think there's some generic applicability, although you'd have to adjust it so. But the notion of taking a smaller set of scenarios and quantifying them very well as opposed to taking a huge number of sequences, binning some more -- over-binning is a word I learned from DRA. That I think is really suspect. I just come to that conclusion. Because it shrouds some of the clear insights you get when you do consistent scenario-specific analysis.

You know, you go to the folks and say "Well, what causes the risk to be this?" And they'd say "Well, it's a lot of things." "Well, what things?" "Well, it's a lot of things. You know, it's a little of this, little of that, little of this, little of that." Well where's the calculation that would pull from that? Well, that's not so clear either. At some level just having clear, scrutable analysis is a wonderful thing and insights are gained from doing that.

Elements of the study. These are all really quite interrelated elements: The sequence selection, the mitigation measures. Just to give you an example. Early in the project the SPAR models told us that our sequence, an internal event sequence for Peach Bottom, loss of AC Bus E-12, was the dominant contributor from the internal events SPAR. We looked at with MELCOR calculation. And we concluded that it did not produce a release. It turned out there was something that needed to be fixed in the SPAR model, but the point is the use of detailed modeling may to the extent in some cases, may actually influence your sense of frequency.

And one of the benefits of this project has been that we in the Division of Systems Analysis are now working closely with the people in the Division of Risk Analysis in Office of Research to take a fresh look on success criteria in PRA using MELCOR. Take another look at them. What's the actual timing? Instead of using some simplified sense of top of active fuel, let's actually dig into this a little bit. And that's been a good thing. So we think actually all this stuff is quite interesting.

When we got to offsite consequences, we didn't just take some generic deal on EALS, emergency action levels. We looked for this sequence when would you declare a site-area emergency? When would you declare a general emergency? That prompts some other questions, but we think that when you start doing all these things consistently, you get benefits that you may never have realized would occur. All things just don't conspire to work against you. It just doesn't work that way. Some of the things that hurt you in one sense, help you others.

And the approach also included a fairly

significant effort to produce an information brochure, a website. We went out and got somebody who actually knows how to communicate. And I think we're going to continue to pursue that work, and that's just a different avenue of activity. I'll talk about it a little bit, but I'm not really qualified to say much about it.

Again, we're going to focus on the important scenarios. We're going to do detailed realistic analysis versus the simplified and conservative. The self-consistent part, I gave you some examples of how we've tried to be self-consistent.

Now the Committee pointed out an area where we were spectacularly inconsistent. The Committee said well you got all these seismic initiators, what's the seismic impact on EP? And we went oh -- oh man. What we really want to say is that's Commission policy, blah, blah, blah. But then we thought about it another 45 seconds and we concluded that if you're going to argue that we're technically consistent, you should, must consider other seismic impacts: Seismic impacts on mitigation, seismic impacts on EP. So we prevailed upon our Division of Engineering seismic specialist Jon Ake, who graciously undertook an evaluation of seismic impacts on the EP infrastructure; byways, roads, traffic signals and all that stuff. And Randy Sullivan and he are going to talk about that later on that.

MEMBER STETKAR: You are going to talk about that?

MR. TINKLER: We are going to talk about it. Simply put: You guys were right on that and we came around to right thinking on it.

Again, we have range of health effects modeling. We've moved around on this topic, but eventually we came back to where we've started in the original SECY versus we would show the results for a range of latent health effects models.

I put this in because we spent a little time on designing well what ends this scenario? In the past, the PRA have kind of just kind of said well, you know under 24 hours or 24 hours after the start of release. And actually, I've been thinking about this more lately since the deal in the Gulf Coast. You know if you've got something that's -- even if it's just trickling out a little bit, after a while people get tired of that stuff.

Now we've considered a longer accident

duration. And we actually, NSIR and us worked together to look at well how long would it take to flood the containment and fill this thing full of water and scrub fission products even if you couldn't arrest the core concrete interaction? So we tried to take another look at that issue and we have extended the accident duration to 48 hours. In the case of the Surry long-term station blackout, because it's so long, we actually extended it to 72 hours. But this is an issue of concern for the public and it's an issue for risk communication.

MEMBER STETKAR: Are you going to talk a little bit more about that bullet later or not?

MR. TINKLER: That particular one, the 48 hours? No, I really wasn't. Actually, Randy can talk about it later if --

MEMBER STETKAR: I mean, it falls into a lot of the emergency planning and offsite response stuff.

MR. TINKLER: Yes. Actually, Randy's quite well --

MR. SULLIVAN: Yes. I'd be happy to. I think I have time with you later.

MEMBER STETKAR: Okay. Good. Good. Let's do that.

MR. TINKLER: Okay. Now I'm going to address specifically -- now I've talked about a number of these issues already and, hopefully, we don't need to talk about them quite so at length. But the Committee in February of '08 issued it's a letter at an earlier review and listed a number of concerns over the use of screening criteria, the a priori CDF screening criteria can overlook many risk significance scenarios. Agreed.

Number of sequences and their aggregate contribution can increase at lower frequency. Agreed.

Does not provide a fully integrate evaluation of total risk. Agreed.

As I said before, these are basic truisms of PRA. But for the operating fleet for the scenarios that we have seen in the past we think they are really of lesser concern. And we can get the approach that we have adopted for all the reasons we discussed earlier as a workable process and is an acceptable process for focusing on risk important scenarios.

Again, I've said this, but while potential vulnerabilities have long been identified, what was really needed was a better and updated assessment, a detailed assessment of those vulnerabilities and what we believe has been lacking for some time, at least as far as the NRC is concerned. I'm not speaking about PRA all around the world and who has done them. But as far as the state of our PRA here at the NRC what's needed is better, more rigorous scrutable quantification of accident progression, source term and consequences.

In response to earlier comments by the Committee we did go back and look at the NUREG-1150 contributors to see if there was anything obvious that we missed. Marty Stutzke and the folks at DRA took a look at this. We didn't find anything with the exception of that very large seismic event that is identified on the contractor reports of NUREG-1150. And we talked to the Committee about that. We talked about how we would defer that to the seismic research plan in a future Level 3 PRA. That's just something that requires a lot of new work.

This is my own little point here that before you get too excited about claiming total risk when you're talking about ten to the minus eight and ten to the minus nine events, somebody in the public can reasonably say "Well, what about security events?" And right now we got nothing.

So claiming total risk is still a claim. So, well, this is one of the arguments well we're not perfect, but nobody else. So, it's not a great argument, but even if we did everything that you guys said, we couldn't. Somebody could say you didn't calculate all this, and I think there's some validity to that.

I do think, and maybe I overstated this a little bit, but I think the original letter from the ACRS didn't perhaps reflect the imbalance we have now between these very low internal events and the state of our external events PRA. If I do ten to the minus nine on internal events, what do I do about an external event ten to the minus nine This is a deal where the water level is dropping and some rock is sticking up out of the water, what do we do? It just in my mind just focuses that we need to do a better job on the external events, particularly the seismic. And we've been saying it.

One area that has caused a little concern is this notion about single-unit events versus dual-unit events. We were a little chagrined when we went to Peach Bottom and they said, you know we got a dual-unit floor model. And if you think you got this big earthquake, maybe it effects both units. And we went "Huh?" Maybe not all of us went huh, I went huh.

CONSULTANT KRESS: It just increases your consequences of --

MR. TINKLER: Yes. I went okay, multiple it times two. Two times a small number is still a pretty small number. But it's an area where we need to think about it a little more probably in the future.

MEMBER STETKAR: Well, you thought about it anyway from the seismic perspective. What about just a plain vanilla loss of the grid in the Northeast for quite a while? That would probably effect both of those units too, wouldn't it?

MR. TINKLER: I -- I --

MEMBER STETKAR: And I'm thinking mostly in terms of application of some of those -- you mentioned diesel-drive pumps. Well if you have one of them at the site, somebody has to decide which of the two units they're going to save?

MR. TINKLER: Right. Well, in some cases we think they could fill up one tank or be used on one. And this gets into depending on how long the event is, you can bring in other stuff offsite. Some of these long-term events you got time to get stuff there. But, it's something that I think needs to be considered a little more. Because this came up in a peer review. And a lot of the peer reviewers said, well gees, you guys, couldn't you have looked at maybe a LOCA, you know and add that to the deal? But in the case of Peach Bottom our SPAR internal event LOCAs were ten to the minus nine, two times ten to the minus nine for a medium LOCA. And now I'm back in this same situation. If I do a two times ten to the minus nine internal event LOCA, what am I going to do for an external event?

MEMBER STETKAR: If you're going to get into this later in some of Marty's discussion, maybe we can talk about it then. But what did you do about fires?

MR. TINKLER: Fires we actually --

MEMBER STETKAR: You characterized them about seismic events, but --

MR. TINKLER: Yes, we did. We did not differentiate them in analysis.

MEMBER STETKAR: I was curious only because if this is restricted to the operating fleet, right now there are people spending a lot of effort looking at probabilistic evaluations of fire under the transition to NFPA 805. And, indeed, some of those plants are making hardware modifications to their plant as a response to that because they've identified unknown large risk contributors from fires. And it's nice to say well we know we haven't quantified seismic, but in a lot of sense we can't quantified fire risk either.

MR. TINKLER: Well --

MEMBER STETKAR: And again, it's not easy to evaluate that.

MR. TINKLER: For me, you know fire/seismic, I wouldn't dispute that we could do a fire PRA, but I'm not really qualified to speak on it.

MEMBER STETKAR: Okay. Maybe when Marty comes up we can explore that a little.

MR. TINKLER: And again, we think station blackout has an appeal because it kind of simplifies things for us. It's a bounding loss-of-heat-removal transient. It's kind of hard to be worse than a short-term SBO. And that point was made by some of our PRA folks in NRO early on.

Remember, originally we didn't have a short-term SBO for Peach Bottom. And a couple of the PRA folks said "Well, you know if you put that in, you'll probably cover it for everything."

Peach Bottom -- well, I'm not worried about that. I'm sorry.

MEMBER BLEY: But you have better coverage.

MR. TINKLER: You have better coverage. But Peach Bottom, you know because they have Conowingo Dam their SBO frequencies are lower. But that may be a Peach Bottom-specific kind of thing.

So now we tried arguing that the short-term SBO would not be severe because its timing was probably still sufficiently long that EP would be effective based on our assessment of earlier and other calculations. And the Committee said "Well, that's great that you think so, but how about doing something."

So, in response to the Committee and this concern about lower frequency and the fact that we didn't have a short-term SBO, we added the short-term SBO to the Peach Bottom scenario consideration. So we do have that. It was added, and it wasn't in our originally -- it was originally in Surry because they didn't have such a low frequency for that.

CHAIRMAN SHACK: Just on this, again. You know, we haven't emphasized it so much today, but I thought in your earlier presentations we got more mileage out of this magical screening frequency because when you left the Level 1 and you went to essentially what was Level 2, you kept picking sort of the most likely event and you kind of neglected failures of subsequent failures because they would kick you below my screening frequency. And, you know I sort of thought your original argument for the human reliability analysis of the B.5.b sort of thing, okay, you know sometimes it fails but all of a sudden I'm now at a level frequency. And that one sort of worries me more than --

MR. TINKLER: Well we didn't consider the reliability of B.5.b mitigation in our scenario frequency. We did not.

CHAIRMAN SHACK: Yes, but you assumed things like that in the consequence analysis.

MR. TINKLER: We did it both ways.

CHAIRMAN SHACK: Well ---

MR. TINKLER: All these can be mitigated.

CHAIRMAN SHACK: For the B.5.b you did it both ways. For other things in that accident progression you didn't. You're working still on the most likely scenario even if the unlikely scenario could have led to much larger consequences. That was where I was concerned that you --

MR. TINKLER: We don't take credit for too much. We take credit for things like cool down of a PWR with the steam generators. And we think those are pretty straightforward kinds of thing. Now there's a probability that the operator won't cool down using the steam generators, but that --

CHAIRMAN SHACK: Well then you get into the models like hot-leg failure before certain things--

MR. TINKLER: No, we'll talk about that. And that was an area of uncertainty that we pursued with sensitivity studies for the peer review. Okay. We looked at that issue. When you do an uncertainty analysis, that's still a different path. You're still quantifying a different path for that scenario.

And you can argue that you need to then assign a distribution to that sort of thing. And I would say that falls under the general umbrella of the uncertainty analysis.

CHAIRMAN SHACK: Well, that comes back to that discussion we had earlier of just how much was going to be -- you know, I'm more comfortable than John is with stopping at the Level 1 and following forward.

MR. TINKLER: Right. But you want to see a more complete --

CHAIRMAN SHACK: I want to see a more complete thing on that --

MR. TINKLER: Going forward?

CHAIRMAN SHACK: -- going forward, just to make sure that my consequences suddenly don't glow for one of those --

MR. TINKLER: Sure. Well like I said, the peer reviewers they seized on a couple of key items pretty quickly. And because we hadn't done it, they asked for sensitivities. So we look at some of that. But in the case of the hot-leg failure, we showed that there was just almost inconceivable that you wouldn't get subsequent hot-leg failure. The damage index is screening upwards. The gas temperature of the hot-leg nozzle is 500 degrees hotter, K, than the steam generator tubing.

CHAIRMAN SHACK: Yes.

MR. TINKLER: The only reason it's closed because the hot-leg nozzle is this thick and the tube is this thick.

CHAIRMAN SHACK: But I sort of sat and watched when Majumdar moved those failure points and times around all over the place as the models for exactly what happens in the entrance to that hot-leg shifted around over time.

MR. TINKLER: Well, in terms of the ABAQUS calculations?

CHAIRMAN SHACK: Yes.

MR. TINKLER: Well, even without the ABAQUS calculations in a simpler SCADF-RELAP calculations, you know it was still -- two minutes later, three minutes later. Now in the SOARCA calculation we have some conservatism there. We failed like 15 minutes later. It doesn't -- you know.

CHAIRMAN SHACK: Yes.

MR. TINKLER: That's still more than enough to divert fission products into the containment.

And again, this is for a perfect hot-leg nozzle with no flaws, no nothing. Anything that's unflawed in the plant is the steam generator tube.

CHAIRMAN SHACK: Well, you know what concerned me when you do this sort of arguments for things like the hot-leg and the tubes, you're taking two sort of connected things and all the mistakes you make in one, sort of effect both. And it's only the relative things. Maybe when I'm looking at hot-leg versus vessel failure, I'm really talking about more independent processes and I'm worried about my ability to do absolute calculations rather than relative calculations.

MR. TINKLER: I guess I don't take issue with that.

CHAIRMAN SHACK: Okay.

MR. TINKLER: I think this is all inner connected. I don't see much independent to this thing. I think you know now you can't always see the interdependence until you do one of these calculations; that's another thing. You just can't sometimes see it. But, you know increased natural circulation through the core out into the loop, flow rates through the loop, you break a tube. Now you've increased the flow rate through the hot-leg. If you break two tubes, you increased the flow rate even more. What's the consequence of increasing the flow rate? You heat up the hot-leg even faster.

So if we break tubes, our flow rate through the hot-leg is now not at natural circulation flow rates but a delta-P driven flow rate. We have higher flow rates through the hot-leg and the hot-leg heats up faster. We saw this in the MELCOR calculations pretty clearly.

So if you're concerned about entrance effects and natural circulation and heat transfer, well if you think a tube failed; we're not driven by natural circulation flow rates anymore. Now we got a pressure driven flow. And that increased flow rate causes that hot-leg to heat up much quicker. We saw that in the MELCOR calculations and Chris Boyd saw the same thing when he repeated it in SCADF calculations. So we feel pretty confident about that.

I agree, it's a thing. But the interconnectiveness of this stuff is something that we see as a common thread through these calculations.

ACRS seismic events. ACRS said we didn't clear what was identified in NUREG-1150 with respect to something that produces an SBO, LOCA and a containment failure. Containment failures, I don't necessarily mean structural failures. It could be tearing of a penetration; that's just shorthand for release through the containment. We said that we would defer it for future evaluation. Lots of stuff that needs research. And we still think that it would require an assessment of non-nuclear risk. If it's so big that it causes a massive damage to a nuclear plant, maybe it will cause other damage and there'll be other risk to the public.

This next item that we need to more comprehensively address seismic impacts. Basically we agree, and we have done so. We've briefed the Commission TAs on this and told them about it. So this is no longer a secret and this is all part of the SOARCA analysis.

Mitigation measures. We had lots and lots of interesting discussion on this one first time through with the ACRS. We described for you the process that we took. We went to the plants early in the projects.

The plants, by the way, have been very helpful in supporting us. We try not to be too much of a burden to them. But they've been very helpful. We recently sent the reports to them. They've reviewed them, we're going through comments and stuff. But basically we had a tabletop review of the scenarios, presented the timing, we looked for when their operators would respond to different symptoms or lack of symptoms if there was a loss of instrumentation. When the TSC would be manned. When the EOF would be manned. And basically we came to the conclusion that the B.5.b measures and other measures made it such that it was likely that you wouldn't mitigate many of these events.

For most of the events you would advert core damage. In other cases you may only delay or reduce the radiation release. There's some continuing debate about that. Some people think you could advert it even in those cases where a more, perhaps, conservative approach would say you only delay or reduce it. It depended on how you think, how you feel about things like RCIC black start and black run. But we have considered at least other paths. But we think at a minimum in two cases where you couldn't advert core damage, you would at least delay it or reduce it.

CONSULTANT KRESS: But when you have something like that, Charlie, your original screening said put this sequence in there. And then you have this mitigation that says well, that gets you below your screening criteria. Well, do you have trouble now or do you get both results, or --

MR. TINKLER: We did not lower the frequency based on that assessment. We did not.

CONSULTANT KRESS: You didn't? You just left it that way.

MR. TINKLER: We just left it that way. Because then someone said well where did you dream up that number?

CONSULTANT KRESS: Yes.

MR. TINKLER: And with the HRA and without the other, you know we said we think it'll be mitigated.

CONSULTANT KRESS: So it would be useful to know what mitigation procedures would be helpful, but it's not going to change the results?

MR. TINKLER: Yes. And frankly, you know we have said this in Commission TA briefings. You could do an HRA, you can attach a number to it. If you want it to be a high reliability measure, it's within the Commission's power to make it a higher reliability measure. Depending on what you think the reliability should be.

We think it's reasonable that a system that could be implemented during a terrorist attack could be implemented during this SBO. But we've done more on this, and we're going to talk about that as soon as I get done yakking, and maybe in an hour after that. Because we went back and, frankly, went back to Peach Bottom to look at control of the RCIC turbine and things like that because we know there would be issues. And, frankly, we wanted to understand a little better some of this stuff with governor overspeed and how long it gets all that squared away with portable power supplies and things like that.

You guys have seen this kind of stuff before, but myself, you know one of the things that it's pretty apparent that the '82 Study had some conservatism. Even some of it uniquely had a pretty substantially higher cesium release than iodine, which was kind of counterintuitive, but nonetheless they're both very big. Many of the SOARCA scenarios are much later in time as well as much less severe in terms of the magnitude of release. The timing is a pretty big deal, and that was one of the things that came out of the security assessments. Because it gives you time for mitigation.

CHAIRMAN SHACK: Now in all fairness you really should 1150 results on here, too.

MR. TINKLER: I went and looked at those.

CHAIRMAN SHACK: You go back to '82.

MR. TINKLER: I went and looked at the Surry ISLOCA in NUREG-1150. And this SOARCA Surry ISLOCA is about nine percent release. The NUREG-1150 ISLOCA varies between 27 percent and 35 percent. So we're a factor of three -- four lower, something like that.

I didn't do it for all of them. I picked the biggest one off there and looked at it.

CHAIRMAN SHACK: When Hossein came up with a source term from 1150 Surry, he got 06 for Cesium, which is pretty close to your --

MR. TINKLER: Well, look, in NUREG-1150 they got whole families of source terms.

CHAIRMAN SHACK: Yes.

MR. TINKLER: But our DF, our

decontamination on the ISLOCA, a lot of it comes from the explicit modeling of the safeguards in aux buildings. Because NUREG-1150 did not have a detailed model of the safeguards in aux buildings. And I would expect it to be lower. We had a DF like five or six going through the pathway. We didn't get that much DF having to the break covered. And NUREG-1150 gave a little more credit for having the break covered.

It would be nice if you could. We didn't give that much credit for the break being covered. The updated models for pool scrubbing we couldn't get because the hydrogen release is big, it's a hot release. We didn't get that much DF in the overlying water. We got a bigger DF going through the building. I might say that NUREG-1150 might have been a little optimistic on the -- this is a case where a different path. Where does the low pressure piping break? We broke it up high in the room so that it couldn't be covered by much water. If we had broken it some other place, then we might have gotten a much lower, a much smaller release. But we didn't go out of our way in a case like well where does the pipe break, when we had those kind of considerations, in a number of cases in order to avoid some of this kind of discussion and as an expedient, we sometimes adopted "conservative assumption."

It really impressed upon us on how hard it is to do a really best estimate because there's just lots and lots of stuff. And you got to make decisions on lots and lots of places.

Anyway, I want to talk about the tables real quick here. This is our sense of the scenario-specific risk. We did not adjust those frequencies. The CDF, we didn't not adjust them for mitigation. This assumes that the probability of the key vital instrumentation is zero. Other steps the operator might have taken to open an SRV or to cool down using steam generators we did take credit for. But we did no credit for the key and vital mitigation measures that we talked about.

And on the first one, we include the short-term SBO even though it was below the ten to the minus six, it's not a bypass event. But it's a pretty early containment failure because of the liner melt-through. The condition risk was not any higher for LCF. The early failure risk was zero, 0.0000. And, you know, the point is these are all pretty low numbers and we didn't see because of the short-term SBO timing was still longer than the EP, it wasn't any worse.

There are a few more points that are available by looking at the Surry results. We got them arranged in order of decreasing CDF. Long-term SBO is minus five, short-term minus six.

For the thermally induced steam generator tube rupture variant of the short-term SBO, we assume conditional tube failure probability of .25. That's taken from NUREG-1570, some average number on NUREG-1570.

Somewhere along the line somebody said "Hey, you guys claim to be site-specific. Why don't you do a site-specific conditional tube failure probability for Surry?" And we said well, you know, we got to finish this before sometime. So that is not a site-specific conditional tube failure probability. It's a rather high one, we believe. But the ISLOCA number is our SPAR model number. The licensees actually have a higher number for the ISLOCA, but the licensees took no credit for the pipe actually remaining intact. Two check valves fail, the licensees assume the pipe fails with a probability of one. Our own SPAR model says, ah, the probability of the pipe failing is not one. I mean, it's a low pressure piping but its got extended capability.

The point we use this table to make is

that if you look at conditional risk, the conditional risk does get higher as you go down. But it gets higher less than the frequency gets lower. So even though we're dropping in frequency, our conditional risk is increasing. The increase in conditional risk is not enough to offset the decrease in frequency. So we're still in a scenario-specific basis dominated by the long-term station blackout even though it has a much lower radiological release because this frequency is higher. Part of this stems from the fact that we're showing you an LNT result, some of it stems from the fact that -- and Johnson is going to talk about this in a lot more detail -- but a lot of the latent cancer risk is attributed to the risk that people receive when they return home. It has nothing to do with their early dose. It's the long-term dose. And there some exceptions to that.

So if the risk you get is going home, it doesn't really matter how big necessarily, because that's established by the habitability criteria. You know, how much you're allowed to get. They have 500 millirem a year, or something like that. So the dose that you get is independent to a degree on the severity of the release. If you're allowed to get 500 millirem a year, you're getting 500 millirem a year whether you had a big release or a small release.

And that's something that you can only see when you do these kinds of detail scenario-specific calculations. I say that; I mean, I guess it's possible you could see it in a full blown PRA, but it sure comes out clearly when you do this kind of work. And we think that's, again, one of the assurance of it.

MEMBER RYAN: Those long frame doses during habitation covered, or were they assumed to be at the limit or are they calculated?

MR. TINKLER: They're calculated.

MEMBER RYAN: Okay.

MR. TINKLER: They're not assumed. They're calculated, whatever the dose is. But by definition it has to be something less than the habitability criteria.

Anyway, now whether or not these trends will all be so clear if you adjusted the frequency for mitigation and you adjusted this for non-LNT, that's not -- Jocelyn is going to talk about this in a lot more detail, but we did upgrade the offsite consequence amount. The beauty of MACCS is it's highly flexible, it's quick running, you can do lots of kinds of different calculations. We did try to get more detailed modeling of the plume release. Because we're concerned about the straight-line Gaussian plume, we tried breaking the plume up into many more segments so we didn't send very long plume duration segments out in a direction forever. So we tried breaking the plume up into one hour segments. We also increased the compass sectors to 64 so we could get a little more resolution. It didn't make much difference in these calculation, partly because we have very low releases. But you don't know what you're going to have when you start out, so we looked at this area.

And again, doing these kinds of calculations allows you to do more detailed analysis of the results, and we did spend some time on that. I believe personally we could do more in this area.

I'm going to get to the conclusions here. Basically we think that a lot of the scenarios could have been mitigated again, either result in a lower core damage or at a minimum delay a reduction. And even in those cases we may have averted core damage depending on the defense of the mitigation.

We think that there are a number of insights. We think that the mitigation probably needs to be assessed again simply because SOARCA even non-

B.5.b stuff, SOARCA suggests that you have more time that these events unfold more slowly. And it's not clear to us that existing Level 1 PRA have reflected the time available for the operators to take actions in some cases. This could have been the result of binning and binning again, which is at least a component of the current PRA, but we think we could take another bite out of this.

We think there is some insights on the Level 1. We think that there is an important insight on the importance of the CRD to avert core damage and at least limit release for the BWR.

The spontaneous steam generator tube rupture we found to take an incredibly long period of time and we believe that there is opportunities for mitigation on that as well and it may not be such an important contributor to CDF.

Things that in the past were considered to be very large releases like the thermally induced steam generator tube rupture and the ISLOCA are seen to be smaller releases. In the case of thermally induced steam generator tube rupture it's much smaller.

Again, for the events that proceed unmitigated, the releases are smaller, they're more delayed. And really fatality risk is essentially zero. We calculated early fatality risk for one sequence, the ISLOCA, for all the others it was absolute zero but without uncertainty.

The individual latent cancer fatality risk in a scenario-bases those numbers that you see, the ten to the minus to eleven, ten to the minus ten numbers are thousands of times lower than the NRC safety goal and millions of times lower than normal of any chance of fatality risk.

Non-LNT numbers make the risk even lower. Now that depends on the magnitude of the release. For the very small releases it gets a lot lower real quick. For the bigger releases you don't see quite as much benefit. You're going to see maybe a factor of three. But, you know if you're worried about heat transfer and fluid flow, factor of three is a big deal. So it all depends on your perspective there.

We did not see higher risk from bypass events. Again the conditional risk wasn't enough to offset the frequency. So if you look at NUREG-1150 and you look at ISLOCA it was a big part of the risk pie, in errors not so much.

Now explicit consideration of seismic impacts on EP really had no effect. Now Randy's going to talk about that and why that's true. But that's a site-specific conclusion. We do not claim in any sense to draw that generically.

Again, the dominance of external events suggests a need for PRA to focus on seismic research. And I guess it's my understanding that EPRI had a pilot program with Surry to look at that very recently. I'm joking that we scared them into it when we started SOARCA, but you know they finished before we finished SOARCA. What does that tell you?

Anyway, risk communication. We have a project underway to communicate these highly complicated issues to the general public. We're getting lots of help from folks who know what they're doing in this respect. And there will be a couple of different vehicles we'll use for this communication.

MEMBER STETKAR: Charlie, I'm honestly quite concerned about this slide. Are we going to have a chance to see that nice glossy brochure before the public sees it? "We," the ACRS?

MR. YEROKUN: I guess.

MEMBER STETKAR: Has the public seen it already?

MR. YEROKUN: I don't think they've seen it already. Again, at the end of the discussions this afternoon when I get into the conclusion perhaps we can get a little more into this. But the current plans don't include coming to the ACRS with this brochure. I mean, there's no objection to think about if we can share with you before it goes public. The plan is to have the brochure ready before we release the documents for public review and comment. And there's nothing that says, you know currently the plan does not include coming to the ACRS for review or whatever before we go public. No objections to sharing with the ACRS before we do that. But maybe we can talk some more about that what the interest and what we can do to help give you something.

MR. TINKLER: Let's go to the next slide.

We weren't planning on a separate presentation of the peer review --

MEMBER BLEY: I'm sorry.

MR. TINKLER: That's okay.

MEMBER BLEY: I'm still looking at the last slide you had up there and thinking about it.

When I read the stuff on the left side it sounds like this is about how you do risk communication. NRC already has a brochure on that, as I recall.

When I look at the picture on the right

side what you're telling us is this is going to be a brochure that uses the concepts on the left to communicate what you folks are learning in SOARCA in a brochure. Did I say that correctly?

MR. TINKLER: Yes. Yes.

MEMBER BLEY: Okay. Go ahead.

MR. TINKLER: Yes.

MEMBER BLEY: But I kind of agree with Mr. Stetkar on this one.

MR. TINKLER: We don't have a specific presentation on the peer review. I've tried to talk about comments we've received from the peer review. You've seen the draft letter reports. Like I say, a number of the comments we got on approach we've used, you've seen mirrored in peer review comments. You know, how you guys, how you justify these screening criteria, why do you think these are okay. And for some of the peer reviewers that's still an issue and you hear it reflected among some of the comments and concern about uncertainty.

I guess I think I would say that the peer reviewers were quite interested and maybe a little disappointed we didn't work further along on the uncertainty analysis. But we tried to address some of the major issues or activities. We still have a little more work to do in that respect. I guess we would expect to get some of that in the next couple of weeks or months. We've tried to address it that way.

And we have a wide range of comments. Lots of different content first on the Committee. And we're working through those comments how best to address them all in a coherent, sensible way. And I guess, like I said, we're considering perhaps revisiting some of these issues in a future activity with the peer reviewers when we get to the uncertainty study.

MEMBER BLEY: Charlie, we have as you know had a chance to look at their comments. Are there places that at this time you can say you really disagree with any particular comments and think they're not pushing in the right direction?

MR. TINKLER: Well, I mean if there's a comment that questions fundamental validity, then yes, we do take exception to that.

For the reasons we've talked about here for the last hour or so, you know we think the approach we've taken for this group of plants given what we know about these plants we think the approach we've taken is perfectly reasonable.

I'm thinking of some comments we got. I

guess I don't want to overstate it, but I got the sense from one of our peer reviewers, Bruce Mrowca, that he was really quite unhappy with our selection criteria. Thought it was without question absolutely, positively, totally without merit and completely invalidated; just about everything. I may be overstating that a little bit. But he really took strong, strong, strong exception. So, yes, I'd say I disagree with that comment. But other comments and concerns about quantifying different paths of the scenario, as I said, we see opportunities to address those kinds of comments in an uncertainty study. But if you tell me right out about all hope is lost, the project is irretrievably broken, you know, no. I'm given to hyperbole myself but that's just too much for me.

CHAIRMAN SHACK: But you're not planning to do one of these point-by-point response to the peer review?

MR. TINKLER: I liked all those comments that said we exceeded the expectations; those are my favorite. I was going to cherry-pick those, but since you guys have read it wouldn't have worked. But I liked those. And I think there was kind of a uniform agreement that the accident progression modeling was good stuff. I think it's hard to miss that in it.

And actually, one of my favorites was Mr. O'Kula's comment that SOARCA's better than a PRA. But, you know, I don't want to argue that one all over again, so --

CHAIRMAN SHACK: You do, but you're not going to do it?

MR. TINKLER: I do, but I'll stop. Since I claimed it to everybody, I'll stop.

MEMBER BLEY: In the beginning I heard you say there were a few things you deferred to a Level 3 PRA, I believe.

MR. TINKLER: Yes. Absolutely. Absolutely. No, no. We joke about this, but look, we understand there are rules for different things. Again, we think there are certain insights based on the way the NRC does PRA today that can only be revealed by doing what we did here.

CHAIRMAN SHACK: Coming back again, you're not going to do a point-by-point response?

MR. TINKLER: I didn't say that. Okay. We're going to walk through all those comments and we're going to decide how to disposition, I believe, all those comments.

CHAIRMAN SHACK: Okay. So there will be a document with the comments and your disposition?

MR. TINKLER: I'm going to look for guidance on that.

MR. YEROKUN: What we provided you were draft peer review reports. We're still working with the peer reviews to get final reports. When we have the final reports to the extent that we need to document responses to questions, comments that may arise from those and then we will work through that. At this point, you know whether it's by letter or whatever, it's not something that we've laid out completely yet. By the time we come back in October, or even before then, you know as to how we're going to address all their comments, your comments from these meetings, public comments, all that will be clearly laid out and understanding by the ACRS.

CHAIRMAN SHACK: Okay. As not totally unexpected, we're a little behind schedule. I suggest instead of moving on to Marty that we take a 15 break.

Thank you very much.

(Whereupon, at 10:09 a.m. off the record until 10:23 a.m.)

CHAIRMAN SHACK: Okay. Marty, scenario selection.

MR. STUTZKE: So I'm Marty Stutzke from

the Division of Risk Analysis from the Office of Research. And I'll highlight some of the issues involved with the scenario selection a little bit. Talk about some general consideration, the selection process itself, the results that were obtained. We'll touch briefly on the scenarios that were not in the scope of the project. Some of the relevant peer review comments, which hopefully I've not cherry-picked. And the conclusions of the result.

By way of preference, I wasn't directly involved in the scenario selection. But that's not necessarily a disclaimer

MEMBER STETKAR: Make sure the reporter has that very clear on the record.

MR. STUTZKE: It was done by Rick Cerry and Chris Hunter of our staff. Then at that time I had been and came from the Office of New Reactors to the Office of Research and one of the first jobs was, gee, Marty, go take a look through 1150 and see what they missed. And so that was my introduction to the project.

One of the things I think you need to remember with SOARCA, and I used to have this note on top of my mirror that every time I'd brush my teeth I'd look at it. It said: There's No P SOARCA." It's not a PRA. It's not a PRA. It a consequence analysis. So the more elegant language that I actually stole from the peer review it says: It doesn't purport to be a Level 3 PRA. I liked that.

So there was a necessity to select some scenarios and the approach was to look at the likelihood and the consequences. You know, from a practical standpoint you can't do all of them in this cycle or study. So an effort was made to look at them based on core damage frequency, mainly because that was the information that was most readily available like this; SPAR models, licensees' PRAs, things like that. There is a lack in general of detailed Level 2 PRA information to guide that along.

So then we come to the must debated selection criteria of CDF above ten to the minus six per reactor year for the bypass sequence going down to minus seven per reactor year. That's going to show you the consideration not just for the frequency but of the consequence as well because bypasses have historically been important to risk like this.

It also should be realized a lot of qualitative insights, a lot of engineering judgment, if you were, was applied to the scenario selection process.

So this flow diagram gives you a rough idea of how it was done. We have results from the SPAR models, from the licensees' PRA and their PRAs are advanced studies like NUREG-1550, sequences were identified and then there was some combining going on like that. And then the screening criteria were applied. That tends to be done more on a consideration of the internal events because the frequencies are better known.

Once that's done, then you use the results of the Level 1 sequences to infer the status of the containment systems. And as Charlie pointed out, when you talk about a station blackout you know that things in the containment aren't working as well like containment heat removal, containment sprays and things like that. And so those define the specific scenarios that were then submitted into MELCOR thermal hydraulics like that.

Okay. So the scenarios that were identified are the spontaneous steam generator tube rupture at about a five minus seven or so coming in. These were al operator errors that are leading to the scenario; failure to isolate, failure to depressurize and cool down and failure to refill the RWST, like that.

Next is the interfacing systems LOCA from the low pressure injection system. Failure of both inboard isolation check valves. Then another operator error, failure to refill RWST.

Two seismic initiated events. The long-term station blackout and the short-term. And the differences are long-term means loss of battery due to depletion, just running out of it whereas in the short-term DC power is assumed to be failed right at the time of zero plus.

Now John had asked earlier where do you get the fire sequences on here. And the notion here first was when you talk about a seismic events, it's presumed that all the seismic failures at times zero. So that's the most dramatic with respect to the consequence modeling. You don't have something that fails to run or operate for some time period and then turns itself off like that, although you do pick up that effect between the short-term versus the long-term blackout like that.

So with respect to the fire you get the same sort of, broadly considering, accident progression when you just assume everything fails off at the time zero. The problem with that is then you begin to question the adequacy of the frequencies in here like this. And it's clear that these are -- probably the frequency estimates are low.

MEMBER STETKAR: I'm glad you mentioned that because that was one. The other is that these are what I would characterize as clean seismic analyses in the sense that the seismic event breaks something such that it doesn't work. The problem, as we know, with a lot of the fire analyses is that fires are pretty intelligent in the way that they don't break things nicely.

MR. STUTZKE: Yes.

MEMBER STETKAR: They cause spurious actuations such that the scenario that's presented to the operators in terms of mitigating options and timing and things can be difficult.

MR. STUTZKE: Right.

MEMBER STETKAR: Compared to a more clean characterization of it.

MR. STUTZKE: Yes, that's true. But in fires things are working that maybe you don't want to be working.

MEMBER STETKAR: That's exactly right. So that not only do these frequencies capture the frequencies of what's called clean fire events, does the plant response adequately cover some of the more troublesome types of spurious actuations and things that people have to deal with.

MR. STUTZKE: Right. The other thing I would point out is this scenario occurred several years ago and we have learned a lot about fire risk assessments and how to them or how not to do them in the implementation of NFPA 805.

With respect to the Peach Bottom scenarios, again you have the two seismic long-term and short-term station blackouts like this. Charlie had mentioned before we originally had from the only internal event sequence loss of AC Bus E-12. So it's like a loss of one division permanent blackout sort of scenario. And it was screened in, but when we got looking at the results of the SPAR model to the license's PRA we realized that there was an error in the SPAR model and so the frequency got lowered down. Meanwhile, the MELCOR guys had already gone off and calculated it and said, gee you know it doesn't even look like it wants to go to core damage on us like this. But the scenario is in fact retained. It's also in the report where they talk about these sorts of results like this.

But I think the whole exercise points to something that Charlie had said, is that sometimes we've done things in PRA, you know piecemeal fashion rather than an integrated type of analysis like this.

Most of the PRAs I know in Level 2 they have the mysterious plant damage state labeled no core damage. It's in 1150. Where based on the simplified assumptions or whatever that were used in the Level 1 PRAs the scenario was assumed to go to core damage. When they actually ran the real thermal hydraulic model they didn't get there. And so these things tend to be binned off; this is what I call the Level 2 garbage can. It's like, yes, okay so we didn't quite get it right in the Level 1 space like that.

And one of the things I've learned in being associated with the project is maybe we need to do things in a more integrated fashion rather than our back of the envelope calculations for success criteria in Level 1 with a few RELAP runs and things like that as opposed to that.

So anyway, you'll see Bus E-12 is actually in the analysis

MEMBER STETKAR: Marty, don't jump quite yet because this will be relevant later on. All that seismic stuff, so I went back and I looked at the -- if you'd flip back up to the Surry slide --

MR. STUTZKE: Yes.

MEMBER STETKAR: You look at the two, the short-term and the long-term seismic events at point three to point five pga and point five to one pga acceleration. So I dutifully went to the USGS seismic hazard maps. And for Surry those numbers look, you know fairly reasonable compared to the mean peak ground accelerations in USGS. If you believe they're means. Now, USGS doesn't do an uncertainty analysis either, but its at least a benchmark.

If you go to Peach Bottom I was surprised that the USGS maps show that the seismic hazard at Peach Bottom is, indeed, somewhat higher than Surry.

MR. STUTZKE: Yes.

MEMBER STETKAR: By about a factor of three. And I was curious if you come now to the Peach Bottom scenarios why are we talking about ten to the minus seven type frequencies for the point five to one pga range when the USGS gives me frequencies in that range that go from about eight times ten to the minus six to about three times ten to the minus five, or sort of lie an order to an order and a half of magnitude higher than these numbers?

MR. STUTZKE: Right. Yes. These frequencies, I believe, are the old EPRI SOG data, the seismic data.

To more broadly answer your question we have another generic issue, No. 199 that is looking at the influence or the impact of increased seismic hazard estimates throughout the central and eastern U.S.

MEMBER STETKAR: Well, but we're publishing this NUREG as the state-of-the-art for these specific sequences today in 2010.

MEMBER BLEY: And in the areas where we could make things look better, we worked hard at it.

MR. STUTZKE: Yes, I see your point.

MEMBER STETKAR: Okay. Thanks.

By the way, we'll be back in front of the Committee I imagine by the summer to talk about 199 and its ramification, like that.

The other thing I would caution you is when you use USGS remember it's a hard rock spectrum, it's not adjusted for --

MEMBER STETKAR: I'm not trying to fine tune it down to even too significant figures. It's just.

MR. STUTZKE: Right.

MEMBER STETKAR: I was just curious that for Surry if I looked at it, the numbers were reasonably consistent.

MR. STUTZKE: That's right.

MEMBER STETKAR: But for kind of a sanity check, I think.

For Peach Bottom they're not.

MR. STUTZKE: That's right. Yes. And you see--

MEMBER STETKAR: And they're substantially not is the problem.

MR. STUTZKE: That's right.

MEMBER STETKAR: I'm talking about factors of two here.

MR. STUTZKE: And you see some parts of the country have what I'll call a notable increase in the seismic hazard based on USGS than what we thought about in terms of the IPEEE days.

MEMBER STETKAR: I was just curious where those numbers came from because they were pretty small?

MR. STUTZKE: Yes. These are EPRI SOG data.

And the other issue that it raised was so called extreme seismic event above 1 g or so that's the third bullet on the slide. The actual EPRI SOG curve just ends at 1 g. Boom, like this, whereas the USGS goes out.

MEMBER STETKAR: Yes, they go out to 2 g or so, little I've seen.

MR. STUTZKE: 10 g.

MEMBER STETKAR: The ones on the public website are only up to about 2.1 or so.

MR. STUTZKE: Yes. The model can extrapolate wherever you want to go to, things like that.

But in general there are scenarios that were not in scope. This is one of the peer review comments and so we've tried to amass them and put them together in one part of it. This notion of multi-unit accidents. And I appreciate your comment. Everybody thinks about multi-unit accidents as the big killer earthquake like in Japan. What about the loss of grid, things like that? They can still be internally initiated like this.

In fact, this issue was referred to the Generic Issues Program. It was accepted. We're in the process of doing the screening analysis to decide what to do. There's a practical nature here because I'm busy with SOARCA and GSI-199. I don't have time to do multi-unit risk. So it's kind of been pending.

And then we'll talk about our aspirations for a new Level 3 site PRA.

Tom, I thought you'd cheer on that one.

CONSULTANT KRESS: You know me well.

MR. STUTZKE: Of course, we're not treating shutdown and low-power accidents. The focus has been on historical sorts of scenarios, i.e., full-power types of scenarios like this.

We have some limited SPAR models for shutdown and low-power states, but to be quite frank they're pretty limited as to their ability.

MEMBER STETKAR: Marty, as you know well in shutdown states the operators tend to be more important so there's broader uncertainly and much more reliance on the front end, the Level 1 part on the operators. And in many cases the containment is not isolated so that the containment mitigation features essentially aren't there.

Is there much of a concern among the SOARCA team about just simply screening out those as de facto low risk contributors?

MR. STUTZKE: I don't think --

MEMBER STETKAR: I mean, I see the bullet there, but I'm trying to get your sense.

MR. STUTZKE: Yes. You know, from my perspective quite a lot of water has gone under the bridge here like that. I'd point out a couple of things.

One is we don't really know a lot about the risk at shutdown and low-power based on our SPAR models. So we have limited things.

And it's true, there are cases where the containment is unisolated like this, but over a fractional time period that doesn't happen too awful. You know, so you need some sort of a weighing about plant availability and things like this to try to get at it.

The other comment, the thing that's always bothered me is whenever I look at shutdown and low-power PRAs and we all remember when the first round came out and they said, gee-wiz, the risk at shutdown was as much as it was at power. And my first inclination is that our tech specs may be wrong, you know, because we're driving people to shut plants down and we get in trouble. It seems amiss here.

MEMBER STETKAR: Well, but because of some of that people have started to pay attention to availability of stuff during shutdown in the tech specs that we didn't use to also.

MR. STUTZKE: Right.

MEMBER BLEY: It was written procedures, and those earliest studies showing it was coming from uncertainty, which to a great extent has been addressed.

MR. STUTZKE: Okay. As far as the large seismic event, the one thing Charlie had alluded to is we have a MOU, memorandum of understanding, with EPRI on PRA issues, one of them and including the seismic issues. As part of that there was an addendum issued to help us with Generic Issue 199. And the follow on to that was I got invited to go look at this new EPRI pilot seismic PRA for Surry.

Now the purpose of that pilot seismic PRA was to smoke test the standard. So its not considered a complete seismic PRA. They were trying to go down item-by-item, requirement-by-requirement for the standard to see if they understood what it was telling them to do. But one of the things I noted when I was ~~our~~ out in Palo Alto, it's been about four weeks, was that I saw that they had assessed the classic NUREG 1150 scenario where the steam generator supports fail, the steam generator collapses and its rips the steam piping out of the penetration like this. And so I did some back of the envelope calculations and I came out with this ten to the minus eight number for that type of sequence. That's much lower than it was in 1150, mainly because the fragility of the supports is considered to be higher.

As a follow-up to John's earlier question is they have their own seismic hazard curve that EPRI has developed and it meets Regulatory Guide 1.208. It's not exactly the USGS at the low gs because they use the cumulative absolutely velocity filter. But when you look at the behavior at 1 g, I mean the curves lay on top of each other for all practical purposes like that.

Of course, their pilot PRA was only Surry. So I don't have anything to ell you about Peach Bottom

One of the reviewers, Dr. Stephenson, had worried about the soil liquefaction at the Surry site like this. The notion is the soil liquifies and you get a differential movement between the reactor building and the other buildings and suddenly your containment is unisolated, all the penetrations shear off or at least a large about of them, like that. And he's got some comments there that, yes, we probably should have looked at that.

MEMBER STETKAR: It might be tough to pump water back in there, too.

MR. STUTZKE: Yes. Yes. I mean, it's more than electrical. But it could be pipes and things like that.

Interestingly enough, this EPRI pilot dismissed liquefaction at the site and they quoted Generic Letter 88-20 and said we didn't have to do it. So, you know that's a case where they didn't do something the standard was pretty clear about doing and it's kind of unsettling in that way.

MEMBER STETKAR: I bet you rehearsed for hours last night, didn't you?

MR. STUTZKE: Okay. No spent fuel pool accidents yet. We have the infamous NUREG-1738 that was a decommissioning study that indicated spent fuel pool risk small but it could have large consequences. The idea was that fuel seemed to want to spontaneously ignite itself and things like that. Work since that time indicates the risk is probably even smaller.

MEMBER BLEY: Is that the Brookhaven study, do you remember?

MR. STUTZKE: I don't remember.

MEMBER BLEY: That's the one I remember.

DESIGNATED FEDERAL OFFICIAL NOURBAKHSH: One was by Brookhaven. But Idaho did some studies, too.

MEMBER BLEY: Okay.

MR. STUTZKE: Security events. You know, part of the motivation for SOARCA was the previous security assessments, as Charlie said, they were getting results that were much lower than were expected in 1150. The Commission has told us don't go there in SOARCA. That'll be its own sort of study like that.

Okay. And so briefly, and again I tried to be a little bit objective about this from the peer reviewers. What did they say about our scenario selection process?

Well, four reviewers said they thought the scenario selection process and its results supported the objectives of the project. One of them, as Charlie indicated, didn't agree with that and nobody else said anything.

MEMBER BLEY: Only one?

MR. STUTZKE: Only one. And everybody else was silent.

CONSULTANT KRESS: How many reviewers were there?

MR. STUTZKE: Eleven.

MR. YEROKUN: Eleven.

MEMBER STETKAR: How many Level 1 reviewers were there?

MR. STUTZKE: Two. Two.

MEMBER STETKAR: Two.

MR. STUTZKE: Well, two assigned but, of course, the reviewers like the Committee feels the right to comment on almost anything, like that. So I mean take it like that.

The other thing, and remember I used to have a big note on the page is that the peer review is not a consensus among the peer reviewers. It's that each individual reviewer wrote what they had to say, like that.

One of the reviewers who was one of the Level 1 experts actually looked through other PRAs to see if we had missed anything. And, again, they identified this large seismic event. It's the same thing that I had identified when I started going through NUREG-1150, which Dr. Nourbakhsh had already pointed out, so it was pretty easy to find.

The comment again about seismically induced soil liquefaction that we were amiss.

The comment from one of the reviewers, I believe it was Dr. Gabor there, about taking care in communicating the results of SOARCA in the context of the risk because it's not complete. And I think that's well stated. You know, again SOARCA is not a

PRA but it does speak to some of the risks, some of the consequences of accidents.

Last but not least, that there were five reviewers that somewhat or indirectly support the development of a new set of Level 3 PRAs like this, and they gave various reasons for why this would be beneficial.

This notion, again, of completeness when you're picking sequences in SOARCA there's always this issue of what about this sequence or that sequence. And they thought it could be beneficial to demonstrate in fact we have captured this.

Some reviewers thought that it would be useful to better characterize the results or communicate the risk to plants.

And some thought it would be useful for confirmatory purposes, which I find is turning it around. If you had a Level 3, you would identify all the risk and hence then you would have some measure of completeness and then you would go off and drill in with the SOARCA approach. This last sub-bullet is saying do SOARCA and then the Level 3 and confirm your wisdom.

MEMBER BLEY: Well, speaking of that from all you and Charlie have said today, are you going to talk more about the coming Level 3 PRAs?

MR. STUTZKE: Did you read these last night?

MEMBER BLEY: Yes. When you do --

MR. STUTZKE: Yes.

MEMBER BLEY: I don't know the status of that. Is there a project plan already out? Is there an intention to try to better link in an integrated way the Level 1 and the Level 2 parts of the PRA than maybe was done for 1150?

MR. STUTZKE: Simply put no and yes. But let me say.

MEMBER BLEY: I think I got that.

MR. STUTZKE: As you know, and I've mentioned it and you've heard it through the grapevine, we are in the process of planning a new Level 3 PRA. It came out from when the Office of Research presented in front of the Commission about our Research plans back in February. The Commission wrote us an SRM; there's the detail so you can see what they told us to go do. And the Commission expressed a conditional report for developing this type of project. They said come back with a list of options and what you ant to do with it. And, of course, money is going to be a big deal given our flatline budget situation that we find ourselves in.

So we are vigorously writing this letter. The SECY paper is due to the Commission in the end of January that will have various options like this. We've already had a pretty healthy internal stakeholders meeting on this. We had like 30 or 40 people that were risk experts within the agency show up, and they gave us all their feedback like this. I've got like seven working groups for various aspects like how are we going to do a new Level 2 PRA, how are we going to ensure that its fully integrated with the Level 1 without breaking the bank, like this? What can we do with HRA in the post-core damage regime? It's not really been looked at too much, and to surprise it's not really in the current Research agenda. So we're cranking Erasmia Lois and Susan Cooper and company to try to give us some feedback on things like that.

One of the other parts of the project that's been my sense of frustration, I guess born out of reviewing 1150, and it's what I'll call the solution is 21st century PRA documentation. No more 100 megabyte, monolithic PDF files for Marty to pore through late at night which try to get something that you can search and sort, and reproduce the answers;

traceable, scrutable, this sort of thing. That by itself is a nontrivial exercise, especially when the analysis is dynamic like this.

The other thing to point out is the general scope of this now is a site-wide. So we would pick up the multi-unit aspects. That also implies we would look at the spent fuel storage, fuel pools as well as dry cask storage. We might look at other sources of radioactivity on the site as well, some leaks and things. Right now everything's on the table and the scope is just enormous. Realizing that cuts will have to be made, that the goal is to be able to springboard off of some of the SOARCA insights. You know we have a great set of thermal hydraulic tools now that we never had before. So part of this, the place into which cycle would you pick?

MEMBER BLEY: Well one area that Charlie talked about was in the seismic PRA part of it, he was talking about consideration of the breadth of seismic impacts on the community associated from which you're going to try to do emergency response, and like. Is that on the table, or nothing's off the table yet?

MR. STUTZKE: It's been discussed.

MEMBER BLEY: Yes.

MR. STUTZKE: Because I have a problem

with what are you computing versus what are you going to use to base policy on like this.

MEMBER BLEY: Yes.

MR. STUTZKE: I mean, one of the issues that was identified in 1150, you know they actually did Level 3 seismic stuff in the NUREG/CRs that wasn't reported in NUREG-1160.

MEMBER BLEY: Yes.

MR. STUTZKE: In fact, there's a page that says well we really need to look at, to have a fair comparison, we ought to think about comparing to the other fatalities that would be created by earthquake and not just general accident fatality. And that's not--

MEMBER BLEY: That's actually a first, because that's pretty dicey.

MR. STUTZKE: Yes, I mean that's --

MEMBER BLEY: But impacts on infrastructure and that sort of thing is less controversial, I suppose?

MR. STUTZKE: Right. And I mean you'll hear later today where they've tried to look at the influence on evacuation because certain bridges have collapsed and things like that. You know, what has been done here for SOARCA I think is scratching the surface and it points just to the broad need to try to get after this sort of thing. Because it's more than bridge collapse. You know, there's all sorts of building collapses and how do people even know they're supposed to leave and things like this that need to get rolled into this.

So, right now, I guess to summarize, everything's on the table for this new Level 3. We expect to start our concurrence in about six weeks or so. So sometime in early August we'll start vetting this through the management at NRC. We'll have a public stakeholders meeting to get some feedback. And then we got to come to you guys. All ears.

MEMBER BLEY: It's going to be fun.

MR. STUTZKE: But sincerely, you know there's a lot of good things that came out of SOARCA that are going to be beneficial to us to plan this type of project. And maybe we can get at whether LERF is truly a site metric or not.

MEMBER ARMIJO: Marty, could you go back to Slide 8, your first bullet?

MR. STUTZKE: Yes.

MEMBER ARMIJO: The one reviewer that didn't agree with your scenario selection, did he propose different scenarios or did he disagree with the process you used to select scenarios, or what?

MR. STUTZKE: My belief is it's a general discomfort with the lack of a Level 3, the systematic screening of it.

MEMBER ARMIJO: Okay.

MEMBER BLEY: Anything else?

CONSULTANT KRESS: You are not constrained, I have to agree with all the peer reviewers.

MR. STUTZKE: No.

CHAIRMAN SHACK: Okay. If there are no further questions, we're going to have a slight change in scheduling. We're going to go to essentially emergency preparedness presentation at the moment just to accommodate an individual's schedule.

MR. SULLIVAN: Thank you.

Thanks for your time. Looking forward to presenting the seismic analysis that we did for emergency preparedness.

And thanks for accommodating my personal schedule. I appreciate it.

So, we have not considered the damage in the county due to this earthquake when we did the baseline SOARCA runs. The fact that we don't know the damage in the county, things like rivers between the plants and the rest of the county. We don't necessarily know all that we would need to know to see what the county looks like, but we made some basic assumptions that we thought were representative. And I'm going to walk you through those. But I want to lay a little bit of ground work first.

We've done a public survey of the population living within EPZs, and this is a rather well educated population. You would be surprised at the level -- well, maybe you wouldn't be surprised. I was not, but I'm not sure it's widespread knowledge that the level of emergency preparedness among this group is higher than you might find in the general public. I understand people on the Gulf Coast know about hurricanes and there's quite an education process there. But there's been a 30 year education process for the people around nuclear power plants.

The reason I'm going through this is because if there's a serious earthquake, these folks know they live in an EPZ. So one of the assumptions we made is that the shadow evacuation will be half again as large as our normal assumptions. So rather than 20 percent shadow evacuation we thought there'd be a 30 percent evacuation. Now that is an evacuation that takes place without the people being asked to leave. So this is a mitigating factor in our case.

Now, I mean, I'm going to go through a bunch of other assumptions.

The sirens at Peach Bottom about one-third battery backup. We didn't know that until the other day, so we assumed that they were not battery backup and they would not sound.

We're assuming that the whole EPZ loses power. We have no reason to know that, but we thought that would be a sensitivity analysis, you know a test case. So if the sirens don't work because there's no electricity to them, route alerting would work but it would be delayed.

You understand that these emergency planning zones have a detailed plan for route alerting. And that involves police cars with speakers and fire trucks, and all that kind of stuff. And although those folks would be busy due to the earthquake and other needs, route alerting would get done.

MEMBER STETKAR: Randy, how do you know that? I mean, your analysis says it will be done because we're doing a nuclear risk assessment and therefore we now have the full benefit of all of those folks because they know that we're doing a nuclear risk assessment.

If you have schools and hospitals destroyed, and Lord knows what's going on else, how do the emergency planning people decide that they want to support our nuclear risk assessment?

MR. SULLIVAN: Actually, we don't have schools and hospitals destroyed. Our assessment was that we'd use long span bridges and we'd have liquefaction under certain vulnerable hunks of road and we'd lose the electrical system.

MEMBER STETKAR: In a 1 g earthquake?

MR. SULLIVAN: Well, 1 g or less, yes. So we deferred if buildings are crumbled and folks are trapped. And by the way, stick buildings you know, I guess I'm told by the seismic people, do pretty well. So if you're looking for widespread county disaster, that's a different study and that's the study we're pursuing. But if we go down that path, then you also have to look at who is killing the people; the radiologic release or the earthquake?

MEMBER STETKAR: I'm not trying to tread in that area. I'm trying to tread in the uncertainties about the effectiveness of the offsite emergency response folks. You have assumed that they are perfectly effective with perhaps some --

MR. SULLIVAN: Well, I don't say they were perfectly effective.

MEMBER STETKAR: -- time delays.

MR. SULLIVAN: No, it's not a small time delay. You know, we assumed three hours rather than--

MEMBER STETKAR: How about two days?

MR. SULLIVAN: Well, what about the 45 minutes that they're rigged for right now? They're rigged for 45 minutes right now according to their plan. Two days --

MEMBER STETKAR: Under things where they know that the problem is inside that nuclear facility out there and the sun is shining on my head and nothing else is going on. It's a beautiful day in the neighborhood except for the fact that there's a problem with the nuclear plant, and under those presumptions they're mobilized within 45 minutes.

MEMBER ARMIJO: I see it as an issue of prioritization.

MR. SULLIVAN: Exactly.

MEMBER ARMIJO: And do the police and the fire and all these other people, will they automatically put priority on the nuclear emergency planning or will they put priority on a school bus that's had problems or a hospital that's out of power, or --

MEMBER BLEY: Let me ask it a different way because I'm not familiar with this area, but these emergency plans are local or state, anyway they're not NRC plans. Do the plans where you are looking, are they written for combined events such as a seismic event that would effect the nuclear plant?

MR. SULLIVAN: In general they're all hazard plans and they've been inspected by FEMA for 30 years.

I'd also like to give you another data point.

MEMBER BLEY: That was pretty glib, and I've heard a lot of discussions of places where NRC has had some trouble with local areas not putting together emergency plan to their liking. So the idea that for 30 years these have been nearly perfect strikes me as a very glib statement.

MR. SULLIVAN: I'm sorry. I didn't say perfect. And 30 years --

MEMBER BLEY: So they've been there for 30 years and fully inspected by FEMA?

MR. SULLIVAN: By FEMA, yes.

MEMBER BLEY: So they're good?

MR. SULLIVAN: Well, yes. I didn't say

perfect. They're good, yes.

MEMBER BLEY: Okay. And you've looked at the ones for where you're trying to do this analysis?

MR. SULLIVAN: Yes. Yes.

MEMBER BLEY: Okay. Because that's the one I was asking about, not some general statement.

MR. SULLIVAN: They've been inspected for 30 years since the TMI --

MEMBER BLEY: And you've looked through them as you do this analysis?

MR. SULLIVAN: We pulled information out of them, yes, for this study. I'm sorry. I mean FEMA takes their work seriously.

MEMBER BLEY: I'm sure they do, but I wanted to understand rather than saying FEMA's been doing it for 30 years, you actually looked at the plans and it's your examination of the plan that's the basis for what you're telling us about, or is it an assumption about what FEMA would have built into the plans that are locally developed?

MR. SULLIVAN: Yes, we used information from the plans to do our assessment.

MEMBER BLEY: That's good.

MR. SULLIVAN: However, I'd like to give you a data point.

MEMBER BLEY: Okay.

MR. SULLIVAN: The whole rest of the country --

MEMBER BLEY: Yes.

MR. SULLIVAN: -- uses router loading, we have siren systems. So we studied a couple hundred evacuations, you know nationwide.

MEMBER BLEY: Yes.

MR. SULLIVAN: More than a 1,000 people, more than a building and those evacuations generally are done with route alerting. So this is not an unfamiliar process for police and fire.

Now, it wouldn't be as smooth as without damaged infrastructure; that's clear. But it would happen and we believe that the compensating factor is the larger shadow evacuation.

Now, we would expect them to prioritize. I don't want to drag you through a nightmare of details, but when we did SOARCA we had to model a 360 degree evacuation because MACCS uses variable wind directions. This was tough to get my head around. But MACCS will take 200 weather cases, or is it 600 weather cases. So I couldn't do 600 evacuation plans, right?

MEMBER BLEY: Okay.

MR. SULLIVAN: I had to just evacuate zero 360, time it and go with it.

Well, in the real case in the accident that we're talking about the wind's only blowing in a direction or two. Now I understand wind direction changes, but those resources don't have to be brought to bear you know ten mile 360. They have to be brought to bear downwind, and we would expect the locals to prioritize as best they can.

And further, this is not an East Coast disaster, this is a county disaster. They have mutual aid agreements with neighboring counties. I would expect there'd be within a few hours -- you know this is ad hoc now. I'm taking you into ad hoc space. But I would expect there would be hundreds of police cars available if you wanted them.

So, I mean I'm confident in what we're saying not because it's all captured in the FEMA approved plan, but because of the ad hoc nature of emergency response in America. So I don't mean to be glib, but I believe this will be covered especially if we're looking at downwind sectors in the time frames that we're talking about.

MEMBER ABDEL-KHALIK: Now the assumptions of 30 percent versus 20 percent shadow evacuation --

MR. SULLIVAN: Right.

MEMBER ABDEL-KHALIK: -- what's the basis for that?

MR. SULLIVAN: Yes. Let me give you the basis for 20 percent first.

MEMBER ABDEL-KHALIK: Okay.

MR. SULLIVAN: Historically we'd use 10 percent. And when we did our public survey -- and the public survey is not the God's only truth. A public survey is a view of opinions and tendencies at the time they pick up the phone. But it's the only data point we have.

We had 14 percent of the people we surveyed said they'd been in an evacuation. And when we parsed that number, we found that something like 23 percent of them evacuated when they didn't need to, which we found very interesting. So we thought a better number for our shadow evaluation of 20 percent. We simply increased that 50 percent due to the earthquake. I don't---

MEMBER ABDEL-KHALIK: What's the basis?

MR. SULLIVAN: Judgment is the only basis.

MEMBER ABDEL-KHALIK: I mean, this is presumably the number of people who would evacuate between the time they sense a seismic event --

MR. SULLIVAN: And they would sense --

MEMBER ABDEL-KHALIK: -- and the time that there are instructions out there that tell them to evacuate, is that correct?

MR. SULLIVAN: Yes. The instructions would be out there, you know we believe, fairly quickly. You know, within an hour or so. And they don't have radio in their house, but they do have radio in their cars, right? Of if they have NOAA radios in their house, then they would have it. You know, the battery supplied radios.

And by the way, the phone system generally works, right?

MEMBER ABDEL-KHALIK: But does that take into account the fact that these people may not be able to physically evacuate during that short time period?

MR. SULLIVAN: You mean due to?

MEMBER ABDEL-KHALIK: Due to damage produced by the seismic event in the short term?

MR. SULLIVAN: Yes. You mean like the garage has collapsed?

MEMBER ABDEL-KHALIK: Whatever.

MR. SULLIVAN: The damage we've assessed is more road damage. We think stick houses would generally survive in this level of earthquake. And also in our evacuation model we have two things going on. We have school evacuation is a different cohort and they have different timing. And then we have something we call the evacuation tail. And that's the last ten percent of the people who may take much longer.

MEMBER ABDEL-KHALIK: If the big picture aim of this activity is to come up with sort of believable results, it would seem like any assumptions that move you in the direction of producing better results would have to be thought out very carefully. And this doesn't seem to be the case here.

MR. SULLIVAN: What would you suggest?

MEMBER ABDEL-KHALIK: I would keep it at whatever the normal value you assume, which you have presumably defended in the past.

MR. SULLIVAN: Some data, yes.

MEMBER ABDEL-KHALIK: Rather than moving it in the direction that would give you better answers.

MEMBER STETKAR: Or, Said, do an uncertainty analysis. Assign probabilities to a range of possible values with justification for those probabilities. You know, the basis for what's your assigned likelihood it would be 30 percent, 20 percent, 2 percent, 50 percent. Now that's the essence of trying to propagate the uncertainties that we were talking about earlier.

MEMBER CORRADINI: Since I'm late, maybe I'm not allowed to ask questions.

CHAIRMAN SHACK: You're allowed to ask question.

MEMBER CORRADINI: So what level of earthquake is this in relation to some natural disasters that I thought before that we've had and they are seismic? That is the one in '89 in San Francisco, the Kobe earthquake. The one where the power plants were recently in Japan.

What I'm looking for is some analog to an example already occurring where there was a facility, not necessarily a nuclear facility, that required regimented evacuation on top of an evacuation due to earthquake. Is there some sort of examples historically that you guys have looked at?

MR. SULLIVAN: Jon Ake is with us, who knows more about this then certainly me.

MR. AKE: Hi. Jon Ake, Office of Research seismologist.

The scenario cases we were looking at here in general are moderate magnitude events, in this case approximately maybe perhaps magnitude 6 to 6.5, 6.6 at relatively close. And really the only change, the magnitude of the earthquake isn't really changing as we move from annual probabilities of ten to the minus four to minus five, minus six. Really what's happening is the likelihood that the earthquake is a little bit closer is increasing.

And in terms of sort of predicted average ground motions, we're moving from sort of a ten to the minus four for a magnitude six and a quarter event, sort of average ground motions to as we move down to ten to the minus five or ten to the minus six we're having an increasingly bad day in terms of predicted ground motions. In other words, we're seeing plus 1 standard deviations --

MEMBER CORRADINI: Right. But the reason I'm asking my question is I think I was at the Subcommittee meeting where a few of us were at that developed where you had your slide that you said -- the ACRS was asking about modeling. I think, at least as I remember from the Committee standpoint, the concern was there was an overlap in some way that there would be confusion. Okay. And I guess I'm asking pragmatically historically did you look at industrial facilities in earthquake zones with these sorts of earthquake sizes to see if there was either no confusion or confusion or a planned evacuation?

What I'm looking for is data, real data from earthquakes in the past if there was some request for an evacuation, as you said, because you called it -- I don't know what you called it. A shadow evacuation, I don't remember the words you used. But that it is as you said, that your judgment is that it didn't seem to happen or it was already evacuating because of the broader event, or facilities weren't even damaged as least my --

MR. AKE: Probably the best analog for this would be the 1971 San Fernando earthquake in terms of the size and severity of shaking, and things like that.

As we move down into the lower probability changes, perhaps even a little bit more severe shaking than one would have seen at San Fernando.

MEMBER STETKAR: Do you have an estimate? I don't remember earthquake, but the peak ground acceleration at the epicenter on that event? That was 6.7, 6.8?

MR. AKE: That was about a 6.6, about a normal magnitude.

MEMBER STETKAR: Okay.

MR. AKE: It illustrates the nature of the problem. Generally in the epicentral area you saw earth shaking on the order of about .5 g, probably .4 g, that kind of number although locally there were recorded at San Fernando Dam and a few other places greater than 1 g.

MEMBER STETKAR: There was?

MR. AKE: So you have highly variably spaced spatially.

MEMBER STETKAR: Thanks.

MR. SULLIVAN: To answer your question more directly I'm not aware of an industrial evacuation due to an earthquake in recent times. I didn't go back beyond 1992, and perhaps we could. But I did not.

MEMBER ARMIJO: I'm sorry. Go ahead and finish and then I'll ask the question.

MR. SULLIVAN: I'm sorry. Our evacuation study went back to '92, if I'm recalling correctly. And there was no industrial facility of the magnitude that we're looking at here evacuated. Right. That would have caused a public evacuation.

I mean, worker evacuation we didn't even study. So, I don't know the answer to that.

MEMBER CORRADINI: Because, at least as I remember when we had the Committee discussion about this before, I thought our concern -- or I'm reflecting on what I thought the concern was. The concern was that you had an event that caused enough damage that the planned evacuation couldn't occur as readily and as easily either because other people were -- there were more people trying to get out or the infrastructure you counted on was damaged, so you couldn't get out on the planned routes. So I'm remembering. I don't know if Sam was at the same meeting.

MR. SULLIVAN: I'll show you a picture of that.

MEMBER ARMIJO: My question was similar to Mike's in that the biggest earthquake we've recently had with a nuclear plant and a local community was Japan, the Kashiwazaki event.

MR. SULLIVAN: Yes.

MEMBER ARMIJO: And I don't believe there was an evacuation of the community because --

MR. SULLIVAN: No. There'd be no reason to.

MEMBER ARMIJO: -- there was no reason to do. But there's some things that didn't work the way they were supposed to. For example, the plant had an agreement with the local fire department to come in and help them fight fires. They had a fire.

MR. SULLIVAN: They didn't come in.

MEMBER ARMIJO: And they didn't come in. And so if you reverse that, it could be that things don't happen the way you expect and it'll probably be a function of how severe the earthquake is. And does this study have some sort of sliding adjustment factor that says for this severe the earthquake we discount the effectiveness of the emergency evacuation? Is that--

MR. SULLIVAN: I think we do.

MEMBER ARMIJO: Okay.

MR. SULLIVAN: I'll get you into some of the details. But a data point out of the Japanese experience that you might be interested in is the Japanese regulatory and his TSO have come to visit us to discuss protective actions. Because, in fact, the way they've explained it to me and I still have trouble understanding this, protective actions in Japan come from Tokyo. So the problem must go to Tokyo, go through some bureau that they assured me is manned 24/7 and then back out to the locals. And that's just not the American system.

So, I hope I'm communicating this correctly because it was difficult for me to understand at the time.

I'm going to show you pictures of the damage, I mean the evacuation routes that have been effected. And we found that at Surry the effect was quite extreme, actually.

This is the kind of stuff that happens. I mean, it's not an elevated freeway that we're looking at there. But we assumed long span bridges failed. We just assumed that because we don't have the money to go study every bridge in the EPZ. And then anything that the seismic folks thought any piece of road that was anywhere near an area that could suffer liquefaction, we assumed that failed too. Because we didn't have time to go do drilling and everything else we would have had to have done.

Sirens failed. We assumed large shadow evacuation. And I take under advisement your advice to do a sensitivity analysis on that subject. I'm not sure there'd be any reason to believe it would be smaller, but we can certainly look at that.

MEMBER STETKAR: It might be just that people tend to be concerned about protecting their private property when their houses are cracked. So, just keep that in mind.

MR. SULLIVAN: Okay.

MEMBER ARMIJO: Sometimes people go the wrong direction. They'll go to their homes as opposed to evacuate maybe because they think somebody is at home.

MEMBER STETKAR: Or just protecting their private property in the sense of looting or subsequent damage and things. I don't know, I'm just making -- but one could think about that.

MR. SULLIVAN: At Peach Bottom these are the bridges that we assumed failed. And it just so happens they're not important. They're just not along evacuation routes, so that's just the luck of the draw.

Even these down here -- I'm sorry. I'm pointing at my screen instead of yours. Even these down here there's plenty of roads around those bridges. And it just had a minimal impact on the evacuation time estimate, to the best of our knowledge.

So at the Peach Bottom situation this was the difference in the individual LCF risk, almost negligible. In the EPZ a little bit bigger. A little bit smaller in the zero to 20 that would have been because of an extended shadow evacuation, which you've questioned.

The situation at Surry is a bit different. Surry has battery backup on their sirens, so we believe the sirens will sound. The public evacuation starts earlier due to that. But once again, we assumed the large shadow evacuation. However, the schools would be delayed. You know, you'd have to summon buses and you hadn't done that, and that would be difficulty.

There's a lot of bridge failures. But the physics of the situation is that at Surry they have a large dry containment, so the release is much longer in coming. However, there was an effect.

If you can see from this rather busy graph, north of the river all those long span bridges on Interstate 64 failed. And that just creates a very long evaluation time; I think 19 hours or 18 hours. And the effect is negligible south of the river, but on the other hand south of the river there's a small population.

Here we did see an effect. I'm sorry. That's the kind of bridge we think fails. Without doing an in depth study we just took them all out. I suppose we could spend some more time on that when we do a more extensive seismic analysis.

So you got to use secondary routes. That was not easy in this area. And we did see a small effect within the EPZ. Not much outside of the EPZ. This is probably a smaller source term than the Peach Bottom source term also.

I took you through that kind of quickly. But let's back to this.

So, did that answer the question about failing local infrastructure? You know, we found a lot of failure in the Surry EPZ, and most of the population is up there too on the northern edge. Isn't that were the resorts are or the Williamsburg and the amusement park and all that business is up there.

MEMBER BLEY: Yes, they're up in that area.

MR. SULLIVAN: So, you know, there's a lot of congestion to begin with. And so that's the kind of assumption we made.

MEMBER ARMIJO: A 100 percent of the bridges of that type are --

MR. SULLIVAN: We assumed it.

MEMBER ARMIJO: Pretty conservative?

MR. SULLIVAN: Yes. We assumed it just

because we didn't know any better. And I suppose we could go study them, but we thought we'll just see what this is like and see what it does to us and figure out where to go from there.

MEMBER ARMIJO: Well the magnitude you're talking about are similar to the Loma Prieta earthquake in the Bay area and that effected the Bay area.

MR. SULLIVAN: Yes.

MEMBER ARMIJO: And the number of bridges and overpasses that were effected were small. They were dramatic, the ones that did fail but most of them didn't.

MEMBER CORRADINI: This is the '89 earthquake.

MEMBER ARMIJO: Yes.

MR. SULLIVAN: Once again, maybe Jon can bail me out here. But, you know, I'm not sure I understand the effect of the river. Does it propagate across the river? Because, I mean we're damaging this nuclear plant on the south of the river and we're then assuming all this damage on the north of the river.

Jon, I'm talking over instead of listening.

MR. AKE: Yes. In this case the river

probably has a negligible effect because the earthquake waves are propagating basically upwards in this case, so really not across the area.

I believe identifying various infrastructure pieces and assuming they all fail probably is conservative. Because for the magnitudes of earthquake we're talking about, the highest intensity of shaking and hence most profound damage would be relatively smaller in terms of area than, say, Loma Prieta was. So assuming everywhere within these zones everything failed probably is conservative. So in a way if you were to try and do this more realistically you would have some probably on individuals that they failed.

Let's say that the strongest shaking was within the northern area, probably less than a probability of one that everything to the south would fail as well. So that would end up, it would make the analysis a bit more complicated but one could see how you could go forward with doing something that would be a bit more realistic.

MEMBER BLEY: Yes. Jon, I certainly believe that assumption is conservative. But what about the one that says essentially none of the buildings are going to collapse or cause major problems?

MR. AKE: We at this point in time choose not to deal with that because of the fact that we were doing this as a -- you know, you can see that we could do considerably more on this, but that the first pass at this was to establish was this a game changing effect or was this a relative small effect. And then that would tell us what to do next.

MEMBER BLEY: I guess the thing that is still sitting in my head about this, is the thing that Mr. Stetkar raised in the beginning. If in fact we are having a number of buildings come down, what could really impact the ability of moving the evacuation forward because -- well, focus emergency services and things like that.

MR. AKE: Right. I think there's no question. And we see going forward that that's one of the things we'd like to do, perhaps as part of the Level 3 study, is to do something that incorporates. You know, here all we did is identify things and say okay, assume they failed. We'd like to take a look at things like existing infrastructure in the area other than transportation routes. What fraction of the residential buildings stock is likely to be significantly damaged to where folks can't get their car out of the garage, that kind of thing.

MEMBER BLEY: Yes. Fires, too, that sort?

MR. AKE: Yes. There were tools available. We think we can attack the problem. It's just at this stage we haven't done that.

MEMBER STETKAR: When I talk about "infrastructure," you focused on physical failures of bridges and road and we're talking about failures of structures and things like that. I think about infrastructure as the integrated emergency response so that it's not strictly related to the number and types of buildings that might collapse. And it's the response to that entire event. So think about how the emergency planners will indeed react to all of that.

MR. AKE: I agree. I agree.

MEMBER STETKAR: It's probably more important than taking an inventory of the actual structures in Williamsburg or wherever the accelerations might go out to. That's interesting information, but we're talking about integrated local state at least initial response to something that' could be pretty interesting.

MR. SULLIVAN: We would expect that --

MEMBER STETKAR: That's where we have seen problems occur, though, by the way. You know, we're all familiar with Katrina. We've seen that.

MR. SULLIVAN: I got a data point there for you, too. Here's one you're not going to like.

MEMBER STETKAR: Okay.

MR. SULLIVAN: The evacuation of Katrina was successful. Everybody who wanted to leave New Orleans left, even poor people, people who needed buses, people who had cars; everybody who wanted to leave New Orleans left. What we had was the people who didn't want to leave New Orleans for a lot of good reasons.

MEMBER STETKAR: And that's part of my concern under some of this stuff. Is maybe there's a reasonable fraction who don't want to leave.

MR. SULLIVAN: That's right. And there is. Actually, we make that assumption.

We would expect in a large nasty event like this that the locals in the state would establish an incident command post and implement the incident command system with a unified command. Everybody's trained in this stuff nationwide, except the nuclear plants. And they will be trained by their locals if they want their cooperation.

So, I mean I don't know. That may go well, it may go badly. But one data point is the

California fires, we studied that in some detail, two of them. The second one was better, they had learned from that. And, in fact, there was a multi-county jurisdictional unified command using web EOC, which mystifies me. We use it in our response center. But that allowed them to see where resources were on a multi-county basis and not have to make a lot of phone calls. They knew where the fire trucks were. They knew what was going on. And it was just a pretty good response.

MEMBER STETKAR: Having lived through those fires and living in Orange County and having one of the fires come within a half mile of my house, I was kind upset that Orange County sent all of their helicopters to Los Angeles and couldn't get them back for three days. It was three days before they got water dropping helicopters back down to us. And that's probably integrated.

MR. SULLIVAN: They prioritized that?

MEMBER STETKAR: Yes did. The fire started up in LA first.

MR. SULLIVAN: But that kind of decision is made by a unified command.

MEMBER STETKAR: It is. It is.

MR. SULLIVAN: And generally it's the

right one. Sorry about yours.

MEMBER STETKAR: The winds turned.

MR. SULLIVAN: Yes. Well, look, I don't mean to indicate that this would go perfectly. But I mean these folks have been doing emergency planning for a long time. And in general, I mean there's some data that the rest of the country has moved ahead of us in some area, like this incident command system business. But in general it was nuclear plant emergency planning that lifted all the boats. And so, yes, I'm proud of it. And I'm sorry if I come across as glib or as bragging about it. But these guys are some of the few communities that actually get inspected. You know, the fire response in Southern California, that doesn't get inspected by federal inspectors and retired guys like me with nothing better to do then pick nits. So, yes, I think they've been inspected for 30 years and I think they have a reasonably good chance of responding to this.

Yes, sir?

MEMBER RYAN: Randy, I appreciate the inspection part and that there's infrastructure developed. But what about the drills, that's where the action is.

MR. SULLIVAN: It really is. It really

is.

MEMBER RYAN: How often do they drill and what's the extent of the drills and --

MR. SULLIVAN: Yes. They have a full blown drill every other year. They usually have a practice drill at least -- many states drill in the off year with their utilities. So it's a good level of drilling.

Actually, we also did a study --

MEMBER RYAN: I mean are the local residents involved and do they have to evacuate?

MR. SULLIVAN: Oh, no. No, no, no. I'm sorry. Residents are never involved.

MEMBER RYAN: So there's never a full blown drill? This is a how ready are we to take care of people that don't know what we're doing today?

MR. SULLIVAN: This is an activate everybody down to the fire department.

MEMBER RYAN: Right.

MR. SULLIVAN: And get everybody out, activate congregant care centers, man --

MEMBER RYAN: So it's a readiness drill? I mean, you don't take patients out of nursing homes, you don't do anything in the hospitals?

MR. SULLIVAN: No. But, I mean, it's

pretty extensive.

MEMBER RYAN: I mean, I understand that. But I guess I'm picking on Dr. Stetkar's point. And until it's actually happening you don't know if the plan's really going to work. I mean, you can only address so many things.

MR. SULLIVAN: No.

MEMBER RYAN: Just a thought.

MR. SULLIVAN: We studied 260 evacuations in the U.S. None of them were unsuccessful. All of them saved lives. We studied 50 of those evacuations in detail and we found several things. Evacuations work in American, and this is without nuclear plant emergency planning.

So I know --

MEMBER RYAN: No, no. That's all my comment. I appreciate that.

MR. SULLIVAN: -- that things will not go all according to plan. But the fact that we can evacuate people in America with the infrastructure out there, I'm certain of. And then in my heart of hearts and my professional judgment having done this for a lot of years, I think that nuclear plants emergency planning only enhances that.

MEMBER RYAN: Is a report available on

that study of the 50?

MR. SULLIVAN: I happen to have -- I've got a stack of hard copies in my office. I'm going to bring them all down to you.

MEMBER BLEY: Right. We would appreciate that.

MEMBER RYAN: Yes.

MR. SULLIVAN: Yes, I would be happy to do that.

I don't know where we left off. But --

MEMBER BLEY: Right there.

MR. SULLIVAN: -- I think that this analysis, while not perfect and be improved, is an evolutionary analysis of emergency response to these kinds of disasters. I don't think we modeled everything as well as we could, but it certainly was several steps forward in the modeling.

You wouldn't believe what we had to do WinMACCS to make it work. But we think we can do a better job with that tool. Those of you who have used it are bemused.

Anyway, at these sits the seismic effect is likely minimal to the best of our judgment. Your mileage may vary, you know depending on other sites and the way the population is dispersed and the way things are rigged.

MEMBER STETKAR: One quick thing. Earlier when Charlie was up we were quizzing him about the plans to do uncertainty analysis and recognize they're not yet developed. Have you thought about doing an integrated uncertainty analysis now in the consequence areas, some of the things we were discussing here briefly? You know, identifying the largest sources of uncertainty and trying to quantify them by sourcing probability distributions and actually applying them to the scenarios?

MR. SULLIVAN: I'm out of my depth. We were going to do what somebody told me is a couple of points. I mean, I don't think we're going to assess the uncertainty -- we're going to do things like -- well we did in this report. I don't report on it to you. But we increased the notification time. We happened to pick a public notification time that aligned really rather well with exercise data. We just used our judgment and then the peer reviewer happened to have -- actually, he inspected exercises at both of these plants as it turns out many times. And he happened to have detailed data on long it generally took these plants to notify the public. Well, that was what we picked. So we increased that.

We could increase it more because that delays the evaluation.

MEMBER STETKAR: You know, I'm not advocating doing sensitivity studies. I'm saying, you know, actually assess the uncertainty. Say that based on what you understand we have a certain confidence that the notification time would be X, a difference confidence that it would Be Y, a different confidence that it would be 0 over the range of reasonable times, you know based on your experience and your expertise. Rather than just saying if it is X, here are our results. If it is Y, here are our results. And it could be as long as Z, and here are our results.

MR. SULLIVAN: I'm out of my depth.

MEMBER STETKAR: Okay.

MR. SULLIVAN: Yes, I could help some experts --

MEMBER STETKAR: What I was asking is not to do it, whether you thought about doing that going forward as part of this?

MR. SULLIVAN: I've picked what I think are the critical parameters for consideration by a uncertainty analysis. I don't think it's all nuked out. I see Charlie standing up to help me out because I'm not sure how we'll pick the span of those things.

MR. TINKLER: As I said, we have not selected the parameters nor developed the distributions. But on its face EP is a candidate for one of those. Now how we construct the distribution, what the shape of the distribution is, that would be done by Randy, Joe Jones, and other people and we'd have to come to some agreement on the shape of the distribution.

And we think we've captured the central value now. I think it's a question would come up -- it would be obvious question that would arise, not only by this Committee but by the peer review and by the public. So I think it's a perfect candidate for an uncertainty study. But --

MR. SULLIVAN: And if I didn't pick shadow evacuation size as one of those parameters, we will before you see this again.

MEMBER ARMIJO: Or forget about it.

MR. SULLIVAN: I think I'm done unless there's other questions.

Thank you very much.

CHAIRMAN SHACK: Thank you very much.

We pick up the Mitigating Measures now.

MR. PRATO: Good morning. I'm Bob Prato. I currently work in the Office in New Reactor in

Vendor Inspection Branch and transferred there two years ago, which prior to that I was the Project Manager for SOARCA and I was the SOARCA Team representative for Operations.

If you put all this into a timeline, you'd recognize that I left SOARCA shortly after I left a presentation to you guys. No correlation. I've been involved in aircraft impacts since 2002, since it's inception. I wanted to get away from it. And when I moved over to DCIP the Vendor Inspection Branch they put me in charge of aircraft impact assessment. So I just can't seem to get away from it.

MEMBER CORRADINI: It's like the Godfather, you're always pulled.

MR. PRATO: Keep getting pulled back.

And our presentation today isn't a whole heck of a lot of different than what we gave you two years ago. What has changed was that we went back to Peach Bottom and we took a lot more objective look at the mitigated measures. We went there and we looked at the staging, we looked at resources, communications. We actually walked down each of the mitigated measures and made sure that it made sense.

When we left there last time there was some skepticism about whether or not you can do RCIC black start and a black run. And I think it's obvious it gave us more confidence that that's a viable mitigative measure. And that's the basis for this presentation, I think, is hopefully we can relay some of that information back to you and give you some increased degree of confidence.

I'm not trying to portray that right now everything is perfect and that if there was to be a major seismic event that every plant would be able to respond property. There was at least one person with us that still has a skeptical outlook on RCIC black start and back run. But one of the more important pieces of information that they gave us was that every refueling cycle they uncoupled the RCIC pump, they hook up the aux boiler and they do a RCIC overspeed drill which involves the same valve manipulations as they would in a RCIC black start.

They also are very aware of the operating parameters, if you will, how much they should open up the valve, that kind of information, the throttle control valve. And they have the necessary capability to get the level instrumentation going and operate the SRVs along with the RCIC black run and back start.

So let me start going through my presentations. And if you have any questions, hopefully, we can give you some of our insights that we gained during the last trip to Peach Bottom. We've only gone to Peach Bottom. We were thinking about also going to Surry, but I got a call about three weeks ago asked if I would mind helping out and share some of my time with Research. And we just haven't had time to go any further than Peach Bottom

MEMBER BLEY: Do you plan to?

MR. PRATO: That has not been decided yet. My recommendation was that we do. And I think that when we talk about some of the problems that we found, I think that you'll understand why we recommend that we should go forward with Surry, and maybe beyond.

On June 10, 2010, we made a third site visit. The first two site visits, the first one was purely tabletop. We sat in their office. We sat down and we went through each of the sequences and we asked them what would they do next.

The second one we went back to refine all that information and to make sure that what we put in our model is accurate. Okay.

This third one we had a different objective. This third one we wanted to go there and make sure that we understood what they were doing. We wanted to make sure that there was proper access and resources were available, communications were available and the equipment would work as they planned.

Since, by the way, our second visit the NRC has inspected each plant for the B.5.b mitigating measures. And I believe that every plant has gotten a bill of health from that inspection. So they've made sure that the procedures were in place. That the equipment was properly stored and everything was staged accordingly. We just went back basically to verify that and we wanted to look at it from a significant seismic event perspective instead of an aircraft inspect perspective.

From the tabletop exercise, again, we viewed newly purchased B.5.b equipment and we performed plant walk-downs for the historic location and connection point throughout the reactor building.

What we found was that there were three levels involved; the 165 elevation --

CHAIRMAN SHACK: Next slide.

MR. PRATO: Oh, I'm sorry.

MR. PRATO: 165 elevation there's a valve vault that you can open up the RCIC injection valve from. And the reactor pressure vessel level instrumentations on 165.

The 135 elevation is where they control the SRV.

And the 91 elevation where they operate the remaining seven valves to get RCIC to black start and black run.

MEMBER STETKAR: This SRV control is strictly mechanical?

MR. PRATO: No. They have AC/DC converter. They've got a panel all set up they've got to take down. I believe it's five panels hook up connections and then they can control each valve with a little panel that they have, open/close it.

MEMBER STETKAR: What power supply do they use?

MR. PRATO: They use a portable gas driven power source, AC power source. And it goes through this converter and operates the valves.

MEMBER STETKAR: They connect it there, the power supply, or is connected through an electrical something?

MR. PRATO: Yes. They have the power supplies stood outside and they do a dry run, a test outside. And then they bring them in and hook this up to this AC/DC converter.

MEMBER STETKAR: This is like a Honda

little generator?

MR. PRATO: It's a little Honda generator.

MEMBER STETKAR: And where does it live outside?

MR. PRATO: It lives over in the corner of the plant in a encased, like what would you call them? A tow-along that has -- it's all enclosed and covered up.

MEMBER STETKAR: Is it seismically qualified whatever?

MR. PRATO: No, it's not, sir.

MEMBER STETKAR: Okay. Thanks.

MR. PRATO: I find it difficult to believe that it would -- Jason?

MR. SCHAPEROW: Yes. Actually they have a couple of generators. One of them is outside.

MEMBER STETKAR: Outside, outside?

MR. SCHAPEROW: Outside like sitting out near a trailer with a plastic tarp over it outside.

MR. PRATO: And the generator itself is inside a cabinet, a relatively very rugged, like those two boxes that they have in back of trucks.

Okay. And we walked-down the procedure for RCIC black start and black run.

With regards to mitigating measures:

Peach Bottom. We walked down the equipment, the resources and the other aspect that I'm going to be covering is the implementation. We're actually going to walk-through the short-term station blackout timeline and show where these things take place.

The specific equipment that they have is a portable power supply. They have multiple power supplies.

They portable controls and AC/DC rectifier for opening SRVs.

They have a portable diesel-driven pump. And again, the heart of their mitigated measures is the RCIC black start and black run.

The portable power supply, they're two handheld gas powered generators. They have 24 hours of fuel. They have access to these pieces of equipment and they have procedures for operating and implementing these pieces of equipment.

The portable diesel driven pump, they have 30 feet of intake hose which is a potential problem because in the large earthquake like that a downstream dam will probably collapse and the shoreline will recede. And there's some problems.

MEMBER STETKAR: What do they use this diesel-drive pump for?

MR. PRATO: For make up and --

MEMBER STETKAR: This is their makeup? Okay.

MR. PRATO: This is their makeup pump.

MEMBER STETKAR: Back up to the CST or--

MR. PRATO: Right.

MEMBER STETKAR: Okay.

MR. PRATO: This system is designed to operate from the fire header. And with a large seismic event, it's likely that it's not going to be there. Now they're going to have to get creative to use it. They do have another water source on site. They have an emergency cooling tower basin, which most likely will survive the seismic event. But there are some problems.

Now they can transfer the water down to the intake for the diesel-drive fire pump and they can close off that area. The question is: Would they would be able to take the water from there and get it to the header? And that's an issue.

Then a plant discharge hose. They have 24 hours of fuel. And they tested the pump with draw from the river, this pump I think requires 60 pounds of input pressure. I think it's that much. And that's why they use the fire header. But with no input pressure they can discharge at 180 pounds of pressure without any input.

MEMBER BLEY: Bob?

MR. PRATO: Yes, sir.

MEMBER BLEY: On both these first two, and I'm sorry I stepped out for a minute, did those come with any specialized hookup capability to like tie the power supply into existing pumps or to actually --

MEMBER STETKAR: Well, no. But he should explain how they're powering the controls for the SRVs from these power supplies.

MEMBER BLEY: Did he already do that?

MEMBER STETKAR: Not in a lot of detail. It's worth --

MR. PRATO: They have a box. And what they call it is portable controls and AC/DC rectifier for opening SRVs. It's on a little cart. And the power supplies are already prearranged just to hookup, but they go to the one -- let me double check the elevation. The 135 elevation, up on a walkway there's four to five panels that they take down, they hookup this rectifier to the panels, they hookup the portable generator directly to the rectifier. They start it up. And they can open and control the valves through switches.

MEMBER BLEY: Okay. And they actually have the hookup connection, whatever they need to hookup?

MR. PRATO: Yes. Yes. They're pre-staged. They've got the tools that they need. The generators are already pre-designed for direct hookup. So all this stuff has been thought out and implemented.

MEMBER STETKAR: Bob, I don't want to take up a lot of time here, but are the normal in-plant equipment operators trained to do that or does it require an electrical equipment operator?

MR. PRATO: They're trained. The operators are capable of --

MEMBER STETKAR: The more than mechanical--

MR. PRATO: Yes. Yes. And I'm going to get into resources shortly?

MEMBER STETKAR: Okay. Fine.

MR. PRATO: Let me cover that next.

RCIC black start and black run you have procedures and manual operation of turbine. Each refueling cycle, as I said before, they manually start the RCIC turbine, they unhook the pump. They manually start it using aux steam, which is 200 pound steam.

And then they manually start it using the same basic procedure they do for RCIC black start. And they ramp it up and they do their overspeed turbine trip.

So there's good reason to believe that they're capable of getting that RCIC. The RCIC really doesn't care where their steam is coming from and it really doesn't care that the pump is uncoupled. It's just that it's physically possible to do a RCIC black start.

Resources. The very minimum staff requirement, and they pretty emphasized this is almost never is the situation. But they have four equipment operators per unit. Actually, they have four and a half.

They have two I&C techs on shift. They have one HP tech on shift. And they have an overabundance compliment of a security staff.

MEMBER STETKAR: They have two I&C techs on shift 24/7?

MR. PRATO: Yes. It's required.

MEMBER STETKAR: Oh.

MR. PRATO: Okay. As far as staging goes, they have all the equipment pre-staged; tools and fuel is available.

Access. We actually walked down where

they put the pump. We walked down where they put both the power supplies. We looked at the staging. We looked at just about everything.

We considered the seismic event and whether or not access would be inhibited in any way. And as far as we saw, okay, I think we're confident in saying that access won't be an issue.

Make-up sources could be a significant issue. If they have to make up for instance to the torus because during that level of seismic event the CSTs are probably going to be non-operable. Now we've asked this question of our seismic folks, and I'm going back a little bit more then two years, and they said that chances are the tanks will buckle. They may not rupture, but chances are they will buckle. And per code if they buckle, they are required to be declared inoperable.

Now this also raised the question if you know Peach Bottom's configuration, they have a large wall behind them and they excavated a lot of the ground behind them. And from a B.5.b perspective they cannot be hit from the back of the plant.

Their CSTs are in the back of the plant. So their procedure isn't attuned to looking and seeing if the CSTs are available. And because of that if the

CSTs failed and the wall that surrounds them, they have a dyke around them that's designed to hold all that water, if that fails as well and they try to start the RCIC pump, they'll burn it up very quickly. So that was one of the lessons learned that they got from our visit. They need to consider that.

And their emergency procedure is supposed to be aircraft impact on threat. And as well as for seismic events. But our review of that procedure is, is that they need to consider some things.

And communications. Well communications is another potential issue. They do have a cell phone system on site. Each of the repeaters are battery operated. The question is: Would it be available during a large seismic event? They're not seismically mounted. So the way it's written is that they're going to be doing -- their assuming that the communication, the portable hand communication is not available. And they have steps in place to be able to communicate between the elevations and between the control room.

MEMBER STETKAR: Bob, maybe you'll get to it. In this scenario does the control room orchestrate the entire scenario? In other words, as you just mentioned, there's coordination between people at least at different elevations of the plant running the RCIC turbine plus controlling SRVs and level. Is all of that coordination done from the control room or is it done locally?

MR. PRATO: For the first 2 and a quarter hours when the TSE takes over, they take over command and control. And then they coordinate with the control room. But essentially for, let's say, RCIC operation they're given the assignment and they're told to go and they basically will do what they were told. There will be very little communication with the control room, obviously, because they don't have remote communication capability.

MEMBER STETKAR: Okay. So these guys out int he plant. I mean, when you walked through this thing and thought about communications, they're basically controlling pressure and level locally--

MR. PRATO: They have and they would take the measure down to 125 pounds and they would try to control within the normal operating band --

MEMBER STETKAR: But that's all done locally? I mean that communication, the fact that you're --

MR. PRATO: Actually, there's somebody in the steps between the 165 and the 90 foot level.

MEMBER STETKAR: Okay. Good enough. Thanks.

MR. PRATO: And they're doing it through verbal, yes.

So what we're going to do now is we're just going to walk through the mitigative measures. When you take a look at the short-term station blackout, it's a large earthquake between 0.5 and 1 pga. And it results in a loss of all AC and DC power.

We ended up with three different scenarios, two unmitigated.

The first unmitigated is that you don't have a RCIC black start.

The second unmitigated is you successfully start RCIC but it eventually fails to the reactor vessel building up and bleeding off over into the main steam lines and flooding out the turbine itself.

And the third one is the mitigated.

So the unmitigated case 1. You lose all AC and DC, your reactor trips, your reactor and containment isolates and RCIC black start fails. And then in that situation you have core damage of one hour.

For the unmitigated case 2 you have a loss of AC, a reactor trip, a reactor and containment isolation, RCIC black start is successful in an hour. Now the question is: Can they effectively start RCIC within one hour? And I guess you can debate that. What I did was from my experience what I assessed was that they gave me an I&C tech and another two operators or one operator and maybe a security guard to help us with communication and access. I felt relatively comfortable that you should be able to get RCIC to start within about an hour.

MEMBER STETKAR: You're talking about three bodies?

MR. PRATO: Actually, I'm talking about four bodies.

MEMBER STETKAR: Four bodies?

MR. PRATO: Okay. The I&C tech to hookup the level and then go help with SRVs. And somebody to communicate in the stairway, somebody at the 165 elevation controlling RCIC inlet and then the main person down in the basement monitoring and making sure that RCIC continues to run.

The procedure would be if somebody would be stationed at the 165 to control the inlet, the RCIC discharge flow and the second operator would go down to the 92 elevation. He would have to manipulate seven valves. Seven. He would only have to manipulate four if the CST was intact. If the CST wasn't intact, he would have to manipulate seven. They're all MOVs, they're all got handwheels on it and hand operators on them. We did ask them the question would a 1,000 pounds of RCS pressure on the backseat, would they be capable of opening it. They were confident that they would, but we suggested that they do some calculations to make sure that the handwheel was manually operated. And they actually did those calculations and sent them to us. I haven't had a chance to review them. I've been out doing inspection and I wasn't available last week. But they actually complicated those calculations and sent us that information. And the implication was was that they would have no problem. And I need to verify that. But the bottom line is, is seven valves in one area and one valve in another area.

So RCIC black start would succeed at approximately one hour. At 2 hours and 45 minutes they would lose RCIC due to steam flooding and core damage would happen in about six hours. And that's the unmitigated second case.

The mitigated case. The mitigated case is that they do successful black start and DC power supplies are connected to the SRV, and reactor pressure vessel. At one hour the EOF is manned. At EOF office in Philadelphia we assumed that it was unaffected by the seismic event.

At one hour and 25 minutes the EOF would make the following recommendations. Portable power supply SRV and reactor pressure level indication, portable diesel-driven pump hooked up to the RCS hotwell and CST for makeup. And a portable air supply manual operation of containment vents. And use of offsite pumper truck and as a portable pump.

They also have a number of submersible pumps.

MEMBER STETKAR: Bob, for the first bullet on there we consumed four bodies, right?

MR. PRATO: For the black start and for the --

MEMBER STETKAR: That's the first sub-bullet, right? You have four bodies involved doing that?

MR. PRATO: That's correct.

MEMBER STETKAR: How many bodies are required for the remaining three bullets?

MR. PRATO: Okay. Their number one priority is makeup. That's the number one priority.

MEMBER STETKAR: Okay.

MR. PRATO: The control room can initiate a call out for all operators who can get to the site. The control room can do that. They usually gather in a predetermined space. And as long as they have makeup to the RCS, they're okay. As people come in, they'll start using them for these other things.

And the other thing is is that once the TSC is manned, again, they take over command and control and start assigning tasks and duties.

MEMBER STETKAR: Okay. Maybe you'll get to the timing of resources as we go along.

MR. PRATO: Okay. TSC is operational at two hours and 25 minutes. At three and a half hours the portable air supply is connected to the containment vent valves. That answers one of your questions. And around ten hours we're going to start having troubles with the torus. The temperature of the torus going too high. Again, it depends on the state of the fire header as to what they would use to makeup. The emergency cooling tower basis is at an elevated level. So that would help. Whether they would use the submersible pumps or how they would make up to the torus would depend on the situation. Okay. But they probably have around ten hours before they'd need to get concerned with being to add to the RCS.

MEMBER STETKAR: The scenario here, though, is they're pumping cold water in the torus and venting steam out of the containment, right? That's the only reason you're hooking up the containment vents?

MR. PRATO: Right. Right.

MEMBER STETKAR: Okay.

MR. PRATO: Did I miss another slide? I'm sorry. Okay.

So that's basically the mitigated measures for Peach Bottom short term station blackout.

Again, we haven't done a Surry as of yet. But Surry has been inspected as well as these for B.5.b and as to whether or not they can deal with a seismic event, we're not sure.

The thing about B.5.b is it's not only added another layer of defense-in-depth, it added a different dimension. And the portable pumps are really helpful. This portable equipment, it's a significant improvement from the perspective of external and internal events, at least I believe that.

MEMBER ARMIJO: Do they train? You know, there are a lot of steps that have to be done. Is there some training that they go through to actually--

MR. PRATO: Training was a part of the

inspection activities. When we went to Surry the first time, they had already gotten their equipment. They were one of the first plants in the country to get their equipment. They actually walked through it, timed everything and wanted to know that information for their procedures. So training is all part of B.5.b as well.

For Surry, the equipment is the portable power supply. They have two portable diesel-driven high pressure pumps. They have one portable diesel-driven low pressure pump. And, again, they have the turbine driven AFW black start and black run capability.

The short term station blackout at Surry is a large earthquake 0.5 to 1 pga, loss of all AC and DC power. The emergency CST limiting scenario in terms of timing and equipment availability.

Again, we ended up with three scenarios: The unmitigated case, the unmitigated case variation 1 which is the same as the unmitigated case above. It includes thermally induced steam generator tube rupture as well. And then they have the mitigated scenario.

The timeline for the unmitigated case. You have a LOOP, a station blackout, loss of DC power.

Reactor shutdown, RCS and containment isolation.

The turbine drive auxiliary feedwater pump falls due to loss of the emergency CST.

You have late reactor coolant pump seal failure.

You have loss of ECCS and containment cooling.

And recovery of offsite and onsite power is not expected during the mission time.

At T equals 30 minutes operations completes its initial assessment and initiates the following actions:

They attempt to start the EDGs and SBO diesel generator. And that fails;

RCS pressure being maintained by the code safety valves, and;

The PRVs are not available due to loss of instrument and backup air;

They used portable power supplies to restore key instrumentation, RCS level, RCS pressure, steam generator level;

Manual start of the EDGs and SBO again if that failed, and;

EOF manned, primary function is to review initiating event, determine plant status and operator actions and to provide guidance on alternative mitigative measures.

MEMBER ABDEL-KHALIK: What's the minimum staffing at Surry?

MR. PRATO: We did know that at our last one. It is comparable. It may have changed, I'm not sure. And that's another reason why we really need to go to Surry. But it's comparable to Peach Bottom. I remember it being very comparable.

MEMBER ABDEL-KHALIK: But you don't have--

MR. PRATO: I don't have the numbers. I'm sorry.

MEMBER ABDEL-KHALIK: Okay.

MR. PRATO: I've been away for two years, so I apologize. No, I don't have it. I'm sorry.

At an hour and a half offsite EOF recommends the following action:

Maintain portable power supply for instrumentation;

Connect the portable, high pressure diesel-driven pump for RCS makeup;

Surry doesn't have a problem with water sources. They've got a whole bunch. The James River is right there. They have an intake canal that holds millions of gallons. They don't have a problem with water sources at all.

Use portable bottles to manually operate the steam generators PORVs, and;

Connect the portable, diesel-drive pump, the low pressure pump for containment spray and containment flooding.

Those are the actions that the EOF would recommend.

At T equals and hour and 45 minutes:

Operations assesses offsite EOF recommendations, prioritizes recommendations based on plant conditions and begin implementation.

T equal two hours. Again, because of the delay due to the infrastructure and the seismic event at two hours:

The TSC is manned and operational, they're reviewing initiating event, plant status and operator actions to provide guidance on alternative mitigative measures.

At T equals three hours core damage begins in this situation.

At three hours and 45 minutes:

The RCS hot leg fails, RCS depressurizes;

Mitigating measures focus on containment cooling and flooding.

For the mitigating event, the initiating event is loss of offsite power, station blackout, loss of DC power;

Reactor shuts down, RCS and containment isolated;

Turbine drive AFW pump fails due to the loss of the emergency ECST;

Late reactor cooling pump seal failure may occur, and;

Loss of ECCS and containment cooling system;

Recovery of offsite and onsite power is not expected during the mission time.

At T equals 30 minutes operations completes its initial assessment and initiates the following action:

They attempt to manually start the EDGs and the SBO diesel generator;

RCS pressure being maintained by code safety valves;

PORVs not available due to loss of instrument and backup air;

They're using the portable power supply to restore key instrumentation;

Manual start of EDGs and SBO diesel generators fail, and;

EOF is manned, again their primary function is to review the initiating event, plant status, operator actions taken and to make recommendations.

These are exactly as the unmitigated for the first two hours.

The EOF recommends the following actions:

They recommend maintaining portable power supply for instrumentation;

They want the ops to connect the portable high pressure diesel-drive pump for RCS makeup;

Use the portable power bottles for manual operation of steam generator PORVs, as needed, and;

Connect the portable diesel-drive low pressure pump, the Godwin pump, for containment spray and containment flooding.

Again, at 1.7 hours Operations assess and prioritize the EOF recommendations --

MEMBER STETKAR: Bob?

MR. PRATO: Yes, sir.

MEMBER STETKAR: I lost something on this timeline. How are we preventing core damage here? I mean, I see things saying steam generator PORVs, but

I'm not making up to the steam generators. I'm making up to the primary system. I don't understand where I'm getting heat out of this one, so can you walk me through this a little bit better?

MR. PRATO: Jason?

MR. SCHAPEROW: Yes. In this case mitigation consists of use of the larger of the portable diesel generator pumps for injecting into the containment spray header. So we are not preventing core damage.

MEMBER STETKAR: Oh, okay.

MR. SCHAPEROW: We are spraying down the containment, depressurizing it. And we are putting more over the core.

MEMBER STETKAR: So this is not a core damage prevention?

MR. SCHAPEROW: That's correct.

MEMBER STETKAR: Okay. Thanks. Thanks. I got confused.

MR. SCHAPEROW: Now people have challenged this. They've said, well, gees they don't get core damage for three hours. What do you do for three hours? So, you know, this is part of that seismic thing. Does the seismic event allow us to do things right away or does it kind of push us later in time.

So if it pushes us later in time, then we're stuck with --

MEMBER STETKAR: That's fine. I thought when you were saying mitigated, I thought this is one of those things where the analyses shows that a realistic estimate would say you not go to core damage. But thanks. I understand. Thanks.

MR. PRATO: At two hours the TSC is manned and they review the situation prepare recommendations.

At three hours the EOF is operational. Onsite EOF is operational. Not the offsite, the onsite.

At three hours and 45 minutes:

The portable power supply continues to supply instrumentation;

Portable air bottles --

MEMBER STETKAR: Wait. We're depressurizing the RCS by opening steam generator PORVs on steam generators that have no water in them?

MR. PRATO: Jason, do you know? We're using the portable bottles to connect to --

MEMBER STETKAR: I see that, but if the steam generators have boiled dry for three and a half hours because they've had no make up for venting --

MR. SCHAPEROW: I think what we mean here is this if you needed it, you have this capability. I know I wouldn't read this thing as that's what they're doing at that time.

MEMBER STETKAR: But in terms of -- you know, I'm consuming bodies of people who are being instructed to do these things. So I hate to have operators running around doing things that are not directly related to mitigating the event.

What I'm concerned about is if the procedures are telling people to do this, they're do that.

MR. PRATO: Yes, they will.

MEMBER STETKAR: Because it sounds like a good thing to do on paper, anyway.

I got confused earlier because I wasn't sure whether you were operating the steam generator PORVs or whether it was a typo and you're trying to open the pressurizer PORVs. But I have no idea how this plant is configured and whether you can actually do that.

MR. PRATO: Yes.

MEMBER STETKAR: But I got convinced that you're not opening pressurizer PORVs for something like bleed and feed cooling. And now I'm more confused about this depressurization stuff. Because that could be important for the Level 2 analyses that if you're taking credit for having this thing depressurized through that, the whole scenario changes in Level 2 space.

They've been sitting on the safeties since T zero on this. So they're -- I'd say by an hour they're pretty dry. I don't know, their steam generators -- the big guys on the new plants are drying out in an hour and a quarter to an hour and a half.

MEMBER BLEY: At South Texas, they're only claiming 40/45 minutes.

MEMBER STETKAR: Forty, 45 minutes, that's right. Yes.

MR. PRATO: At 3.7 hours I don't think resources is the problem. But you're right, we shouldn't be worried about that at that point. And I just don't know why it was included in there. I apologize.

MEMBER STETKAR: My only point is I don't know how it's all integrated and I don't know whether this mitigated even in the Level 2 analysis is taking credit for some type of depressurization because that's what that second sub-bullet says. In terms of how they're treating those scenarios through the Level

2 models. I just don't know. I mean, I just don't know how the scenario is treated.

MR. TINKLER: I am sorry. You should not be concerned that thermal hydraulic population is deriving benefit from depressurizing a boiled dried steam generator, because that's just not the case.

MEMBER STETKAR: Well this says depressurize RCS. So I don't know whether this is a space out into Level 2 that this is --

MR. TINKLER: This is -- from licensee procedures with respect to possible benefits. But the benefit here in this case is the steam generator has boiled dry at a minimum, if measurable at all. Okay. But it's a step that would be included. Now whether or not it's a step that would divert resources is another matter.

MEMBER STETKAR: I guess, Charlie, what I was asking is, this is a scenario for Surry, right? Did the Level 2 analyses for this scenario pick up with a depressurized primary system or did --

MR. TINKLER: No. Absolutely not.

MEMBER STETKAR: Okay.

MR. TINKLER: No. Let me make that clear.

MEMBER STETKAR: Okay.

MR. TINKLER: It would not have

arbitrarily depressurized the RCA on the basis of this.

MEMBER STETKAR: Okay.

MR. TINKLER: Okay?

MEMBER STETKAR: That's good to hear.

MR. TINKLER: Well the purpose of the MELCOR calculation is to look at the steps that might be done --

MEMBER STETKAR: Ah, okay.

MR. TINKLER: Okay? And if the step phenomenologically would result in a response, then we phenomenologically calculate the response. We wouldn't take it from a procedure that something would be achieved simply because it says something in the procedure. Is that clear?

MEMBER STETKAR: Yes. And Bill Shack pointed me to the next slide which answers that.

MEMBER ARMIJO: Before you go on, I have a simpler problem.

If I look at your charts for the unmitigated and the mitigated events everything is exactly the same --

MR. PRATO: And it's going to be.

MEMBER ARMIJO: -- up to three hours and in one case you get core damage and the other case you don't.

MEMBER STETKAR: No, but they have core damage here. This mitigated is not preventing core damage. That's where I got confused early on.

MEMBER CORRADINI: It's delaying it, but it's not mitigating the events.

MEMBER STETKAR: It is not delaying it, though.

MEMBER ARMIJO: I don't see how it's delayed because every step is exactly the same things that didn't work for still didn't work?

MR. PRATO: Yes.

MEMBER ARMIJO: So does core damage begin in three hours in this case?

MR. SCHAPEROW: Yes. I worked on the MELCOR analysis for both the mitigating and unmitigated cases for the short term station blackout for Surry. The only difference in the analysis was the start of containment spray at eight hours as from the diesel -- that's it. Everything else is exactly the same.

Core damage at three hours. At three and a half hours hot leg rupture.

MEMBER ARMIJO: Okay.

MR. SCHAPEROW: One case has a variation

with the steam generator tube rupture just slightly before that, but then that's it. Everything just cooked along. Core relocated, went to the lower plenum, boiler water off, went to the bottom head, core on the floor. And about an hour and a half later we turn on the containment sprays.

Now except for that little tube rupture there's no release. This is a large dry containment, so you know nothing is happening for a long -- for many, many, many hours.

MR. PRATO: Okay. At six and a half hours. You depressurize the RCS using portable air bottles. Accumulators will provide RCS makeup.

Unable to connect portable injection system.

No other mitigative attempts are successful.

At T equals eight hours you connect portable, diesel-drive pump to containment spray to mitigate a release and delay containment failure.

Jason, with the -- isn't the RCS hot leg going to fail at 3.75 even in this scenario?

MR. SCHAPEROW: Yes. The hot leg fails around three and a half-ish, three-quarter hours.

MR. PRATO: Okay. And that's missing from here?

MR. SCHAPEROW: Yes.

MR. PRATO: So you're still going to have the failure and your accumulators are not going to have any effect at six and a half hours, correct?

MR. SCHAPEROW: The classic short-term station blackout with no injection.

MEMBER STETKAR: After the hot leg fails, I probably don't need those portable bottles to depressurize the RCS.

CONSULTANT KRESS: Not much use.

MR. PRATO: Any questions?

CHAIRMAN SHACK: If there are no more questions, thank you very much.

And I think we can break for lunch. Come back at 1:15.

(Whereupon, at 12:27 p.m. the meeting was adjourned, to reconvene this same day at 1:16 p.m.)

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

1:16 p.m.

CHAIRMAN SHACK: Okay. Now we can come back into session.

CONSULTANT KRESS: Yes. This is the good stuff.

CHAIRMAN SHACK: The floor is yours.

MR. SCHAPEROW: Thank you. My name is Jason Schaperow. I'm the Severe Accident Analyst in the Office of Nuclear Regulatory Research. And I've been working on SOARCA for about four years now. I've mainly worked on SOARCA for the last four years, so it's been a big part of my life. I and many others have learned a great deal from this.

To kind of recap a little bit, our approach taken for the thermal hydraulics and severe accident analysis draw on two elements. The first element is to use our model and as input to that model to include the mitigation measures according to the table top exercises. So if the operator said they could do X at this time, we would put that in. That was something that they said they would do at that time. And these calculations did serve a confirmatory role.

When we first left the sites, well sure,

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they'll mitigate it. So we put in the MELCOR to confirm it. And in the majority of cases we confirmed the prevention of core damage. And in a couple of cases we also confirmed delayed release or reduction of release.

Of course, you know that wasn't really the end point of the project. That's nice and well and good at all, but what's the consequences of a meltdown given that they can't mitigate it and we --

MEMBER BLEY: Jason, can I just ask you a question? When you say when you looked it prevents core damage. Does that mean completely or does that mean something more like a PRA would say of extensive damage and melting of the core?

MR. SCHAPEROW: Like the fuel temperatures don't get high enough to rupture fuel. So I guess that would be more along the PRA thing of, you know water level stays above top of active, that sort of thing. We typically use as a measure, at least I've been using, is there's no fuel rod ruptures.

MEMBER BLEY: Okay.

MR. SCHAPEROW: Which when it gets hot enough, the first thing that happens to a rod is it'll burst.

MEMBER ARMIJO: Right. So the water level is always above the top of the core.

MR. SCHAPEROW: Well, actually in the case of BWR the water will come out quite a ways before you hit ruptures of fuel rods.

MEMBER ARMIJO: Because of steam.

MR. SCHAPEROW: So we performed the calculations assuming no credit for mitigation. And when I say no credit for mitigation, I mean those actions necessary to prevent core damage. So if the procedures told the operator to depressurize the RCS and he did that, we would model that because that was not enough to prevent core damage. But if the procedure said hookup this B.5.b pump to the RCS and keep water in the RCS, we would not model that.

So, in the second case we did not model actions that were critical to prevent core damage.

We did this to assess the benefits of the mitigation measures. So we have a number now. We can say well this is the risk adverted by having this measure, at least in the terms of the particular sequence that we analyzed.

It also provides the basis for a comparison to all the older studies, including 1150 and the Sandia Siting Study.

You've seen this list a couple of time

already today, and I just want to go through it kind of briefly here.

For Peach Bottom we analyzed two station blackouts, external events, the long-term and the short-term.

As Marty Stutzke mentioned, we also did do some work on another scenario know as the loss of vital AC Bus B-12. This was the top event in terms of core damage frequency in the SPAR models, at least at the time when we started SOARCA. And we did this in MELCOR analysis. And lo and behold, we're like wait a minute, why is this thing a core damage scenario. We don't get core damage. The two things that were critical to preventing core damage were that they did have RCIC, at least until battery exhaustion so that got us through the period of the accident where you had a high decay power level. And then later in the accident when RCIC was lost due to battery exhaustion, you still had ~~blow~~ flow from one train of CRD, which was more than enough to keep the core covered.

We actually had some others, too, that we didn't include like the standby liquid control system had 50 gpm of liquid they could inject. And we didn't credit that. But we like to cite this example because, you know it's a way to show the benefit of this integrated system analysis and we found that this as far as success criteria are concerned in this case, and so again we did retrain this in the documentation although when we summarize the results we don't always point to this. This is, again, another example of the benefits of using this type of modeling.

On Surry, again, we had both station blackouts, a long-term nd a short-term station blackout. We also had a variation of he short-term station blackout, which is the induced tube rupture.

We had two internal events that we analyzed for Surry. The first was the interfacing systems LOCA. The second was the spontaneous steam generator tube rupture, meaning the tube rupture wasn't initiated. So we ran the MELCOR calculation for that case and we didn't get to core damage for about two days. And this is because if you realistically model the injection and how long it takes to exhaust the tanks, that's how long it takes. The refueling water storage tank takes about 11 hours to exhaust and so you start to ge which was inventory in the RCS,but you still have inventory in the steam generators, so whatever steam the RCS is circulating in the RCS, it's being pulled by the steam generators. So basically you have along time before core damage.

We did not take the spontaneous steam generator tube rupture out beyond core damage because after two days we felt that that was enough and anything more was, in our view, not reasonable to continue such a calculation.

MEMBER ABDEL-KHALIK: Now we've had several steam generator tube rupture events. And I'm just wondering what is so special about this one that makes this probability five times ~~to~~ ten the minus seven.

MR. SCHAPEROW: This one involves, a lot of things get lost. One thing that gets lost, the main thing is the operators don't do anything. They don't anything for a long time. And, of course, the longer they don't do something, the lower the frequency is going to get on the event.

MEMBER ABDEL-KHALIK: Okay.

MR. SCHAPEROW: So at some point you have to conclude that the operator is going to do something at some point. So, at least by two days.

So while we did an unmitigated sensitivity case, we didn't do it out beyond core damage. That's what this means when it says "no mitigated case." You won't see a MACCS calculation for this.

MEMBER STETKAR: Jason, on the Surry when I was reading through, I didn't have a chance to get back in the bowels of the appendices. But on the Surry for the interfacing system LOCA scenario the scenario develops, as I understand it, at least the summary says it develops with a failure of -- you know, interfacing system LOCA itself fails the low pressure injection system because that's the system that's broken and the operators fail to refill the RWST or cross connect to another water source, core damage occurs due to the fact that I don't have anymore water to pump in there.

But there's a note that says the high pressure injection system remains available because the pumps are located in a separate location. Does your analysis of your scenario assume that they remain available, are available for later injection?

MR. SCHAPEROW: Yes. All three of them come on.

MEMBER STETKAR: I know, and when they run out of water they all cavitate and seize.

MR. SCHAPEROW: About three hours and 20 minutes into the event.

MEMBER STETKAR: But core damage --

MR. SCHAPEROW: I've got lots of slides.

MEMBER STETKAR: Okay. You do?

MR. SCHAPEROW: Actually in Slide 18 --

MEMBER STETKAR: Okay. Good enough. You're going to go through it, fine. Fine.

MR. SCHAPEROW: I'm going to go through the stuff that we did basically since we met with you last, which is ISLOCA --

MEMBER STETKAR: Fine. I'm sorry.

MR. SCHAPEROW: The tube rupture and the short-term station blackouts for Peach Bottom.

MEMBER STETKAR: I was assuming you were going to -- I didn't look ahead to see.

MR. SCHAPEROW: I'm glad you didn't.

I've got a couple of summary tables here for the cases where we did not credit these actions critical to prevent core damage So I have one here on this slide for Peach Bottom and the next slide I have for Surry.

For Peach Bottom, I'll start out at the top. The most likely scenario that is the long-term station blackout. And as you'll find out later, it also has the highest risk of any of these scenarios, highest latent cancer fatality risk.

The start of core damage was about ten hours. So we have this nearly significant delay until core damage. This is due to having RCIC available until battery exhaustion at about four hours. So the core damage time is pretty far out there.

About another ten hours to lower head failure, until the core hits the lower head, evaporates the water down there and fails the lower head, 20 hours.

And then the vessel, lands on the floor, it spreads, hits the liner, hits the drywell shell and melts through it 15/20 minutes later.

So you'll see the time to lower head failure is 20 hours, the time to the containment failure and the release start is also 20 hours.

So just kind of a slowly evolving scenario, at least compared to how we used to do things or how we had thought of things.

The next two rows deals with the short-term station blackout. We ran two cases of the short-term station blackout, as Bob Prato had mentioned. One case in the middle row there was assuming that they were able to black start the RCIC system in ten minutes. And that case we assume that they did control the RCIC so they just filled up the vessel until water started going down the steam line and then ended up in the RCIC terminal, and we assumed that stopped the system from operating. So it operated for maybe on the order of about an hour.

For this case, we got core damage starting around five hours and containment failure around 13 hours.

The final case I have here is the short-term station blackout without RCIC black start. And you'll see there that core damage starts in about an hour because it's starting to get pretty quick.

It's kind of nice to compare the second and third in that table. You'll see that the RCIC black start just filling up the reactor once buys you four or five hours on core damage and time to start of release.

MEMBER STETKAR: Jason, before you mentioned that the long-term station blackout is the largest contributor to risk, right? Would that conclusion change if you changed the frequency of the short-term station blackout by a factor of 20 to 50?

MR. SCHAPEROW: Well, you'd have to go to Charlie's table that he had. There's a comparison of all three scenarios.

MEMBER STETKAR: Okay.

MR. SCHAPEROW: I don't have it handy.

MEMBER STETKAR: All right.

MR. SCHAPEROW: It's back in my chair.

I would like to point out that these

scenario frequencies listed here on the column labeled "Core Damage Frequency," these assume that the supportable pumps and diesels aren't used. So these scenario frequency probably should be pushed down a little bit. And this is a point of discussion during the peer review committee meetings. One of the guys said "Well, obviously you get a factor of ten for these, so you should move all these CDFs down by a factor of ten." But other people say "Well, how do you know?" As portrayed earlier, there were different views on that.

On Surry, again, the top scenario, the long-term station blackout was our most likely scenario in terms of CDF and also had our highest risk. We have about 16 hours in this case until core damage and about 21 hours to lower head failure. But in this case the containment doesn't fail for another day. And this is, of course, a reflection of the benefits of having a large dry containment as opposed to a Mark 1 containment. So what happens is the case is the sitting on the floor and the containment atmosphere is continuing the heat up and you're producing noncondensibles from core concrete interaction. So eventually you'll get overpressure of containment.

The latest thinking on containment modeling is what's going to happen when you hit overpressure, when you get the very high pressures is you'll tear the liner and the concrete will crack and you'll get a hole in the concrete. It won't be like a big brown hole, it'll be more like a crack with kind of a pulling apart kind of a thing. So when I say containment failure, I mean increased leakage as a result of very high pressures in the containment.

For the short-term station blackout, in this case we have no injection so we get the core damage in about three hours. This is a slower than the corresponding BWR scenario. And, of course, this is attributable to the higher inventories, right? The BWR just has whatever is in the vessel to boil off. This has got steam generators and RCS. This has got a ways to go so it takes three hours to boil off for Surry.

We get lower head failure at about seven hours. And again, no containment failure until about 25 hours.

The next row or the thermally induced tube rupture is a variation on the short-term station blackout. And in this case we do get a release starting quite a bit earlier. We get a release starting at three and a half hours. The thing that helps here that makes this really smaller than we had previously predicted in earlier thermally induced tube ruptures is that we do get a hot leg failure shortly after tube rupture. So the release really only takes place over a fairly short time interval, just 15 minutes, however long between tube rupture and hot leg rupture.

So you'll see in the last column the release fraction is only .004 of the inventory of cesium in the core.

And finally, the interfacing systems LOCA. For that case the core damage start around nine hours, lower head failure around 15 hours. The release start time is actually very close to, obviously, the start of core damage. The reason that it looks like it's an hour apart is that we round it off to the nearest hour. So in one case it was like nine hours and 25 minutes, the other case it was nine hours and 35 minutes, or something. It was not a huge difference, but it looked like they were an hour apart. I wouldn't read anything into that.

This was our biggest release in terms of release magnitude. We had nine percent cesium release and a similar ion release.

MEMBER STETKAR: Jason, I'm going to keep going back to the frequencies because they do matter.

This was one area, and I think Charlie mentioned it, where the SPAR frequency that you've used is three times two to the minus eight per year core damage frequency and yet the licensee's PRA itself was about a factor of 20 times higher than that. And you mentioned that, well, apparently SPAR looked at conditional pipe failure probabilities.

I wonder, did SPAR look at perhaps relief valves and things? You don't necessarily need to fail piping structurally to get releases out into the buildings.

I'm just worried that if I were a licensee I think I'd look pretty doggone carefully at my pipe not failing and it's surprising that their frequency is a factor of 20 times higher than the SPAR models.

MR. SCHAPEROW: Is. Marty Stutzke in the house?

MEMBER STETKAR: I think Marty's already absolved himself of any responsibility.

MR. SCHAPEROW: I'm not qualified to answer that.

MEMBER STETKAR: Okay.

MR. SCHAPEROW: I have glanced through the

IPE for Surry and they spent a lot of time on this. I mean, this is something that people have gone through.

MEMBER STETKAR: Well then, that's my point. That if they spent a lot of time on it and have a higher frequency than the SPAR model, I would be somewhat suspect that that frequency in the SPAR model might be low.

MR. SCHAPEROW: Well, one could argue that there have been many cases in where when people did their Level 1 PRAs they took certain assumptions.

MEMBER STETKAR: Yes.

MR. SCHAPEROW: I mean, that's the case we're making here, I guess let's say.

MEMBER STETKAR: And you haven't really examined why that might be a difference? Since it has such a high conditional risk, it could be a large source of uncertainty in the overall analysis is my point. That it has by far, you know a factor of 20 plus conditional risk on that. So a factor of 20, for example, on the frequency would change your conclusions.

MR. SCHAPEROW: Yes. On the mitigation side of this one, we've had a number of discussions certainly among people on the SOARCA project team. And the idea that this would go on for nine hours to get to core damage and they would not do anything, they would not refill their refueling water storage tank is almost incredible. So I think on the mitigation side we can make a pretty strong case.

It's been a lot harder for these seismic induced station blackouts. But thank goodness this one's not a seismically induced accident. This is normally the lights are on, sort so speak. So we're talking about operator errors and --

MEMBER STETKAR: Well and again, you know people come up with small integrated human error probabilities on the order of ten to the minus fifth to ten to the minus sixth that account for things like long times and shift changes and things like that also. So it's a bit of a trade-off there.

MEMBER ABDEL-KHALIK: In the thermally induced steam generator tube rupture event what parameters or assumptions could actually delay failure of the hot leg?

MR. SCHAPEROW: Would you mind if I talked about that -- I got slides and graphs and things. Maybe it would be easier to talk --

MEMBER ABDEL-KHALIK: Okay. I'm just trying to find out somehow by virtue of the assumptions you've made you've accelerate the time at which the hot leg fails and therefore --

MR. SCHAPEROW: Well, I have slides that go right into that.

MEMBER ABDEL-KHALIK: Okay.

MR. SCHAPEROW: Just humor me and we'll go through a couple of more.

MR. TINKLER: Jason I'm sorry. I just caught a little bit about the difference between the licensees' highest LOCA frequency and ours.

MR. SCHAPEROW: Yes.

MR. TINKLER: I made a vague reference, a quick reference to it this morning. The licensees' SPAR or equivalent internal events PRA assume that upon the failure of the two check valves the probability of the low pressure piping failure was one. In our SPAR model considering yield strength and capabilities of the piping, we concluded and our own internal SPAR model that the probability of the low pressure piping failure was .1. You know, why would the licensee have a much higher frequency?

Frankly, we saw this when we talked to the licensees about their PRA and our PRA. We saw what I think were a number of examples where the licensees' PRA were, frankly, conservative whether it was to meet regulatory requirements, whether it was because they'd spent enough money and the risk was low enough. It wasn't all that unusual to find cases where the licensees' PRA was more conservative in a rather dramatic way. And I think, frankly, there's something out of whack when that's true because there's very little incentive for the licensees to either come up with another value or pursue it. But, you know, ultimately if the risk is low enough, the risk is low enough and they have no need to sharpen the pencil or come up with a better number. But we saw this in a number of cases.

Our favorite whipping boy for this is ASME standard which has different levels, I guess, for much documentation analysis you do. And if you're not willing to run the gauntlet, then you're kind of stuck with a more conservative approach. But it wasn't something that was not seen. We saw this in a couple of incidents. And you can make of it what you will, but Chris Hunter and folks in DRA when they went through this -- and the folks at INL who worked on these updated SPAR models were pretty confident in our frequency.

MEMBER STETKAR: I think that, you know I don't want to belabor it. I have seen examples myself where if you ask a piping engineer to go evaluate the conditional probability of a pipe failing, they will do that. A systems engineer might note that there's a very large relief valve that, indeed, will cause a release and open well before the pipe fails, but it's guaranteed to open. So the question is did you go look for those types of things that maybe the plant people know about, relief valves that would open or pump seals, or packing on valves or those other things that pipe analysts don't look at if you just tell them do a structural analysis of a piece of pipe.

MR. TINKLER: Well, like I say, in this case it was the other way. Now the licensee had a higher probability of the pipe rupture --

MEMBER STETKAR: They had a higher probability of releasing the water into the auxiliary building in a way such that the low pressure injection system didn't work. Now, if they said they did a piping analysis and said it was guaranteed that the piping fail, that's something else, looked at welds and things.

MR. TINKLER: Well in this case, like I said, they just assumed a very high -- assumed a unity probability of pipe failure.

MEMBER BLEY: I guess, let me restate what John just asked you. Regardless of what they did, when you guys looked at this did you look at relief valves and pump seals and packing as well as the pipe itself?

MR. TINKLER: I can't legitimately speak to the SPAR model, okay. But to the respect did other things create a leak in addition to pipe rupture, that is a possibility. Because we're sensitive to the issue of a bypass load anyway, I would presume they would consider if it was indeed a bypass path. But I can't--

MEMBER BLEY: Okay. And the reason he raised it is because almost all of this low pressure pipe has thermal release set at 400 pounds or less.

MR. TINKLER: I just want to point out this wasn't the only occasion where we saw where a licensee's PRA might be conservative. Because there's just not incentive --

MEMBER STETKAR: It might very well be, Charlie. I'm obviously playing the devil's advocate. Because once the frequencies get this small, especially if the licensee hasn't been sensitized to Level 2 type issues --

MR. TINKLER: Right.

MEMBER STETKAR: -- it may very well be.

MR. TINKLER: Right. Well, when the whole world revolves around a Level 1 non-seismic PRA and internal events are already low, you know, this is what you end up with. That's a summary statement you can ignore.

MR. SCHAPEROW: Okay. So for the rest of the presentation I'd like to focus on the analysis that we've been doing since we met with you last. Now we did more than just do this analysis over the last seven and half years. We spent about a year of it on the peer review. So I'd like to think that we've done more than this, but the peer review was actually a long and involved and, of course, very useful effort.

The three analysis I'm going to talk about, and I'll start with thermally induced tube rupture and then move on to the interfacing systems LOCA and finally I'll talk about the Peach Bottom short-term station blackout.

Okay. So kind of an opening point here is that, of course, we didn't just start doing thermal hydraulic analysis on tube rupture in the last week. We've been doing this, I don't know, I guess since the late '80s or many, many, many years. We have the benefit of the Westinghouse 1/7th scale experiments, we've got a bunch of CFD analysis including the latest fluent analysis. We've got boatloads of SCDAP/RELAP calculations done in the '90s, and I was even involved with some of that. Bill Shack will remember I was at Argonne back in 1999 on this issue.

We did a few calculations with VICTORIA to look at fission product deposition in the tube bundle and if that would affect the tube heat up.

And most recently in the last few years we've done tests at the Paul Scherrer Institute again to look at disposition of fission products inside a tube bundle.

The one new thing about that we think we're trumpeting here and in SOARCA is the last bullet about we have revealed regardless of whether the tube fails before the hot leg or not, we do get a hot leg failure. So for us this has again confirmed the value of integrated self consistent analysis.

I have a couple of plots, mainly a pressure plot here and a water level plot.

So, as you can see here, this is a high pressure scenario. The RCS is the red line. So we're starting off at 16 megapascals. We do see a little decrease in pressure but as a result of boiling of the steam generators. But we do get the dryout, and the RCS pressure goes back up to the relief point.

So you see a jagged line there. The red

line gets very jagged. That's the relief valve opening and closing.

On the secondary side the steam generator pressure at its relief valve setpoint.

We get to core damage around three hours for this scenario. And because we're trying to model a thermally induced tube rupture, so we have to have some kind of depressurization on the primary side or we won't get it to rupture. So we're going to assume that secondary side relief valve sticks open at three hours. Maybe there's another way to get so low pressure on the secondary side, but this is the one we chose. At that point we've already got probably about a 100 or 200 cycles on the valve. It's been opening and closing quite a bit.

So now we have high pressure on the primary side, low pressure on the secondary side. And the secondary side is dry. So now this is the opportunity for tube rupture.

Under these conditions our most recent estimate NUREG-1570 estimated the likelihood of condition of tube failure is .25, thereabouts.

We don't have a special tube rupture model in MELCOR at this point. So what we did, as you can see on the red curve, we put a thermally induced tube rupture at about three and a half hours. We introduced this tube rupture at the time when the hot leg creep failure rupture index was .01. So the hot leg's just starting to get hot. We induced the tube rupture. And 13 minutes later we predict a hot leg rupture. And what you see there is hot leg C creep rupture.

MEMBER STETKAR: Bill, stop me if I'm going off.

Jason, is the timing in the -- not necessarily the likelihood, but the timing of that tube failure closely influenced by the time that that steam generator PORV is open to depressurize the second side? For example, if I moved that time instead -- it's assumed here at three hours. If I moved it up to one hour?

MR. SCHAPEROW: Well, that might not affect the tube behavior. It could affect the thermal hydraulics of the other steam generators in the RCS. But it's not going to affect whether the tube ruptures. The likelihood of tube rupture is not necessarily affected by that.

I guess the short answer is, no, I don't think so. But the long answer is well, you'd have to have -- the probability of having a stuck open relief valve really in the vent is probably quite a bit lower.

MEMBER STETKAR: The probability is pretty high --

MR. SCHAPEROW: The probability starts going up as you get more and more cycles on the valve.

MEMBER STETKAR: If I'm an operator and I'm told to blow down the steam generators to try to get low pressure feedwater into the steam generators, I'd say the probably is pretty high that the line is open because I've been told to do that to get a source of low pressure feed if I can't get high pressure feed. That's pretty much what i thought I had been trained to do.

MR. SCHAPEROW: Yes, but he doesn't have any feed at all.

MEMBER STETKAR: He knows he doesn't have any high pressure feed. He's trying to maybe get condensate, he's trying to maybe work down the low pressure --

MR. SCHAPEROW: There's no injection.

MEMBER STETKAR: You know that. He doesn't know that.

MR. SCHAPEROW: I'm pretty sure the procedure is telling him to depressurize if they have injection. If they don't have injection, they're not going to be doing anything. I'm not a procedure expert here, but --

MEMBER STETKAR: I don't want to argue about procedures. I'm just curious about the actual thermal hydraulics and mechanics whether the overall results would make a difference.

CHAIRMAN SHACK: I don't think it would. When it's important is when the temperature takes off here. Because that tube can sit there under pressure for a long time.

MEMBER STETKAR: Okay.

CHAIRMAN SHACK: It's when it's under pressure and it heats up.

MEMBER STETKAR: Thanks. That helps. Because it might be likely that its open pretty much of the whole time, yes.

MR. SCHAPEROW: This is a reactor vessel level plot. As you can see, it's a station blackout with water boiling off. Water boils off until about almost four hours and then we get the hot leg failure. And now the reactor system RCS depressurized, we get an injection from the accumulators and we recover level. And again, after the accumulators have injected, we begin boil off, heat up the core melt the core, failed vessel.

Looking at temperatures of the gas going into the RCS, we have plotted here three of the core exit temperatures, core exit ring 1, 2 and 3. The gas and the hot leg and the hot leg nozzle itself.

So, again around three hours we start getting core damage. We get around 1000 K, 1100 K the core exit gas temperatures are really ramping up there. We introduce the tube rupture at about three and a half hours and a little bit after that we get predicted hot leg creep rupture failure. And then followed by the accumulation injection, of course it brings all the temperatures back down again.

Regarding the fission products. The release starts at around three and half hours when the tube ruptures. The release stops, it almost ends at three and a half hour. But right half is that little segment between when the tube ruptures and when the hot leg ruptures, that's when most of the fission products are released to the environment. As you can see from this plot, most of the fission products end up in the containment and the total release is the black line and the containment is the blue line. And 85 percent of the iodine ends up in the containment. We got some in the RCS.

MEMBER ABDEL-KHALIK: Are the assumptions made with the analysis then to accelerate the hot leg pre pump, or do they --

MR. SCHAPEROW: One more slide. I'll skip over the slide on cesium release because we about the same behavior. Nothing really exciting there.

Peer review. So the peer review asked questions in this regard. They asked about -- they didn't necessarily say you got that best estimate wrong. They said well how about this, how about this; they are looking at the uncertainties a little bit and about the likelihood of the timing of the failure, the margins that might be involved.

We also had a second question from the peer review committee regarding the chemical form of iodine.

Okay. So if you'll turn to Slide 15. We went back to our old workhorse to help us out here. We went back to SCDAP/RELAP5. And for SOARCA we did perform some SCDAP/RELAP5 analysis. This analysis was based on our latest FLUENT model, which I believe the Committee's heard a lot of this as far as where they are in SCDAP/RELAP5 and FLUENT and how far we've progressed.

We're including in this our modeling of

the hottest tube. So we set aside the hottest tube and we've assigned that that temperature of the hottest tube based on the normalized temperature ratio, which again I think the Committee has heard a little bit about.

We modeled two cases with SCDAP/RELAP5 with a single doubled ended tube rupture. And the way we got the tube to fail in this case was we assumed a stress multiplier of two. And with that assumed stress multiplier of two we calculated with SCDAP/RELAP5 that the tube would rupture at three hours and 46 minutes, which is actually very similar to the MELCOR timings we're talking about here. SCDAP/RELAP5 then went on to predict the hot leg would fail about a minute later.

They did another sensitivity with a stress multiplier of three on the hottest tube. And again they got tube failure about three hours and 39 minutes. And in this case the hot leg failed a little later, in this case at 8.8 minutes later, no to be too precise there.

CHAIRMAN SHACK: Just on this thing, too, those multipliers are really flaws in the tube. And so a multiplier of two is like a one inch long crack about six tenths of the way through the wall. So it's a fairly hefty flaw. And the three --

MEMBER ARMIJO: If you didn't have a stress multiplier, if you had an unflawed tube, what do you do then?

MR. SCHAPEROW: Great.

MEMBER ARMIJO: Then you're saying okay, I'm in fat city. But eventually it's going to get hotter and hotter.

MR. SCHAPEROW: Well eventually the hot leg will rupture and then you won't -- no more pressure.

CHAIRMAN SHACK: It's a horse race between those two.

MR. SCHAPEROW: Exactly. Exactly. You know, and 20 minutes is a long time because not only is the tube heating up, the hot leg's heating up along those 20 minutes also. You know, it's just a horse race.

We also did what we would characterize as an extreme case where we modeled multiple tube ruptures. We assigned a stress multiplier of two to several tubes. And in this case, again, we got hot leg failure about a minute or so later.

So we think we've done some analysis with SCDAP/RELAP5 that confirms this idea that if the tube fails first, that we will get a hot leg failure shortly thereafter.

And the MELCOR prediction, which we got hot leg at 13 minutes later, we're characterizing here as slightly conservative. So basically this lets the fission product release go on for a few minutes then, the SCDAP/RELAP5 analysis.

Getting a little further into the question of when the things fail. So the peer review committee was certainly interested in when things fail. And they said, well, you know we think you should take this calculation out a little further in time. Fine, let the tube rupture but don't let the hot leg rupture. You should look at things with a tube rupture but just let it keep going out in time.

So if you look at our graph on the left side, you'll see the case that I just described a few minutes ago is the black line where when the hot leg ruptures, you get an accumulator injection and, lo and behold, your temperatures come down.

The red line was the case where we did not allow the hot leg to rupture. And so the hot leg temperatures continue to rise until they got to around 1300 K.

On the right hand side I've got a graph

showing what happens to the creep damage index if you do that, if you let the thing keep heating up. The creep damage index, you know, just buckles off the map. You know, it's no longer 1, it goes up to like 10,000.

MEMBER ARMIJO: It turns into a balloon.

MR. SCHAPEROW: Pardon?

MEMBER ARMIJO: It turns into a balloon.

MR. SCHAPEROW: Yes, it goes straight up.

CHAIRMAN SHACK: Jason, with your multiple tube rupture how many tubes did you let rupture?

MR. SCHAPEROW: I believe it was four tubes with a double ended break. So it's kind of like eight single tube areas.

CHAIRMAN SHACK: Okay. And a little less than a two inch break.

How many tubes are hot in Chris Boyds' analysis?

MR. SCHAPEROW: Oh, goodness.

CHAIRMAN SHACK: What would be the maximum number that we could see --

MR. SCHAPEROW: I have no idea. I mean, it was an area --

CHAIRMAN SHACK: Yes, it's a pretty good sized area. How did you pick four?

MR. SCHAPEROW: Oh, goodness. Well, in hindsight it was certainly something that was extreme. Because the likelihood of all these tubes having cracks in them is pretty low.

CHAIRMAN SHACK: Okay. Right. I mean that's only true if you allow them to be flawed --

MR. SCHAPEROW: I mean, for one tube in the hottest tube area to be flawed there's already a pretty low likelihood of that.

CHAIRMAN SHACK: Right. To have 15 of them--

MR. SCHAPEROW: Yes. It's hard to imagine.

So what we saw here was that the creep damage index went way up. And so we concluded that it was probably not credible to have this thing keep going without having a hot leg rupture.

The model does show high sensitivity to thermal stress when you get about 1000 K, the prerupture model.

Did I address your question, Sam?

The last question we have is from one of our peer reviewer from IRSN who has a lot of experience with the Phebus program. He said well look we did see some gaseous iodine in a Phebus containment during these integral prototypical tests so you guys need to make sure you've reflected that in your analysis.

The MELCOR analysis does not right now consider gaseous iodine. We've taken the testing over the years and our experience to suggest that the iodine would be aerosol. But again, the Phebus data did show a small amount of gaseous iodine.

So what we did was we used the Phebus data to try and estimate what the additional release would be associated with a small amount of gaseous iodine that showed up in a Phebus containment.

If you look at the inset graph here, this shows the Phebus test results during the two phases of the Phebus test. The aerosol phase is what I would characterize as the early phase, basically while the Phebus fuel bundle is heating up and melting. But right there in the core degradation.

The chemistry phase is later after the fuel assembly is melted and you're observing what happens to the iodine and cesium, where stuff goes.

So for our purposes in SOARCA we think that the early phase, the aerosol phase is more representative of what kind of gaseous iodine concentrations we may see during our core melt part of our accident analysis.

So to estimate how much additional iodine might be released due to a gaseous iodine release, we used the numbers in this range of .1 percent to .2 percent of the release being gaseous iodine, which is again directly out of the Phebus test.

Using that number and the flow rate at the break we estimated the additional iodine release we might see from gaseous iodine. Those are the three curves along the bottom of the plot. And again, as you can see, those curves are very low compared to our aerosol release at the break, which is the green line. So we felt pretty good that what we were doing in MELCOR was reasonable, that by not having explicit gaseous iodine model that we were capturing the release fuel. Excuse the pun there. We were getting the release correct, at least to an order of magnitude.

Okay. Turning to the interfacing systems LOCA. Of course, as I mentioned earlier, this has been a longstanding accident that's been analyzed many, many times over the years. We've already looked at the IPEs. And now we're getting another shot at it with SOARCA. So that's going to be our best shot.

So the initial condition for the

interfacing system LOCA that we analyzed was a common mode failure of both of the inboard check valve disks. This resulted in overpressurization of the low heard safety injection piping in the safeguards building. And so we got a little schematic here showing the system, where it's connected to the cold leg.

One thing this picture shows is when they flood the safeguards building area, the first thing it does is flood the low head safety injection pump motor. So that takes that pump motor out in about a minute or two, it's gone. Because this is a ten inch pipe break with an orifice in it.

The second thing this picture shows is that the safeguards building is connected to the aux building. And so we see a spillover both of water and of course of any fission products would go from the safeguards building to the aux building on its way to the environment.

Now, although the benefit of having the safeguards building connected to the aux building is you can get a lot of fission products deposition in the aux building because that's a big building and lot of surface area, and a lot of residence time. The down side is that the water that spills into the aux building if that level gets high enough, it can flood out the high pressure safety injection pumps which are in the basement of the aux building. So, you know, we consider all these things in a consistent and integrated fashion.

This first plot shows the RCS pressure and the steam generator pressure as a result of the break, a nice LOCA break. And one thing that kind of stands out for me. when I look at this plot is that the RCS pressure is lower than the steam generator pressure. You don't see that in a lot of accident scenarios besides station blackouts. But that's where the break is, the break is in the RCS. So the break is cooling off the RCS and the RCS is cooling off the steam generators. Kind of a reverse heat transfer.

Another thing you see is at one hour we do model the operators beginning a 100 degree per hour cool down. Now this is an unmitigated case and one might say well this is mitigation. But again, we're not model in this calc the mitigation of somebody refilling a tank so they don't get to core damage. We're modeling mitigation, but not the mitigation critical to prevent core damage.

With regard to water level, the break does take the water level down fairly quickly. But we do have high head safety injection and we do have accumulators operating during the first three hours or so, so the core does stay covered. We don't get a release early on. Around three hours, though, the refueling water storage tank does become empty. And as you know, one of the critical actions is the operator needs to refill their refueling water storage tank. We assume that he doesn't, hence we get to core damage eventually.

The next plat shows the water level calculated by MELCOR in the refueling water storage tank.

We tried to, again, infuse this with all the detail we possibly could.

You'll notice all the way up on the upper left hand corner we show a low pressure injection running for two minutes.

MEMBER STETKAR: Jason, why does it say "secure HHSI #3 secure HHSI #2" on that plot?

MR. SCHAPEROW: So the operator is watching, he's watching level. He's seeing that his levels --

MEMBER STETKAR: No, no, no.

MR. SCHAPEROW: His instrumentation is telling him that he doesn't need at all.

MEMBER STETKAR: If I'm an operator I'm

told to keep in injecting unless I meet the criteria to reset safety injection. I've not met those criteria.

MR. SCHAPEROW: He is injecting all the time.

MEMBER STETKAR: Does he have level in the pressurizer? Does he have a controlled secondary heat removal? And does he have control and not decreasing pressure in the primary system?

MR. SCHAPEROW: He doesn't need all three pumps operating. All three pumps operating will deplete the --

MEMBER STETKAR: No, I can't shut it off.

MEMBER BLEY: He has to follow his procedure that says these three things.

MEMBER STETKAR: I can't shut off a pump until I reset safety injection. The great god Otto prevents me from doing that, so I have to actually reset safety injection before I can take manual control. To reset safety injection I need to satisfy those criteria. I'm an operator, I'm following my procedures.

MR. SCHAPEROW: Okay. I'll say two things.

The first thing is that we conducted the table top exercises and the operators said that they don't need all three pumps and they would shut two of them down.

The second thing I would say is that if Bob Prato were here, I'd give additional information.

And again, we sent this through a fact check. We just got fact check results back from the licensee.

We can certainly take a close look at this and make sure they ~~saws~~ said this, and agree that this is what they would do.

MEMBER STETKAR: Okay. I would be curious about that. Because it's not clear to me why they would be cutting off injection in this case. Apparently, obviously, it affects the time.

MR. SCHAPEROW: Yes. And actually, we could see how the time would be affected by drawing a straight line.

MEMBER STETKAR: Yes, but that's not a substantial --

MR. SCHAPEROW: Yes, you'd saved, I don't know, you'd run at water at two and a half hours instead of three and a quarter or something.

MEMBER STETKAR: Well --

MR. SCHAPEROW: But you're right, the

time's important and we're making a big stink about time.

MEMBER STETKAR: You are.

MR. SCHAPEROW: Thank you.

Okay. So assuming the operator did not refill their refueling water storage tank, we are seeing that the release is starting around nine or ten hours. And the bulk of the release occurs from about ten to eleven hours. You can see kind of the dark blue line near the bottom is the release starting at ten hours and ending around eleven and release to the environment.

Another thing you'll note here is we're getting pretty large amount of deposition in the aux building. It's the next to top line. We get about 57 percent deposition in the aux building. And it's a big building. The fission products have -- they actually come into the aux building at the basement level and they can't get out there. They have to go travel up through the building a ways.

MEMBER BLEY: I'm sorry to take you back o the one you just left. But I've been thinking about your interchange.

MR. SCHAPEROW: Okay.

MEMBER BLEY: Can you tell me a little

bit, I don't remember reading it, it might be in there, on how you actually conducted these table tops and who was there.

MR. SCHAPEROW: Okay.

MEMBER BLEY: Had engineering there and maybe people writing the procedures for these particular activities?

MR. SCHAPEROW: We have --

MEMBER BLEY: That's one half of the question. The other half was there good representation of licensed operators who were really on shift and running the plant?

MR. SCHAPEROW: Well, the short answer to your question is yes. I mean, there were quite a few people around the table. We had SROs, we had people who were previous SROS, we had emergency preparedness people, we had PRA staff there, I remember. I went on Surry visit two and a half years ago and Ross Anderson was sitting there across the table from me. He knows all the ins and outs of the Surry PRA, obviously. So we feel we had the right people there.

On the NRC side we are our PRA staff. We had Rick Sherry, Salim Sancaktar, myself, Bob Prato who is our operations guy. So I think we had pretty much all the people who were in the know. We had the right people, that's the short answer to your question.

MEMBER BLEY: Okay. I mean, the reason I asked it that way is because sometimes the guys who are trying to make the new stuff work and the guys who are doing the PRA envision what they think operators will do because that's what they expect them to do, and it may not be what they're allowed to do by their training and procedures. And sometimes they can be shutdown in these kinds of exchanges, too. It's just that one seemed a little funny.

MR. SCHAPEROW: Yes. No, they had the seasoned SRO types there in the meeting. And they weren't shy about saying what they could do and how quickly they were do it.

MEMBER BLEY: Maybe they changed their procedures from the kind of standard approach.

Go ahead.

MR. SCHAPEROW: Okay. Moving to the Peach Bottom short-time station blackout.

As Charlie mentioned, this is a scenario that was added, in part, to address ACRS comments regarding completeness.

The core damage frequency for this scenario is three times ten to the minus 7 per reactor year. Again, this number assumes the likelihood of B.5.5 mitigation as zero. So this is a pre-B.5.b number, so to speak.

We analyzed two unmitigated cases leading to eventual core damage and release. The first case is the simplest case, which is no black start of RCIC. And the second case involved a black start of RCIC but no level indication so that the reactor vessel was overfilled and flooded the RCIC turbine.

So I've got three slides for each case.

Okay. So for the Peach Bottom short-term station blackout the first thing you see is the pressure going up until it hits the release valve setpoint. And then you see the relief valve opening and closing many times. Although you can't see it here, this is hundreds of times, I guess at least a hundred or a couple of hundred times. That's the reason our line is so fat; it's the relief valve opening and closing in the width of the line.

Something pretty important happens around two hours, and what's going on is we've already in-core damage for, gosh, about an hour now and the RCS is really starting to heat up. We've got this very, very high temperature steam and hydrogen coming off the core going through the steam line, through the safety relief valve, through the SRV tail pipe and into the suppression pool. So we're getting some very high temperatures in the RCS.

And what's happening here is we're heating this thing up so hot that it's not clear that it's going to keep functioning. You know, once you get up around a 1000 K, 1100 K, I mean the structural properties of this SRV is going to go downhill pretty quick. And you'll have the spring that's holding the pressure that closes the valve, that may soften and so the valve may not close so well there. Another point is that you're going to get thermal expansion of components in the valve.

So what we do in this case is when we get to these high temperatures we stick open the relief valve, or should I say we don't allow it to reclose because these passing these very high temperature gases. And again, the thinking is that the thing would not be able to reclose because of either differential expansion or otherwise failure of the valve due to high temperatures.

So this sticking open of the valve what it does, of course as you can see here, it depressurizes the RCS. There's a lot of fission products in the system right now because we've had an hour of core damage and the fission products are basically send to the bottom of the suppression pool through the SRV tail pipe.

MEMBER CORRADINI: What is sent to the bottom? I'm sorry.

MR. SCHAPEROW: Fission products.

MEMBER CORRADINI: Oh.

MR. SCHAPEROW: Your core damage started at one hour. So by two hours you got a lot of fission products in the RCS. And now you stick up this SRV, and it's a pretty straight path pretty much from there to the bottom of the suppression pool through the spargers. And you'll see that in the fission product plots where we can capture the fission products in the suppression pool.

MEMBER BLEY: That is not an unreasonable story.

MR. SCHAPEROW: Yes, that's true.

MEMBER BLEY: Is it equally unreasonable that instead of sticking in the open position, it just got all jammed up and stuck in the closed position?

MR. SCHAPEROW: Well --

MEMBER BLEY: And what would that do to you?

MR. SCHAPEROW: You know, actually you're getting to the area of the peer reviewers. The peer reviewers brought us into this area. They asked a number of questions in this area. Because, yes, we thought that was kind of an important modeling effect.

First of all, let me say that we're going to look at this in our uncertainty study. This is something that we thought was kind of a big deal.

MEMBER BLEY: Okay. It's one of these things where we're counting on a failure to do us good.

MR. SCHAPEROW: Yes.

MEMBER BLEY: It always makes me a little uncomfortable and I wonder if you thought of all the failure modes?

MR. SCHAPEROW: Yes. Also we asked about the timing of it also. So, first, the one thing we did is we looked at the timing aspect. I don't have all the detailed plots in there. There's a couple of failure modes that one could postulate.

One is high temperature. You know, the thing is passing high temperature steam, differential expansion doesn't allow the thing to close.

Another failure mode is just sheer number of cycles. I've seen this and the PRA area specialists tell us, look, we have a curve we use for failure probability. After ten cycles your failure probability is X. After 50 cycles its Y. So, as you get more and more cycles on the valve that increases the likelihood that it's not going to work.

So we did do some sensitivity calculations to look at what if the valve failed a little earlier, what if it failed a little later. So, we did pull that string. We're still working on that a little bit. It's fair to say that we've been working with Sandia over the last few weeks on this issue and we're working to get a little tighter resolution to that. But we think we've got our arm around it at this point, or we're getting our arms around it.

I don't know if I've answered your question okay or not.

MEMBER BLEY: I'm looking forward to the uncertainty analysis when it comes because I don't think any of us know what's going to happen to this thing. You know, it could just fall apart and jam itself all up --

MR. SCHAPEROW: Yes.

MEMBER BLEY: -- as well as stick in a nice wide open mode, or outside of the design operation of the valve by a long shot.

MR. SCHAPEROW: Yes. But the particular

question about well what if the valve sticks in the closed position, one of the analysts says "Well, I got a whole bunch of valve there. You know, if one of them sticks closed the next one's going to open."

MEMBER BLEY: Well, it's bound to have stayed open.

MR. SCHAPEROW: He says "So if that one sticks closed, the next one is going to open and close and open and close."

But then we had people that said what if it's stuck in the half open position? So, again, we pulled the string quite a bit and we're still working on it a little bit.

MR. TINKLER: We also thought about the fact that if one valve was first preferentially opening heating of that valve spring would soften that spring and make it one be preferentially be the one that opened anyway.

MR. SCHAPEROW: Yes.

MR. TINKLER: As Jason noted, there's a whole bunch of valves. If that one doesn't, another one opens up pretty quickly. And by that point you're in part of the transient where the gases are very high. So it won't take long for that next valve to heat up either.

MR. SCHAPEROW: Yes. Actually, if you assume the valve doesn't stick open and you let the thing keep cycling and cycling, eventually you're going to fail a piece of piping somewhere in the system and your relief path to the suppression pool will no longer be the SRV tail pipe. It'll be through the drywell vents

So, the peer review group made us actually pull the string pretty hard on that one and we're still putting a little effort on that to try to make sure we have our arms around that fully. But so far I think we're making some good, good headway on that.

Vessel level. So again, this is short-term station blackout so right from the get-go we start seeing boil off through the SRV and you'll see the vessel level will come down.

We show here two level curves. One is level inside the core region at in shroud, that's the red curve. And the blue curve is the downcomer water level. Of course, you can see the blue curve stops going down once it hits the bottom of the downcomer.

And fission product release for this case starts at eight hours and then we fail the lower head of the vessel, and then fail the containment -- the drywell shell. We get about a ten percent release of iodine and about a two percent release of cesium. The cesium release is lower, and this kind of thing comes out of all of our tests that we've done over the last, I don't know, 20 years or so that would tend to -- Phebus in particular would tend to show that the cesium is less volatile than iodine.

The one curve here which we were a little surprised by is the barium curve. You'll see that the barium jumps up right at the time when the release starts. What's going on here is the core relocates from the vessel to the drywell floor and interacts with the concrete. We have a chemistry model in MELCOR that says that if you have an unoxidized zirconium during this core concrete interactions, you're going to give off barium. Well, here it is. We had a case where we had the core hit the floor, we had unoxidized zirconium and so for first, like, half hour we are using up the rest of the unoxidized zirconium.

We don't see this kind of behavior in Surry because in Surry the containment is all buttoned up. So even though we get a release of barium in the containment in Surry, it settles out in the next few hours. So by the time the containment fails, we're not getting a barium release to the environment.

MEMBER CORRADINI: Can I ask a question?

So in both Peach Bottom and Surry everything is dry when -- I'm trying to understand -- well maybe let me not ask that. Let me ask a different question, more generally.

So the way I read the way you're presenting this that from the moment that I get to meltdown it's long inside the vessel and then all the physical processes that occur from the time I start releasing fission products in vessel to the time I worry about its coming out into the environment or second order of importance relative to the uncertainty, that is it dry outside of the vessel, is it wet outside the vessel, what physical processes would change the source term in that case? All the uncertainty in the core meltdown process you don't mention, so that means they weren't found to be important?

MR. SCHAPEROW: The uncertainties in the core melt progression in-vessel, we started off the project with --

MEMBER CORRADINI: There's a contractor report.

MR. SCHAPEROW: -- an expert panel meeting. And we went through the thing. And we went through for Peach Bottom and Surry each of the scenarios that we had at the time. We hadn't done station blackouts. And we discussed with the experts what we were using for our best estimate numbers for phenomena, what we had in the code. And we went through that. I remember, I think one of the issues was, was when the core left the core region and went into the lower plenum, what are we doing about cooling of the core with the water remaining in core plenum. So we were using some numbers that we had that divine from, I guess it was a FARO test.

I mean, you going to hear more about this than I do, you were involved in --

MEMBER CORRADINI: Well, I'm just --

MR. SCHAPEROW: We went through this expert panel of kind of a elicitation to make sure we had a reasonable set of best estimate numbers for phenomena. And then for any variations we were going to get into an uncertainty study later on.

MEMBER CORRADINI: Okay. So where's the results of that peer review? Was that the CR report that is referenced but I can't see to find? I can look it up.

MR. SCHAPEROW: We have letter reports, one for MELCOR and one MACCS. We also have -- oh, that's why there's a fourth volume of the NUREG is that it was a MELCOR best practices volume that you might not have gotten. I don't know. We didn't send that down. But that has some of the detail. It has our benchmarking in Phebus and VERCORS. I don't see why we can't share it with you.

MEMBER CORRADINI: Okay.

MR. SCHAPEROW: It has all the numbers and kind of the more specific numbers that we used in some of these areas.

MEMBER CORRADINI: So let me ask one that probably is not a problem, but it just interests me.

So if I delay release to the lower plenum, the way I guess I'd view in a very maybe too simplified fashion, is you cook in-core a whole lot longer these days than you used to cook in-core before.

MR. SCHAPEROW: I think that's a fair assessment.

MEMBER CORRADINI: So does that weaken the vessel so if I have an FCI in the lower plenum, I could have a failure where before no failures were assumed due to an FCI to get to the point at hand? I'm cooking it in-core, it would seem to me that you could potentially have a different response because you're all at low pressure, right? You are starting to cook in-core in time sequence after you have depressurized by you the steam generator tubes. I'm back at Surry at least, and this one for another reason, right?

MR. SCHAPEROW: Yes. I think some of our previous calculations, at least with SCDAP/RELAP5 for Surry showed that you could get melting and relocation of structures above the core. You know, you would hit 1700 K which is nominally the melting temperature of some of the steel structure.

Similarly for Peach Bottom, some of the melt core temperatures in structures just above the core are getting around the melting point.

So, yes.

Now the vessel itself with regard to vessel temperatures in the structure of that --

MEMBER CORRADINI: Well, I guess --

MR. SCHAPEROW: I mean, the vessel itself, I guess, further out and further out.

MEMBER CORRADINI: Right. But where I'm going with this is, at least where I'm asking, I'm thinking is that I just see the progression of Peach Bottom and Surry, everything looks like it's a dry sequence externally unless I misunderstood Surry. And nothing, even though you're cooking longer and core seems to affect, you have basically a pretty quiescent low pressure meltdown into water which eventually fills the vessel and then leaks into a dry cavity? Am I missing anything there? That's why I was asking for the report, because I --

MR. SCHAPEROW: Peach Bottom is dry because when the SRV releases steam and water it goes out into the suppression pool. But Surry is not. I mean, Surry the pressurizer relief valve is in the containment, so it's putting stuff in the containment. And also, after the hot leg fails and you get an accumulator injection, you're also getting water on the containment floor. So you're actually getting a bit of water. You're getting all the RCS plus three accumulators into the containment floor for Surry.

MEMBER CORRADINI: And then it all goes into the cavity?

MR. SCHAPEROW: There is enough of that to go into the cavity. As a matter of fact, at Surry there's a hole in the cavity wall about a foot up that they put in there as a result of Generic Safety Issue on --

MEMBER CORRADINI: Because of an IPE?

MR. SCHAPEROW: No. It deals with a recirculation of water in the containment spray -- I get this right. RCCS recirc at 4 30 minutes. So they have a hole now in the bottom. They bored a hole in the bottom of the cavity wall. So there is water flow between the cavity and the rest of the containment. So Surry also has water in the cavity.

MEMBER CORRADINI: Okay.

MR. SCHAPEROW: I believe. And there is water in the containment.

MEMBER CORRADINI: But all this would be in that fourth report for us to better understand it.

MR. SCHAPEROW: The stuff that's in the fourth report is stuff like what we assume for transfer between corium and the water and the blower head of the vessel. I think, hopefully, most of what you want will be in there.

I'm near the end of my presentation. I don't have much on that.

MEMBER ARMIJO: I have a question on your chemistry of the iodine and the cesium.

MR. SCHAPEROW: Yes.

MEMBER ARMIJO: In normal operation for a BWR fuel the cesium is about tenfold the concentration of iodine. And based on work that I did years ago, we found that the iodine was chemically bound with the cesium, it's a very stable cesium iodine. But yet, and maybe it's a temperature affect why the cesium and the iodine don't track together. Does cesium iodine decompose at these temperatures?

MR. SCHAPEROW: When you're saying "cesium there's ten times as much of that as iodine," you're referring to in the coolant.

MEMBER ARMIJO: No, the fission yield in the fuel pellet. We have a lot more cesium formed than iodine.

MR. SCHAPEROW: Oh, that's correct. That's correct. And what we're doing with the iodine is we're assuming that

MEMBER ARMIJO: It's free?

MR. SCHAPEROW: --however much iodine there is that gobbles up that much cesium to form cesium iodine; that's how it travels through the RCS. The leftover cesium, the other 90 percent we have to have a chemical form for that too so we can predict where it's going to go in the system and when. And so the model that has been used, at least until like the mid-'90s, I think, or late '90s was that the cesium would be cesium hydroxide. So based on the latest tests and our code analysis against those tests with MELCOR and other tools, we've switched over from cesium hydroxide to cesium molybdate, which has a lower vapor pressure than cesium hydroxide.

MEMBER ARMIJO: And in this case the iodine is also some sort of a -- is it a free iodine in this case or some type of compound?

MR. SCHAPEROW: Well once it defuses out of the fuel pellets, we're assuming it's in the form of cesium iodine. And so once we make that assumption, then that dictates its vapor pressure and that dictates how much of its vapor and how much is aerosolized.

MEMBER ARMIJO: Okay.

MR. SCHAPEROW: And as it cools down through the system, more and more of that becomes aerosolized.

MEMBER CORRADINI: I thought Sam's question was different. I thought Sam was asking -- I thought you were asking how do you resolve the purple being higher than the green.

MEMBER ARMIJO: Yes, that's what it was. Right. And what he told me, I think I heard --

MR. SCHAPEROW: These are releases -- these are core fractions, first of all. So that ten percent iodine is ten percent of the core inventory of iodine makes it to the environment.

MEMBER ARMIJO: As cesium iodine?

MR. SCHAPEROW: As cesium iodine.

MEMBER ARMIJO: That was my question.

MEMBER CORRADINI: So they're actually tied. It's just the fraction I'm dividing by?

MEMBER ARMIJO: They are tied. And the additional cesium is a molybdate form.

MR. SCHAPEROW: Yes, that's a good point. That ten percent cesium one percent of that is just tied up with the iodine and the other one percent of it is from cesium molybdate getting out.

MEMBER ARMIJO: Okay.

MR. GAUNTT: And some of those signature differences that you see have to do with the volatility of the presumed forms?

MR. SCHAPEROW: Sure.

MR. GAUNTT: And you tend to see the cesium molybdate in the lower volatile revaporizing later and not as readily as the cesium iodine.

MEMBER ARMIJO: Okay.

MR. SCHAPEROW: Yes. Okay. Moving to the other case that we did that went through core damage.

Again, this case we assumed that the operators were able to do a RCIC black start. The figure is labeled here that RCIC was pumping into the RCS for about an hour. And so during that time period that had a cooling and depressurization effect. So we see pressure going down about 800 pounds. And then RCIC stops and the pressure goes right back up to the safety valve setpoint.

Now again we get a couple hundred more cycles on the SRV and the core damage, and eventually the SRV will stick opening after excessive cycles at high temperature.

And the rest of this plot is basically the same as the one I showed you without RCIC black start.

CONSULTANT KRESS: How did you decide when that SRV sticks open? Were you able to decide?

MR. SCHAPEROW: Our criteria at the time was RCIC would have to reach a steam temperature flowing through that valve of a 1000 K.

CONSULTANT KRESS: Okay.

MR. SCHAPEROW: And then you have to go through ten more valve cycles opening and closing.

MR. SCHAPEROW: Okay. That's reasonable.

MR. SCHAPEROW: So we actually when we looked at it most recently as we were going through the peer review comments, we looked really hard at it and realized that we waited ten cycles after the -- okay. When the valve opens and closes the temperature of the gas goes up and down, it swings quite a bit.

So we actually started that ten cycle count after the entire valve cycle saw a 1000 K. So we actually kind of delayed even more.

So we're kind of thinking where we should maybe move the SRV sticking open a bit earlier, although --

CONSULTANT KRESS: That would make things a little worse.

MR. SCHAPEROW: Actually, we're seeing about the same fission product release. Because the fission product release starts --

CONSULTANT KRESS: Well, this is Peach Bottom? Fission product release starts around five hours or so. So we've already got the fission product release going on for about an hour. So if we move that thing a little closer to the start of core damage, everything is still going in the suppression pool. Not everything, but most things. Maybe we should talk about that a little more.

Anyway, this next graph just shows the vessel level returning as the result of RCIC black start and then declining as a result of termination of RCIC.

And finally, this shows -- this is basically the same plot as I just showed you, but everything shifted over about five hours as the result of running RCIC for an hour. We were able to delay everything by quite a bit.

And that's a very high level review of a lot of work.

CONSULTANT KRESS: Let's get to the final release of that into the environment. Is that revaporization?

MR. SCHAPEROW: Yes. What's going on, this is kind of an interesting issue for us. Is that Peach Bottom is a relatively -- this is I think a Mark 1, it's a relatively small containment. So eight hours, you know as we relocated the core; the core is standing on the lower head, it's dry, you get a creep rupture of the lower head, the core falls on the floor. The core is still very hot and there's no water in there. So the core is heating everything up. It's heating up the walls, the pedestal that holds the vessel up, it's heating the vessel up, it's heating the RCS up; it's heating all the internal surfaces of the drywell are being heat up and they're getting really hot. And so not all the iodine went into the suppression pool. Not all the cesium went into the suppression pool. So the iodine and cesium that's still stuck to the drywell or inside the RCS is going to revaporize.

If you let this thing keep going and going, I will predict eventually you're going to revaporize everything that didn't make it into the suppression pool. So that was one of the issues that we bumped up again. Well, you know how long are we going to continue this calculation for; one day, two days, ten days? That's a quite heated question. Sorry about that.

That's a very good point.

CONSULTANT KRESS: I would take the calculations all the way out until I got nothing more released. Because I'm interested in the societal risk and even the amount of wind that happens, you know.

MR. SCHAPEROW: Well, if it hasn't been clear already, the evacuations happen very early compared to the start time. I mean, we usually declare a emergency like within an hour. So, you know, the people are pretty much all gone before this stuff is going on.

MEMBER STETKAR: But it's also assumed that the release is terminated in 48 hours period.

MR. SCHAPEROW: Yes. He's talking about societal; if you're looking at just cancer fatalities, you know then I might argue that well, you know everybody's kind of gone or they've kind of like left the area. Because the societal risk you're concerned about maybe where there's really long term stuff and, you know, making the move back home. Do we have to abandon whatever that place is near.

CONSULTANT KRESS: Those are things that we got to worry about.

MR. SCHAPEROW: That's a much higher level than I in making those kinds of decisions.

MEMBER CORRADINI: So, can I take you back? You're done? I didn't mean to --

MR. SCHAPEROW: I'm done.

MEMBER CORRADINI: So I guess I'm still back with the qualitative observation which I think is a big finding from this. Maybe it was already there in the MELCOR calculations but SOARCA brings it to the fore, which is you cook inside the core longer. And that releases more. And because you're cooking you get more oxidation, you release more fission products early on.

MR. SCHAPEROW: Early on.

MEMBER CORRADINI: Does that compromise any of the structural barriers by the heating or change any of the downstream qualitative branch points? The one that you seem to have written down that I guess struck me was valve cycling and failure. Because that would change the path of whatever residual inventory you have would go.

Are there other things that were identified by this peer review panel as to qualitative differences because of the finding that MELCOR tends to hold things up in the core longer, oxidize longer, release in kind of a cooking pot longer, physical process?

MR. SCHAPEROW: Well, I don't whether the reviewer themselves identified. But we've thought about this issue of well if you're going to start circulating high temperature steam and hydrogen through the system, you're going to start heating up other things in the system and you'll eventually get a failure. So, this whole idea that the lower head fails -- that nothing fails before the lower head, I think we kind of tossed that out. I don't think -- none of our calculations would suggest that you can get to lower head failure without failing something else first.

I don't know if I completely answered your question.

MEMBER CORRADINI: Well, that's the one thing that you've identified?

MR. SCHAPEROW: Yes, we've identified some things. Whether there's something we missed, I mean I like to think we didn't, but --

MEMBER CORRADINI: So the strongest part of the whole primary system is the lower head because that's the last thing that has water in it, is that what you're talking about?

MR. SCHAPEROW: Well, the whole vessel, I mean the vessel itself.

MEMBER CORRADINI: You're now at a point with meltdown the only left is water in the lower plenum, isn't it?

MR. SCHAPEROW: That's right. And actually core relocates into there and gets rid of that as well.

MEMBER ARMIJO: There are a lot of holes in the lower head of a BWR. A lot of penetrations.

CONSULTANT KRESS: The hot core heats up things faster than steam, too.

MR. SCHAPEROW: Yes, a lot of the time between when the core relocates to the lower head and the lower head failure is just heating the lower head, as Tom points out. I think that if I had a plot showing, as he said, the water boils off fairly quickly. Maybe like one hour for that and like three more hours to heat up the water.

I wish I had that plot, but I don't have it with me. Actually, it is in the report, though. Maybe I do have it. Yes, I do have it. Let's see. It doesn't show where the water in the lower head ends.

MEMBER CORRADINI: You're at low pressure at the lower head?

MR. SCHAPEROW: Lower head failure is around 15 hours, right.

MEMBER CORRADINI: But you're at low pressure?

MR. SCHAPEROW: Yes, these are all low pressure.

Yes, I'm sorry I do have the information here. So we relocate at six hours and then the water's going eight hours. And then I don't get lower head failure until 13 hours. So two hours we have water in the lower head and five hours we don't.

CHAIRMAN SHACK: Any more questions for Jason?

We're going to take a break for 15 minutes, just to keep on if that's okay with everybody.

(Whereupon, at 2:38 p.m. off the record until 2:53 p.m.)

CHAIRMAN SHACK: Let's come back into session.

Jocelyn?

MS. MITCHELL: Okay. Thank you very much. Last but not least, I'm Jocelyn Mitchell from DSA.

Pardon?

And I'm going to talk about the offsite consequences. I'll talk about a code called MELMACCS which is the bridge between MELCOR and MACCS. I'll talk about MACCS2 inputs in modeling with emphasis on what is different, new, special about what we've done for SOARCA compared with the standard way of doing things. And then I'll repeat in a little bit more detail what Charlie introduced on the results, and then repeat in a little more detail the conclusions that Charlie introduced.

So MELMACCS, as I said, is a bridge. It transfers the source term information that includes everything; the timing, the heat, so forth. We have nine chemical bins.

One of the new things is that we have the aerosol size traditionally had been done as one aerosol bin with one dry deposition velocity. And MELCOR and indeed the source term copackage had multiple aerosol bins. And we have now carried over

MACCS. MACCS always had the capability and was never utilized. And so we are utilizing in this case ten aerosol bins which are actually chosen for the bin aerosol sizes correspond to the MELCOR.

One other thing that we have done that Charlie touched on is we have broken up almost completely into one hour plume segments. We do have in a couple of cases two different releases paths. One is a leakage, very small leakage. So something that is a very small fraction of the total amount that is going to be released, we put into a longer segment. But the anything that looked to us as if it were a reasonable amount of release, we put into a one plume segment.

MEMBER RYAN: Jocelyn, the aerosol bins, how many could end up in the respirable range being released? Is there a big fraction --

MS. MITCHELL: Nine.

MEMBER RYAN: Huh?

MS. MITCHELL: Nine.

MEMBER RYAN: Nine are in respirable and one is not?

MS. MITCHELL: Probably, yes.

MEMBER RYAN: Okay. Thanks.

MS. MITCHELL: The dry deposition velocity

STET - ok to release this is info from MACCS program file. MPA itself is actually estimated by MELMACCS. You input a wind speed, surface roughness and a choice of percentile. That is we have in put, something that you'll see later, US/CEC, Commission of European Communities Study of offsite parameters. One of the things that they estimated was dry deposition velocity. And we have an equation that allows you to input these and it will chunk out a dry deposition velocity.

So, as I said, the equation and parameters come from the US/CEC study. So from MELMACCS we get in addition the -- one of the things that's missing out of here is the inventory. MELMACCS is also the place that you choose the inventory. We have two choices that we have used, one for Peach Bottom and one for Surry.

Peach Bottom is a specific calculation which is discussed in the first volume of the SOARCA report. And it is a mid-cycle and actually is a very detailed calculation.

The Surry we didn't redo, but we use an end of cycle inventory that was appropriate to a high burnup, which is close to the modern burnup for PWRs.

As I mentioned, the nonsite-specific parameters came from this US/CEC study. The study itself was based on -- I've called it a PERT-like process where they got a bunch of folks together who were considered to be expert in offsite consequences and they asked them what kinds of things do you think are going to be important for either significant or moderate in their influence on the results, important for the results. And based on that there are more than a 100 questions that they put to various teams of experts. Each team was made up of experts from the U.S. and from Europe.

And the questions that they asked them were meant to be something that at least in a gedankenexperimente could be measurable. Now whether one could practical ever do it or not, but they didn't want to ask for the transfer coefficient from soil to the root vegetables. So they asked them if the stuff fell on the ground 15 days, and I'm making up a number, before the harvest, how much could be transferred? What would you find in the root vegetables?

So we used pretty much most of those. We did not use the food pathway, which was one of the big ones from the US/CEC study, as you'll see. We didn't use that. But we used a goodly fraction of the stuff out of this study.

MEMBER STETKAR: Quantification of uncertainties.

MS. MITCHELL: Well, we'll see. That's exactly where we're going to get the ranges of values, the degrees of belief. So we've got a leg up on this uncertainty study, a way of putting it into MACCS through WinMACCS and all the ranges of values and degrees of belief. But it was based on his recommendation that we use the 50th percentile.

MEMBER BLEY: Just a comment. If it's very complex, it doesn't completely work. But if you propagate means, you have some chance of getting a mean value. But if you propagate medians, you don't know what you have at the end.

Just a comment. But when you do the full uncertainty we'll be ready.

MS. MITCHELL: I know. We'll see. We'll see. But if you have nonlinear equations, in particular if you have one over A plus B and you put in the mean value of A and the mean value of B, you do not come out with the mean value of the answer.

MEMBER BLEY: The same thing is true for the medians. But under many conditions you do. But never I think -- well, that's an overstatement. Almost never for the means.

We picked the 50th percentile. So Sandia went through and took the discrepant views of the experts and did a resampling process and produced ranges of values and degrees of belief. And we used the 50th percentile.

MEMBER STETKAR: Jocelyn, why did you use the median value rather the mean value? What you've explained is a fitting of probability distribution --

MS. MITCHELL: We have a probability distribution.

MEMBER STETKAR: Why did you use the median rather than the mean because the mean would be the best estimate in this sense here?

MS. MITCHELL: Well, we talked to a guy named Helton, Jon Helton, who used to be at Sandia and is presently at some university. And it was the uncertainty guru. And he said for a lot of these things you should not use the mean value, the expectation value. But if you're putting it into a calculation, you want to have the 50th percentile value.

MEMBER STETKAR: Mmm. Do you know why? Why? Has he ever done any of this?

MS. MITCHELL: Well, I believe so. I mean, SOARCA-like stuff?

MS. MITCHELL: Yes.

MEMBER BLEY: But anyway. so you kind of have your plan for what you'll do when you address uncertainty, though?

MS. MITCHELL: For the nonsite-specific values there are a fair number of site-specific values which we'll get to shortly where we have to go still and get, gin up a range of values and degrees of believe. I have a laundry list which does, indeed, include elements of the emergency response that I think we ought to put into this uncertainty analysis.

MEMBER BLEY: Wonderful.

MS. MITCHELL: The meteorology data we took from Surry and Peach Bottom's their meteorological towers. Surry is 2004 and Peach Bottom is 2005.

We took population data from the Census Bureau data 2000 data which we corrected to 2005 based on the Census data. We ran it through a code called SECPOP.

MEMBER STETKAR: Now, Jocelyn, on meteorological data you used one year of records from each of the plants

MS. MITCHELL: Yes.

MEMBER STETKAR: Have you thought at all

about, again in the sense of uncertainty, what the effects of annual variability in those meteorological data might be?

MS. MITCHELL: People have looked at that. A lot of people used to believe that you needed to have ten years of data. Now, of course, they didn't look at the uncertainty in their source term. But they felt that you couldn't get a decent answer unless you had ten years of met. data.

I think that they're finding for a lot of the ones that they've looked at, it's a ten percent effect. And we've got a lot of other things that are going to be biggies. And met. data, the peer reviewers discussed that issue because if you look at, we had two years for each of Peach Bottom and Surry, and there was a little bit of rainfall difference in one of the plants in one of the years. And there was maybe not quite a factor of two, as I remember the number of hours. But people have found in general that it's a ten percent effect in the answer.

MEMBER STETKAR: If you look at annual variability for some sites, you can see quite a bit of difference in terms of rainfall and storm patterns and things. If you're looking at severe rainfall events or values. But these are not hourly, these are cumulative rainfall where the ten year variability is a factor of ten in total rainfall over the year. Now that isn't necessarily hour-to-hour variability, but it's an indication of the --

MS. MITCHELL: Yes.

MEMBER STETKAR: -- likelihood of severe storms, for example.

MS. MITCHELL: Yes. Well, wet deposition is a very effective process. And if you have something in an hour it rains, I don't know, a quarter of an inch and then you have something that rains two or three inches, it's a difference between very effective and very hurry effective. And as long as you don't go from, say -- of course, we're talking in SOARCA, we are doing Surry and Peach Bottom. So things that happen at other sites may be interesting if we ever get to do those other sites, and you may come up with another answer for the other site. But where you have very, very few hours in normal years at a desert site and you have twice as many hours, you may want to rethink the issue. But for Surry and Peach Bottom, I don't think it's probably an issue.

MEMBER STETKAR: You wouldn't expect that much, that significant variability. Okay.

MS. MITCHELL: I think Charlie also

mentioned that we changed the previous 16 compass directions to 64 compass directions. And this allowed us to have a little bit better definition on exactly where the plume went and combined with a one hour plume segments, compared with the fact that we used to have 16 compass directions and plume meander. This is certainly much more realistic and can be defended better than 16 compass directions and plume meander.

There isn't a heck of a lot of difference between them for Surry and Peach Bottom.

We also put in morning and afternoon mixing heights. The overnight mixing height is normally lower. So if you have an evening and a night release and it goes up to the mixing height, it's going to be lower so the concentration has to be higher. It turns out that isn't worth very much either.

We changed to a different plume rise model. Briggs, I think, has probably, I don't know, one to two handfuls of different plume rise models. We picked one which we compared with the National Institutes of Standards and Technology where it ha fancy plume rise calculation and have compared their methods with data. And we picked the one of the Briggs plume rise models that compared the best with

NIST.

We used the long-range plume spreading as a distance model. We have a non-uniform weather bin sampling and we had about a thousand samples for SOARCA. In the past what we've assumed is that it was released in one direction and then it processed around the 16 compass directions. So you got 16 answers that were not truly independent of one another, but for a relatively small additional computation you got a lot more information.

Given that we used the network evacuation model, MACCS does not allow rotation around the compass for the network evaluation model. So we have a thousand samples that we picked up in a non-uniform way.

MEMBER STETKAR: Jocelyn, when you say a 1,000 samplings, you had hourly weather plans, right?

MS. MITCHELL: Yes.

MEMBER STETKAR: So you sampled a 1,000 out of the --

MS. MITCHELL: 8,760.

MEMBER STETKAR: -- 8.760? Okay.

MS. MITCHELL: Yes.

MEMBER STETKAR: The sampling routine that you used you feel that you're reasonable comfortable that you picked up extremes?

MS. MITCHELL: It is a stratified random sample. So we take the 8, 760 hours and we bin them into 39 different bins. And there are a certain number of them that are rain related so that you look at intensity of rainfall and distance. And then the others that are left over are binned just by wind speed and stability class.

And so each one of the samples that you pick carries a weight. So we definitely have looked at those things that can be -- they were picked out to be the most important that you won't under estimate the early fatalities. But we have compared with what we used to do. We have done more sampling in the bigger bins of just wind speed and stability class.

MEMBER STETKAR: I mean your population of bins that you're sampling from is --

MS. MITCHELL: Population.

MEMBER STETKAR: But the number of bins that you're sampling from is 39?

MS. MITCHELL: Yes.

MEMBER STETKAR: Okay.

MS. MITCHELL: Right.

MEMBER STETKAR: You're going to get decent presentation of those 39?

MS. MITCHELL: Yes.

CONSULTANT KRESS: Did you actually use the site population?

MS. MITCHELL: The met. tower.

Population comes out of the Census data, the year 2000 Census data.

CONSULTANT KRESS: That's what I was going to ask.

MS. MITCHELL: Right. And it is corrected for what they said and the Census Bureau said is the increased per year. So we corrected it to 2005. Okay?

So, I might mention that SECPOP has a stated simplification which we have not investigated for 64 directions. And somewhere along the line it will breakdown. And because we did not look at it for 64 compass directions, we actually ran SECPOP for 16 compass directions where it was considered to be adequately accurate. And then we just spread those folks out into 64 compass directions.

MEMBER RYAN: Jocelyn, do you look at an age distribution, too; children, adults?

MS. MITCHELL: No.

MEMBER RYAN: No? All does?

MS. MITCHELL: In the Census Bureau?

MEMBER RYAN: Yes.

MS. MITCHELL: We do not have any little box broken down into male and female, it's just people.

MEMBER RYAN: Okay.

MS. MITCHELL: Just people.

The relocation parameters, we have in looking at what could be done, we took the five rem per week hot spot and one rem in one week normal relocation. Those are the EPA guidelines for considering emergency action. And we looked at those two values and said given for this scenario when would it be likely that the folks who are running the evacuation would be finished running the evacuation and so they could go out and find these hot spot or the normal elevated level and get those folks to relocate.

So the values are not changed from scenario-to-scenario but the timing is changed from scenario-to-scenario depending upon when we felt that the evacuation would free up the bodies. You were talking about the bodies; where you going to get the bodies to do it? That's the basic thing that we looked at here is where are you going to get the bodies to do this.

We have dose conversion factors, came from Federal Guidance Report-13. This is an EPA document. It was done by folks from Oak Ridge. Keith Eckerman and company, who is the world's guru in this area. And he and his company down there -- his group. I shouldn't say company. His group down there produced Federal Guidance Report-13. And we took our dose conversion factors from there.

This is a change. These are based on ICRP, I guess it's 68 and 72. We used to use the numbers from like 20 -- and you probably know better. Twenty and what?

MEMBER RYAN: Thirty.

MS. MITCHELL: Thirty.

MEMBER RYAN: Twenty-six and 30.

MS. MITCHELL: Right. So this is more up to date.

Because we have only a finite number of individual tissues for which we actually calculate individual cancers, we have to do something for residual. And we called up Keith and Keith suggested that for the residual cancers we should use the dose conversion factors for the pancreas. We have a letter report that, hopefully, explains that.

The latent cancer fatality risk factors

came from BEIR V. Previously we used BIER III. The change from BEIR III to BEIR V, all else being constant, will be to raise the latent cancer fatalities by a pretty noticeable amount. So when Charlie said in general the Sandia Siting Study had conservative values throughout, this is one of the places where it didn't have conservative values at all. So --

MEMBER CORRADINI: I guess maybe I misunderstand. Jackie Yanch in the review suggested that you move on t BIER VII and --

MS. MITCHELL: Well, yes. We would have liked to have done that. And when BIER VII came out, being totally naive, I just got the report and I was looking for a table that I could just -- it says BEIR V is this and BEIR VII is that. And I could just make a one-for-one replacement.

And if you even look at Jacqueline Yanch's table, you see that they are offset. And BEIR V has a number where the tissue is described in one way and then on the next line down is he BIER VII where the tissue is described as somewhat different.

So I was, gee, I can't just make a one-to-one substitution. I mean, they themselves didn't write it on the same line. What is it that I don't know.

So we talked to Keith Eckerman and he says, well, he's going to have to go back. He's got a job from EPA that he's going to go back and produce the daughter of Federal Guidance Report-13.

MEMBER RYAN: Which lines up BEIR VII?

MS. MITCHELL: Which lines up with BEIR VII.

And he said that reading BEIR VII gives him a headache. And if it gives him a headache, you know not being a local expert in this, what is it going to do for me.

MEMBER CORRADINI: This is way far removed from what I understand. But if I understood the comments by that one peer reviewer, by Professor Yanch, my impression was now you guys are over estimating by about 50 percent.

MS. MITCHELL: No.

MEMBER CORRADINI: Am I misunderstanding that?

MS. MITCHELL: Yes. Yes.

MEMBER CORRADINI: Because I looked at her table and that's the way it kind of came down to me.

MS. MITCHELL: Yes. You're right. I'll get to that.

MEMBER CORRADINI: Okay. Sorry.

MS. MITCHELL: Okay. So the latent cancer fatalities, as I mentioned, from BEIR V, the values for the tissues we got from Keith Eckerman. One thing, he talks about biological effectiveness factor rather than RBE, relative biological effectiveness because he absorbs or they now absorb something else into it, which is why you can get bone marrow equal to one and breast equal to ten rather than the standard RBE for high linear energy transfer that is alpha particles normally is considered to be 20.

So all of this stuff we have been in intimate discussions with Keith Eckerman and company about exactly what can we do today to get a better job on it.

MEMBER RYAN: Correct me if I'm wrong, Jocelyn, but I think some of those things, you know like LET and all the rest, they try to combine them into a factor that's an effectiveness of the energy in a given tissue

MS. MITCHELL: Yes. Right.

MEMBER RYAN: So I think the goal is to describe them in one number that takes care of how much energy is deposited in a specific organ of tissue and what the effectiveness is of having an effect --

MS. MITCHELL: Yes. Yes.

MEMBER RYAN: -- in that organ of tissue for, say, alpha versus beta versus gamma; whatever it might be. So I think it's more of a translation issue with a little bit of new science here and there than it is a wholesale replacement of the science. Would you agree with that?

MS. MITCHELL: Yes.

MEMBER RYAN: Yes.

MS. MITCHELL: Yes.

MEMBER RYAN: Like you say, it makes the translation job and the bookkeeping of what number changed to what and why and what the answers change means is important.

Does that help you, Mike?

MEMBER CORRADINI: Kind of. I'll sit next to you and get more.

MS. MITCHELL: Okay. We also changed the shielding factors. NUREG-1150 had four of the five plants that they analyzed. They had gone through regional-specific look at what kind of buildings do they have in each area. And so therefore, for anybody who was inside the building what exactly would the shielding factor be.

So we took that information and what we

actually changed was the fraction of the time that people spend outdoors versus indoors. And we have actually compared with NUREG-1150, raised the fraction of the time inside a little bit.

Both Peach Bottom and Surry have KI, potassium iodide that they would provide for the people in their EPZ.

MEMBER RYAN: Is it pre-staged? In other words, do the people have it in their homes now or--

MS. MITCHELL: I believe that they both do. I know that some states do not.

MEMBER RYAN: Because, I mean that's really an important thing. Because if they try to distribute it after the incident, it's going to be tough to get a high return.

MS. MITCHELL: Yes.

MEMBER RYAN: If it's pre-staged in the homes, not in the emergency response center, that's a big difference. I mean, it carries down.

MS. MITCHELL: Well, we only assumed that 50 percent of the people knew where their pills were and/or decided to take them with them. So we did not give a lot of credit for it. So the non-optimal time we gave them 70 percent effectiveness.

MEMBER RYAN: How many days of uptake? So

50 percent take it and a non-optimal time. What's a non-optimal time?

MS. MITCHELL: Such that they only get 70 percent instead of 90 percent effectiveness.

MEMBER RYAN: Blockage?

MS. MITCHELL: Yes.

MEMBER RYAN: So you're doing it on a --

MS. MITCHELL: Yes. Yes.

MEMBER RYAN: Great. Very nice.

MS. MITCHELL: One of the things that Charlie talked about was what we called the habitability criteria. We're moving on to the late phase of the accident.

This is one thing that has been changed. Peach Bottom uses a Pennsylvania-specific value of 500 millirem in a year. And Surry uses the implementation of the EPA guideline which we implement as four rem in five years.

It used to be a lot higher than that. So we have reduced the amount of dose that we are allowing people to receive as they come back to their homes.

People refer to this as voluntary. That was one of the peer reviewer comments is "Oh, well, this is just voluntary." Yes, in some sense it's voluntary. But it sure would cost a lot; that is you might have to condemn a very noticeable area depending upon how you choose to do this.

People said well if you're getting a very large fraction of the latent cancer fatalities are actually come from people returning to their homes after the incident is over, then all of that voluntary and you could just dispense with it. Yes, but actually they're going in an exactly and opposite direction.

The Department of Homeland Security has suggested a 19 criteria optimization process for dirty bombs and for improvised nuclear devices. EPA was talking --

MEMBER RYAN: That would be very costly, too.

MS. MITCHELL: Yes. And one would not even start this until after the accident was over, or in this case the dirty bomb or the improvised nuclear device was over. But it's interesting kinds of things like intergenerational equity and something to do with ecological damage and lots of other, and it says, "like the 19, at least consider these and maybe more."

MEMBER RYAN: Jocelyn two questions if I may. One is has anybody taken a look at deposition and tried to estimate either outdoor and/or indoor exposures to theoretical residence in the planning zone for either of these cases?

MS. MITCHELL: Well, yes. That's exactly where the stuff comes. As the plume is moving downwind --

MEMBER RYAN: But the plume is gone now.

MS. MITCHELL: Plume is gone. So you're not going to any inhalation, no cloud shine, no additional --

MEMBER RYAN: Resuspension and --

MS. MITCHELL: -- you get resuspension inhalation. But as that has moved down, then stuff is depositing either wet or dry.

MEMBER RYAN: Yes. And that's going to be suppressed.

MS. MITCHELL: And so you deposit all this stuff down and this is the particle size. We now have particle size dependent dry deposition velocities. Wet deposition is not modeled as particle size dependent.

So you're depositing all of this stuff. And so MACCS knows that in this little area of this grid this is how much stuff has deposited there and this is of the nine chemical element groups, noble gases are not depositing, but of the eight --

MEMBER RYAN: Yes.

MS. MITCHELL: -- that would deposit, this is what is deposited. And so it knows exactly --

MEMBER RYAN: But that ends at the passage of the plume and now we have some sort of process to sequester those materials in place, right?

MS. MITCHELL: They stay there until they either weather or somebody decontaminates it.

MEMBER RYAN: Right. But how realistic are the dose estimates for real life conditions in those areas or homes, or both after the plume's long gone?

What I'm trying to get at is at Chernobyl, for example, people have rehabited Pripyat.

MS. MITCHELL: Yes.

MEMBER RYAN: Even today.

MS. MITCHELL: I thought Pripyat wasn't, but certainly the zone in which --

MEMBER RYAN: Well, close by that area.

MS. MITCHELL: -- zone in which people--

MEMBER RYAN: And they're farming and doing all sorts of other things and it's really interesting as to how that's turned out over time.

MS, MITCHELL: Yes.

MEMBER RYAN: So, I just wonder if any of the realism of what's been measured and the value there has been checked against what these models calculate?

MS. MITCHELL: No.

MEMBER RYAN: By the way, the ecologists have said that the area around the Chernobyl reactor is a very robust ecosystem because people have been out of it for so long.

MS. MITCHELL: Right.

MEMBER STETKAR: You get rid of the people.

MEMBER RYAN: There's species of animals that they haven't seen in a 100 years.

MS. MITCHELL: Take the people out of the equation.

MEMBER RYAN: Well, I guess I'm just trying to understand what a dose estimates against the criteria the EPA puts forward really might be and how confident we are those are realistic as opposed to stylistic?

MS. MITCHELL: Well, they're probably as good as, I guess, the state-of-the-art.

MEMBER RYAN: I hear you, but that doesn't answer my question.

MS. MITCHELL: And that isn't saying very much.

MEMBER RYAN: Okay.

MS. MITCHELL: That isn't saying very much, right?

MEMBER RYAN: Not much.

MS. MITCHELL: Charlie mentioned that we have no food and water pathway. We assume that uncontaminated stuff could be brought in from the outside.

The economic parameters are used from NUREG-1150 but they're adjusted from the time that NUREG-1150 determined them for inflation by the Consumer Price Index.

Costs are not reported, but the economic model definitely affects the doses. MACCS makes a trade-off between dose and cost. It makes a cost-based decision on whether or not to decontaminate to interdict or to condemn.

MEMBER RYAN: And what exactly is the criteria, or is there?

MS. MITCHELL: The user puts it in.

MEMBER RYAN: Oh, the user is specified?

MS. MITCHELL: -- The user puts it in.

MEMBER RYAN: I'm going to spend X dollars to eliminate a person rem.

MS. MITCHELL: In Peach Bottom we're not going to let anybody come back anywhere unless it's 500 millirem in a year or less. And then we have a cost of decontamination and an efficacy of decontamination, and a time period over which it takes them to do it. So, you look at it --

MEMBER RYAN: Well, that's to a multipliers on your basic cost?

MS. MITCHELL: The time period if it's a big level of decontamination, it takes longer to do it so nobody can come back during that time period because they're still working on it. So that's where that comes in and influences the amount of dose. So we're only doing a 50 year calculation. And so if it takes a year to do the decontamination, that means under the best of circumstances they could only be there for 49 years.

So all of these things affect the dose. If land is cheap, then it isn't worth it to decontaminate stuff. And so the land is condemned, and that reduces the dose, but the cost goes up.

So, as I say, there's a trade-off between dose and cost and we probably -- not we probably. We do not display it. And I think it leads people into the idea that it's voluntary to get all these doses and we could easily reduce them if we wanted.

MEMBER ABDEL-KHALIK: Is the no food/water pathway consistent with the total evacuation plan?

MS. MITCHELL: The food that you have in your house already isn't contaminated because it was produced some --

MEMBER ABDEL-KHALIK: No. People in transit?

MS. MITCHELL: It only takes them a few hours to get out. And so even if something fell on the land, you're not going to harvest the root vegetables. So in the early phase of the accident the food has come from someplace that's not contaminated. This is a late phase issue.

CONSULTANT KRESS: Do you decontaminate land by digging it up and hauling it off?

MEMBER RYAN: Right.

CONSULTANT KRESS: Where do you put it?

MEMBER RYAN: That's not part of the equation.

MS. MITCHELL: Not part of the dose equation, though the people who are decontaminating do get dose. They do get dose.

MEMBER ARMIJO: Jocelyn?

MS. MITCHELL: Yes.

MEMBER ARMIJO: Is this a state decision whether you use, for example, the Pennsylvania-specific criterion for habitability or the EPA criterion, or is this a federal?

MS. MITCHELL: The EPA is a federal guideline. The Pennsylvania --

MEMBER ARMIJO: Pennsylvania more stringent?

MS. MITCHELL: -- has a Pennsylvania-specific value.

MEMBER ARMIJO: That is more stringent?

MS. MITCHELL: Yes.

MEMBER ARMIJO: Okay. So that's okay. But if you're not using the Pennsylvania number, you would use the EPA number?

MS. MITCHELL: Well if at the time that the accident happened sometime in the future the DHS process will have been put into place for reactor accidents, then the local people would get together and use this 19 criteria optimism process.

MEMBER ARMIJO: God help us.

MS. MITCHELL: And I haven't a clue as to what it would actually come out.

MEMBER ARMIJO: So DHS would actually be

regulating reactor accident criteria the way --

MS. MITCHELL: No. The local people, the local -- DHS gave a list of 19 criteria. And they said after the accident, after they did it for dirty bombs and for improvised nuclear devices, this is published rule from DHS for dirty bombs and for INDs.

MEMBER ARMIJO: Yes.

MS. MITCHELL: EPA was talking about adopting it for reactor accidents, but they haven't done that yet. So what it says is after this incident has occurred, the local people come to a decision balancing at least these 19 criteria, optomizing them however they choose. And whatever they choose will have some dose implication.

MEMBER RYAN: And the DHS criteria that aren't based on dirty bombs and all that, are of course dramatically different than a reactor accident both in terms of the content, the distribution materials, you know the kinds of physical and chemicals forms that you'd see; all those sorts of things.

MEMBER ARMIJO: Yes.

MEMBER RYAN: So, I think you've hit on an important point that it's apples and oranges in terms of criteria.

MEMBER ARMIJO: Yes.

MS. MITCHELL: They don't have a number.

MEMBER RYAN: Well, in terms of a system to make the evaluation.

MS. MITCHELL: A system to make an evaluation --

MEMBER RYAN: A whole different basis.

MS. MITCHELL: -- would be dramatically different.

Pennsylvania has a number, and the EPA has reimplemented as 4 rem in five years is actually written as 2 rem in the first year and a half of rem each year thereafter.

MEMBER RYAN: It is thereafter.

MS. MITCHELL: So that's where we get this implementation of it.

We're getting to your answer now on what is Jacqueline Yanch's position. Okay.

The dose-response modeling for low doses, which in this context is defined as less than ten rem--

MEMBER RYAN: Over what period of time?

MS. MITCHELL: Lifetime, if necessary.

MEMBER RYAN: Yes, I'm making a point here. It's very low dose rates. It's not ten rem, you know like a CAT scan would be in one sitting.

MS. MITCHELL: Right.

MEMBER RYAN: Okay.

MS. MITCHELL: So there's absolutely no unanimity on what dose-response model should we use at low doses. And opinion, as Mike knows very well, ranges from supralinear to hormesis and everything in between.

MEMBER ARMIJO: Supralinear is at low doses or even worse?

MEMBER RYAN: Yes. Low dose rates --

MS. MITCHELL: So instead of being like this, it would actually have an --

MEMBER CORRADINI: A Y intercept versus an X intercept, versus zero; that's the way I look at it.

MEMBER ARMIJO: Okay.

MEMBER RYAN: And hormesis is are the radon mines good for you?

MEMBER CORRADINI: Good for you, right. And I understand that one.

MS. MITCHELL: And radiation is good for you. Okay.

We didn't actually even suggest using either of those. We've looked at recognized national and international group opinions to get our ranges of values.

The last time we met with the ACRS we told you that we were going to use the Health Physic Society position, which is five rem in any one year or ten rem in a lifetime. Prior to that, as Charlie mentioned, an original paper that we wrote said we were gong to use a range of values. But at the last time that we were here, we were going to use just one.

Subsequent to that we wrote another SECY paper that said here are some alternatives, and the one we suggested was to use the linear no threshold model, and a threshold of ten millirem. Ten millirem comes out of an ICRP document.

Nobody tells you. When they suggest that you should use a threshold, people are reluctant to stick their neck out and say what the value is.

What the ICRP said is that the response model is actual linear, no threshold; however, you should avoid summing up accumulating trivial doses because the caveats that go with them normally do not get carried over and it is not really the way it was supposed to be used and so forth. But they never bothered to define "trivial."

So you go to another document and you can maybe deduce that ten millirem in a year is not a bad estimate.

We were also going to zero to ten, zero to 50 and zero to 100 miles from the site. Now we're only going to report the two closer in values. They happen to be higher than the zero to 100 miles. We found that for those two, zero to ten and zero to 50 there's almost no difference whatsoever between LNT and 10 millirem. So in order to really reflect fairly the range of opinions in this area we're going to go back to our original suggestion and actually add two more thresholds: 620 millirem a year which is the average U.S. dose including the medical and then the Health Physic Society position.

So now we have four dose-response model linear no threshold. And then truncation values of ten, 620 millirem, and then five rem in a year and ten rem in a lifetime. This is where Jacqueline Yanch--

MEMBER CORRADINI: Can you just go back one slide? You kind of accelerated through the point slide, I want to make sure I get it right.

MEMBER RYAN: Yes.

MEMBER CORRADINI: So you've got four thresholds, or I should say four ranges.

MS. MITCHELL: Yes. Four dose-response models.

MEMBER CORRADINI: So one the LNT?

MS. MITCHELL: Right. Truncation values of ten.

MEMBER CORRADINI: Okay.

MS. MITCHELL: And 620 millirem in a year.

MEMBER CORRADINI: Or the HPS recommendation?

MS. MITCHELL: And the Health Physics Society recommendation.

MEMBER CORRADINI: Okay.

MEMBER ARMIJO: Now is a truncation value the same as a threshold?

MEMBER RYAN: No.

MS. MITCHELL: No. No. We implemented it as just as a flat out truncation value. If you look at what reality would be, suppose there really is some sort of a threshold? People want to get up to a point where people sort of agree on what point it should go through. But where the threshold is to this, there's going o be some sort of a curve that will go through it. Given that we have people who believe its 10 millirem and people who believe that its ten rem, trying to gin up some very nice looking, smooth curve is just gilding the lily. So we just flat out said if it's below that value --

MEMBER RYAN: It is such a small increment of risks and you'd be hard pressed to define any population group --

MEMBER CORRADINI: Yes.

MEMBER RYAN: -- in which you could demonstrate a hypothesis that ten is different than 20, that 20 is different than 50. It's just an intractable kind of answer.

MEMBER CORRADINI: But I thought Sam was about to ask a question. I understand what you're saying here. I don't understand how you institute it.

MEMBER ARMIJO: Yes. I think he and I are in the same confused state. The fact you said it, now I understand --

MEMBER RYAN: Assuming the dose is ten millirem is really the question. If my dose in the exposed population is ten millirem, how am I counted?

MS. MITCHELL: We look at the whole body dose. We calculate based on dose --

MEMBER RYAN: Let's say my whole body dose is ten millirem. The question is what happens to me as a member of the cohort? Am I counted as zero or am I counted as truncated and who cares about him?

MS. MITCHELL: It's ten millirem. You're talking about where is the equal to sign

MEMBER CORRADINI: No.

MS. MITCHELL: No?

MEMBER CORRADINI: No, I think he's says is if there's ten of us at the table and this side was just shielded properly and we're at eight millirem and everybody else is greater than ten millirem.

MEMBER RYAN: Yes.

MEMBER CORRADINI: And ten millirem is your truncation, how is it computed? That's what I think --

MS. MITCHELL: It's an average. It's average--

MEMBER RYAN: Are we averaged in?

MS. MITCHELL: Average over a little box.

MEMBER RYAN: Who's in the box?

MS. MITCHELL: I --

MEMBER RYAN: The people over ten or the people at eight plus the people at ten?

MS. MITCHELL: The granularity of the calculation doesn't distinguish how the people that might be inside versus outside are not distinguished. But the calculation is only done on a grid element.

MEMBER RYAN: Well then with that explanation it's not clear what ten millirem as a truncation point does to the calculation.

MEMBER ARMIJO: I think it's going to be really hard to explain. The communication part is a big issue here.

MS. MITCHELL: Yes.

MEMBER ARMIJO: And you've got five or four different dose-response models.

MS. MITCHELL: Four.

MEMBER ARMIJO: Four. And I think at some point the NRC should say this is what we think is the right one. You may not want to say it, but I think somebody --

MEMBER RYAN: That this is the one that we're going to use for the purposes of calculation.

MEMBER ARMIJO: -- should say this is one that we, whether we believe its right or conservative, just pick something that you believe in. If you can't, then who is going to do it.

MS. MITCHELL: Yes.

MEMBER RYAN: Jocelyn, let me try it a little different way. And if we agree, and I agree fully with the idea that 620 millirem is a good representative number of a U.S. average dose for natural and man made including medical sources of exposure, the realism is we're going to have some fraction of that, or maybe even a multiple, I don't know based on where you are and what the accident is, of a multiple of that relative to the dose received and where I'm located and all the rest. So if my dose is 620 millirem plus my background, which let's say is 620, I'm not feeling great but I'm not feeling horrible. If my dose is ten millirem and at 620, I could care less.

So, I guess I'm trying to get you to tell us how these numbers are interpreted. And, Sam, I think that's kind of where you're coming from. What does this mean?

MEMBER ARMIJO: This is the agency that has the responsibility.

MEMBER RYAN: Yes.

MEMBER ARMIJO: And I'm looking to what is this agency going to tell the public.

MS. MITCHELL: From the point of view of regulatory arena, it is abundantly clear what the NRC uses, and that's LNT. And no plans that I know of to change that at all. So from a regulatory point of view it's LNT.

MEMBER CORRADINI: But let me --

MEMBER ARMIJO: I am talking informing the public of what's safe.

MS. MITCHELL: But the problem is that you have all of these august bodies that are out there in the world and they don't agree. They don't agree.

The French believe that LNT is not supportable technically and that have either a threshold or a practical threshold. But they don't tell you in writing what value that is. If you speak to them, they may tell you a value in private, but they haven't actually written a number on the page.

MEMBER CORRADINI: But I guess I just go back to something really simple. I want to understand how these things instituted.

So just take the ten people in the room. We're saying ten people in the room, this is 10 million people in a sector.

MEMBER RYAN: Good enough.

MEMBER CORRADINI: What I think we're asking is if there's ten million of us in one of your sectors in the calculation and one million of the ten million is below ten millirem, they are not counted in the accumulated dose that would cause some health effect? Is that what this means?

MS. MITCHELL: Yes.

MEMBER CORRADINI: Okay.

MS. MITCHELL: But it's still not on an average over --

MEMBER CORRADINI: Right, some grid.

MS. MITCHELL: -- a grid.

MEMBER RYAN: That number assigned is ten millirem. They're out.

MS. MITCHELL: Yes. They're out.

MEMBER ARMIJO: So you don't calculate latent cancer fatalities for many of those things?

MS. MITCHELL: We look at the dose that is calculated if it less than ten millirem, then we do not go through the latent cancer fatality calculation.

MEMBER ARMIJO: Exactly.

MS. MITCHELL: If it is 11 millirem --

CONSULTANT KRESS: Then there's a --

MS. MITCHELL: -- they go through the standard calculation.

MEMBER CORRADINI: And then you do that at 10, 620 and five per year or ten rem?

MEMBER RYAN: Right.

Sam, it's a fair thing I think to derive these numbers based on cancer incident rates adjusted for all of the causes and all that because that's an average. It's bad science in my opinion to go the other way and say my dose is, therefore my cancer risk is X. Well, that has nothing to do with me and the rest of my either good or bad habits on what my risk might be.

MS. MITCHELL: Yes.

MEMBER RYAN: Smoking and you know all the rest of the things that would have big influences on cancer risk --

CONSULTANT KRESS: Or delta risk.

MEMBER RYAN: -- including my genetic background. So, you know it's very difficult to get across, and I appreciate the point you're making that you can derive limits based on all that epidemiology, but you can't then apply the epidemiological number to me as an individual and expect it to accurately represent my risk.

MS. MITCHELL: Yes.

MEMBER RYAN: So that's the problem that we're trying to wrestle here. And I fully appreciate what you're saying is, you know it's people are going to take the number and apply it to themselves. Well, that's just wrong. I mean, on average we have you know people who are 5'8" in the room. And I'm always the tallest one in the room. So, you know, it doesn't work to apply an average to an individual in a backward away.

MEMBER ARMIJO: Agreed.

MEMBER RYAN: Almost always, except on an

NBA court.

So I appreciate what you're wrestling with. We haven't made it any easier by having four different metrics up there either.

MEMBER ARMIJO: Yes, I think that's--

MS. UHLE: This is Jennifer Uhle, Director of Division of Systems Analysis.

This was actually Commission direction to us about taking a look at the difference in responses according to some of the theories that I would say reputable health physics bodies have come up with. And I would like to point out that we do use LNT from the standpoint of regulatory decision making. But this study is supposed to be a best estimate study and the Commission was specific about don't consider how this information is going to be used. That's another step that they will, of course, be very involved in.

So at this point in time we're trying to represent the best science possible. And as there is a difference of opinion across some reputable organizations, we felt that having a sensitivity study and looking at the effects from the different dose models was appropriate. Now how we go forward and communicate to the public is going to be handled separately.

MEMBER ARMIJO: Yes. Got it.

MS. MITCHELL: One of the things that Jacqueline Yanch was very interested in was dose and dose rate effectiveness factor, lovingly known as a DDREF.

We implemented, along with the BEIR V numbers, a DDREF equals to except for breast which we put in based on Keith Eckerman's recommendation, equal to one.

During the late phase of the accident it applies to all doses. There is no check made on what the dose is, likely to be very small given the habitability criterion, but there is no check made on the dose. It's just applied across the board.

For the early phase of the accident it is applied if the whole body dose is less than 20 rem.

So Jacqueline Yanch I don't think quite understood that we really do apply dose and dose rate effectiveness factor.

I believe that reading her comments that she would think that it might even be more than this. But she does not suggest another value. She suggests further research on the subject.

CONSULTANT KRESS: The lower dose's rates are less effective?

MEMBER ARMIJO: No, more.

CONSULTANT KRESS: The rate. Rate.

MS. MITCHELL: Dose rates. We should have been more careful about this. It goes in the denominator, okay. So it is low doses and low dose rates are considered to be less effective in causing damage, mainly there's repair --

MEMBER ARMIJO: Well, that is refreshing. That's the first time I've ever heard one of these things that sort of makes sense.

MS. MITCHELL: It's been done for years. It used to be one and a half, and I believe ICRP said that they only felt that you knew it to one significant digit. And so that's where those numbers come in.

CONSULTANT KRESS: But for the breast, it doesn't matter what the dose is.

MS. MITCHELL: Yes.

For early fatalities, I think Charlie talked about it. The releases are delayed in time both for processes within the core. The natural circulation stretches things out. But one of the important parts of the issue is actually the behavior of the containment. We used to believe that there were processes that could give you early containment failure, and we no longer believe that those are reasonable scenarios. So basically the releases are later in time and they're also very much smaller because the mode of containment failure has changed from opening a very large hole which rapidly depressurized the containment and flushed all of the fission products out so that you had a puff release followed by a long tail. The leakage, excessive leakage failure mode that we now consider gives you very, very long slow releases. And because of those, the early fatality for both mitigated and unmitigated cases for the scenarios examined have a essentially no early fatalities.

We did see the Surry ISLOCA unmitigated scenario actually predicted very, very small but non-zero early fatalities.

MEMBER STETKAR: Jocelyn, how would that conclusion be changed if you had the scenarios developing with containment isolation failure? Because I noticed all of the scenarios, except for the ISLOCA obviously and the induced tube ruptures had successful containment isolation.

MS. MITCHELL: Well, Peach Bottom runs inerted and if you had a hole open in that containment that failed to isolate, you would be constantly putting out your nitrogen. So it's really not a very likely scenario for Peach Bottom.

MEMBER STETKAR: I'm not talking about preexisting. I'm talking about normally open containment isolation pathways that fail to isolate.

MS. MITCHELL: Like what? The liquid pathway at in TMI or --

MEMBER STETKAR: Some liquid pathways, some other lines.

I guess what I'm asking is I don't think that the analyses actually qualified the reliability of containment isolation. They did not. So the question is -- but I don't know the sensitivity of the results of that.

MS. MITCHELL: Yes. Peach Bottom is inerted.

MEMBER STETKAR: Okay.

MS. MITCHELL: And Surry is sub-atmospheric. And neither one of those could be held if you had an open containment.

MEMBER STETKAR: A preexisting open leak, that's true.

MS. MITCHELL: Yes.

MEMBER STETKAR: I'm talking about other normally open piping pathways that might communicate with the external environment.

MS. MITCHELL: We'd have to ask the containment folks. Certainly the TMI release was through a liquid pathway.

MEMBER STETKAR: One thing that came up in some work a week ago was a steam line break, for example on a boiling water reactor that you failed to isolate the main steam line. There's one.

MS. MITCHELL: Yes. I don't think we looked at it.

MEMBER STETKAR: Do you have a sense of how sensitive the early fatalities would be for that given the timing or you just hadn't really thought about it?

MS. MITCHELL: I don't know. I haven't thought about.

MEMBER STETKAR: Okay.

MS. UHLE: I'm sorry. I didn't quite hear. Can you repeat your question?

MEMBER STETKAR: The question is that the analyses have not quantified the likelihood that the containment is not isolated. They've simply inferred whether containment isolation would be successful or not. And there are scenarios where, you know without quantifying that you don't actually know the likelihood the containment is not isolated.

MS. MITCHELL: I think, you know you're talking about not containment, you're talking about like the ISLOCA in that the RCS has failed --

MEMBER STETKAR: No. No.

MS. MITCHELL: -- outside of containment. The main steam line --

MEMBER STETKAR: I was pretty careful to say the word "containment."

MEMBER CORRADINI: So it's more than just essentially a tube rupture or an ISLOCA, it could be other ways in which it failed to isolate?

MEMBER STETKAR: MSIV, you know boiling water reactors. I picked steam line break in a boiling water reactor.

MEMBER CORRADINI: And it fails to totally break.

MEMBER STETKAR: The last time I checked the steam line communicates with the reactor vessel so you can consider that an ISLOCA, or --

MS. MITCHELL: Yes.

MEMBER STETKAR: -- you can consider it a containment isolation failure. Ventilation lines that are normally open in certain containments. Now the two that you picked, two you picked are lucky; its a sub-atmosphere and its a normally inerted one. So you're pretty lucky on those. But the vast majority are not sub-atmospheric and they're not normally inerted.

MS. MITCHELL: Yes. Well, I think Charlie made a pretty good case for the fact that we believe now that's it important to do calculations from beginning to end based on a particular plant. So the fact that we're talking about what is true for Surry and Peach Bottom, they may or may not be true for other things.

MR. TINKLER: I'm recalling, at least some OECD work that was done a few years ago that looked at containment insolation failures. And independent failures of containment isolation where, as I recall, in the ten to the minus three range. Because the important valves that connected containment atmosphere are rare operators. They'll close. I mean, that's a requirement, and it's been a requirement with the NRC for a long, long time.

MEMBER STETKAR: Well, be careful and look at some of the new plant designs. I will tell you that they are not.

MR. TINKLER: No, I understand. I understand there's some issues whenever you go back to things like isolation events, there's some things like that, your return path for the operating fleet with air operators on containment isolation valves. And I think it's generally seen, like I say, on generic studies I'm recalling, OECD studies, that they have that kind of reliability. And if you pile that on top of another scenario with a frequency of then to the minus seven, you're getting in really small numbers now.

So could you get a scenario with an early fatality? Sure, but you're talking ten to the minus ten, then it means then we're back in that same discussion we had earlier this morning.

And the other point I would make is for that case where we did have a none zero number, the non zero number had one mile conditional early fatality risk was two times ten to the minus seven conditioned on the event. Considering the event, it's going to put you into ten to the minus 13 to the ten to the minus 15 range for that scenario. That's how close to zero that non zero number is.

MEMBER RYAN: I think it is real important to grasp that in this population around the reactor the cancer incidence rate will be .3 if the reactor is magically removed.

MS. MITCHELL: Yes.

MEMBER RYAN: Point 3 is the cancer rate in that population, that's roughly the dose.

MEMBER STETKAR: Yes, I understand.

MEMBER RYAN: So we're talking about these very, very small numbers away from a number that's 30 percent. I just want to keep a little reality on the table.

MR. TINKLER: You know, I always joke I'm going to put up a slide that ten to the minus 13 does indeed equal zero.

MEMBER RYAN: That works for me.

MR. TINKLER: The other point I want to make is non zero at one mile and two miles, but beyond two miles it went back to zero again.

MS. MITCHELL: The threshold that was put in for it. This is a threshold event.

You've seen all these numbers before.

This is zero to ten miles.

This is Surry. These are the accidents that we looked at.

The only issue that I would point out to you is if we're looking at one of the things is what exactly do the mitigative measures buy for us. And so the last column is the risk reduction.

And in the thermally induced steam generator tube rupture accident where the release is early and it's going to happen anyway, you really reduce very little. But the rest of them are pretty effective.

So you've seen all these numbers before.

Peach Bottom the same thing. You've seen all these numbers before. Based on what Bob Prato said, I wish I hadn't put in here delayed release on the mitigation. There's a little bit of discussion about exactly what is mitigated. Me, I wish it had been blank. So in your mind erase these. But you've seen all of these numbers before also.

I did want to show a few what I think of as interesting kinds of things. That here is for Surry, ISLOCA. This is the result of the four dose-response models zero to ten miles, 20, 30 and zero to 50. So the numbers that we will report are the first ones and the last ones. And you can see that there's very, very little difference, as I mentioned, with the ten millirem per year. But then when you get to the background, the 620 millirem year and the Health Physics Society, you see that they drop down. Close to the site they're dropping down a decade and a half or so. And outside at 50 miles it's about a decade.

A little bit different behavior. This is Peach Bottom --

MEMBER RYAN: Jocelyn, I don't mean to pick on it, but it looks like a big difference. But the bottom number on the Y axis is zero. So that's more the magnitude away. I think that's a little unfair to show. Because if you did these on relative scale, they'd all be relatively the same.

MS. MITCHELL: Okay.

MEMBER RYAN: Fair enough?

MS. MITCHELL: Yes.

MEMBER RYAN: Okay.

MS. MITCHELL: A little bit different behavior. This is Peach Bottom unmitigated short-term station blackout. This is a later release, smaller release. As a function of time it's a smaller release. And hardly anybody lives in the EPZ at Peach Bottom so they rocket out of there very rapidly and you do see the fact that the zero to 20 miles is actually larger. If you remember the other one, it was monotonically decreasing. This is the fact that those people from 10 to 20 miles are actually relocated rather than evacuated.

This is the issue of how much is the early phase versus the late phase, or in this case the name of the subroutine is CHRONC. This is Surry unmitigated short-term station blackout with a thermally induced steam generator tube rupture. And you can see that the vast amount close to the site actually comes about because people come back and live getting the -- this is Surry, so they have the EPA Guidelines four rem and five year dose for the habitability criterion.

This is a Peach Bottom unmitigated short-term station blackout. Again, the same thing but you do see here that for the Peach Bottom more of it comes from the early phase of the accident because Pennsylvania has a smaller habitability criterion. So those folks are only getting 500 millirem in a year.

The conclusions, we've heard all of them i think before.

That safety has been increased.

We've actually lowered the core damage frequency because of plant improvements in design and operation.

If the mitigated actions are successful, they can reduce the core damage frequency.

The radiation releases occur several hours later than earlier thought, and they would be substantially smaller.

We have essentially no early fatalities, and those early fatalities are far fewer than previously calculated.

The late individual latent cancer risk values are smaller than the safety goals. You can see that using the truncation models can lower the perceived values of latent cancer fatalities.

For some sequences the latent cancer fatality predictions are heavily dependent on the return criteria, the habitability criterion using LNT.

Bypass events don't pose a higher latent cancer fatality risk because of the offset of the higher conditional risk by the lower frequency.

That's it.

CHAIRMAN SHACK: Any more questions for Jocelyn?

Thank you very much.

MS. MITCHELL: Okay.

CHAIRMAN SHACK: Jimi, it's back to you.

MR. YEROKUN: Thank you.

First, let me thank you for the time spent to go over these very complicated project.

We'll look forward to getting to getting the transcript for this meeting to go through it and pick up all various comments, questions, issues that are raised so that we can work forward towards probably prepare addressing those comments and issue.

But I just wanted to pick a little on a couple of these comments that were for today.

One of them is that there's very clear interest in certain analysis. That's kind of identical to the feedback we received from the peer reviewers.

Again, there's no question about the plans that you want. The details as to what went into the process, the approach to take, we're still working with that. And we'll communicate with your staff as to how to share that with you. You know, I think you have some desire for following events in that process. So we'll make sure we find a way to improve that gap. That's no surprise that you have certain -- so we'll take care of that.

There was a request for one of our draft documents, is the MELCOR best practices documents. That's also under development. We'll be glad to that review. I think there was some questions came up that that might be useful.

MEMBER CORRADINI: Can I clarify what I'm looking for just so I don't make you do more work than you wanted to or need to? But what I'm looking for is something that was mentioned in some of the documents, which was a contractor report, which is NUREG/CR-7008. And I don't see it in any of the stuff that was transmitted to the Committee.

MR. YEROKUN: That's correct.

MEMBER CORRADINI: Okay.

MR. YEROKUN: And I recognize that document, and we'll get you a copy of that document. It is still in draft.

MEMBER CORRADINI: Oh, okay. Because it implies that it talks about the modeling assumptions that were embedded in the MELCOR calculation we saw the results of.

MR. YEROKUN: All right.

MEMBER CORRADINI: Okay. Thank you.

MR. YEROKUN: Again, one of the things is the interest that the Committee has in the communication brochure of SOARCA. We had no original plans to run the brochure through the ACRS for reviews, comments. But I'm making a note of we'll share with you before its release to the public.

Our plan is to have the communication brochure developed to be able to communicate to the public the results of SOARCA such that when we release for public review and comment, there will be some aid to help understand this in a technical document.

Basically, the public with attached NUREG will have the communication brochure and we'll communicate with your staff again as to how to get that to you before then.

You had some questions earlier this morning about what we're doing with the peer review comments. I know we give you the draft reports and we expect the final reports eventually for the peer reviews. But in addition to those documents, we have also a collection of all the comments received from the peer reviews in the past several months on interaction for the peer reviewers. We have those comments tabulated with responses to each of the comments. Those comments, comments from the ACRS and comments when we go for public review and comment will be captured in some shape or form and ultimately the intent right now might end up being published in some document in some shape or fashion. But that will also be out of there.

So if I wasn't clear this morning as to your question, you know the peer review comments, I just wanted to be sure that was very clear to the Committee. Those detailed comments will be available in some shape or form at some point.

So I wanted to just get feedback from this meeting. I know there were a lot of technical issues that were discussed, issues with mitigated measures, how we address seismic with EP, and specifically as a surrogate for fire, flooding. So all those issues again we're flushing out from the transcript and we'll work in the next month or so and make sure we get our hands around all those comments that was from this meeting.

So just to give the ACRS some sense of the next steps for SOARCA.

In the next month or so we'll be dealing with comments from the ACRS. We'll dealing with comments from the peer reviewers, the ones we have not finished addressing yet. We also will be dealing with the feedback we received from licensees when we shared the documents with them for their fact checks. So we'll be working those in the next month or so.

At the same time, we'll be working to get the communication brochure ready for publication.

Sometime early August time frame we intend to release the draft NUREG for public review and comment. We'll put it out there for the time period of a month, maybe two months depending on what the schedule allows us. We'll put it out for public review and comment. Because of what we expect will be a short time period for that, we plan to have public meetings, multiple meetings. We plan to have one in the location of Peach Bottom and one in the Surry area, and one maybe somewhere physically in the D.C. area. So we'll have public meetings as well to try to work the document.

At the end of all this, after we -- it depends on how quickly or how well we can get our hands around all those comments from all these sources, right now I think we've planned to come back to the ACRS in October. That's a full Committee ACRS meeting. The assumption is, you know we have all these issues, comments, address them. We have a document we think is ready to come to the ACRS with. When we do that, we'll present the results --

CHAIRMAN SHACK: Will the uncertainty analysis be completed by then, or is that a separate analysis?

MR. YEROKUN: That's a separate analysis. That will not be completed by then.

Originally we had plans to do this entirely. After multiple interactions with peer reviews and trying to get our hands around what analysis to do, you know what parameters to address and what plants come up with, we examined the optional separate uncertainty analysis and moved forward with it. You know, there are pros and cons to that. So right now the schedule for getting the uncertainty analysis completed is after. It's not part of getting SOARCA completed in October.

So when we come back in October, we'll come back with the results. But also we'll come with some recommendation. Because one of the things we have to do along with giving the Commission the results of this pilot project, the Commission has asked for staff recommendations on what to do next. Do we have enough to represent the collective of plants, or should we do more plants, or should we do everything? Those questions we owe the Commission some recommendation of where do we go from here.

You know, based on the results again, we should have a good sense of what we plan to recommend to the Commission. We'll come to the ACRS in October to share that with you.

And we did get some feedback from the peer reviewers on what they think we should be doing there. And I think some of those were shared with you. And, hopefully, insights, input from ACRS we work as well, but we'll have a sense of a plan at that time. We're just going to get everybody's input and then see exactly what the results are before we tell you what results are. We have some idea now, but we want to wait until to that time to be certain as to what we want to recommend.

Currently the plan is to have final draft NUREG, a new NUREG ready for publication to the Commission in October. And the time the Commission would take to review that, to approve publication, that's up to the Commission. But our task right now is to get a document that's ready for publication by end of October to the Commission.

Now the fact that we have to deal with comments and involvement with the public, interactions with the ACRS, peer reviewers if we come up with issues that means we have problems meeting that schedule, we'll inform the Commission about that. But right now we're working on that schedule of getting it ready for publication or near ready to the Commission by end of October.

When that NUREG gets published depends will depend on the Commission at that time as well.

So that's next steps. Those are the steps we will take from here. If you want to know before on any of the topics, we'll be glad to come up. I'll be glad to through your staff, you know, communicate that to you. But just wanted to make sure you know that.

And that's that.

CHAIRMAN SHACK: Okay. Should we go around the table and see any impression and any final comments from the members.

Sam?

MEMBER ARMIJO: I just thought the summary report was very good. I thought the presentations were very informative.

I think the communication of the findings to the public are really going to be very important because it isn't easy to explain to people how this effects them, whether they live near or far from a nuclear plant. But as far as the rest of it, I think very nice work.

MEMBER ABDEL-KHALIK: Again, the presentations were very informative.

I was looking at it from a credibility standpoint. And you know after all, the whole underlying basis for doing this is that these security assessments that we have for events indicate that the radiological releases may have been significantly over estimated. But when I see decisions made in the process that tend to bias the results towards lower releases, I always ask for what is the basis for those decisions. Examples would be things like the shadow evacuation being increased from (20 percent to 30 percent.) Anything that sort of tends to force the results in the direction that you want the outcome to be takes away from the credibility of the entire study unless those decisions are firmly supported. And that would be my only caution.

Things like the probability of seismic events, the difference in the data between whatever you're using and the U.S. Geological Survey; things of that sort.

So I would just caution you in that regard.

MEMBER BLEY: I would like to thank everybody for today's presentations. I found the tone of the report and the presentations much more palatable than the last time around. I don't see quite as many claims that seemed hard to buy into.

When you get to the uncertainty analysis, I really hope, and I was glad to see Jocelyn talk about it for the offsite, I hope you do something like a PERT to really organize the thoughts that you've gathered from talking to so many people into a scheme where it's clear what was considered and what wasn't considered, and what's the basis for why you thinking you're picking up the most important pieces.

I remain less than comfortable with taking substantial credit for things failing outside of the regime where they've been designed and tested. And there are pretty good arguments here, but it's an area that seems open to challenge, and I hope that's close real well in the next things we see.

I'm glad they were here. I wish they'd come sooner.

MEMBER STETKAR: Yes. Again, I'd like to thank everyone. I think this was really helpful.

I echo Dennis' recommendation regarding the PERT-type process, you know as an input to that uncertainty analysis and extending that PERT to cover all elements of the quantification process. In other words, also the Level 1 type issues.

And I think my largest concern right at the moment is with regards to this issue of public communication of what this study is and what this study is not. And my own personal bias it would be to be very, very cautious about any type of public communication before you do that uncertainty analysis. Because there are many, many statements in the summaries that will almost certainly be taken out of context. Statements like there are no early fatalities. People will read that and not read the rest of the report, and not read the caveats. And that will certainly become an agency position that it then may be very difficult to later retract from when you start to say well we didn't really mean that there would never be any early fatalities. There might be some probability when you do the uncertainty analysis. But that would be my only sort of caveat and caution about if you go forward with the glossy brochure or however its characterized. That needs a bit of thought.

CHAIRMAN SHACK: Mike?

MEMBER RYAN: I'd extend John's comment to think out loud for a minute and say that the fatal cancer rate in a population around the plants 25/30 percent. It's a fact of life.

We're talking about incremental cancer rates that are very, very small compared to that incident rate just by being a population. So I think the idea that we're going to talk about some very small fraction of fatal cancer rate increase or related to whatever kind of accident scenario you want to look at is a very difficult and tricky thing to communicate to the public. And very often you can get twisted up in how to best explain that. So it's a big challenge to think through how to get that done and get it done well.

You know, you could have a range of answers saying we don't see any statistical increase to the rate of cancer from what's there already. That's not a bad thing to think about being true. Do we really need to come up ten to the minus four of X, Y, Z as being some number that we assign it? Well, you could argue in one way from the technical point of view we all understand what a small fraction of a number that has uncertainty what that means. It might be masked by the uncertainty, or not.

So I think I would urge that you think about a range of ways to explain cancer rates from accident incidents versus cancer rates from living in the area period, without the plant there. I think because that's really what we're talking about is those differences.

We certainly have the technical done to help us get the numbers right or the fractions right. But a communications plan I think is a very important aspect, as others have already said. But I think that needs some hard thinking to figure out how best to get that across in the public arena.

But that, and just the fact that we kick around numbers of ten millirem, and five rem, and 500 millirem. And all of those numbers are dwarfed by your lifetime medical exposure or folks like Dr. Armijo that travel across the country a couple of three times a month. He gets his ten millirem every trip.

So, you know, as practitioners we can all smile at that, but that's an immediate factor and most folks don't have a clue about any of that. So we have to do a better job of figuring out how to get all of this across. And I struggle with it myself and appreciate the struggle that you all are working very hard to study and do a better job at. As others have said, I think that's the crux of this whole effort, is that without getting that right, it has a potential of not being well received.

Thank you.

MEMBER CORRADINI: Well, I want to thank everybody also. I'm sorry I came a bit late.

I guess I have a couple of points, a lot of things were mentioned. So the one thing that I'm still not clear about is the role of the peer review you had separate from sending it to us. I look at the summary, I don't see it mentioned. It's going to be an appendix somewhere. So my question is: Is it really clear what the role is? I didn't have a chance to ask that question earlier on. Evidently people have similar sort of questions or slightly different questions. And so that's the one thing.

The second thing is you're going to provide to us the volume in terms of, I guess, best practices is the proper title for it for the modeling. I guess I'm not so clear why -- now again, this is a schedule question but since we're a little bit into process too, I'm not so clear why you're going forward with this at the time table without the uncertainty analysis. That is a big question in my mind.

And then I'll go further. If you don't have the uncertainty study, why do you want to have any communication at all about this? I would rather say if you think you've done a good set of point calculations, which I do think you've done a very good set of point calculations, let somebody else do the communication. If it's that good, I assume NEI or the DOE will run around and use it and reference it. But I don't think you are in a position now without an uncertainty study to develop a communication plan. This could backfire.

I just think about to WASH-1400 when I was in school and I remember a professor had to explain the executive summary when the main report was very good. So that's just a thought.

Other than that, I guess I looked through a lot of the detail volumes, and I just think -- I said it once, but I repeat. I think the technical content is very good. What you good comes through. I still have to dig in certain places of it, but I think what you did comes through and it's a good piece of work.

CHAIRMAN SHACK: Tom?

CONSULTANT KRESS: Well, being a bit of a johnny-come-lately, the things I'd say may have already been said in prior meetings. I agree with many of the things said today. But, you know if this has been said before, why just please excuse the fact that that I may not have known that.

I think the study ought to primarily focus on the consequences and to go easy on the risk issues, very easy on risk. They will go to complicate things and make things confusing and not going to be real risk values.

A lot of people seemed to have been concerned with the cut off value for the truncation as the sequences used. I actually think that was a good choice. And the way I would have justified that is if

I look at the frequency cut off and think about it in terms of the number of plants we have in this country and their lifetimes, this would recommend to me things that weren't ever going to happen, really. And so you're interested in consequences of things that are actually going to happen and not the real risk. I would have been tempted to justify it in that type of discretion framework.

In that same sense, you can justify not including frequencies of very large seismic events because they just don't happen often enough.

As for as a need for Level 3 as a benchmark, many of you know me as a Level 3-type guy. But in this case I don't think it's needed. And I'll tell you why; I think the work that Dr. Nourbakhsh did with the simplified approach in his white paper adequately provides such a benchmark in terms of saying what we're doing is all right in terms of consequences. So I really don't think there's a need for Level 3.

But on the other hand, I would have liked to have seen the consequences include societal effects; immediate costs, total deaths and so on. Of course, you knew that was going to come anyway, but I really think we're missing the point when we don't put that in there because that's what the general public is interested in.

I certainly liked the way they looked at the potential mitigating measures. I mean, I think that's a very interesting and very useful role. I liked that very much. I don't know every plant out there has the same mitigating case of buildings, but I think the security requirements did end up with pretty much the same.

I agree with an earlier comment by somebody that the emergency response measures ought to include looking at the effects on potential evacuation in terms of the entire bridges, roads, buildings. Does the priorities include the right evacuation and so forth. So I think that needs to be part of the uncertainty analysis.

And with respect to the uncertainty analysis, if it were me I would focus strictly on the selective accident sequences and look at phenomena and -- for my uncertainty analysis. That keeps it consistent with the actual what I think is the purpose of this. I would only not be including risk uncertainties.

I think the insights and knowledge gained by this study are pretty good and pretty interesting.

And somehow I think they ought to work their way into the regular PRAs someway. Particularly SPAR models. I'm not sure they're in there yet.

The issue of dual unit sites, that's not important. It mostly doubles whatever consequences are, and the consequences were zero so two times zero is still zero. I wouldn't worry about doing dual sites

The study itself to me reflects improvements in the source terms, in the timing, and the phenomenology. And somehow I would like to see those improvements listed somewhere. These are the things that have made improvements in this area and result in this kind of different result. And I really didn't see them outlined very well. There are varying pieces and parts, but not in real details. I would like to see that in it better.

On the dose of response, it didn't look like it made much difference. And I agree with what Mike said, it's almost a no, nevermind which one to use. So I would just stick with the linear nonthreshold because the regulatory position anyway.

But all in all, it's a very good study. And I was glad to be here. And I think they did a good job with their presentation.

CHAIRMAN SHACK: Well, I guess I echo pretty much what most of my colleagues have said.

You know, I think back what you do with a consequences study and the previous ones have really been based on Level 3 PRAs. You know, you can argue that they weren't very good Level 3 PRAs, you know there were problems with them, but that sort of gave you confidence in the completeness. And now we're coming back to a different approach where instead of getting source terms from a Level 3 PRA that we can run off and apply to some other site, now again that source term may not really apply to that reactor, but at least it's a source term that applies to some reactor as a sense of completeness for a certain reactor and you can then sort of do the consequence analysis. So I'm still back to the original ACRS position that I think we need Level 3 PRAs to do this and I'm a little concerned with how you present these results to the public without that information. On the other hand, I think that the sequences they've picked are very robust challenges to the reactor. I mean, in going back to Hossein' white paper and some of the NUREG from Brookhaven on consequences, when you look at the source terms they picked up and generated out of 1150, the leading sequences they picked look a whole lot like the sequences that they're dealing with here. I mean, these are real challenges and the fact that you can deal with them and come up with modest consequences I think certainly does give you confidence that these consequences are not as severe as they are. But I really do think you still need to look at this in an integrated risk sense. And I'm going to be curious just to see how you present this to the public. It's a marvelous technical achievement. I think it's important, great insights. But still, you know, someone who still finds the Sandia Siting Study a credible source is probably not going to be convinced by your argument.

Any other comments? Jimi?

MR. YEROKUN: Again, I mean we'll look forward to the transcript. I mean, there's so much very usefully, things we really will take time to scrub out so we can be sure to factor all that the Commission provided and we'll deal with those things according.

And there's area I forget to mention at the beginning was when I said the membership was achieved was all those offices, we also have Office of Public Affairs on the team. This aspect of how do we communicate from day one with you we had an issue there. And we still have it, and we're still dealing with it. And I appreciate your comments on how we communicate with the public was something that was not lost to us, not even to the Commission. The communication issue, we realize that.

That was an oversight, but it's important. Again, thank you again.

MEMBER BLEY: Bill, I feel moved to add one last thing, although I agree multi-unit sites from strictly the consequence point of view are at worst at doubling if it's two. From the mitigative strategy point of view, it might well be that it's a nothing into a big something. So I think it's important to look at them.

CHAIRMAN SHACK: Okay. IF there are no further comments, we'll adjourn for the day.

(Whereupon, at 4:40 p.m. the meeting was adjourned.)